# Something borrowed, something new: acquiring unexploited sets of feature contrasts

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## Abstract

The present paper addresses the question of whether Second Language (L2) segmental acquisition can be successful if the learner's Native Language (L1) does not implement an entire 'tier' of phonetic/articulatory information exploited in the L2. The results from a re-framed analysis of perceptual discrimination studies with speakers of three Indigenous Australian languages (Wubuy; Kriol; Light Warlpiri) indicate that this appears possible only when L2 learners can leverage phonetic aspects of their consonantal inventories to acquire some new featural contrasts, and that distributional information can act as a key to at least some new contrastive features. The results also indicate that voicing, especially in fricatives, appears particularly challenging.

**Index Terms**: L2 perception, voicing, frication, feature theory, Perceptual Assimilation Model.

## 1. Learning something truly new

The present paper addresses the question of whether Second Language (L2) segmental acquisition can be successful if a learner's Native Language (L1) does not implement an entire 'tier' of phonetic/articulatory information exploited in the L2. The acquisition of novel L2 *phonemes*, and the acquisition of new *phonetic realisations* of shared L1-L2 phonemes has received ample attention in the psycholinguistic and applied linguistics literature. Typically, however, the target L2 phonemes and/or novel L2 phonetic realisations of interest exploit linguistic variables already in use in the learners' L1. As a consequence, many studies have focused on understanding the degree to which perceptual, acoustic, and articulatory overlaps and differences between L1 and L2 phoneme inventories and their phonetic realisations hinder or help L2 segmental acquisition; e.g. [1][2][3]. Such studies contribute to our understanding of those aspects of L2 acquisition that pertain to the *re-tuning* of the perceptual systems to already systematically controlled and manipulated linguistic variables. It does not, however, directly address questions of learnability of truly new variables for contrast maintenance, a question that is important in terms of applied linguistics, but also in terms of the fundamental question of what is learnable. In other words, if a novel linguistic tier is encountered for the first time in an L2, can it be acquired? And to what extent will learners be able to attune to speech information that they have not previously had use for? This question indeed goes to the heart of to what extent phonological features are really 'universal' in some sense, as proposed in [4].

The present paper addresses these questions by reviewing and reconsidering the results from a series of speech perception studies with what we argue are genuinely *novel* phonemic distinctions, relying on *novel* tiers of linguistic information (voicing; frication) with speakers of the traditional Australian language Wubuy, and the Australian contact varieties (Roper) Kriol and Light Warlpiri, in long-term and continuing language contact situations in the Northern Territory of Australia. The combined results indicate that speakers of these languages can leverage phonetic aspects of their consonantal inventories to acquire some new featural contrasts, but not all of them.

## 2. The Perceptual Assimilation Model, Articulatory Organs, and the acquisition of novel phonological contrasts

One of the leading theories of L1 segmental acquisition, the Perceptual Assimilation Model (PAM; [1][2]), and its extension to L2 acquisition PAM-L2 [3] has its basis in Direct Realism [5], positing that the objects of speech perception are articulatory gestures, and that acoustics are important only because they carry information about the articulatory gestures of speech. This information is complemented by information about the same gestures obtained through other modalities (eg., vision, touch). PAM posits that language learning is possible throughout the lifespan but shaped by linguistic experience.

PAM further relies on the principles of Articulatory Phonology [6][7][8][9] which posits that the lips, tongue tip, tongue body, tongue root, velum, and larynx, and the glottis constitute distinct and potentially independent articulatory organs, as each of these can be used to create an articulatory constriction without inducing a constriction in another. The related Articulatory Organ Hypothesis (AOH; [10][11]) predicts that consonants produced by different articulators should be discriminated better than consonants produced by the same articulator, providing a pre-experience tendency in segmental speech perception. It is not clear to which degree the AOH predicts that (innate?) knowledge of articulatory organs provide only an initial set of perceptual biases scaffolding language learning or whether these biases are lifelong. PAM has focused less on what might constitute innate biases in speech perception and more on the role of linguistic experience in the first year of life, as infants develop from universal to language specific listeners. According to PAM, linguistic experience allows infants begin to recognise that particular constellations of articulatory gestures contrast with other constellations, and from these constellation, they tune into the higher-order invariants that characterise their linguistic environment [12].

