# Loanword adaptation and the evaluation of similarity*

Jonathon Herd
University of Toronto

This paper presents a phonological analysis of loanword adaptation of English loanwords into several Polynesian languages, following and extending a model of phonological structure developed by Clements 2001. This analysis bears on a number of theoretical issues. I argue that the loanword facts presented support the conclusions of Hyman 1970, Paradis & La Charité 1997, and Jacobs & Gussenhoven 2000, who contend that the evaluation of input-output similarity may be influenced by phonological structure of the host language. This draws against several current efforts that reduce the notion of similarity to a purely phonetic-perceptual metric (Steriade 2001, Kenstowicz 2001). I show that marrying Clements' universal feature accessibility hierarchy with the system of contrastive underspecification developed by Dresher & Zhang 2000 and Dresher 2001 restricts the range of feature hierarchies that can be present cross-linguistically. Consequently, basing the evaluation of phonological similarity upon these feature hierarchies also sets limits on the range of nativization strategies we predict can appear cross-linguistically. This model of adaptation is therefore able to be both predictive and explanatory. I explore these generalisations, and further show that they are largely upheld in the data presented. I argue that Clements' accessibility model must be modified in the following ways: Firstly, following Avery & Rice 1989, Ghini 2001, redundant features may be present underlyingly in certain defined instances (implicational activation). Secondly, the accessibility of certain features in the contrastive system is conditioned by prior activation of others (contingent accessibility).

## 1 Introduction

When confronted by non-native segments or sequences in a loanword, the L1 speaker may either import the ill-formed segment without modification, thereby enriching the host phonemic inventory, or modify it in such a way that native phonotactic or segmental constraints are satisfied. This latter process is often assumed to involve a

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choice regarding the relative or absolute 'similarity' of the segments involved, such that a non-native segment is realized as a host segment with which it is 'closest' in some defined sense.[1]

This paper investigates the notion of phonological similarity, and evaluates several models of adaptation with regards to their adequacy in explaining two conflicting observations; the first is that cross-linguistically there exists pervasive regularities with regards to nativization strategies invoked to repair the same well-formedness violations. An example of this, noted by Steriade 2001, is the repair of voiced plosives as their voiceless counterparts in instances where a voiced plosive would cause a phonotactic or segmental violation. The overwhelming preference for devoicing as a repair for illicit voiced stops cross-linguistically is presented by Steriade as a problem for OT-type frameworks, which allow phonotactic and correspondence constraints to interact freely, hence predicting that a range of repairs should be possible, including nasalisation (e.g., *[b] → /m/), lenition (*[b] → /w/), or spirantization (*[b] → /v/). Steriade argues that this problem of 'Too-many-solutions' mitigates against free ranking, and suggests that possible repairs need to be constrained by an external mechanism that informs speakers' judgements about what sounds are relatively more or less similar.[2] The same cross-linguistic regularities can be found in loanword adaptation, suggesting that models of adaptation also need to ensure against overgenerating or overpredicting non-attested nativization strategies.

The second observation is that, despite certain regularities, other loanword violations *are* in fact subject to a limited degree of cross-linguistic variation. An example noted by Hyman 1970 concerns the adaptation of the English voiceless dental fricative [θ] as /s/ in European French, but /t/ in Quebecois and Serbo-Croatian, despite both /s/ and /t/ being available to each of the host languages. An explanatory model of similarity must therefore be flexible enough to allow for – and if possible, predict - some cross-linguistic variation in judgement of similarity. I refer to this as the problem of Persistence-of-the-Subjective.

These conflicting points are illustrated in this paper via a study of loanwords from English into several Polynesian languages, including New Zealand Māori, Cook Islands Māori, Niuean, Tongan, Tahitian and Hawaiian. Loanword data gathered from these languages reinforce the observations made above regarding the need to explain certain consistencies in similarity evaluation as well as capture (and predict) instances of systematic variation.

The following sections explore the adequacy of several loanword models proposed in the literature for predicting and explaining patterns of nativization found throughout Polynesian, and argue that in many of these models evaluation of 'best-candidate' or 'closest match' needs to make crucial reference to underlying phonological (feature) structure. I will then show that marrying an adaptation model such as the TCRS (Theory of Constraints and Repair Strategies – Paradis 1988) with the economy-based phonological model of Clements 2001, in which contrastive feature specification is

[1] Additionally, the segment may be realised as zero in positions of reduced saliency. See Steriade 2000 for discussion. There is evidence from the languages studied here that syntagmatic context does play a role in determining whether a non-native segment is adapted or deleted – for example, [s] in pre- or post-consonantal position is often realised as zero. However, my focus here is on instances where the nativization procedure has resulted in the ill-formed loanword segment being replaced with a member of the host inventory.

[2] In Steriade's framework, similarity is a perceptual metric measured in terms of relative confusability, such that pairs of sounds that are more confusable than other pairs are considered more similar.

constrained by a universal hierarchy of feature accessibility, captures many of the universal and language-specific patterns of loanword adaptation found in the Polynesian data. In this model input is matched against the underlying feature hierarchy of the host, with repairs targeting terminal features. Since feature hierarchies are established on a language-specific basis, variation in adaptation is predicted. However, the range of *possible* hierarchies is circumscribed by a universal feature 'accessibility' hierarchy, which in turn restricts the possible variation and allows for some universal predictions regarding similarity between segments. In this model, underlying feature organization is viewed as a prism through which universal phonetic and perceptual cues are distorted and given a language-specific interpretation.

While I show that Clements' model makes many correct predictions with regards to cross-Polynesian adaptation, I argue that the following modifications are required – first, the notion of 'contingent accessibility' (the accessibility of certain features being dependant upon prior specification of others) employed by Clements needs to be extended to more features than suggested in his analysis, particularly within the laryngeal system; and second, that redundant features are present – or 'active' - at the lexical level under certain conditions as free riders via 'implicational accessibility'. This follows Ghini's 2001 analysis of vowel contrasts in Miogliola, in which he proposes that certain marked features (e.g. [labial] amongst non-back vowels) require prior specification for redundant place of articulation features (in this case, [coronal]). I claim that [coronal] may also be specified in the consonantal system under certain conditions, despite its status as the universally (contrastively) unmarked place of articulation (Avery & Rice 1989, papers in Paradis & Prunet 1991), with the result that non-contrastive features may play a limited role in the nativization process.

This paper is organized as follows: Section 2 presents a brief introduction to the Polynesian languages whose adaptation patterns form the basis of this study. Section 3 introduces a selection of loanword data from these languages, and uses this data to highlight some of the crucial problems any model of loanword adaptation must resolve. A wide range of approaches and frameworks is then surveyed and evaluated with regards to their adequacy in dealing with these problems, and outstanding issues are delineated. Section 4 outlines the loanword model that I will adopt (Clements 2001), while Section 5 tests the adequacy of this model by looking at the various Polynesian loanword patterns in greater depth. Several revisions to Clements' model are argued to be required. Section 6 is a summary and conclusion, and discusses both implications for the revised model, as well as outlining outstanding questions and problems for future research.

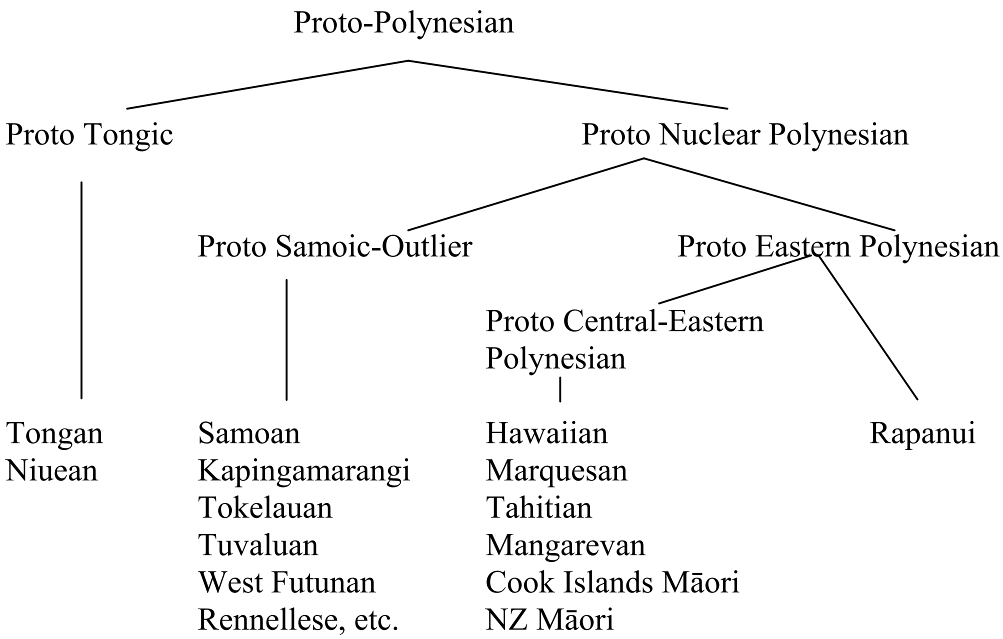
## 2 The Data

The data analysed in this paper come from English loanwords borrowed into several members of the Polynesian language family. These languages are set out and described below.

### 2.1 The Languages

Polynesian is a subgroup of the Oceanic family of languages (Lynch 1998), and can be subdivided into three main groups: Tongic, of which Tongan and Niuean are the only members; Samoic-Outlier, consisting (among others) of Samoan, East Futunan, Kapingamarangi, Tokelauan and Tuvaluan; and Eastern Polynesian (EP). EP can be further divided into Central-Eastern Polynesian, which includes Hawaiian, Marquesan, Tahitian, Cook Island Māori and NZ Māori, and a branch consisting solely of Rapanui.[3] This organization is shown in (1):

(1) The Polynesian Subgroup (Lynch 1998)




The languages considered in this paper are listed in (2):

(2) Tongic: Tongan, Niuean
Central-Eastern: Hawaiian, Tahitian, Cook Islands Māori, NZ Māori

| | | |
|---|---|---|
| (2) | Tongic: | Tongan |
| | | Niuean |
| | Central-Eastern: | Hawaiian |
| | | Tahitian |
| | | Cook Islands Māori |
| | | NZ Māori |

These languages are characterised by severely impoverished consonantal systems that contain little or no voicing contrast amongst obstruents, few fricatives, and a dearth of non-nasal sonorants. These traits have also been ascribed to Proto-Polynesian (PPN), as reconstructed by Krupa 1982, from which the languages in (2) are all derived:[4]

(3) Proto-Polynesian (Krupa 1982)

| | | | | |
|---|---|---|---|---|
| Plosives | p | t | k | ʔ |
| Fricatives | f | s | | h |
| Nasals | m | n | ŋ | |
| Approximants | w | l r | | |

[3] For other slightly different classifications, see Marck 2000

[4] I will use /r/ to denote what is phonetically variously an alveolar approximant, alveolar tap, or alveolar flap. /t/ may be realised in some of the above languages as a dental [t̪] or alveolar [t]. The labial approximant /w/, voiced fricative /v/ and voiceless fricative / f/ that developed in some of the daughter languages are subject to particular variation across Polynesian languages, occurring variably with bilabial or labiodental articulations.

Reflexes of this inventory are found throughout Polynesian, with deviation from the reconstructed proto-language limited in the most part to a set of recurrent sound changes. These changes chiefly affect the glottal stop, one or more of the fricatives (most commonly /h/ or /s/), one of the liquids, the bilabial approximant and the velar nasal. Primary sound changes have been reduction of a segment to zero (segmental loss), shift in place/manner of articulation (without loss of contrast) or coalescence with another segment (with a corresponding loss of contrast). The result of these sound changes is a set of daughter inventories that differ by a limited set of phones from PPN. The table in (4) catalogues the impact of (diachronic) sound change on the inventories of each language, listed in terms of their correspondences to PPN (Gaps indicate that the segment has been lost):[5,6]

(4) Reflexes of PPN consonants (Krupa 1982**:** 18-19)

| Proto-Polynesian | **p** | **t** | **k** | **ʔ** | **f** | **w** | **s** | **h** | **m** | **n** | **ŋ** | **l** | **r** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Tongan | p | t | k | ʔ | f | v | h | h | m | n | ŋ | l | |
| Niuean | p | t | k | | f | v | h | h | m | n | ŋ | l | |
| Hawaiian | p | k | ʔ | | h/w | w | h | | m | n | n | l | l |
| Tahitian | p | t | ʔ | | f/h/v | v | h | | m | n | ʔ | r | r |
| Cook Islands Māori | p | t | k | | ʔ/v | v | ʔ | | m | n | ŋ | r | r |
| NZ Māori | p | t | k | | f/h/w | w | h | | m | n | ŋ | r | r |

Contact with European languages, particularly English, during the past two centuries has led to lexical integration of new terms and concepts into Polynesian languages on a massive scale.[7] Consider the English consonantal inventory in (5):

(5) English consonantal inventory

| | | | | |
|---|---|---|---|---|
| Plosives | p<br>b | t<br>d | k<br>g | |
| Fricatives | f θ<br>v ð | s ʃ<br>z ʒ | | h |
| Affricates | | tʃ<br>dʒ | | |
| Nasals | m | n | ŋ | |
| Approximants | w | l ɹ | j | |

The relatively small size of Polynesian consonantal inventories, compared with those of donor languages such as English and French, means that Polynesian speakers were

[5] Table (4) does not include segments that have been independently reintroduced via language contact (e.g. /s/ in Tongan and Niuean).

[6] The variation in phonemic correspondences to proto-Polynesian *f is striking. This diffusion may reflect dialectal variations in diachronic sound changes, although Krupa is not clear on this point.

[7] Additionally, of course, many Polynesian vocabulary items have also been incorporated into the respective contact languages.

frequently confronted with loanword input that contained segments for which no phonemic equivalent could be substituted. This has resulted in various repair strategies, for which uniform trends can for the most part be assessed. The following sections will elaborate on these patterns, and will evaluate the adequacy of previous loanword models in capturing the range of adaptation strategies encountered.

## 2.2 The Data

The loanword data presented in the following sections is taken from a variety of published sources, including grammars, dictionaries and papers. The total sample of tokens for each language is given in (6), and is broken down into loanword sources. As this chart shows, the majority of loanwords are from English, reflecting the historical influence of English-speaking settlers in Polynesia.[8] The high proportion of French loanwords into Tahitian (relative to French loanwords in the other languages) likewise signals the heavy influence of French-speaking settlers in Tahiti:

(6) Loanword Sample

| **Language** | **source: English** | **source: French** | **source: other** | **total # of tokens** |
|---|---|---|---|---|
| Tongan | 476 | 0 | 1 | 477 |
| Niuean | 285 | 0 | 0 | 285 |
| Hawaiian | 152 | 0 | 0 | 152 |
| Tahitian | 158 | 108 | 13 | 279 |
| Cook Islands Māori | 303 | 3 | 0 | 306 |
| NZ Māori | 480 | 3 | 0 | 483 |
| TOTAL | 1854 | 114 | 14 | 1982 |

# 3 Literature Review

This section prefaces my analysis of Polynesian loanword adaptation by offering a general survey of the loanword literature. My point in doing so is to highlight several important questions raised by selected Polynesian loanword data that any loanword model must take into account, most notably the problems of Too-many-solutions and Persistence-of-the-Subjective, and to show how these data lead me to adopt the model of Clements 2001.

## 3.1 What is the input?

A good place to begin when considering how to develop a model for borrowing might be to ask 'what is being borrowed?' Put another way, 'what is the input to the loanword model?' Two views are prevalent in the literature.

The first, that loanword input is a fully-specified phonological string, is proposed by Paradis 1988, Paradis & Prunet 2000, and Jacobs & Gussenhoven 2000 (henceforth

[8] English loanwords have been donated primarily from non-rhotic dialects such as NZ, Australian and the various British English dialects. In this paper I am pointedly ignoring the possibility that some of the English loanwords found in certain Polynesian languages may have in fact been imported from sister Polynesian languages, rather than directly from English. This is done in part as a simplifying measure, but also because any attempt to segregate loans taken directly from English from loans borrowed through other host languages requires more evidence than I currently possess.

J&G). Their reasons for doing so vary, however. For Paradis and Paradis & Prunet, adaptation is crucially carried out by bilinguals, who therefore are familiar with the phonological representations of both L1 and L2. For J&G, input is assigned L1 phonological representation via a 'universal phonological vocabulary' (p.198), and subsequently is matched against the various constraint rankings in the host.

The more common view, however, is that the input is a phonetic string, devoid of any phonological structure (Hyman 1970, Silverman 1992, Yip 1993, Steriade 2001, Kenstowicz 2003). Several pieces of evidence from Polynesian adaptation can be seen to support such a view.