Taken together, however, the AOH and PAM raise questions of the learnability of L2 phonemes, and L2 phonological contrasts, that differ from the L1 in terms of the organs and articulatory gestures used—and importantly, in the phonetic *tiers*, *features* or (combinations of) *organs* that are used for contrast maintenance. Indeed, it may be possible to argue that: **(1)** spoken language is (biologically) special; **(2)** the articulatory organs have special status as an initial bootstrapping mechanism, at least in very early infancy; **(3)** linguistic experience allows for identification of language-specific use of the articulatory organs (and the potential 'neglect' of some organs as important-in-speech; and, **(4)** language acquisition may be a 'use it or lose it'-scenario with respect to the continued importance of each articulatory organ.

In other words, it is possible to hypothesise that organs—and importantly the (phonetic) tiers of information that they produce for the purposes of contrast maintenance—must have a role to play in the L1, if they are to maintain their initial, pre-experience, linguistic relevance. If a tier of information is not in use in the L1, L2 acquisition would presumably be difficult, as learners would have to identify information which is non-speech or irrelevant to speech in the L1 as important to contrast maintenance in the L2. This is different, in essence, to other challenges in L2 acquisition pertaining to resetting of, for instance, VOT boundaries, or carving a given corner of the vowel space into a different set of L2 vowels. These latter examples may constitute 'retuning' of existing speech perception/production skills, while the acquisition of new tiers of linguistic information demands the expansion of the perceptual space in relation to what kinds of major articulatory mechanisms can constitute speech at all.

Few studies have examined cross-language or L2 perception—by adults or infants—of non-native contrasts that can be argued to be truly new in the sense that they rely on the perception of new 'tier' of information. Studies of non-native perception of click consonants may provide one of the few exceptions: click consonant articulations are among the typologically rare ingressive phonemes. Clicks, however, do not present themselves as particularly difficult to discriminate for non-native listeners: Zulu clicks are discriminated with relative ease by adult speakers of English, and amplitude-modified Zulu clicks are discriminated as accurately as native English /ba/ versus /da/ by infants [13]. Clicks are however often perceived as non-speech mouth sounds, and it is possible that crosslinguistic discrimination success does not reflect linguistic processing (alone).

## 3. Discrimination of L2 stop voicing and fricatives by speakers of three Australian Indigenous languages

Traditional (i.e., non-contact) Australian Indigenous languages are quite homogenous in their phonological inventories [15]. They typically have 4-6 Places of Articulation (POAs) in stops, the same number in nasals, and several laterals, with the maximal inventories including bilabial, lamino-dental, apico-alveolar, apico-retroflex, lamino-palatal and dorso-velar POAs (see Table 1). Many Australian Indigenous languages also have multiple rhotics, but they rarely have voicing distinctions in stops (or anywhere else), though some have a contrast in stops for duration (sometimes described as fortis-lenis) with a duration ratio of approximately 1:2.5 [14]. Most Indigenous Australian languages have a complete absence of fricatives [15]. These inventories thus differ from that of Australian English in a number of critical ways: English employs a voicing-based distinction not just in stop consonants, but also in affricates and fricatives. To conserve space, we will burden the reader with the assumption that they are well-enough familiar with the phoneme inventory of English and abstain from including a table.

Table 1. *Maximal consonant inventory for Indigenous Australian languages.*

| | Lab. | Dent. | Alv. | Retrofllex | Palatal | Velar |
|---|---|---|---|---|---|---|
| Stop | p | t̪ | t | ʈ | c | k |
| Nasal | m | n̪ | n | ɳ | ɲ | ŋ |
| Lateral | | l̪ | l | ɭ | ʎ | |
| Trill/ tap | | | ɾ | | | |
| Glide | w | | | ɻ | j | |

Acoustically, the stop consonants of Indigenous Australian languages are often voiceless, including intervocalically, and (linguists') perceptions of the voicing characteristics of stops vary by language and context (and by linguist). These perceptions are reflected in the orthographies of Australian languages (often produced by Europeans).

Intervocalic stops are often characterised by extraordinarily long Voice Termination Times (VTT), the time from offset of the previous (nasal or vowel) segment until cessation of vocal fold vibration during the constriction phase of the consonant [16], particularly the lenis series. This suggests that speakers are in no rush to turn off vocal fold vibration as they transition into the stop, and, in fact, there is no real reason to do so, given that there is no voicing distinction to maintain in stop consonants. Long VTTs further suggest that the timing of vocal fold vibration is not intentionally controlled (stopped or extended). In languages with a long/short or fortis/lenis contrast, the long VTTs can give the impression of short/lenis stops being voiced while the long/fortis stops can be perceived as voiceless as physiological/articulatory constraints often result in voicing 'running out' in these long stops, particularly in velars. [16] gives an average duration of 22 ms for VTT in the fortis series in Bininj Gun-wok. Extended, continuous contact between speakers of Indigenous Australian languages (traditional as well as contact varieties) with English/English-based varieties provides a rare opportunity to study acquisition of entirely novel phonetic variables: stop voicing distinctions and a new Manner of Articulation (MOA) in fricatives that contrast not just in POA but also in voicing.