Firstly, English /d/ is usually nativized as /t/ in those languages which contain the voiceless alveolar stop. This is unsurprising, since voicing contrasts are uncommon in these languages. However, /d/ is occasionally borrowed as an alveolar approximant, either a tap /r/ or lateral /l/, depending on which is phonemic in the given Polynesian language. This mirrors the adaptation of English alveolar laterals [l] and alveolar (or rhoticized) approximants [ɹ̺ ɹ], which are likewise nativized as whichever alveolar approximant is present in the host. Nativization of English /d/ as /ɾ/ or /l/ is restricted to those instances where the borrowed stop appears positionally in a loanword where it is likely to be realised as a tap in British and NZ English (i.e. in onset position of an unstressed syllable immediately following a stressed syllable):

| | | | | | |
|---|---|---|---|---|---|
| (7) | fri**d**ay | [ˈfɹajɾej] | → | varai**r**e | (Cook Islands Māori) |
| | (gun)pow**d**er[9] | [ˈgʌnˌpawɾə] | → | pau**l**a | (Niuean) |
| | stu**d**y | [ˈstʌɾɪ] | → | ta**r**i | (NZ Māori) |
| | holi**d**ay | [ˈhɑləɾej] | → | hara**r**ē | (NZ Māori) |

The nativization of /d/ as an alveolar approximant in (7) is unsurprising if the input is the non-phonemic alveolar tap [ɾ], rather than the phonemic voiced alveolar stop. On the other hand, if the host is privy to the underlying structure of the loanword, then we falsely expect /d/ to be realised as /t/ in (7) as elsewhere.

Secondly, in many dialects of English, vowel-initial words begin with a glottal. In those Polynesian languages for which glottal stop is phonemic, vowel-initial loanwords are pronounced with a glottal stop preceding the word-initial vowel (8). This appears to be another instance of L1 speakers interpreting as phonemic a segment that is purely phonetic in L2.[10]

(8) /VCV… / → [ʔVCV…]

[9] Powder used for guns is realised with a tap - '*paura'* – while powder used elsewhere (for baking, etc,) has the plosive -'*pauta'*. It is possible that these alternations reflect variation in the adaptation of one or both lexical items, with the differing realizations of /d/ being maintained upon standardisation of these forms in order to mark the lexical contrast.

[10] Of course, if glottalization is present phonetically in these Polynesian examples (if, for example, the languages in question had the same glottalization process as English), it may be that the glottal has simply been misinterpreted as phonemic by those responsible for translating the words orthographically. This might be resolved via phonetic testing, but lies beyond the scope of this paper. Note that this solution is still not consistent with Paradis' model, which assumes (near)-perfect knowledge of both L1 and L2 by the borrower.

| | | | | | |
|---|---|---|---|---|---|
| (9) | elephant | [ˈʔæləfn̩t] | → | /ʔelepani/ | (Hawaiian) |
| | India | [ˈʔɪndiˌjə] | → | /ʔinitia/ | (Tongan) |
| | item | [ˈʔajˌtɪm] | → | /ʔaaitamu/ | (Cook Islands Māori) |

The fact that two strictly allophonic segments in English - alveolar taps and glottal stops - are faithfully realised in nativizations of English loanwords supports the hypothesis that the loanword input is phonetic in nature, and not phonemic.

## 3.2 What is perceived?

Interestingly, languages lacking a phonemic glottal stop - NZ Māori and Niuean - realize the loanwords in (9) as vowel-initial, consistently failing to realise the stop:

(10) /VCV…/ → [VCV…] (if L1 lacks /ʔ/ phonemically)

| | | | | | |
|---|---|---|---|---|---|
| (11) | elephant | [ˈʔæləfn̩t] | → | /elefani/ | (Niuean) |
| | agent | [ˈʔejdʒn̩t] | → | /eiseni/ | (Niuean) |
| | orchid | [ˈʔɔkɪd] | → | /okiti/ | (Niuean) |
| | alter | [ˈʔɑltə] | → | /aata/ | (NZ Māori) |
| | inch | [ʔɪntʃ] | → | /iinihi/ | (NZ Māori) |
| | ox | [ʔɒks] | → | /okiha/ | (NZ Māori) |

What are we to make of (11)? Why do NZ Māori and Niuean systematically realise the word-initial glottal as zero, while others realise the same input with a glottal stop? A number of answers are attested in the literature, each reflecting assumptions regarding how to evaluate similarity within the adaptation process.

Firstly, we need to know whether the glottal stop is actually perceived or not by the host. Let us consider first an analysis that assumes that the languages in question here uniformly fail to perceive phonetic glottalization in English loanwords, and that the appearance of word-initial glottal stops relates to some other process in the host language. We might hypothesize that the languages in (9) have a preference for CV syllable types, and that consequently word-initial onset-less syllables undergo epenthesis to create CV syllables. Presumably /ʔ/ is chosen as the epenthetic consonant due to its being 'closest to zero', either phonetically (lacking perceptual and strong acoustic cues) or phonologically (lacking oral features).[11] For whatever reason, NZ Māori and Niuean would not instigate this repair strategy. An Optimality Theoretic (OT) approach could encode this by ranking a syllable well-formedness constraint such as [Fill (Onset)/#_] above a DEP(I-O) constraint for languages which require epenthesis, and reranking these constraints for Niuean and Māori.

Intuitively, however, this approach is unappealing for the following reasons: Firstly, NZ Māori and Niuean permit exactly the same syllable types (CV, V, VV, CVV)[12] as Hawaiian, Tahitian, Tongan and Cook Islands Māori, all of which can occur either word-initially or word-internally. In fact, all of these languages have numerous native words that begin with not only a single onset-less syllable, but sometimes two or even three such syllables:

[11] In feature geometric systems (e.g. Clements 1985, McCarthy 1988, Avery & Idsardi 2001, Padgett 2002), the phonological impoverishment of /ʔ/ is represented by assuming that the glottal stop lacks a [Place] node, having only a [Laryngeal] specification (or perhaps [Laryngeal] plus a [Glottal Width] dependant).

[12] Certain sequences of three vowels, such as *kaao –re* 'NEG', may also be analysed as tri-vocalic syllables (C)VVV.

| | | | |
|---|---|---|---|
| (12) aoa | *dwell* | (Tahitian) |
| iaua | *here* | (NZ Māori) |
| paua | *Paua (a kind of shellfish)* | (NZ Māori) |
| kuia | *old woman* | (NZ Māori) |

While the evolution of a dispreference for onset-less syllables in word-initial position would not be surprising in and of itself, the fact that only loanwords – and not examples such as (12) - undergo this epenthetic repair may be problematic.[13]

Another problem for an epenthesis analysis is that this repair must only be invoked for those languages that happen to contain /ʔ/ phonemically, while Niuean and NZ Māori, languages that lack a glottal stop, do not exhibit the same repair. However, the only evidence for any kind of epenthetic consonant in any of the Polynesian languages considered here comes from one of these languages, NZ Māori: In this language, /h/ is used occasionally to break up instances of tautomorphemic vowel hiatus. As an example, the sequence of isolating morphemes ‘personal marker’ *a* + ‘me’ *au* is often realised phonetically as *ahau.* Since /h/-insertion seems to only occur when the vowels are identical, this suggests that epenthesis here is in response to an OCP-type violation, rather than a syllabic dispreference. However, the availability of an epenthetic consonant for NZ Māori suggests that this language is an equal or better candidate for developing word-initial epenthesis than those for which epenthesis must be proposed. However, NZ Māori does not generally have word-initial consonantal epenthesis, as we saw in (11).[14] Secondly, it appears more than accidental that those languages that systematically realise word-initial glottalization are those that have a phonemic glottal stop.

The data in (9) and (11) are therefore unlikely to be explained by syllable-level processes. This leaves two possibilities: either the glottalization in the input is universally perceived, with some languages borrowing it as a glottal and some adapt it as zero, or the perception of vowel-initial glottalization is not perceived in a uniform manner – languages which have [ʔ] phonemically perceive the glottal, while those that lack it underlyingly fail to perceive it in the borrowed word. Let us consider both possibilities in order.

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[13] This might be viewed as an instance of loanword adaptation highlighting the ‘emergence of the unmarked’ (Shinohara 1997, *et alia*), given that CV syllables are assumed to be the unmarked syllable type.

[14] Interestingly, I did find two examples in NZ Māori of vowel-initial loanwords being nativized with what could be construed as an epenthetic /h/:

| | | | | |
|---|---|---|---|---|
| umbrella | [ʔʌmˈbɹɛlə] | → | /haamarara/ | (NZ Māori) |
| egg | [ʔeg] | → | /heeki/ | (NZ Māori) |

This suggests that NZ Māori may have indeed developed a preference for word-initial CV syllables, although the paucity of examples involving epenthesis suggests that the constraint against vowel-initial syllables is neither strong nor widespread. Additional support for this come from the following four examples, which show that occasionally word-initial vowels in loans are deleted in NZ Māori, again suggestive of a weak desire for word-initial CV syllables in this language:

| | | | |
|---|---|---|---|
| Elastic | → | raahiteke | (NZ Māori) |
| Apricot | → | pirikooti | (NZ Māori) |
| Accordion | → | kooriana | (NZ Māori) |
| Account | → | kaute | (NZ Māori) |

### 3.2.1 Perceptual Uniformity

One model advocated by early linguists such as Paul (1880, described in Hyman 1970) states that a host speaker, upon encountering a foreign segment, matches this phonetic signal with the native segment with which it is *most closely related*. In this model, evaluation of similarity during nativization makes reference to universal physical phonetic properties. Although Paul says nothing of the role of perception, let us assume that in this type of model the initial glottal in the loanword input is perceived. Such a model predicts that languages such as Hawaiian and Tongan which contain /ʔ/ underlyingly would faithfully reproduce the glottal in the borrowed form. We could assume, as above, that /ʔ/ is phonetically closer to zero than to any other segment; in this case, it might be predicted that /ʔ/ is borrowed as zero, if the definition of *most closely related* above can make reference not only to segments, but to zero. However, as Hyman notes, authors who rely on absolute comparison between the surface phonetics of the input and output forms face problems when confronted by instances of cross-linguistic variation in segmental adaptation. An example from the Polynesian data illustrates this: Hawaiian, and NZ Māori both lack sibilants, and differ in how they are realised in loanwords. Hawaiian consistently borrows /s z ʃ ʒ/ as /k/, while NZ Māori chooses /h/ as the repair segment, despite both /h/ and /k/ being available as repairs to both languages.

(13) a. Hawaiian

| | | | |
|---|---|---|---|
| September | [**s**ɛpˈtɛmbə] | → | /**k**epakemapa/ |
| commissioner | [kəˈmɪ**ʃ**ənə] | → | /komi**k**ina/ |
| rose | [ɹow**z**] | → | /lu**k**e/ |

b. NZ Māori

| | | | |
|---|---|---|---|
| brass | [bɹɑ**s**] | → | /paraa**h**e/ |
| cheese | [tʃi**z**] | → | /tii**h**i/ |
| bishop | [ˈbɪ**ʃ**əp] | → | /pii**h**opa/ |

Hyman suggests that a loanword model based strictly upon phonetic approximation would need to appeal to some notion of 'equidistance of similarity' to account for this kind of alternation. Thus, it could be supposed that /h/ and /k/ are phonetically equidistant in some way from [s]. As Hyman notes (p.10), this incorrectly predicts that, being confronted by a loanword containing the ill-formed segment, we would see equal numbers of speakers substituting one or the other repairs; in this case, we incorrectly expect an equal number of Hawaiian and NZ Māori speakers replacing /s z ʃ ʒ/ with either of [t] and [k]. Additionally, the notion of equidistance becomes somewhat bizarre when more languages are included: Cook Islands Māori, for example, lacks /h/, but instead of borrowing /s z ʃ ʒ/ as /k/, it chooses to adapt ill-formed sibilants as /t/:

(14) Cook Islands Māori

| | | | |
|---|---|---|---|
| sledge | [**s**lɛdʒ] | → | /**t**ereeti/ |
| topaz | [ˈtowpæ**z**] | → | /toopa**t**i/ |
| sheet | [**ʃ**it] | → | /**t**iiti/ |

A phonetic approximation model must conclude that /k/, /h/ and /t/ are all phonetically equidistant, with variation assigned (perhaps) to a one-time parametric choice. However, consider now what happens when Cook Islands Māori borrows loanwords containing /h/:

(15) Cook Islands Māori

| | | | |
|---|---|---|---|
| heave | [hiv] | → | /ʔiivi/ |
| hyphen | [ˈhajfən] | → | /ʔiipena/ |
| hammock | [ˈhæmək] | → | /ʔaamaka/ |

These examples show that /h/ is consistently resolved as /ʔ/, not /t/ or /k/ (despite the latter two being present phonemically in Cook Islands Māori). Does this mean that /t k ʔ h/ are all phonetically equidistant? This is highly implausible; in fact, it is not even apparent what the best way is to evaluate such a claim, since there are several ways in which phonetic similarity can be measured. Questions arise such as what sorts of phonetic cues are evaluable – Acoustic, perceptual, or visual cues, or a mixture of these? If the latter, are some cues 'worth' more (i.e. inherently more salient or distinguishing) than others?

An alternative approach is that phonetic similarity is measured in terms of shared phonetic features. This is the basis for the 'structured specification' models of similarity proposed by Frisch et al 1997, Broe 1993. These authors develop an algorithm for determining absolute similarity between segments based on natural classes delimited by phonetic features. Similarity between any two segments is measured by dividing the number of shared natural classes by the number of shared plus unshared natural classes. However, as Mackenzie 2003:13-14 discusses at length, such an approach makes different predictions depending on which features are allowed to enter the computation. For example, Mackenzie considers the vowels /a i u/, and their privative specifications for the features [high], [low], and [back] (plus [syllabic], which groups all three vowels together):

| (16) | /a/ | /i/ | /u/ |
|---|---|---|---|
| [high] | | √ | √ |
| [low] | √ | | |
| [back] | √ | | √ |

These feature specifications create three natural classes, {a,i,u}, {i,u}, {a,u}. These sets yield the following set containment relations:

| | |
|---|---|
| {a, i, u} ⊇ {a,u}, {i,u} | [syllabic] |
| {a, u} ⊇ {a}, {u} | [back] |
| {i, u} ⊇ {i}, {u} | [high] |

/a/ and /u/ share two natural classes (a, i, u), (a,u), against one non-shared class (i, u). The similarity metric determines the rate of similarity between these segments as 2/3 (i.e. two shared classes over three shared + non-shared classes). Compare this with the rates of similarity between /a/ and /i/: these segments share one natural class (a, i, u) and two non-shared natural classes (i,u), (a,u). Hence their rate of similarity is 1/3. The features [back][high][low] thus determines /a/ to be more similar to /u/ than to /i/. However, Mackenzie notes that changing the features that can factor into the evaluation of similarity can change the rate of similarity. For instance, if [labial] is used instead of [back], the following feature specifications eventuate:

| (17) | /a/ | /i/ | /u/ |
|---|---|---|---|
| [high] | | √ | √ |
| [low] | √ | | |
| [labial] | | | √ |

Now /a/ shares one natural class with /i/ and one with /u/ (i.e. (a, i, u)). /a/ has one unshared natural class with /i/ - (i,u) – and one with /u/ - (i, u). The rate of shared over shared plus unshared natural classes is thus 1/2 for each. Thus, the features [high][back][labial] determine /a/ to be equally similar with both /i/ and /u/. The result is that structured similarity can be better viewed as a metric for relative similarity, rather than an absolute measure, since similarity measurements will vary depending on which features are used.

### 3.2.2 Production mapping

Jacobs & Gussenhoven 2000 (henceforth J&G) propose a different conception of phonetic similarity, attempting to build production-based similarity into their nativization model. [15] J&G assert that repairs to non-native segments are effected so as to avoid the production of marked or illicit segments or strings. Working within OT, dispreferences for certain articulations are encoded in the host language via the presence of ranked anti-association (i.e. markedness) constraints (Prince & Smolensky 1993). These rankings place constraints forbidding more marked articulations above those forbidding less marked articulations. For Prince & Smolensky, these rankings are fixed, expressing universal markedness. For example, universal markedness in place of articulation labial > coronal (e.g., Avery & Rice 1989, papers in Paradis & Prunet 1991) is expressed by the ranking in (18a), and translates into the markedness dominance hierarchy in (18b):

| | | | |
|---|---|---|---|
| (18) | a. | Unmarkedness Scale: | PL/Cor > PL/Lab |
| | b. | Dominance Hierarchy: | *PL/Lab >> *PL/Cor |

Double articulations are also encoded, and are represented as an unordered set of features X-Y. For example, front unrounded vowels have a Cor(onal) articulation, while front rounded vowels have Cor-Lab articulations. J&G do not provide a list of all possible vowel articulations alongside their respective feature specifications, with the result that at times it is not clear what segments are intended, leading to some ambiguity. However, I have attempted to reconstruct a full list of available specifications alongside possible articulations, and list them as follows:

| | | | | |
|---|---|---|---|---|
| (19) | V-Place/Cor | = | front unrounded | /i ɪ e ɛ æ/ |
| | V-Place/Cor-Lab | = | front rounded | /y ʏ ø œ ɶ/ |
| | V-Place/Dor-Lab | = | back rounded | /u o ɔ ɒ/ |
| | V-Place/Dor-Cor | = | back unrounded | /ɯ ɤ ʌ ɑ/ |

[15] Usisshkin & Wedel 2003 (U&W) also present a production-governed model of similarity, relying on the presence or absence of sequences of atomic gestural units (gestural *molecules*) in utterances to determine whether or not certain non-native elements are likely to be imported or not. As a model of nativization, however, U&W face the same problems as phonetic approximation models – it is not clear which gestures partake in the assessment of similarity, whether all gestures are of equal rank, both in comparison to each other and cross-linguistically, and how such a model avoids the pitfalls inherent in phonetic 'equidistance' approaches listed above. (See also Browman & Goldstein 1989.)

| | | | |
|---|---|---|---|
| V-Place/Dor | = | central unrounded (?) | /a ɨ ɘ ɜ/ |
| V-Place/Lab | = | central rounded (?) | /ʉ ɵ ɞ/ |
| V-Place (?) | = | schwa (?) | /ə/ |

French has a vowel inventory consisting of front unrounded /i,e,ɛ/, front rounded /y ø œ/, back rounded /u o ɔ / and central unrounded /a/ vowels. J&G propose that this inventory equates to the following set of anti-association constraint rankings (p.202):

(20) French vowel articulation ranking
Fill(Place) >> *V-Place/Dor-Cor >> *V-Place/Lab >> Parse(feature) >> *V-Place/Cor, *V-Place/Dor, *V-Place/Cor-Lab, *V-Place/Lab-Dor

The effect of placing Parse below *V-Place/Dor-Cor is to exclude back unrounded vowels from the inventory, while placing Parse above the other anti-association constraints allows these articulations. These rankings are contrasted with those required for Mauritian Creole (MC). MC has a five-vowel system /i e u o a/. For J&G, it is minimally different from French in that the constraint *V-Place/Cor-Lab – precluding front rounded vowels – must be ranked above PARSE:[16]

(21) MC vowel articulation ranking
Fill(Place) >> *V-Place/Dor-Cor>> *V-Place/Cor-Lab >> *V-Place/Lab >> Parse(feature) >> *V-Place/Cor, *V-Place/Dor, *V-Place/Lab-Dor

Loanword input is assumed to interact with the constraint rankings of the host phonology, with any adaptation reflecting the inherent constraint ordering of the host. For J&G, ranking of anti-association constraints plays a crucial role in determining how an ill-formed segment will be adapted, as do the faithfulness constraints PARSE and FILL:

(22) PARSE(feature): An input feature must be parsed
FILL(place): A place node must not be empty

To show how this model works, consider front rounded vowels in French loanwords, which are adapted into MC as front unrounded (p.203):

| (23) | French | | MC | |
|---|---|---|---|---|
| | *plumeau* | [plyˈmo] | *plimo* | [plimo] |
| | *cheveux* | [ʃœˈvø] | *seve* | [seve] |

J&G accounts for this by assuming that the loanword input, is evaluated according to the following feature tableau, with the optimal candidate an unrounded coronal articulation:

[16] Additional constraints are required to exclude the segments /ɛ ɔ/ from MC, something J&G do not discuss.

(24)

| {V-Pl/Lab-Cor} /y ø œ/ | Fill(Place) | *V/Dor-Cor, *V/Cor/lab, *V/Lab | Parse(f) | *V/Lab-Dor | *V/Cor | *V/Dor |
|---|---|---|---|---|---|---|
| a. [Cor-Lab] /y ø œ/ | | *! | | | | |
| b. <Cor>[Lab] /ʉ ɵ ɞ/ | | *! | * | | | |
| c. [ ] <Cor-Lab> /ə/ | *! | | ** | | | |
| >>d. [Cor]<Lab> /i e/ | | | * | | * | |
| e. <Cor>[Lab-Dor] /u o/ | *! | | * | * | | |

Note, however, that the ranking in (24) is not identical to that in (21), since here the articulations *V/Lab-Dor, *V/Cor and *V/Dor are no longer unordered. In fact, the ranking of *V/Lab-Dor over *V/Cor is crucially required to eliminate a possibility unmentioned by J&G, that of adapting front rounded vowels as back rounded vowels (i.e. as the output statement [Lab-Dor]). In fact, as J&G note, there are languages that do employ this latter repair strategy. Tunica, for example, is a language that has the same phonemic inventory as MC, but repairs front rounded vowels as back rounded (Haas 1947). An example from Haas offered by J&G is *dejeuner* [ˈdeʒyˌne] as [tesuni]. This is accounted for simply by switching the relative rankings for *V/Lab-Dor and *V/Cor for Tunica:

(25)

| {V-Pl/Lab-Cor} /y ø œ/ | Fill(Place) | *V/Dor-Cor, *V/Cor/lab, *V/Lab | Parse(f) | *V/Cor | *V/Lab-Dor | *V/Dor |
|---|---|---|---|---|---|---|
| a. [Cor-Lab] /y ø œ/ | | *! | | | | |
| b. <Cor>[Lab] /ʉ ɵ ɞ/ | | *! | * | | | |
| c. [ ] <Cor-Lab> /ə/ | *! | | ** | | | |
| d. [Cor]<Lab> /i e/ | | | * | *! | | |
| >>e. <Cor> [Dor-Lab] /u o/ | | | | | * | |

For J&G, loanwords provide evidence as to the rankings of constraints that we would otherwise have to leave unranked. Adaptation patterns are therefore an example of the 'emergence of the unmarked', or in theory-neutral terms, offer insight into the internal workings of individual phonologies that would otherwise remain obscured. Thus, a fundamental shift in focus is evident – unlike the phonetic approximation accounts listed above, which are predicated upon notions of absolute similarity, J&G's model allows the structure of individual phonologies to determine the shape of nativized segments. Since phonological structure/ constraint rankings are subject to language-specific variation[17] (as evidenced by the reranking of *V/Dor-Lab and *V/Cor above), the adaptation process itself is inherently subjective, relativised based on the organization of the host inventory of repair segments.

A number of questions are raised by J&G's work, however, especially when consonantal adaptation is considered. For example, how would they account for the adaptation of [s] as /h/ in NZ Māori, /t/ in Cook Islands Māori and /k/ in Hawaiian? Consider their analysis of Cantonese adaptation of ill-formed voiced obstruents. To exclude voiced obstruents, an anti-association constraint *[-son +voice] is assumed, and is ranked above IDENT (-son,+voice) (IDENT(f) states that a feature in the output is identical to that in the output). All this states is that Cantonese prefers to exclude voiced obstruents, such as /d/. No clue is given as to why a corresponding voiceless obstruent /t/ constitutes the most optimal repair candidate, and not the respective voiceless fricative /s/, or even the corresponding nasal /n/. Perhaps numerous other anti-association constraints could be posited, such as *[-son,-voice], *[-son,+cont], *[Cor,+nas], and ranked with *[-son,+voice] in the following order: *[-son,+voice] > *[-son,+cont] > *[Cor,+nas] > *[-son,-voice]. However, we now predict voiceless obstruents to be the optimal repair for a host of non-native segments – for example, we predict an illicit nasal N (where N refers to any non-native nasal segment appearing in a loanword) will be repaired as a voiceless obstruent, which is likely to be false – more likely is that N will be realised as the default (or 'unmarked') nasal, usually /n/. One way to derive these results via interaction between faithfulness and markedness constraints is to introduce IDENT constraints that specify individual *features,* such that certain features from the loanword input are deemed more important than others to retain in the output. Thus, ranking the constraint IDENT(+nasal) higher than the anti-association constraint *[+nasal] will lead to N being realised as a nasal, rather than being repaired as an obstruent or liquid. Similarly, ranking IDENT(+coronal), IDENT(-nasal) and IDENT(-continuant) higher than the respective anti-association constraints *[-son,Cor]; *[-nas], *[-cont] (but lower than *[-son,+voice]) will predict that the 'best' repair for [d] is /t/, rather than /n/ or /s/.

Consider again the NZ Māori adaptation of /s/ as /h/. Firstly, NZ Māori must have the constraint IDENT(+continuant) ranked higher than IDENT(Cor) to explain why /s/ is borrowed as /h/ and not /t/. Conversely, ranking IDENT(Cor) above IDENT(+continuant) in Cook Islands Maori prefers [s] to be nativized as /t/, rather than /h/. Hawaiian, on the other hand, has no non-sonorant coronals. This is captured by the constraint *[-son,Cor], which must be ranked higher than PARSE. However, there is no obvious way in which IDENT constraints can inform us as to why [s] is borrowed as /k/, as opposed to /h/, or even /p/. One way to eliminate /p/ as a potential repair would be to add a DEP constraint (every segment in the output has a corresponding segment in the input), such as DEP(Lab), and rank it above IDENT(+continuant). However, since /h/ shares more features with /s/ ([+continuant, -voiced]) than either of /k/ or /p/ ([-voiced]), any IDENT( ) constraint should prefer it as the repair for /s/. This highlights a problem for J&G's analysis: although referencing identity constraints to features allows them to use the constituency of individual inventories to inform the kinds of constraints relevant to nativization, their phonological model does not allow them to conclude from the

[17] This constitutes a major split from the universal nature of anti-association constraints assumed by Prince & Smolensky, and raises the question of whether certain orderings of markedness constraints are ever possible. If not, it is unclear how this restriction can be encoded in J&G's model.

underlying *shape* of these inventories which features are more or less relevant to the evaluation of optimal candidature. For instance, loanwords entering the Hawaiian system containing coronals [t d θ ð s z ʃ ʒ tʃ dʒ] and velars [k g] are systematically borrowed as /k/:

(26) Hawaiian: [t d θ ð s z ʃ ʒ tʃ dʒ] → /k/

| | | | |
|---|---|---|---|
| talent | [ˈtæln̩t] | → | kālena |
| medal | [ˈmɛdl̩] | → | mekala |
| theatre | [ˈθiərə] | → | /keaka/ |
| percent | [pəˈsɛnt] | → | paikeneka |
| dozen | [ˈdʌzn̩] | → | /kaakini/ |
| commisioner | [kəˈmɪʃənə] | → | /komikina/ |
| watch | [wɒtʃ] | → | /uaki/ |
| sandwich | [ˈsændwɪtʃ] | → | /kanuwika/ |

The same elements are borrowed into Tahitian as /t/, however:

(27)

| | | | |
|---|---|---|---|
| tapioca | [ˌtæpiˈowkə] | → | /tapiota/ |
| diablo | [ˌdiˈablow] | → | /tiaporo/ |
| Sabbath | [ˈsæbəθ] | → | /tapati/ |
| salmon | [ˈsæmən] | → | /tamanu/ |
| rose | [ɹowz] | → | /roti/ |
| China | [ˈtʃajnə] | → | /taina/ |
| June | [dʒun] | → | /tiunu/ |

Without looking at the available choices for repair segments in each inventory, these patterns appear arbitrary. However, considering the respective consonantal phonemic inventories given in (28) below shows that Hawaiian lacks any coronal obstruents, but has a single velar stop, /k/. Conversely, Tahitian has a single coronal /t/, but lacks any velar elements. If we ignore the glottal consonants, *relationally* /t/ is the single non-labial obstruent in Tahitian, while /k/ is the single non-labial obstruent in Hawaiian:

(28) a. Tahitian

| | | |
|---|---|---|
| p | t | ʔ |
| f v | | h |
| m | n | |
| | r | |

b. Hawaiian

| | | |
|---|---|---|
| p | k | ʔ |
| | | h |
| m | n | |
| w | l | |

Borrowing terminology from Dresher (2001, 2003) and Dresher & Zhang 2000 (henceforth DZ), another way of expressing this commonality is that *positionally* /t/ and /k/ occupy the same relation within the respective contrastive feature hierarchies in both Tahitian and Hawaiian. That is, Tahitian and Hawaiian have similar underlyingly *shapes*, defined as the underlying contrastive relations between phonemes.

If adaptation makes reference to contrastive underspecification and the feature hierarchies that fall out from the specification process (contra J&G), then the patterns of adaptation in (26) and (27) are wholly unsurprising. Interestingly, this is exactly the model suggested (somewhat obliquely) by Hyman 1970:

> 'Differing phonological properties are then responsible (at least in part) for different nativization processes. The French and Serbo-Croatian example is far from being resolved. However, if it can be shown that there is no extra-linguistic interference…, then we must look into the individual phonologies (perhaps the individual feature hierarchies?) for an explanation. But the explanation must be phonological.' (p.12)

The idea that underlying feature organization can play a role in informing phonological constraints (and thence nativization strategies) is appealing. Clements 2001 proposes exactly such a model, allowing contrastive underspecification at the lexical level to influence possible features available to constraints at lower phonological and phonetic levels. I discuss Clements' model in Section 4. First, however, I will conclude discussion regarding the realisation or non-realisation of [ʔ] in Polynesian by considering the role of relative and absolute perception in similarity evaluation, a topic that has received much attention in recent literature.

## 3.3 The role of perception

Models of phonetic approximation that acknowledge the importance of perception in determining similarity are widely attested in the literature. Hyman 1970, in fact, ties the notion of 'similarity' in nativization to *Sprachgefühl,* which implies that speakers adapt a non-native segment to one which they 'feel' most closely resembles the former. For Hyman, the fact that different languages 'feel' different segments to be closer to certain ill-formed segments than others is proof of the phonological nature of adaptation. Other authors, such as Silverman 1992, Yip 1993, Kenstowicz 2001, 2003 have sought to maintain a phonetic approximation model, but have allowed for perception to play a privileged, and distinct, role, either via some pre-operational perceptual parse, or by judicial ranking of a PARSE (salient) constraint that ties perception of contrasts in loanwords with contrasts in the host. These models would predict that [ʔ] is not realised in Niuean and Māori because this segment falls below some level of perceptability, and is perceived as zero. This in turn would be a direct consequence of [ʔ] being absent within the system of contrasts in these languages.

A drawback of these analyses is that they must make some uncomfortable assertions about perception of segments in languages with extremely impoverished inventories. For example, Yip's model predicts that neither Tahitian nor Hawaiian speakers will be able to perceive the difference between /θð t s ʃ ʒ tʃ dʒ k g/ in English loans, since opposition between coronals and velars is unattested in both languages.[18] As J&G note (p.195), this is at odds with evidence that speakers are often able to perceive non-native segments with ease. It would also be surprising, given the high degree of bilingualism prevalent in both Hawaiian (with English) and Tahitian (with French), both of which contain the above-mentioned segments.