We present here summaries, re-framing, and re-interpretation of three studies of stop and fricative perception with speakers of Indigenous Australian languages: the English-lexified creole Roper Kriol; the mixed language Light Warlpiri, and the traditional Indigenous Australian language Wubuy. The studies have been published in [17] and [18] but the combined results and comparisons provide an opportunity to assess the outcomes on a more general level. Theoretically, this is important because the set of studies provides a rare departure from those which focus on the retuning of boundary placements and target values on shared already-exploited variables, as discussed in the introduction. The studies discussed here also depart from those which focus on what we might conceive of as 're-segmentation' of a particular variable, increasing or decreasing the number of boundaries on a shared and continuous variable in a continuous space, e.g, moving from two-to-three or three-to-two VOT boundaries, or increasing or decreasing the number of vowels in any given part of the vowel space. Similarly, we are not concerned with defining an 'end

state' of L2 acquisition: the contact environment is lifelong and changing over time and speaker generations.

The three studies reported on jointly here made use of a cross-speaker XAB discrimination paradigm (see [17], [18] for details). The stimulus materials were produced by three female Australian English speakers, and consisted of a number of stop contrasts, fricative contrasts and a stop-fricative contrast in a combination of syllable-initial and intervocalic position (See Table 2). In addition to testing discrimination of English stop contrasts /p b/ and /k g/ in intervocalic position, we also tested discrimination of Kriol-like stop contrasts in which the voiceless stop is characterised not only by a longer VOT, but also by a longer constriction duration (CD), consistent with the constriction duration found in the fortis/long stops in those of the Kriol substrate languages that have a fortis/lenis contrast. Discrimination of each target contrast was tested in blocked discriminations tasks consisting of 72 individual trials, with an ISI of 500 ms and an ITI 3000 ms. Missed trials were repeated.

The participants in the three studies were 11 speakers of Wubuy (age range 25-65), all from Numbulwar community in East Arnhem Land; 13 Light Warlpiri speakers (age range 16-33), all from Lajamanu Community; and 11 speakers of Kriol (age range (18-50), all from Numbulwar community also. All speakers were lifelong L2 learners/users of Australian English, the language of instruction in schools and some workplaces in their communities, as well as the language used in communication with members of the broader Australian community, including non-Indigenous people in their local communities. All participants had some English literacy, and some also had some literacy in their native languages. The Wubuy and Light Warlpiri speakers typically had some competence in Kriol, and most had at least some competence in one or more other Indigenous languages (particularly Warlpiri, in the case of the Light Warlpiri speakers).

## 4. Is acquisition happening?

Table 2 summarises the results from the studies introduced above.

Table 2. *Contrasts and results from Wubuy; Kriol; Light Warlpiri (LW) participants. /CV/ = initial; /CVC/ = intervocalic. * indicates no data from Wubuy and Kriol. % values = accuracy where performance was significantly above chance, but below ceiling.*

| | /CV/ | Result | /VCV/ | Result |
|---|---|---|---|---|
| **Practice** | /p k/ | **ALL** | | |
| **Stop-Stop** | /p b/ | LW ~70% | /p b/ | LW ~65% |
| | | | /p: b/ | LW + Kriol |
| | /k g/ | **NONE** | /k g/* | LW ~65% |
| | | | /k: g/* | LW |
| **Stop-Fricative** | /b v/ | **ALL** | | |
| **Fricative-Fricative** | /s z/ | **NONE** | | |
| | /s ʃ/ | **ALL** | | |

These results allow us to examine the acquisition success of truly new information tiers used for contrast maintenance in an L2 in two different domains: **(1)** acquisition of a new MOA in the case of frication, and **(2)** acquisition of voicing-based distinctions (in stops). It further allows us to discuss the difficulties that may arise from having to acquire not just one of the two new tiers (frication *and* voicing) for successful L2 acquisition, but in the case of fricative voicing contrasts, such as English /s z/, two novel tiers simultaneously.