Others (e.g., Steriade 2001, Kenstowicz 2001, 2003) have followed Silverman and Yip in assigning positional salience (syntagmatic context) an integral role in certain

[18] Note that Yip and Silverman do not provide a means to explain why it is that these segments are perceived as /t/ in Tahitian and /k/ in Hawaiian.

adaptation strategies, especially with respect to predicting in which environments certain consonants are more likely to be deleted (i.e. within consonant clusters, when non-adjacent to a vowel, in an unstressed syllable). However, they replace absolute and relative perceptual salience of individual segments with the notion of absolute and relative perceptual salience of *contrasts* between segments. For Steriade, speakers confronted with non-native segments or phonotactics will attempt to minimize differences between input and output. The crucial notion in establishing similarity between input and output forms is the notion of relative 'confusability', i.e. the extent to which a pair of speech sounds (a,b) are more or less confusable than (a,c) in a given context. Information about rates of confusability between any given segments are encoded in a Perceptual Map (P-Map), which is the repository for judgements about absolute and contextual confusability. This P-Map in turn is responsible for informing constraint ranking. To give an example of how Steriade's system works, consider the lack of voicing contrasts between plosives in Polynesian languages. When confronted by a voiced stop in a loanword input, a repair must be effected. As the following shows, devoicing is chosen as the predominant repair - a voiced stop is borrowed as its voiceless counterpart, if such a segment is available:

(29) a. b → p

| | | | |
|---|---|---|---|
| He**b**rew | → | he**p**elū | (Tongan) |
| **b**alance | → | **p**alanisi | (Tongan) |
| **b**icycle | → | **p**aikikala | (Hawaiian) |
| **b**ucket | → | **p**ākete | (Hawaiian) |
| **b**ucket | → | **p**akete | (Niuean) |
| February | → | fe**p**uali | (Niuean) |
| **b**lu**bb**er | → | **p**arā**p**a | (Cook Islands Māori) |
| **b**icycle | → | **p**ātikara | (Cook Islands Māori) |
| **b**ankrupt | → | **p**ēkerapu | (NZ Māori) |
| ham**b**urger | → | hāmi**p**ēka | (NZ Māori) |
| **b**ear | → | **p**ea | (Tahitian) |
| **b**oat | → | **p**oti | (Tahitian) |

b. d → t

| | | | |
|---|---|---|---|
| **d**ictator | → | **t**ikitato | (Tongan) |
| lea**d** (element) | → | le**t**e | (Tongan) |
| gra**d**er | → | kule**t**a | (Niuean) |
| **d**ozen | → | **t**āsini | (Niuean) |
| in**d**igo | → | 'ini**t**iko | (Cook Islands Māori) |
| gra**d**e | → | kerē**t**i | (Cook Islands Māori) |
| **d**ollar | → | **t**āra | (NZ Māori) |
| pa**dd**ock | → | pā**t**iki | (NZ Māori) |

c. g → k

| | | | |
|---|---|---|---|
| **g**allon | → | **k**ālani | (Tongan) |
| mon**g**oose | → | moŋo**k**ūsi | (Tongan) |
| **g**allon | → | **k**alana | (Hawaiian) |
| ci**g**ar | → | kī**k**ā | (Hawaiian) |
| **g**um | → | **k**amu | (Cook Islands Māori) |
| ci**g**ar | → | tī**k**ā | (Cook Islands Māori) |
| fi**g** | → | fi**k**i | (NZ Māori) |
| **g**uitar | → | **k**itā | (NZ Māori) |

Steriade's main concern is explaining why out of several possible repairs to illicit voiced stops (devoicing, nasalization, deletion, spirantization), languages almost universally choose devoicing, as in (29). Steriade proposes that devoicing is overwhelmingly chosen as a repair for a violation of *[+voice, -sonorant] because *universally* the contrast between [d] and /t/ is perceptually more confusable than that between [d] and /z/, /n/ or zero. This judgement is encoded within the P-Map, which will then encode the fact that [d] and /t/ are more confusable than [d] and [n] by ranking IDENT[±nasal/V_] above IDENT[±voice] cross-linguistically. Consequently, [d] will usually be realised as /t/ in languages lacking a voicing contrast amongst obstruents. Similarly, Hawaiian lacks a velar nasal [ŋ]. The fact that Hawaiian nativizes this sound as /n/ and not as /k/ can be related to the fact that generally [ŋ] is adjudged more confusable with [n] than with [k]. This observation will project correspondence constraints IDENT[±sonorant] >> IDENT[±place]. The P-Map is also capable of projecting the fact that consonants are less perceptible (i.e. more confusable with zero) following another consonant and in prosodically deficient contexts, by simply adding the relevant context to the appropriate IDENT constraint. The result is a set of statements regarding cross-linguistic preferences for similarity, which in turn will encode cross-linguistic patterns of loanword adaptation. In terms of non-realisation of [ʔ] in Hawaiian and Niuean, the P-Map would presumably encode the fact that confusability between the glottal stop and zero is higher than between [ʔ] and some other segment, leading to its non-realization in loanwords.

Allowing some statements of confusability in the P-Map to be universal has the advantage of encoding strong cross-linguistic tendencies to effect certain repairs over others, and by projecting certain constraints as universally higher than others constrains the types of OT systems that can occur. This is a positive step, since a major drawback of traditional OT systems is that they grossly over-generate possible phonological systems, and over-predict the range of responses to any given non-native segmental violation. Resolving this over-prediction of repair strategies ('Too-Many-Solutions') is the main aim of the P-Map. However, Steriade also acknowledges (if fleetingly) a second, conflicting demand – that the P-Map (or any other component of the phonology that limits possible constraint rankings or underlying structure) account for instances of variation in similarity judgements, and hence in nativization preferences:

> 'If the perception of similarity is governed, in part, by "the contents of the universe of discourse" (Tversky, cited in Frisch, Broe & Perrehumbert 1997), then the same pairs of sounds will rate differently for similarity, when embedded in different systems.' (p.52)

This is crucial, of course, since we have seen that different languages choose different repairs for the same ill-formed loanword input. Allowing the P-Map to undergo some limited constraint reranking will account for this variation. We might expect, then, that NZ Māori speakers would perceive [s] as closer to [h], while Cook Islands Māori speakers would deem [s] and [t] more confusable than [s] and [h]. This is empirically testable, and would be support for the P-Map hypothesis if correct.

However, simply allowing correspondence constraints to vary raises the question of why *certain* correspondences can undergo reranking, while others show a marked dispreference to rereranking. Furthermore, it sheds no light on why segments that are open to variation in adjudged similarity are repaired the way they are in a particular language. What factors influence the perception of /h/ as 'closest' to [s] in NZ Māori and /t/ as 'closest' to [s] in Cook Islands Māori? This is the main drawback of the P-Map; it is primarily a *descriptive* device, which can express nicely what is going on, but has nothing to say about the *motivations* for variation in similarity/confusability judgements. It therefore lacks any real explanatory or predictive power. On the other hand, if (as Hyman entertains) perception is dependent upon underlying feature structure, then a model that allows for some limited variation in feature specification has the potential to account for the general uniformity in repair strategies described by Steriade, as well as predict the kinds of variation that might be possible in perceived similarity, and hence in loanword adaptation.

### 3.4 Summary

This section came to a number of conclusions regarding a suitable loanword model. These are summarised as follows:

1) Loanword input is phonetic
2) Perception is relative, and may be influenced by underlying structure
3) Reference to underlying structure is crucial in dealing with two competing demands, namely:
   a. Too Many Solutions: Only a subset of possible repairs for ill-formed segments are attested
   b. Persistence of the Subjective: Adaptation is subject to a certain degree of cross-linguistic variation

In order to account for the demands in 3), it was suggested that both production-based and perception-based models of similarity require recourse to language-specific ordering of underlying features or constraints. However, it was also concluded that real explanation of adaptation patterns must make reference not only to underlying structure, but crucially also to the shape of the individual inventories. In the next section I will outline and revise an adaptation model that was first proposed in Clements 2001, and which relies heavily on contrastive underspecification. This model will be tested against the full range of loanword data from the Polynesian languages introduced above, and several alterations and additions to Clements' model will be entertained.

## 4 Analysis

Before investigating Clements' analysis, I will discuss briefly two features that underpin his loanword model – the Theory of Constraints and Repair Strategies (TCRS), and contrastive underspecification.

## 4.1 TCRS

The TCRS is a model of loanword adaptation articulated by Paradis 1988, and subsequently developed in work by Paradis, including Paradis & La Charité 1997 and Paradis & Prunet 2000, but has its roots in the observation by Hyman 1970 that nativization is essentially phonological, in the sense that repairs are informed by the underlying structure of the host. The model is governed by the following overarching Preservation Principle, which prefers adaptation of a non-native segment over outright deletion, up to a defined point at which deletion is in some sense more 'economical':

(30) Preservation Principle:
Segmental information is maximally preserved within the limits of the Threshold Principle

The Threshold Principle is a hypothesis that states that any given language will effect up to two repairs in a given domain before resorting to deletion. I assume this without argument, since it is not crucial to the current analysis. More important is Paradis' assertion that any repair strategy must apply at the lowest available phonological level, thereby minimizing the alteration to the loanword input. This notion is encapsulated within a Minimality Principle:

(31) Minimality Principle
a) A repair strategy must apply at the lowest phonological level to which the violated constraint refers
b) Repair must involve as few strategies (steps) as possible

The 'lowest phonological level' referred to in (31a) is in turn governed by the Phonological Level Hierarchy, given below:

(32) Phonological Level Hierarchy
metrical level > syllabic level > skeletal level > root node > feature with a dependant > feature without a dependant

For Paradis, (32) is adduced against a phonologically-specified input string, presumed to be known by the borrower following the assumption that adaptation is carried out by bilinguals, who thus have access to phonological structure of the loanword input. Adaptation is therefore a process of matching phonological structures of the host against the donor, and minimizing mismatch between them. This is somewhat at odds with the result of the discussion in section 3, where realization of borrowing of phonetically glottalized vowel-initial loans in Hawaiian, Cook Islands Maori and Tongan was cited as evidence that the input to the loanword model was a fully-specified acoustic signal, devoid of phonological structure. Hence, I will modify Paradis' model as follows:

(33) Revised TCRS:
a) Full phonetic specification (including redundancies) of segments in a borrowed (L2) form are matched with underlying feature values for phonemes in the host (L1) language
b) An input segment is modified (repaired) in such a way that, within scope of the Minimality Principle, there is a maximal correlation between features in L2 and L1

The notion of 'maximal correlation between features' in (33b) is important, since it enshrines the Minimality Principle as the prime evaluation metric for input-output similarity.

Note that the Phonological Level Hierarchy in (32) presupposes a geometrical organization of underlying features, such that delinking certain features (e.g. terminal features) is less 'costly' than delinking non-terminal or root nodes, which may have terminal dependants. The predictions made by this revision are contingent on the kind of feature organization to which the model is applied. If, for example, full underlying specification of features was assumed, as perhaps in feature geometries such as Clements 1985, McCarthy 1988, Padgett 2002 and others, two languages with identical inventories would be expected to repair a given loanword violation in identical ways. We have seen already that this is overly strong. Instead, I will take up a proposal of Clements 2001, that a model such as (33) involves reference to contrastive underspecification. Matching input forms against the host phonology thus becomes an exercise in 'fitting in' non-native forms into the systems of contrast inherent in the native system.

## 4.2 The Contrastive Hierarchy

Contrastive underspecification holds to the view that in any given inventory of speech sounds, only a subset of available features are utilized in distinguishing each member of the inventory. The contrastive hierarchy is a tiered hierarchy of contrastive features that results from applying a derivational algorithm to a particular inventory, iteratively splitting the superset into smaller contrastive groups until each segment is uniquely specified (or, using privative features, uniquely non-specified). In this way, contrastive features not only serve to establish lexical distinctiveness, but also delineate commonality amongst members which share contrastive specification for a particular feature – items that fall under the scope of a common feature will undergo any phonological rule triggered by underlying specification for that feature. The process I adopt to establish contrast is the Successive Division Algorithm (SDA, e.g., Dresher & Zhang 2000, Dresher 2001, 2003, Mackenzie 2003), given below:

(34) Successive Division Algorithm (SDA)

- a, In the initial state, all tokens in inventory I are assumed to be variants of a single member. Set I = S, the set of all members.
- b. i) If S is found to have more than one member, proceed to (c).
  - ii) Otherwise, stop. If a member, M, has not been designated contrastive with respect to a feature, G, then G is *redundant* for M.
- c. Select a new *n*-ary feature, F, from the set of distinctive features. F splits members of the input set, S, into *n* sets $F_1 – F_n$, depending on what value of F is true for all members of S.
- d. i) If all but one of $F_1 – F_n$ is empty, then loop back to (c).
  - ii) Otherwise, F is *contrastive* for all members of S.
- e. For each set $F_i$, loop back to (b), replacing S by $F_i$.

This algorithm searches a given inventory for sets containing more than a single member, and when such a set is encountered provides a feature that splits the set into further subsets. This process continues until each subset contains no more than a single member.

In order to integrate contrastive underspecification into the modified TCRS, we need to add the notion of feature scope to the Phonological Level hierarchy (32), such that repair strategies will apply to features that have the least scope, thereby maintaining maximally the system of contrasts in the host. A simple way to do this is to dispense entirely with the notion of feature dependency, and replace it with feature scope. I will assume this for the present, although I will show later that feature dependency (in the sense used by works dealing with feature geometric systems) also plays a role in the loanword model.

An upshot of this approach is that numerous feature organizations can be posited for any given inventory, depending on which features are used and the relative order in which they are applied. For example, consider a hypothetical system α that contains just two labial obstruents [p v]. The SDA might contrast [v] from [p] by applying either the feature [continuant] or [voice], in both cases specifying [v] and leaving [p] unspecified. This choice is not vacuous, since only in the first case will a rule or constraint specifying [continuant] apply to [v], while only in the second case will [v] partake in a process targeting or triggered by [voice].

Consider also the implications of choice-of-feature on relative phonological similarity. In system X the consonants /p f v/ are the only consonants that are contrastively [labial]. To further distinguish them, we can use the features [continuant] and [voice], but we derive different hierarchies depending on which feature is applied first. Applying [continuant] before [voice] gives (35a), while the reverse order gives (35b):[19]

(35) a. [cont.] > [voice]

[labial]

[continuant] (non-continuant) /p/

[voice] /v/ (voiceless) /f/

b. [voice] > [continuant]

[labial]

[voice] /v/ (voiceless)

[cont.] /f/ (non-continuant) /p/

In (35a), /v f/ are contrastively grouped together with /p/ by the feature [labial], but as a class are distinguished from /p/ by the feature [continuant]. Hence /v f/ are more similar than either /v p/ or /f p/. On the other hand, [voice] in (35b) distinguishes /v/ from /f p/, with [continuant] now only serving to contrast /f/ from /p/. Hence /f p/ are now more similar phonologically than /v p/ or /f v/. We therefore see a direct correlation between

[19] Here and throughout I use square brackets [ ] to denote contrastive features. Arced brackets ( ) are used to denote groups of segments whose domain is distinguished by lack of a given contrastive feature (otherwise put, in an approach that utilized binary features, ( ) would denote domains created by the negative specification of a contrastive feature).

the features used to establish contrast and the evaluation of phonological similarity amongst members of an inventory, a point that was raised in response to the 'structured similarity' algorithm above.

The same considerations become important in determining similarity between ill-formed loanword input and output forms. For example, consider what would happen in language Y, which contains only two labial segments /p v/, were it confronted by an ill-formed voiceless labial fricative [Φ] in a loanword. The revised TCRS states that there must be a maximal correspondence between the fully specified input and whatever L1 segment is chosen as a repair, in addition to minimizing the difference between features in the input and contrastive specifications of the repair. If [labial] is ranked above either [voice] or [continuant], the repair segment will also be a labial. However, whether [p] or [v] is chosen relies crucially on the relative ranking of [voice] and [continuant]. The two alternatives are given in (36):

(36) a. [labial] > [voice]

[labial]

[voice] (voiceless)

/v/ /p/

b. [labial] > [continuant]

[labial]

[continuant] (non-continuant)

/v/ /p/

If [voice] is contrastive (36a), we predict [Φ] will be realised as [p], since /p/ is the only (contrastively specified) non-voiced labial, and this nativization would not require modification to any contrastive features in the host. The repair [Φ] → [v], on the other hand, is dispreferred since the input and output differ by the contrastive feature [voice]. On the other hand, if [continuant] is contrastive amongst labials, then [Φ] → [v] becomes the optimal repair, since /v/ is the only (contrastively-specified) labial continuant, and [Φ] shares more (and higher-ranked) contrastive features with /v/ than with /p/.

As noted above, the SDA allows for numerous organizations for a given inventory, which in turn predicts that similar inventories might display variation in what repair strategies they employ. On the one hand, this is promising given Persistence of the Subjective, which identifies variation as a recurrent theme in adaptation systems. On the other hand, if left unconstrained this adaptation model runs up against the problem of 'Too-Many Solutions' discussed in section 2, since many more repair strategies are predicted than are actually attested. In what follows I discuss one approach that reins in possible feature hierarchies by circumscribing the possible feature orderings available to the SDA.