### 4.1. Acquisition of a new MOA (frication)

The results relevant to the question of acquisition of a new MOA—frication—are consistent across the three learner groups. Speakers of the traditional language Wubuy as well as the two contact varieties Light Warlpiri and Kriol all successfully discriminate the POA-based fricative-fricative contrast /s ʃ/, and the MOA fricative-stop contrast /b v/, both in word-initial position. In the case of Kriol and Light Warlpiri speakers, performance likely reflect L1-like perception of fricatives (which are found in some Kriol/Light Warlpiri words of English origin). In the case of the Wubuy speakers, performance must indicate successful L2 learning, as Wubuy, like other Indigenous Australian languages, has no fricatives in its phonological inventory. None of the three participant groups were able to discriminate the voicing-based distinction between English /s z/ in word-initial position, a noteworthy failure of acquisition considering the very extended language contact situation in Australia, and the fact that, for the Kriol and Light Warlpiri speakers, this contact has given rise to new languages with (voiceless) fricative phonemes in the phonological inventories. We return to the /s z/ contrast in Section 4.2 below.

### 4.2. Acquisition of voicing distinctions in stop consonants

The results relevant to the question of acquisition of voicing as a new tier of contrastive information are less straightforward and consistent than the results for acquisition of frication as a MOA. Firstly, the studies indicate that speakers of Wubuy remain unable to discriminate voiced versus voiceless stops in any context, despite extended (lifelong) L2 English acquisition and use. This is perhaps surprising given the time-depth and quantity of exposure that the speakers have had to English. Kriol and Light Warlpiri speakers can discriminate voicing-based stop distinctions in bilabial stops, but they are not able to discriminate voicing-based stop contrasts at the velar POA. Kriol and Light Warlpiri speakers are (unsurprisingly) much better at discriminating English VOT-based stop contrasts when the voiceless stop is 'enhanced' to have a constriction duration that is consistent with a 'long stop' in Kriol and in Light Warlpiri, and in those traditional Indigenous Australian languages that have a fortis/lenis contrast in stops. As Wubuy does not implement duration-based contrasts in stops, this acoustic enhancement does not result in improved performance. As indicated in Section 4.1, none of the participant groups can discriminate the voicing-based fricative contrast /s z/.

### 4.3. Piggybacks: Ways into the inventory?

The group differences in discrimination success for fricative- and voicing-based contrasts, and the particular difficulty in discriminating voicing in fricatives, even for speakers who are lifelong L2 users, demand explanation. We speculate that, in cases where L1 perceptual attunement is particularly unhelpful because the crucial tier(s) of contrastive information falls outside of the 'language space', it may be the case that non-native contrasts are acquired by means of 'linguistic piggybacks'. These speculations rest on the assumptions that the human speech perception apparatus remains available across the lifespan and engages with any language acquisition task it encounters, using to its advantage (and sometimes disadvantage) skills and strategies developed in response to previous language experience. Where this language

experience comes up short in terms of solving a new language puzzle, we further assume that a learner will recruit and exploit any information, skill or strategy that offers itself as a key to identifying new language patterns (articulatory, or acoustic). In the following sections, we investigate the potential of 'linguistic piggybacks' to account for differences and similarities in the discrimination of voicing and fricative-based contrasts in the three studies included here.

#### *4.3.1. Fricatives*

The relative success in acquiring fricative MOA by the three participant groups may reflect at least two contributing factors, one perhaps classifiable as a piggyback (pertaining to the acquisition of frication as a MOA), and one as a more straightforward case of transfer from the L1 to the L2 (pertaining to the acquisition of different POAs in fricatives).

In terms of the acquisition of frication as a MOA, it is possible that non-speech use of /s/ (*sa!* is used in interjections to shoo dogs away in for instance Wubuy) provides sufficient experience to provide a piggyback for frication as a MOA. We may think of this as an analogous situation to what has been reported for the perception of Zulu click consonants by English speakers: clicks are often reported to be perceived as non-speech 'mouth sounds', used in relation to animals, yet English-acquiring infants and English-speaking adults [13] successfully discriminate Zulu click consonants. It is also possible that the three participant groups have other phonetic experiences with fricatives that may support the acquisition/discrimination of fricatives. In many Australian languages, stop consonants can be realized as approximants in certain contexts, resulting in phonetic fricatives at least some of the time [19]. Indeed, phonetic fricatives occurring in predictable environments provide some experience with fricatives as allophones—and may support the view that /s/ perhaps is not considered 'non speech' in the same manner as Zulu clicks, though [s] is unlikely to be one of the allophones of any of the native stops. Secondly, with respect to the acquisition of *place* distinctions in fricatives, we hypothesise that learners make good use of their L1 POA inventory, which may involve, as outlined in Section 3.1, up to six distinct POAs, including alveolar and palatal POAs. This means that while frication as a MOA may well be novel, the use of POA distinctions, once the manner is acquired, is a matter of little difficulty.