## 4.3 Clements 2001

Clements 2001 articulates a phonological model that is in many ways identical to that described directly above, and, like Steriade, notes that only a subset of possible representational elements play an essential role in understanding the behaviour of a given phonological system. Clements agrees with Steriade that this constitutes a problem to descriptive evaluative systems such as OT, which – if left unconstrained – generate a multitude of potentially active universal constraints for a given grammar. Clements therefore proposes a means by which OT frameworks can be instilled with representational economy, by making the constituency of possible constraints in a given system a function of specified features in the grammar. Clements proposes a layered organization of the phonology in which features are specified at a series of tiered levels, where higher, more abstract levels (lexical, underlying phonological) levels feed more concrete ones (surface phonological, phonetic). Clements hypothesizes that a feature is available to write into a constraint only if it is specified at the relevant level of abstractness. At this point representational economy is built into the system by postulating the principle of *active feature specification*, such that feature specification is constrained by necessity: a feature is specified if it is 'distinctive' (i.e. contrastive) at the lexical level, or if it is 'active' at subsequent levels. Feature 'activation' occurs if that feature is required to state some phonological or phonetic generalisation. Note that this leaves open the possibility of allowing redundant features to be active at non-lexical levels, a point that I will return to below. These conditions are set out as follows (Clements 2001:77-78):

(37) a. lexical level: distinctiveness
- A feature or feature value is present in the lexicon if and only if it is distinctive
  - A feature is distinctive in a given segment if it is required to distinguish that segment from another[20]

b. phonological levels: feature activity
- a feature or feature value is present at a given phonological level if it is required for the statement of phonological patterns (phonotactic patterns, alternations) at that level

c. phonetic level: pronounceability
- feature values are present if required to account for relevant aspects of phonetic realization

Clements further assumes that features present at any given level filter down to subsequent levels, so that features specified in the lexicon are present throughout.

Clements acknowledges that a counterpart to the Too-Many-Solutions problem exists when considering how to contrastively specify an inventory in the form of the Indeterminacy Problem (Mohanan 1991). This states that for any phoneme system, there are numerous possibilities by which it could potentially be underspecified. While the problem of over-generation has already been broached, Clements also raises the question of learnability of such systems, a problem that is of particular import in Polynesian systems that lack overt phonological evidence for particular feature orderings.[21] To address these concerns, Clements proposes that features are made accessible to a contrastive division algorithm such as the SDA according to a universal feature hierarchy, which is presumably available to the language learner as a part of UG. This

[20] As E. Dresher points out, 'required' here is ambiguous between 'needed' and 'used'. This ambiguity may be intended, since the choice of features at the lexical level is simultaneously language-specific (i.e. dependant on the make-up of the individual inventory) and deterministic (i.e. once the inventory is established, the choice of distinctive features are also known).

[21] This is particularly problematic for cue-based learning systems such as those described and proposed by Dresher 1999.

feature 'accessibility' hierarchy constrains the possible contrastive cuts that can be made at any given point in the derivation of contrastive hierarchies, and therefore addresses the problem of indeterminancy.[22]

### 4.3.1 Feature accessibility

Clements bases his hierarchy on universal observations of frequency and entailment, such that features used more frequently in the construction of phonological inventories are ranked above those that are less common. Additionally, entailment relations are encoded such that if a feature α *entails* a feature β, then α is ranked above β. A partial ranking reconstructed from Clements' discussion is given below:

(38) Feature accessibility hierarchy**:**

1. [consonantal]
2. [sonorant]
3. [labial]
4. [dorsal] ([-sonorant])
5. [strident]
6. [nasal]
7. [posterior] ([+son, -nas])
8. [posterior] ([-son])
9. [spread]
10. [constricted]
11. [lateral] ([+son])
12. [continuant] ([-voice, -son])
13. [voice] ([-son])

An important feature of this hierarchy is that it is not a flat structure - certain features are restricted such that they can only be accessed once other particular features are activated (i.e. the former are only permitted within the domain of the latter). Thus, [lateral] is available only for those segments that are already specified for [+sonorant]. This restriction is intended to capture dependencies within natural classes, as well as to account for relative frequency amongst segments.[23]

This structured approach is particularly appealing when considering languages that are almost entirely bereft of phonological processes or phonetic variation, since it predicts that such languages still have feature structure at the lexical level. As the previous section suggested, some kind of feature organization is crucial in understanding the variation in adaptation patterns adopted by different Polynesian languages, despite the near-total absence of phonological processes in these languages.[24]

---

[22] The question of whether the feature accessibility hierarchy itself is open to variation, and what variation is permitted (and when) is an open one. While this paper assumes a strong 'minimalist' thesis (no variation), it is likely that this is overly strong, especially with vowel systems. The more interesting question is, given the feature accessibility hierarchy in (38), what is the range of reorderings that might be (or, given a particular hypothesis, should be) permitted. The answer to this is, primarily, empirical.

[23] An example of the latter is the dependency of [dorsal] on [-sonorant], imposed to express the observation that dorsal obstruents are more frequently encountered than dorsal sonorants. However, given that the velar nasal [ŋ] is common to almost all of the Polynesian languages investigated here, I will modify this by assuming that [dorsal] is also available to contrast amongst nasals.

[24] This requirement mitigates against a phonological model for which general economy principles might dictate that inactive features be left unordered in the lexicon.

To incorporate the accessibility hierarchy into the SDA given in (34), we must specify that at step (c), feature selection makes reference to the feature accessibility hierarchy. That is, at the point at which the SDA nominates a feature to reduce a set to its binarily appositive daughters, the highest available member of (38) is accessed. This choice is constrained to choose not only the highest available feature, but also to ensure that implicational relationships amongst already-specified features are upheld.

In the following sections I will apply this model to the several Polynesian languages, establishing contrastively (lexically) underspecified matrices for each. Recall that these languages are almost completely lacking in phonological alternations. This means that the active features in each phonology are in the most part restricted to those required at the lexical level, plus any that are needed to account for phonetic variation. I will show that integrating both the TCRS and SDA with Clements' feature organization makes interesting and – for the most part – correct predictions regarding adaptation patterns described for these languages. However, I will show that the feature accessibility hierarchy in (38) alone is insufficient to capture all instances of cross-linguistic variation.

## 5 Tongan (Tongic)

Consider first the Tongan consonantal inventory:

(39) Tongan consonantal inventory

| | | | |
|---|---|---|---|
| p | t | k | ʔ |
| f v | s | | h |
| m | n | ŋ | |
| l | | | |

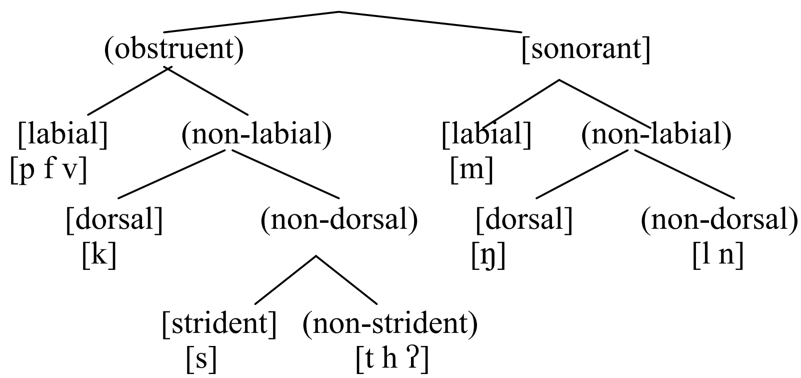
Assuming that this inventory is already contrasted with vowels by the feature [consonantal], the first feature from the accessibility hierarchy that the SDA will choose to employ will be [sonorant], which divides the inventory into sonorants and obstruents:

| (obstruent) | [sonorant] |
|---|---|
| [p t k ʔ f v s h] | [l m n ŋ] |

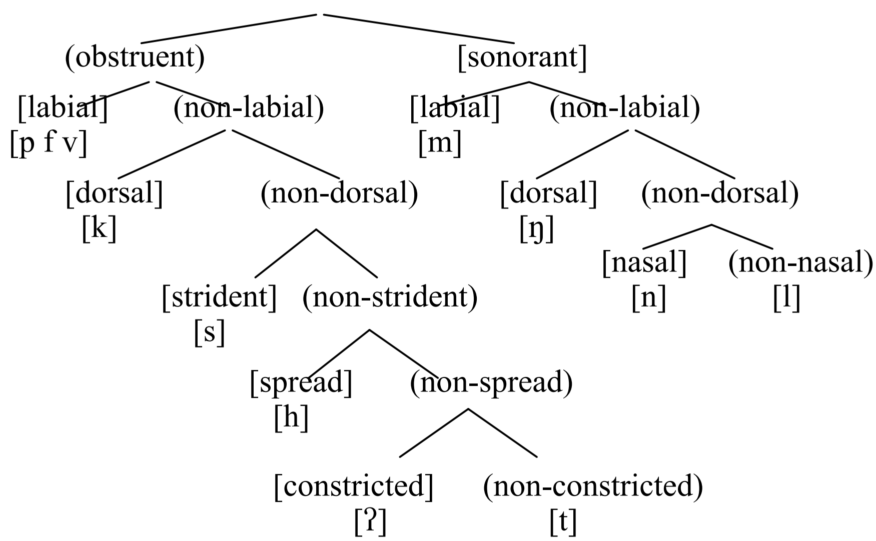
The next feature, according to (38), is [labial]. This feature is specified in both sonorants and non-sonorants:

| (obstruent) | | [sonorant] | |
|---|---|---|---|
| [labial] | (non-labial) | [labial] | (non-labial) |
| [p f v] | [t s k h ʔ] | [m] | [l n ŋ] |

[dorsal] is then used to contrast [k] with [t ʔ s h], and [ŋ] with [l n], after which [strident] contrasts [s] with [t ʔ h].

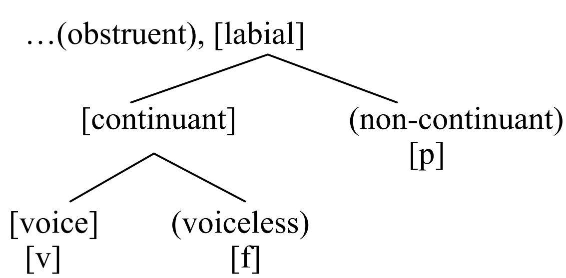



Next, [nasal] contrasts [n] with [l], [spread] contrasts [h] with [ʔ t], and [constricted] contrasts [ʔ] with [t]:[25]




Note that it makes no difference which of [spread] or [constricted] are applied first, since the same contrastive specifications will result. I will return to the question of which should be accessed first later in this section, and discuss a possible source of evidence.

This leaves the non-sonorant labials as the only non-contrastively specified set. Accordingly, following (38) [continuant] is accessed first, and distinguishes [f v] from [p], after which [v] is specified as the lone contrastively [voiced] obstruent:




[25] Note that these specifications correctly predict that /m n ŋ/ - though phonetically nasal – will not pattern together as nasals phonologically, since they are not all contrastively specified as [nasal].

All of the Tongan phonemes are now contrastively specified, as the following table shows. These feature values will therefore be present at the lexical level in Tongan:[26]

(40) Contrastive specifications for Tongan consonants ([consonantal])

| Tongan | p | t | k | ʔ | f | v | s | h | m | n | ŋ | l |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| [sonorant] | | | | | | | | | √ | √ | √ | √ |
| [labial] | √ | | | | √ | √ | | | √ | | | |
| [dorsal] | | | √ | | | | | | | | √ | |
| [strident] | | | | | | | √ | | | | | |
| [nasal] | | | | | | | | | | √ | | |
| [spread] | | | | | | | | √ | | | | |
| [constricted] | | | | √ | | | | | | | | |
| [continuant] | | | | | √ | √ | | | | | | |
| [voiced] | | | | | | √ | | | | | | |

The English segments that are not found in Tongan are the following: voiced plosives /b d g/, fricatives /θ ð z ʃ ʒ/, affricates /tʃ dʒ/, and approximants /ɹ j w/. Recall that the prediction of the revised TCRS is that these segments will be matched with phones in the host with which they share most contrastive features, and in such a way as to preserve maximally features with higher scope. We have already seen in (29) that voiced plosives are adapted as their voiceless counterparts. This falls out from the contrastive hierarchy created by the feature specifications in (40), as follows: /p/ is specified as the sole non-continuant, labial obstruent, and hence is the best repair for [b]. /k/ is specified as the sole velar obstruent, making it the best match for [g]. /t/ is unspecified for place or manner, meaning borrowing [d] as /t/ does not lead to the deletion or addition of contrastive features. On the other hand, borrowing [d] as /s/ requires the addition of [strident], and any other repair will also require the linking of a contrastive feature. Hence /t/ is the optimal repair for [d]. Indeed, the low accessibility of [voice] generally means that voiced obstruents will predominantly be realised as their voiceless counterparts in systems that do not have voicing contrasts, as observed by Steriade 2001 above.

Next, consider the adaptation of non-glottal fricatives and affricates:

(41) Tongan

[z] → /s/

| | | | |
|---|---|---|---|
| pansy | [pænzi] | → | pani**s**ī |
| physics | [fɪzɪks] | → | fi**s**iki |
| c**z**ar | [za] | → | **s**ā |

[26] Note that a blank denotes non-specification. I depart from Clements by assuming privative features here and throughout.

| | | | |
|---|---|---|---|
| [ʃ] → /s/ | | | |
| shah | [ʃa] | → | [sā] |
| bishop | [bɪʃəp] | → | [pīsope] |
| shamrock | [ʃæmrɔk] | → | [samiloki] |
| | | | |
| [ʒ] →/s/ | | | |
| Persia | [pɜʒə] | → | [pēsia] |
| vision | [vɪʒən] | → | [visone] |
| | | | |
| [tʃ] → /s/ | | | |
| church | [tʃɜtʃ] | → | [siasi] |
| crotchet | [krɒtʃət] | → | [kolositi] |
| peach | [pitʃ] | → | [pīsi] |
| | | | |
| [dʒ] → /s/ | | | |
| june | [dʒun] | → | [sune] |
| passage | [pæsədʒ] | → | [pāsese] |
| giant | [dʒajənt] | → | [saiāniti] |

(42)

| | | | |
|---|---|---|---|
| [θ]→ /t/ | | | |
| throne | [θɹown] | → | [talani] |
| mammoth | [mæməθ] | → | [mamota] |
| anthem | [ænθəm] | → | [‘anitema] |
| | | | |
| [ð] → /t/ | | | |
| leather | [lɛðə] | → | [leta] |
| heather | [hɛðə] | → | [heta] |

These examples show that dental fricatives are realised as /t/, while sibilants are adapted as /s/. This outcome is predicted if [strident] is the relevant feature distinguishing /s/ from /t/ in Tongan, since [s z ʃ ʒ tʃ dʒ] are all phonetically [strident], while [θ ð] are not. The nativisation of the latter as /t/ is also predicted, since any other repair will necessitate a repair involving a contrastive feature (linking of either [spread] for /h/, [strident] for /s/, or [labial] for /f/ or /v/).

Lastly, note that /l/ is contrastively specified as the only non-nasal, consonantal sonorant. This explains why /l/, and not /t/, is chosen as the repair for the alveolar approximant [ɹ], which shares /l/’s specification for [sonorant]:

(43)

| | | | |
|---|---|---|---|
| [ɹ] → /l/ | | | |
| fairy | [ˈfeɹi] | → | [feeli] |
| crystal | [ˈkɹɪstl̩] | → | [kalisitala] |
| admiral | [ˈʔædməɹəl] | → | [ʔaamelali] |

Happily, the adaptation patterns found in Tongan reinforce the model of adaptation proposed here, and so far offers support for the ordering within the feature accessibility hierarchy proposed by Clements.