Existing research may shed additional light on the question of whether fricative POA contrasts are hard to acquire once the MOA has been noticed/acquired by a learner. For example, [12] found that English-learning 6- and 11-month-olds discriminate both non-native voiceless fricative POA contrasts (from non-native Nuu-Chah-Nulth and native English) with one within-organ and one between-organ contrast from each language. This result, though dealing with infants, suggests that non-native POA contrasts (or as the authors frame it, articulatory-organ differences) do not pose difficulties for infants. These results are somewhat parallel to our observations here, and they suggest that perception or acquisition of novel POA contrasts is scaffolded by existing linguistic experience (i.e. POA contrasts are implemented in consonant series with other MOAs) and perhaps also articulatory or other biases such as those proposed by AOH, or by models proposing Natural Referent Consonants [20]. In either case, it would appear that novel POA contrasts in a novel MOA (here, frication) pose little challenge to listeners: This is a tier of information that they have already mastered.

#### *4.3.2. Voicing*

The acquisition of voicing distinctions in stops and fricatives is a tale of some success but also of persistent difficulty for the participants in the studies reviewed here, and we again invoke the notion of 'linguistic piggybacks' in our account of the differences observed. Speakers of Wubuy, who do not implement an L1 voicing or duration contrast in stops, appear to fail to attend to VOT cues to contrast in both bilabial and velar stops. This is consistent with a 'use it or lose it'-principle, or at least with a need for extraordinary quality/quantity of L2 input to facilitate acquisition, beyond the lifelong exposure of the participants here. It would appear that these speakers are without L1 experience that allows them to 'unlock' voicing as a means to contrast maintenance: input from just a single series of stops does not provide necessary systematic phonetic variation for learners to use as a piggyback to noticing voicing as a potential means of contrast.

Speakers of the two contact varieties, Kriol and Light Warlpiri, each of which has stop duration contrasts (via substrate language influence) fare somewhat better, in particular with stop voicing contrasts with Kriol-like constriction durations. Speakers of Light Warlpiri additionally have some success with voicing only-contrasts. We suggest that L1 experience with long/short or fortis/lenis stops may provide the necessary piggyback for (at least partial) acquisition of contrastive voicing, as differences in proportion of VTT in long versus short stops may be systematic enough to feed a perceptual match with voiced versus voiceless English-derived stops. It is further the case that lenis stops have approximated allophones in languages with a duration contrast, but not the fortis stops [16]. Partial success aside, it remains, however, the case that 100+ years of continued language contact has not resulted in a 'full system' of contrast at all stop POAs. Finally, we speculate that velars may be difficult because they tend to be long, and the difference in proportion of voicing in long-short consonants may be less apparent.

## 5. Conclusions

The present paper discussed the question of whether an L2 learner can acquire an entire 'tier' of L2 contrasts that is not implemented in any form in their L1 language (L1). The studies reviewed suggest that the answer is 'Maybe': success may depend on the feature in question and a learner's linguistic experience. Fricative acquisition appears to be easier than acquisition of voicing, at least for the Australian sample here. The studies suggest that the strategy to success is using whatever systematic distributional information is available in the existing linguistic experience. This may be entirely coincidental (e.g., VTT) to the target tier, and the distributional information may not be sufficient (e.g., failure to acquire voicing in velars, fricatives). L2 learning is not always successful even when the learner is not directly constrained by conflict between the L1 and L2 phonological systems on shared tiers. It is possible that different organs/features/tiers may have different saliency to learners, related to biases in speech perception/production/processing, and in the extreme interpretation, this means that if you don't use it, you may lose it. One consequence of our findings is that some foundational features such as [±voice] may be lacking in languages such as those discussed here, providing evidence for an 'emergent' view of phonological features such as that espoused by [22].

## 6. Acknowledgements

We thank the participants, and the funding agencies: the Australian Research Council (DP170104457), the US National Science Foundation (#1348013), and the Australian National University (ANU) Futures Scheme grants.

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