## 5.1 Niuean (Tongic)

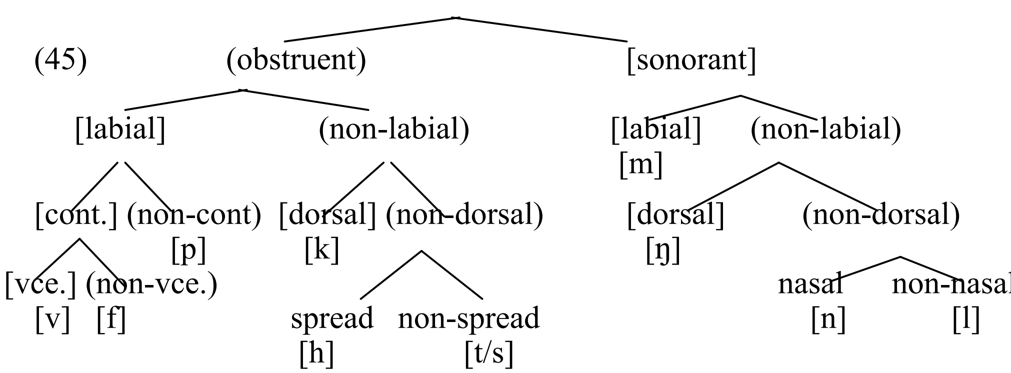
The other Tongic language, Niuean, has exactly the same patterns of adaptation as Tongan, despite having a slightly different phonemic system. The main difference is that at some point in its history, /s/ lost its phonemic status in Niuean, but was retained as an allophone of /t/ before the non-back vowels [i e]. Additionally, the glottal stop [ʔ] was lost altogether. Following Dresher & Zhang 2000, sound change can often be viewed as neutralization or development of contrast. In this case, the loss of /ʔ/ can be explained as [constricted] being lost as a contrastive feature. The resulting inventory is given in (44). The non-phonemic status of [s] is indicated by italics:

(44) Niuean consonantal inventory

| | | |
|---|---|---|
| p | t | k |
| f v | *s* | h |
| m | n | ŋ |
| l | | |

Applying the revised SDA establishes the following contrastive underspecifications at the lexical level:

(45)




We also need a feature to contrast /t/ and [s] at the surface phonological level. We could perhaps use either [continuant] or [strident] to effect this contrast, and Clements is unclear which should be accessed – on the one hand, [strident] is higher on the accessibility hierarchy, but on the other [continuant] is already activated, establishing contrast amongst labial obstruents, which could conceivably affect its availability for establishing low-level contrasts. We can look to empirical evidence as a means to inform this choice, by looking at what each choice would predict in nativisation. If [s] is specified as [continuant], then the revised TCRS predicts it to be chosen as the repair for all coronal fricatives. On the other hand, if [s] is specified as [strident], we predict that only stridents will be repaired as [s], while non-strident coronal fricatives [θ ð] will be nativized as the non-sonorant, non-labial, non-strident /t/. As the data in (46) show, the latter makes the correct predictions. This provides additional support for the accessibility hierarchy in (38):

(46) Niuean

a. [s] → [s]

| | | | |
|---|---|---|---|
| aspirin | [ˈʔæspɹɪn] | → | /asepoloo/ |
| slab | [slæb] | → | /selepe/ |

| | | | | |
|---|---|---|---|---|
| b. | [z] → [s] | | | |
| | galvanized | [ˈgælvənajzd] | → | /kalavanisi/ |
| | fertilizer | [ˈfɜtəˌlajzə] | → | /fetalaisa/ |
| c. | [ʃ] → [s] | | | |
| | fashion | [ˈfæʃn̩] | → | /faasone/ |
| | sugar | [ˈʃʊgə] | → | /suka/ |
| d. | [tʃ]→ [s] | | | |
| | March | [matʃ] | → | /masi/ |
| | champion | [ˈtʃæmpjɪn] | → | /samipioni/ |
| e. | [dʒ] → [s] | | | |
| | journal | [ˈdʒɜnl̩] | → | /seenolo/ |
| | jar | [dʒa] | → | /siaa/ |

(47)

| | | | | |
|---|---|---|---|---|
| a. | [θ] → [t] | | | |
| | sabbath | [ˈsæbəθ] | → | /sapeti/ |
| b. | [ð] → [t] | | | |
| | leather | [ˈlɛðə] | → | /leta/ |

These contrasts are schematised as follows:

(48) Niuean contrastive underspecification

| **Niuean** | **p** | **t** | **k** | **f** | **v** | **s** | **h** | **m** | **n** | **ŋ** | **l** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| LEXICAL [sonorant] | | | | | | | | √ | √ | √ | √ |
| [labial] | √ | | | √ | √ | | | √ | | | |
| [dorsal] | | | √ | | | | | | | √ | |
| [nasal] | | | | | | | | | √ | | |
| [spread] | | | | | | | √ | | | | |
| [continuant] | | | | √ | √ | | | | | | |
| [voiced] | | | | | √ | | | | | | |
| SURFACE [strident] | | | | | | √ | | | | | |

There are two important points to note here. The first is that Niuean provides evidence that non-lexical contrastive feature specifications access the feature accessibility hierarchy the same way as do lexical contrasts. Secondly, non-lexical contrasts must be able to influence nativization strategies. This is supported by the fact that [strident] influences the adaptation of phonetically strident fricatives and affricates as [s] in Niuean, despite it only being specified at the surface phonological level. This reproduction of [s] in loanwords has led to an extension of the distribution for [s] in Niuean, since it is no longer in complementary distribution with /t/ in loanword environments. Conversely, if non-lexical features were unable to factor into nativisation repairs, we would have expected loanwords containing strident segments to be realised as the *phonemically* non-labial, non-spread [t]. This in turn suggests that close attention must be paid to even low-level phonetic contrasts, since these can provide explanations for otherwise obscure adaptation patterns. In other words, *all* active features (in the sense intended by Clements) must be available to the TCRS for computation of similarity.

## 5.2 Proto-Eastern Polynesian

The rest of the languages to be looked at are all members of the Eastern Polynesian subgroup, and are diachronically related to the older Tongic languages (Tongan and Niuean). Proto-Eastern Polynesian (PEP) is reconstructed by Krupa 1982 as containing the segments listed in (49b). Compare this with Proto-Polynesian, repeated in (49a):

(49) a. Proto-Polynesian

p t k ʔ<br>
f s h<br>
m n ŋ<br>
w l r

b. Proto-Eastern Polynesian

p t k ʔ<br>
f v h<br>
m n ŋ<br>
l

Krupa reconstructs the main sound changes as follows: /h/ was lost as a phoneme, becoming zero. Subsequently, /s/ underwent a sound change to /h/, with the net result that /t/ became the only coronal obstruent. The alveolar approximant /r/ was also lost, either dropping out altogether or neutralizing with /l/. Finally, the labial approximant /w/ underwent a sound change, becoming a voiced labial fricative /v/. I will now consider several of PEP daughter languages, beginning with Hawaiian.

### 5.2.1 Hawaiian

Hawaiian is well-known due to its severely impoverished consonantal inventory, given in (28) and repeated below:

(50) Hawaiian consonant inventory

p k ʔ<br>
h<br>
w l<br>
m n

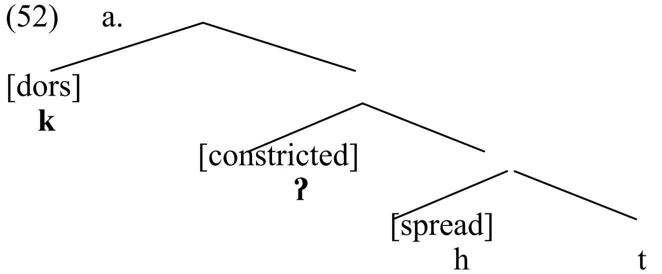
The paucity of segments is the result of a series of consonant shifts and sound changes, which are as follows:

(51) Sound changes (PEP → Hawaiian)

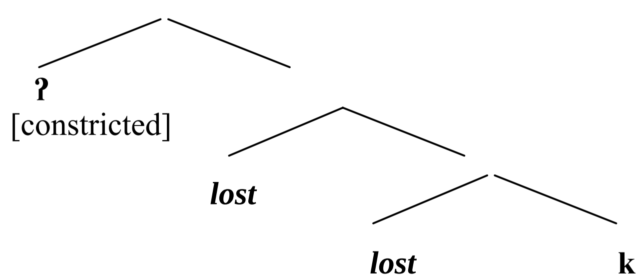
v > w
f > h
h > zero
t > k
k > ʔ
ʔ > zero
ŋ > n

The following is an attempt to reconstruct these changes: /v/ underwent a sound change to /w/, becoming contrastively [sonorant] and losing its specification for both [voice] and [continuant]. This resulted in the specification of [nasal] for /m/, required to contrast it with /w/. Phonetically, the place of articulation of the voiced labial also changed from labiodental to labiovelar, although labiodental articulation [ʋ] was retained as allophonic variation following front vowels /i e/ (Elbert 1970). This in turn meant that /f/ and /h/ became contrastive by a single feature, [labial]. Subsequently, a generalised consonant shift occurred, whereby the glottals were lost, resulting in the velar /k/ backing to glottal /ʔ/ and the coronal /t/ backing to velar /k/. Schematically, this movement can be represented by considering the contrastive relations in (52a) being replaced by those in (52b):

(52) a.




b.




In terms of feature specifications, (52b) shows that the loss of /ʔ/ and /h/ resulted in loss of [constricted] and [spread] as contrastive features. Importantly, the hierarchical relations between the remaining segments remained in place, with /t/ → /k/ maintaining its position as the unmarked obstruent. After /k/ changed to /ʔ/, [constricted] was then reintroduced to maintain the new contrast between /ʔ/ and /k/, with the result that [dorsal] was lost as a contrastive feature amongst obstruents. Analogously, [dorsal] was also lost amongst sonorants, resulting in the loss of /ŋ/. Lastly, the sole [continuant] /f/ underwent a change in value to become /h/, losing its [labial] specification and once again leading to

/h/ contrasting with /ʔ k/. This contrast was then re-established by reintroducing [spread]. The resulting specifications are given in (53), and set out in table form in (54):

(53)

(obstruents) [sonorant]

[labial] (non-labial) [labial] (non-labial)

/p/

[spread] (non-spread) [nasa] (non-nasal) [nasal] (non-nasal)

/h/ /m/ /w/ /n/ /l/

[constr.] (non-constr.)

/ʔ/ /k/

(54) Hawaiian contrastive specification

| **Hawaiian** | **p** | **k** | **ʔ** | **w** | **(ʋ)** | **h** | **m** | **n** | **l** |
|---|---|---|---|---|---|---|---|---|---|
| LEXICAL | | | | | | | | | |
| [sonorant] | | | | √ | √ | | √ | √ | √ |
| [labial] | √ | | | √ | √ | | √ | | |
| [nasal] | | | | | | | √ | √ | |
| [constricted] | | | √ | | | | | | |
| [spread] | | | | | | √ | | | |
| SURFACE | | | | | | | | | |
| [dental] | | | | | √ | | | | |

Note that the allophonic labiodental articulation for /w/ is taken care of by linking a [dental] feature to /w/ at the surface phonological level.

Again, Clements' feature accessibility hierarchy predicts the correct adaptations of non-native segments: all non-labial fricatives (as well as all other non-labial, non-glottal obstruents) are realised as /k/, rather than the glottal fricative /h/. This is wholly unsurprising since /h/ is contrastively [spread], rather than [continuant], while /k/ is the default non-labial, non-glottal obstruent:

(55) Hawaiian

a. [t] → /k/

| | | | |
|---|---|---|---|
| truck | [tɹʌk] | → | /kalaka/ |
| carrot | [ˈkæɹət] | → | /kaaloke/ |

b. [d] → /k/

| | | | |
|---|---|---|---|
| card | [kɑd] | → | /kaaleka/ |
| drive | [dɹajv] | → | /kalaiwa/ |

c. [θ] → /k/

| | | | |
|---|---|---|---|
| theatre | [ˈθiətə] | → | /keaka/ |
| mathematics | [ˌmæθəˈmætɪks] | → | /makemakika/ |

d. [s] → /k/

| | | | |
|---|---|---|---|
| lettuce | [ˈlɛtɪs] | → | /lekuke/ |
| soap | [sowp] | → | /kope/ |

e. [z] → /k/

| | | | |
|---|---|---|---|
| dozen | [ˈdʌzn̩] | → | /kaakini/ |

f. [ʃ] → /k/

| | | | |
|---|---|---|---|
| commsioner | [kəˈmɪʃənə] | → | /komikina/ |
| brush | [bɹʌʃ] | → | /palaki/ |
| machine | [məˈʃin] | → | /miikini/ |

g. [tʃ] → /k/

| | | | |
|---|---|---|---|
| watch | [wɒtʃ] | → | /uaki/ |
| chocolate | [ˈtʃɑklət] | → | /kokaleka/ |

h. [dʒ] → /k/

| | | | |
|---|---|---|---|
| sandwich | [ˈsændwɪdʒ] | → | /kanuwika/ |
| average | [ˈævəɹədʒ] | → | /ʔawelika/ |

Other loanword data fall out naturally from the specifications in (54): the voiceless labial fricative /f/ is realized as the sole [labial] obstruent /p/, velar nasals are realized as the default nasal /n/, and [w] is in most cases faithfully represented by the [sonorant][labial] /w/.[27] Adaptation of [v] as [w] is also predicted, due to the existence of the labiodental approximant [ʋ] as an allophone of /w/. Clements 2001:87 proposes that since /v/ has frictionless articulations in English, the Hawaiian speaker classifies [v] in the loanword input as a sonorant similar to [ʋ], resulting in it being borrowed as /w/.[28]

(56) Hawaiian

a. [v] → /w/

| | | | |
|---|---|---|---|
| violin | [ˈvajəˌlɪn] | → | /waiolina/ |
| November | [ˌnowˈvɛmbə] | → | /nowemapa/ |
| guava | [ˈgwɑvə] | → | /kuawa/ |

b. [ŋ] -> /n/

| | | | |
|---|---|---|---|
| stocking | [ˈstɑkɪŋ] | → | /kaakini/ |
| Washington | [ˈwɑʃəŋˌtɪn] | → | /wakinekona/ |
| handkerchief | [ˈhæŋkəˌtʃif] | → | /hainakaa/ |

---

[27] Note, however, I did encounter three examples that appear to show [w] being adapted as a high back round vowel /u/, as in (55g). Also *wick* /uiki/, *wire* /uea/. Due to lack of data, I am unable to determine whether this variation is phonologically conditioned, whether diachronic factors may be involved, or whether there really is in fact variation here at all (i.e. whether the 'variation' is simply orthographic convention rather than a phonetic alternation).

[28] An interesting question is whether the borrowed segment obeys the same phonotactic restrictions on its pronunciation as /w/ in native words, or whether it is always rendered a labiodental articulation. I leave this as a topic for future research.

So far, then, the data that we have seen from Tongan, Niuean and Hawaiian support Clements' ordering of features within the feature accessibility hierarchy given in (38). Particularly, we saw that in Hawaiian /h/ needed to be contrasted with /k ʔ/ via the feature [spread], rather than [continuant], since the latter would make /h/ the default non-labial fricative, incorrectly predicting it to be the repair for ill-formed coronal fricatives instead of /k/. In fact, the loanword model as it stands makes an even stronger prediction, namely that in a system that lacks coronal fricatives but contains /h/, /h/ should never be interpreted as the default fricative, since in accordance with the universal accessibility hierarchy it will always be specified as [spread] rather than [continuant]. NZ Māori provides an opportunity to test this prediction, since – like Hawaiian – it lacks /s/ and contains /h/.

### 5.2.2 NZ Māori

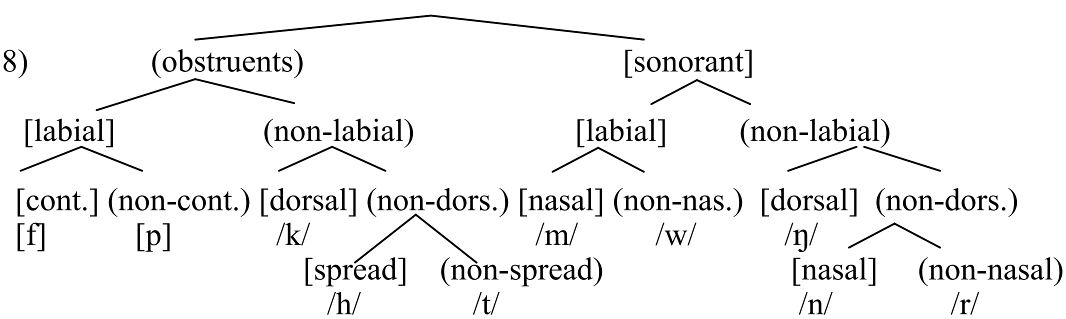
NZ Māori has the following phonemic inventory:

(57) NZ Māori consonantal inventory

| | | |
|---|---|---|
| p | t | k |
| f | | h |
| m | n | ŋ |
| w | r | |

It shares many similarities to Hawaiian, having lost the glottal stop, and /h/ having become zero at the same point at which /s/ underwent a sound change to become /h/. Unlike Hawaiian, these consonantal losses did not spark a wholesale consonant shift, with /t/ retaining its phonemic status. Additionally, [dorsal] remained as contrastive in both the sonorant and non-sonorant groups, and /f/ remained contrastively [labial]. Assigning contrastive specifications to this inventory in the same way as we did previously results in the following contrastive hierarchy:

(58)




This hierarchy is represented in table-form below:

(59) NZ Māori contrastive specification #1

| NZ Māori | p | t | k | f | h | w | m | n | ŋ | r |
|---|---|---|---|---|---|---|---|---|---|---|
| [sonorant] | | | | | | √ | √ | √ | √ | √ |
| [labial] | √ | | | √ | | √ | √ | | | |
| [dorsal] | | | √ | | | | | | √ | |
| [nasal] | | | | | | | √ | √ | | |
| [spread] | | | | | √ | | | | | |
| [continuant] | | | | √ | | | | | | |

These specifications predict the following adaptations:

1) [l] will be adapted as /r/, the sole non-labial, non-dorsal, non-nasal sonorant
2) The labio-velar approximant [w] will be realized as the non-nasal labial sonorant /w/
3) Since /p/ is the default non-sonorant labial, it will be the repair for [p b], while the non-sonorant labial continuant /f/ will be the repair chosen for both [f v]
4) Since /h/ is [spread], /t/ is the default non-sonorant, non-labial, non-dorsal segment, and will be chosen as the repair for all coronal obstruents.
5) Since /k/ is narrowly specified as [dorsal], it is no longer a default obstruent (as in Hawaiian), but will only be used to repair dorsal obstruents [k g]

The following data show that several of these predictions hold true – [l] is borrowed as the default sonorant /r/ (60a), while [w] is faithfully realized as /w/ (60b):

(60) NZ Māori

a. [l] → /r/

| | | | |
|---|---|---|---|
| pill | [pɪl] | → | /pire/ |
| lady | [ˈlejɾi] | → | /reire/ |
| gallon | [ˈgælən] | → | /kaarani/ |

b. [w] → /w/

| | | | |
|---|---|---|---|
| will | [wɪl] | → | /wira/ |
| weasel | [ˈwizl̩] | → | /wiihara/ |
| railway | [ˈɹejəlwej] | → | /rerewee/ |

One prediction that is not correct concerns the adaptation of labiodental fricatives. While our adaptation model predicts /f/ to be the optimal repair (being contrastively [labial] and [continuant]), we find [v] consistently realized as the bilabial approximant /w/:

(61) [v] → /w/

| | | | |
|---|---|---|---|
| vinegar | [ˈvɪnəgə] | → | /winika/ |
| value | [ˈvælju] | → | /waariu/ |
| level | [ˈlɛvəl] | → | /reewara/ |

This mirrors the pattern found in Hawaiian. It may be that in NZ Māori, as in Hawaiian, an explanation may be found in the surface phonetics of /w/ - if NZ Māori employs the same kind of phonetic variation in the articulation of /w/ as we saw in Hawaiian, then the perception of [v] as a sonorant and subsequent realization as /w/ might be less mysterious. In the absence of compelling data, I leave this as an unresolved problem.

As the following data show, prediction 5) is also upheld - velar stops [k g] are borrowed as /k/ (64), while other non-labial obstruents are not (62-64):

| | | | | |
|---|---|---|---|---|
| (62) | fig | → | fiki | (NZ Māori) |
| | guitar | → | kitā | (NZ Māori) |

(63) a. [θ] → /t/

| | | | |
|---|---|---|---|
| oath | [owθ] | → | /oati/ |
| throne | [θɹown] | → | /toroona/ |
| catholic | [ˈkæθəˌlɪk] | → | /katorika/ |
| thread | [θɹɛd] | → | /tarete/ |

b. [ð] → /t/

| | | | |
|---|---|---|---|
| weather | [ˈwɛðə] | → | /weta/ |

(64) a. [s] → /h/

| | | | |
|---|---|---|---|
| canvas | [ˈkænvəs] | → | /kaanawehi/ |
| glass | [glɑs] | → | /karaahe/ |
| sardine | [ˌsɑˈdin] | → | /haarini/ |
| whisky | [ˈwɪski] | → | /wehike/ |

b. [z] → /h/

| | | | |
|---|---|---|---|
| weasel | [ˈwizl̩] | → | /wiihara/ |
| rose | [ɹowz] | → | /roohi/ |
| prize | [pɹajz] | → | /paraihe/ |

c. [ʃ] → /h/

| | | | |
|---|---|---|---|
| commision | [kəˈmɪʃən] | → | /koomihana/ |
| brush | [bɹʌʃ] | → | /paraihe/ |
| pension | [ˈpɛnʃən] | → | /penihana/ |
| sheep | [ʃip] | → | /hipi/ |

(63) shows that dental fricatives are borrowed as /t/. This follows from the contrastive hierarchy in (58), which offers /t/ as the default non-dorsal, non-labial obstruent. However, the data in (64) is unexpected (and hence interesting), since it shows all other coronal fricatives systematically adapted as /h/. This is in addition to /h/ being the repair for loanwords containing [h], as we expect:

(65) [h] → /h/

| | | | |
|---|---|---|---|
| heifer | [ˈhɛfə] | → | /hefa/ |
| handle | [ˈhændl̩] | → | /hanara/ |
| hammock | [ˈhæmək] | → | /haamaka/ |

Ignoring the realization of dental fricatives as /t/ for the moment, if /h/ is the optimal repair for the segments /s z ʃ h/, then the relevant feature at the lexical level that determines /h/ being the closest match must be [continuant]. Returning to the contrastive specifications in (58), this means that /h/ must be contrasted from /t/ by [continuant] rather than [spread]. Recall from our discussion in the previous section that this state of affairs that was explicitly predicted not to be possible, since [spread] is ranked above [continuant] in the feature accessibility hierarchy - hence the former will always be accessed first when required to contrast /t/ with /h/.

There are two ways to proceed at this point. First, we could abandon the strong hypothesis that the order of the feature accessibility hierarchy is universally fixed, and instead allow language-specific reordering. This would grant NZ Māori access to a different hierarchy than Hawaiian, where [continuant] is accessed before [spread] in the former and [spread] before [continuant] in the latter. However, the cost of allowing reordering on a language-by-language basis is high, since our adaptation model loses much of the predictive and explanatory power; this is the kind of convenient, language-specific reordering of features or constraints found in Jacobs & Gussenhoven, Steriade and others that was argued against in Section 2. Instead, I will continue to maintain that the feature accessibility hierarchy given in (38) is essentially correct. I will argue instead that the variation in adaptation of coronal fricatives in Hawaiian and NZ Māori comes from the fact that the feature [spread] is not available to NZ Māori in the same way as it is to Hawaiian. In other words, at the point at which NZ Māori seeks to contrast /t/ and /h/, the only *accessible* feature is [continuant].

In considering how such a state of affairs might eventuate, note first that NZ Māori lacks a phonemic glottal stop [ʔ], while this segment is fully productive in Hawaiian. Throughout this section I have assumed [ʔ] to be specified contrastively as [constricted]. In traditional feature geometries (e.g. Clements 1985, McCarthy 1988, Padgett 2002), both [spread] and [constricted] are assumed to be dependants of the articulator node *laryngeal*. More recently, however, Avery & Idsardi 2001 (henceforth A&I) have argued that *laryngeal* should be decomposed into both a level of *dimensions*, which denote particular muscle groups in the larynx, and their dependents, called *gestures*. The features [constricted] and [spread] are argued to be dependents of the dimension *Glottal Width*:

(66) Organization of the Laryngeal node: (Avery & Idsardi)

| *Articulator* | *Dimensions* | *Gestures* |
|---|---|---|
| | | [spread] |
| | Glottal Width | [constricted] |
| | | [stiff] |
| Laryngeal | Glottal Tension | [slack] |
| | | [raised] |
| | Larynx Height | [lowered] |

Avery & Idsardi claim that in the general case, only dimensions – and not gestures – can be contrastive. This is tied to the notion of 'head', insofar as the head of a segment must have a minimal amount of structure phonologically, while non-head dependants are less specified. In segments containing oral constriction, laryngeal features are always dependants, and thus are less specified. Consequently, laryngeal gestures cannot be used contrastively for oral segments.[29] However, if a segment projects only a laryngeal

[29] In languages such as English where contrast between glottalised (or 'tense/fortis'), aspirated and voiceless stops is purely phonetic, these non-phonemic contrasts are supplied via completion. In languages

articulator node (e.g. if it is a glottal stop or fricative), this node must be the head, and therefore must have at least minimal structure (p.49). Since the gestures are the only available structure, gestures may be projected contrastively for segments that contain only laryngeal structure.

A&I state (p.49) that when GW is the head of a segment, [spread] or [constricted] must be specified phonemically (even though it is not required contrastively), depending on whether /h/ or /ʔ/ is required. Korean /h/, for example, is assigned the following underlying representation (p.61):

(67) Representation of /h/

```
   C
   |
 [GW]
   |
[spread]
```

Regarding the structure of /ʔ/, A&I propose that in systems where the glottal stop and glottal fricative are contrastive, /ʔ/ is specified as having both a GW node and a dependant [constricted]. This contrasts with instances where [h ʔ] are in non-contrastive variation, in which case the glottal contains a bare GW node. From the point of view of establishing contrast, there is no difference between specifying /ʔ/ as [GW-constricted] or leaving it as simply [GW]. In terms of representational economy, the latter is preferred, since it reduces redundant information (i.e. the specification [constricted]) in the phonology. I therefore adopt the following representations for /ʔ h/ in a system where they are contrastive (such as Hawaiian):

(68)

```
 /ʔ/        /h/
  |          |
  C          C
  |          |
[GW]       [GW]
             |
          [spread]
```

The feature [constricted] is added late at the phonetic level to the representation of [ʔ] as phonetic completion (A&I:62) Thus, [GW], and not [constricted], is contrastive for [ʔ]. On the other hand, [spread] may be contrastive for [h], but only if [GW] is also specified, since [spread] is a dependant of GW.

There is therefore a conditional relationship between [spread] and [GW], such that [spread] is only available as a contrastive feature if [GW] has already been accessed (i.e. if [GW] is active). This relationship is proposed by Clements elsewhere in the accessibility hierarchy, such as between [sonorant] and [lateral]. I will refer to this association as *contingent accessibility*.

This proposal makes a strong prediction: /h/ can only be contrastively [spread] if /ʔ/ is also phonemic in the system, otherwise [spread] is unavailable contrastively, and will only be present as phonetic enhancement. [continuant] will therefore be used to

---

like Korean, where these contrasts are phonemic, A&I use length contrast as well as phonetic enhancement to derive the same alternations.

contrast /h/.[30] In terms of adaptation, this implies that /h/ may only behave like a fricative (i.e. be a prospective repair for ill-formed fricatives in the input) if /ʔ/ is not present phonemically. This correctly predicts that in languages like NZ Māori, which lacks /ʔ/, /h/ will be contrastively specified for [continuant], and will be the preferred repair for non-labial fricatives. On the other hand, /ʔ/ is phonemic in Hawaiian, and therefore the activation of [GW] makes [spread] available for /h/; hence, /h/ will not be deemed a prospective replacement for non-labial fricatives, which will instead be nativized as /k/.

This analysis resolves a question raised earlier regarding which of [constricted] (i.e. [GW]) or [spread] ([GW-spread]) is accessed first, since implicational relations impose the requirement that [GW] be accessed first.

We see also that only by accessing [GW] can the organizing node *laryngeal* play a contrastive role in the phonology. Since this only happens when glottal stops are phonemic, systems such as NZ Māori that only have the glottal fricative /h/ do not employ the *laryngeal* node except as late phonetic enhancement. This serves to maintain representational economy in the phonology.

Let us now consider whether this reanalysis of feature specifications within the laryngeal system requires any reanalysis of the systems and hierarchies that have already been discussed. Tongan and Hawaiian both have /ʔ/ and /h/, so the former is reanalyzed as contrastively [GW] and the latter as [GW-spread]. These labels simply replace [constricted] and [spread], with /h/ being narrowly specified as a glottal fricative in both languages. In these languages we correctly predict that /h/ will act as a repair for [h] only, and not for other fricatives in the loanword input (as attested by the data in (41), (46) and (55)).[31]

Returning to NZ Māori, the revised contrastive specifications are as follows:

(69) NZ Māori contrastive underspecification #2

| **NZ Māori** | **p** | **t** | **k** | **f** | **h** | **w** | **m** | **n** | **ŋ** | **r** |
|---|---|---|---|---|---|---|---|---|---|---|
| LEXICAL<br>[sonorant] | | | | | | √ | √ | √ | √ | √ |
| [labial] | √ | | | √ | | √ | √ | | | |
| [dorsal] | | | √ | | | | | | √ | |
| [nasal] | | | | | | | √ | √ | | |
| [continuant] | | | | √ | √ | | | | | |

Contingent accessibility explains why [s z ʃ h] are nativized as /h/ in NZ Māori. However, the analysis as it stands faces another problem, since it incorrectly predicts that *all* non-labial fricatives will be adapted as /h/ - as we saw in (63), dental fricatives are borrowed as /t/. Since /h/ is specified as the default non-labial fricative, it should be the preferred adaptation for not only sibilant fricatives, but dental fricatives as well. This same problem surfaces for Niuean – Niuean does not have a phonemic glottal stop, so [GW-spread] cannot be accessed to contrast /h/ with /t/. As in NZ Māori, we must use [continuant] instead. In Niuean, [s] contrasts with /t/ at the surface phonological level via [strident], so strident fricatives are still predicted to be realized as [s]. However, as in NZ

[30] Following Vaux's Law (Vaux 1998), fricatives have [GW] added as an obligatory phonetic enhancement. Hence [GW] plus the dependant [spread] will be added as phonetic enhancement.
[31] Things are more complicated in Niuean, as I discuss below.

Māori we incorrectly predict that dental fricatives will be nativized as the default fricative, /h/.

However, recourse to phonetic detail hints at an explanation; Biggs 1966, 1969, Harlow 1996, 2002, Krupa 1982 note that the coronal phoneme /t/ in NZ Māori is actually articulated primarily as an apico-dental [t̪], as are all coronals in NZ Māori. Sperlich (personal communication) likewise describes the Niuean coronal stop as apico-dental. This suggests that the feature specifications for NZ Māori (69) and Niuean (45) may be wrong, and that /t̪/ should be narrowly specified as [dental], with /h/ left unmarked.[32] Clements does not provide a place for this feature in the accessibility hierarchy, but it seems reasonable that [dental] be introduced at a similar point as another sub-coronal place feature, [posterior].[33] This would explain nativization of dental fricatives as the dental stop, while predictions regarding adaptation of other coronal fricatives are unaffected. The revised contrastive hierarchy for NZ Māori is given in (70), while the revised accessibility hierarchy is listed in (71):

(70)

- (obstruents)
  - [labial]
    - [cont.] [f]
    - (non-cont.) [p]
  - (non-labial)
    - [dorsal] /k
    - (non-dors.)
      - [dental] /t̪/
      - (non-dental) /h/
- [sonorant]
  - [labial]
    - [nasal] /m/
    - (non-nasal) /w/
  - (non-labial)
    - [dorsal] /ŋ/
    - (non-dorsal)
      - [nasal] /n/
      - (non-nasal) /r/

(71) Feature accessibility hierarchy (revised):

1. [consonantal]
2. [sonorant]
3. [labial]
4. [dorsal] ([-sonorant])
5. [strident]
6. [nasal]
7. [dental]
8. [posterior] ([+son, -nas])
9. [posterior] ([-son])
10. [GW]
11. [GW-spread] ([GW])
12. [lateral] ([+son])
13. [continuant] ([-voice, -son])
14. [voice] ([-son])

At first glance, the hierarchy in (70) makes the nativization of English alveolar stops as dental stops mysterious - /h/, being the unmarked phoneme, should be a better match for [t] than the narrowly-specified dental. Once again, however, an explanation is offered by phonetic variation: Harlow states that /t̪/ is articulated as an alveolar before the high front vowel [i], where it is slightly affricated $[t^s]$.[34] This suggests that NZ Māori speakers

[32] This would explain the epenthetic behavior of /h/ noted above, on the assumption that epenthetic elements are phonologically impoverished (i.e. maximally unspecified)

[33] This strategy was suggested by E. Dresher.

[34] This explains the usual nativization of English alveopalatal affricates as sequences of /ti/, as follows:

classify alveolar [t] in loanwords as a variant of /t̪/, and thus reproduce it as the dental. It may be that a similar solution is possible for Niuean, although this requires closer examination, little fine phonetic detail being available for this language.

While contrastively specifying Niuean and NZ Māori as [dental] correctly captures many of the adaptation patterns in these languages, it supplies a structural problem; both languages need surface alternations involving larger coronal places of articulation within the scope of the narrow feature [dental] – between [t̪] and [s] in Niuean, and between [t̪] and [$t^s$] in NZ Māori. This suggests the following representations:

(72) a. Niuean [dental] b. NZ Māori [dental]

[t̪] [strident] [t̪] [delayed release]

[s] [$t^s$]

These hierarchies cannot be correct – [strident] is distinctive amongst non-dental coronal obstruents, while (72a) implies that it should be contrastive *amongst* dental elements; similarly, [$t^s$] is articulated as alveolar, while (72b) implies that it is a dental affricate.

A way to solve this problem is to follow a line of argument employed by Ghini (2001) in discussion of vowels in Miogliola, who proposes that certain marked features require prior specification of usually non-distinctive features in order to be used contrastively. Specifically, Ghini proposes that [labial] cannot be specified amongst [-back] vowels (to contrast rounded from unrounded front vowels) unless [Coronal] is first specified. The activation of [Coronal] in this instance, which has been argued to be universally unmarked underlyingly (cf. the papers in Paradis & Prunet 1991), is therefore a relaxation of general economy principles, since it allows a non-distinctive features appearing in underlying representation. A similar kind of relaxation is proposed by Avery & Rice 1989, who allow [Coronal] to be specified if a system contrasts segments within the coronal space.

Similarly, I propose that specification of [dental] is contingent upon prior activation of [Coronal]. This captures the generalisation that [dental] is typically used to contrast elements within the coronal space (e.g. /t/ vs. /t̪/ in Luo, Kota, Tiwi and Nuggubuyu – Maddieson 1984). Since [Coronal] is activated, allophones of /t̪/ in Niuean [s] and NZ Māori [$t^s$] – contrasted with [strident] and [delayed release] - can fall under the scope of [Coronal] rather than [dental], as follows:

(73) a. Niuean [Coronal] b. NZ Māori [Coronal]

[dental] [strident] [dental] [delayed release]

[t̪] [s] [t̪] [$t^s$]

In this discussion of NZ Māori, several modifications to Clements' model were proposed. First, I argued that specification for [GW-spread] was contingent upon prior activation for [GW]; and second, the feature accessibility hierarchy was modified slightly to allow specification for [dental]; this feature was claimed to require activation of a

| | | | |
|---|---|---|---|
| i. | *chalk* | [tʃɔk] | tioka |
| ii. | *cheque* | [tʃek] | tieki |
| iii. | *jug* | dʒʌg] | tiaka |

redundant feature, [Coronal], whose presence in the lexicon is highly marked, and limited to instances where marked dependants are also required. These modifications were also required to account for patterns of nativization in Niuean, and were commensurate with successful analyses of adaptation in Tongan and Hawaiian. While these claims reintroduce some representational 'baggage' into underlying representation, the elimination of which is a priority of Clements' schema, it also recognizes the marked nature of the systems that rely on this activation. Marrying bottom-up 'contingent accessibility' with top-down constraints on 'prerequisite specification' introduces additional complexity into Clements' loanword model, the full range of implications for which have yet to be fully explored.

### 5.2.3 Tahitian

Tahitian is another Eastern Polynesian language, whose consonantal inventory is given in (74).

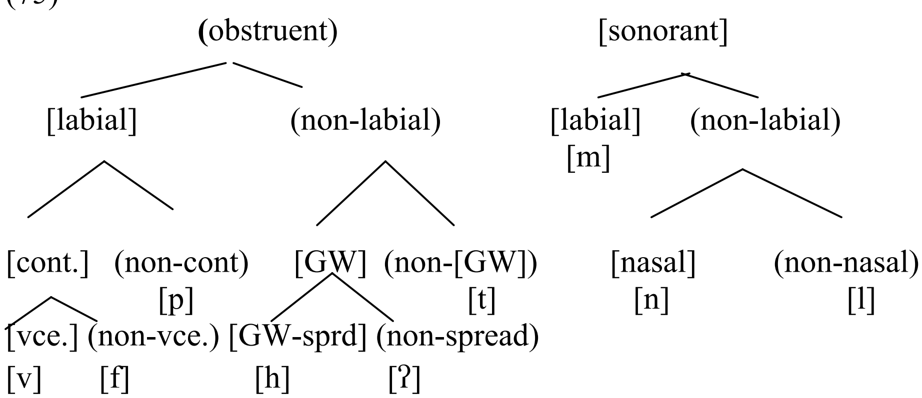
(74) Tahitian

| | | |
|---|---|---|
| p | t | ʔ |
| f v | | h |
| m | n | |
| | r | |

Tahitian has many similarities to Hawaiian, in that a generalized consonant shift took place amongst non-labials. /h/ and /ʔ/ were lost, and then were replaced by the alveolar fricative /s/ and velar stops /k ŋ/ backing to assume the empty glottal positions.[35] Unlike Hawaiian, /v/ was retained as a fricative, rather than an approximant.

Since both /ʔ/ and /h/ are present phonemically, we predict /h/ will be contrasted by [GW-spread], leaving /ʔ/ as contrastively GW. Contrastive cuts are predicted to be as in (75), given in table form in (76):

(75)




[35] As in the Hawaiian discussion, I remain agnostic as to whether this shift was effected by velars raising to glottal articulation, or by glottals dropping out of the system (i.e. whether the glottals jumped or were pushed).

(76) Tahitian contrastive specification

| **Tahitian** | **p** | **t** | **ʔ** | **f** | **v** | **h** | **m** | **n** | **r** |
|---|---|---|---|---|---|---|---|---|---|
| [sonorant] | | | | | | | √ | √ | √ |
| [labial] | √ | | | √ | √ | | √ | | |
| [nasal] | | | | | | | | √ | |
| [GW] | | | √ | | | | | | |
| [spread]-[GW] | | | | | | √ | | | |
| [continuant] | | | | √ | √ | | | | |
| [voice] | | | | | √ | | | | |

The specification of /h/ as [GW-spread], along with the absence of [dorsal] segments, means that /t/ is the only non-labial, non-sonorant oral phoneme. As such, we predict it to be the repair for a host of ill-formed elements, including all coronal segments and velars. Additionally, since [n] is the only segment specified for [nasal], it is predicted to be the optimal repair for [ŋ]. As the following data show, these are precisely the adaptation strategies that Tahitian employs.

(77) [ŋ] → /n/
stocking [ˈstɒkɪŋ] → /totini/
ink [ʔɪŋk] → /ʔinita/

(78) a. [θ] → /t/
thousand [ˈθawzn̩d] → /tauatini/

b. [s] → /t/
salmon [ˈsæmən] → /tamanu/
servant [ˈsɜvənt] → /tavini/
rice [ɹajs] → /raiti/

c. [z] → /t/
razor [ˈɹejzə] → /reta/
president [ˈpɹɛzəˌdn̩t] → /peretiteni/
rose [ɹowz] → /roti/

d. [ʃ] → /t/
missionary [ˈmɪʃəˌneɹi] → /mitinare/
Prussia [ˈpɹʌʃə] → /purutia/

e. [tʃ] → /t/
hatch [hætʃ] → /hati/
China [ˈtʃajnə] → /taina/

f. [dʒ] → /t/
June [dʒun] → /tiunu/
general [ˈdʒɛnəɹəl] → /tenerara/

(79) a. [k] → /t/
captain [ˈkæptən] → /tapitana/

| | | | |
|---|---|---|---|
| coffee | [ˈkɒfi] | → | /taofe/ |
| bucket | [ˈbʌkət] | → | /patete/ |

b. [g] → /t/

| | | | |
|---|---|---|---|
| guava | [ˈgwavə] | → | /tuava/ |
| vinegar | [ˈvɪnəgə] | → | /vineta/ |

Tahitian thus provides strong support for the adaptation model presented here. Finally, I turn to the last language considered in this study, Cook Islands Māori.

### 5.2.4 Cook Islands Māori

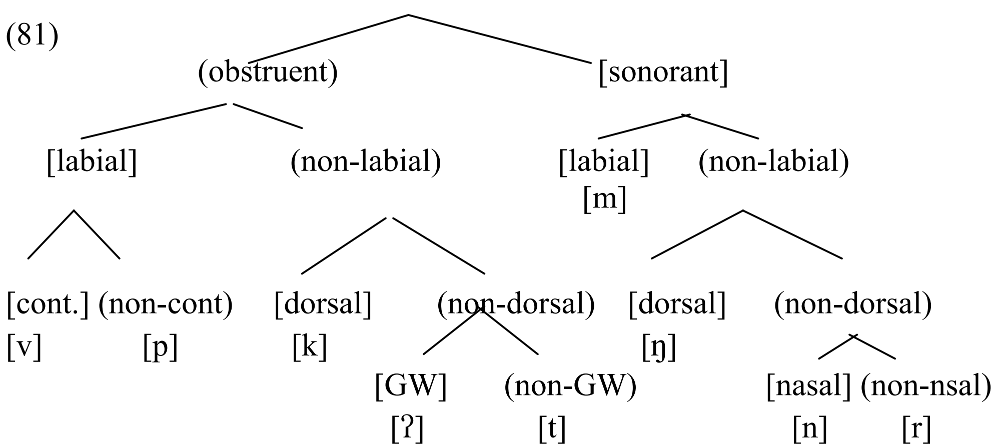
Cook Islands Māori (CIM) has the following consonantal phonemic inventory:

(80) Cook Islands Māori

| | | | |
|---|---|---|---|
| p | t | k | ʔ |
| v | | | |
| m | n | ŋ | |
| r | | | |

CIM underwent a sound change whereby /s/ became /h/, with /h/ subsequently coalescing with /ʔ/. The latter change constituted a loss of contrast in the *laryngeal* system. Specifically, [spread] was lost, with the resulting neutralization of contrast to [GW]. The [voice] contrast between /f/ and /v/ was also lost, leaving /v/ contrasting with /p/ alone amongst the non-sonorant [labial] set. Applying the SDA derives the feature specifications as follows:

(81)



(82) Cook Islands Māori phonemic inventory

| **Cook Islands Māori** | **p** | **t** | **k** | **ʔ** | **v** | **m** | **n** | **ŋ** | **r** |
|---|---|---|---|---|---|---|---|---|---|
| [sonorant] | | | | | | √ | √ | √ | √ |
| [labial] | √ | | | | √ | √ | | | |
| [dorsal] | | | √ | | | | | √ | |
| [nasal] | | | | | | | √ | | |
| [GW] | | | | √ | | | | | |
| [continuant] | | | | | √ | | | | |

These specifications predict that, as in Tahitian, /t/ - being contrastively non-sonorant, non-labial, non-dorsal and non-GW - will be chosen as the repair for all coronal segments. The data in (83) supports this prediction:

(83) Cook Islands Māori

a. [θ] → /t/

| | | | |
|---|---|---|---|
| thread | [θɹɛd] | → | /tereeti/ |
| Sabbath | [ˈsæbəθ] | → | /tapati/ |
| thousand | [ˈθawzn̩d] | → | /tautani/ |

b. [ð] → /t/

| | | | |
|---|---|---|---|
| heathen | [ˈhiðən] | → | /ʔeetena/ |

c. [s] → /t/

| | | | |
|---|---|---|---|
| sausage | [ˈsɒsədʒ] | → | /tootiiti/ |
| kerosene | [ˈkɛɹəˌsin] | → | /kaaratine/ |
| passenger | [ˈpæsəndʒə] | → | /paatete/ |

d. [z] → /t/

| | | | |
|---|---|---|---|
| razor | [ˈɹejzə] | → | /reta/ |
| freezer | [ˈfɹizə] | → | /piriita/ |

e. [ʃ] → /t/

| | | | |
|---|---|---|---|
| cushion | [ˈkʊʃən] | → | /kuutini/ |
| sheet | [ʃit] | → | /tiiti/ |
| polish | [ˈpɑlɪʃ] | → | /paraiti/ |

f. [tʃ] → /t/

| | | | |
|---|---|---|---|
| chocolate | [ˈtʃɑklət] | → | /tiaokereeti/ |
| March | [mɑtʃ] | → | /maati/ |

g. [dʒ] → /t/

| | | | |
|---|---|---|---|
| cabbage | [ˈkæbədʒ] | → | /kapati/ |
| jam | [dʒæm] | → | /yiaamu/ |

Furthermore, Cook Islands Māori lacks a phonemic glottal fricative /h/. However, it does have a phonemic glottal stop /ʔ/, which is specified contrastively as [GW]. Since [h], fully specified, is [GW-spread], shared specification for [GW] predicts that /ʔ/ will be judged more similar to [h] (and hence the better choice for nativization) than /t/, which is unspecified, and /v/, which is contrastively [labial]. Again, nativization patterns support this choice:

(84) [h] → /ʔ/

| | | | |
|---|---|---|---|
| ham | [hæm] | → | /ʔaamu/ |
| harness | [ˈhanəs] | → | /ʔaaniti/ |
| heave | [hiv] | → | /ʔiivi/ |

So far it appears that patterns of nativization in CIM follow neatly from the contrastive cuts in (81). However, the adaptation of [f] presents a problem. /p/ is contrastively specified in (81) as [labial] and non-sonorant, while /v/ is non-sonorant, [labial], and [continuant]. The TCRS consequently predicts /v/ to be the best repair for [f], it shares one more feature with [f] – [continuant] – than /p/ does. Adaptation data shows that things are not quite so conclusive, however. While there are several instances of [f] being adapted as /v/ (85a), it is more common to find /p/ chosen as the repair (85b).

(85) a. [f] → /v/

| | | | |
|---|---|---|---|
| file | [fajl] | → | /vairu/ |
| flour | [ˈflawə] | → | /varaaoa/ |
| Friday | [ˈfɹajˌdej] | → | /varaire/ |

b. [f] → /p/

| | | | |
|---|---|---|---|
| wharf | [wɔf] | → | /uaapu/ |
| sofa | [ˈsowfə] | → | /toopa/ |
| elephant | [ˈʔɛləfənt] | → | /ʔerepani/ |
| flannel | [ˈflænl̩] | → | /paraana/ |
| freezer | [ˈfɹizə] | → | /piriita/ |
| frame | [fɹejm] | → | /pereemu/ |

It appears that this alternation is partially positional, since all examples of [f] → /v/ involve [f] being word-initial. However, as the final three examples in (85b) show, word-initial [f] may also be realized as /p/.

There are two questions that arise from the data in (85): Firstly, does the more common nativization of [f] as /p/ suggests that the specifications in (81) need to be altered to allow /p/ and /v/ to contrast with the feature [voiced]? This would mean that [continuant], which is ranked above [voiced] in the feature accessibility hierarchy, has been skipped, and would in turn lead to two possibilities – either [voiced] and [continuant] must be allowed some degree of variation in relative ranking, or [continuant] is inaccessible as a contrastive feature in Cook Islands Māori. I leave this as an outstanding issue, and suggest that – again – a closer look at the surface phonetics in Cook Islands Māori may shed some light on the issue.

Secondly, what are we to make of language-internal variation in nativization repair strategies? This is a problem that has largely been ignored in this paper, due mostly to the fact that adaptation patterns in the languages investigated are generally very robust. However, the presence of more than one nativization strategy in the same language raises a number of questions that are extremely relevant to the discussion at hand; If variations reflect adaptations occurring at different periods of time, then we can use these alternations to tell us something about diachronic change in the host, and comment on the degree to which variation reflects changes in underlying feature specifications of the given language. On the other hand, if inter-linguistic variations in adaptation patterns are synchronic, we must look to other reasons for this variation; we must investigate how much can be attributed to dialectal differences in those responsible for borrowing the loanwords into the L1 grammar. Alternatively, we might look at whether top-down factors such as positional salience and context condition such variation – this leads to interesting discussion of the interaction between the type of bottom-up, deterministic evaluation proposed here and the kinds of syntagmatic factors described by Steriade 2001. The other option – that speakers of the same dialect might vary in their realization of the same loan – is troublesome for the Clements' model, since it would suggest one of two unpalatable possibilities: either nativization is not quite so deterministic as the model presented here suggests, or else speakers of the same dialect may have different contrastive hierarchies, suggesting that the feature accessibility hierarchy does in fact allow some limited reordering. I leave inter-linguistic variation as an important topic for future study.

## 6 Conclusion

This paper has articulated a model of loanword adaptation that attempts to capture two conflicting demands: first, that a model of phonological similarity be rigid enough to capture general cross-linguistic tendencies in nativization strategies (the 'Too-many-solutions' problem), and conversely that it be flexible enough to allow for a limited degree of variation (the 'Persistence of the subjective'). Various models of similarity and of loanword adaptation were presented, and all were found to lack either predictive power or explanatory adequacy in the face of these two demands. Instead, it was argued that theories of production-based or perceptual similarity needed grounding in some theory of abstract phonological structure in order to avoid being merely descriptive.

A model of adaptation was articulated that adopted a version of the TCRS, in which fully specified loanword input is matched against contrastively underspecified host inventories, with similarity evaluated in terms of both shared features and the degree of repair a given adaptation would entail. The structured model of phonological structure presented in Clements 2001 was advocated and married to the TCRS in such a way that similarity was appraised against a limited amount of phonological structure, independently required to contrast segments within a given inventory and to inform possible phonological constraints within a system. The need for such a model mitigates against a trend, prevalent in recent years, of reducing phonological representation to internal constraints or universal well-formedness conditions. This paper lends support to those who maintain that phonological structure, though severely constrained by general economy principles, plays a vital role in informing and shaping phonological patterns.

I presented evidence from several Polynesian languages that lent broad support to Clements' proposal that possible contrastive feature orderings are circumscribed by universal accessibility constraints, encoded within the feature accessibility hierarchy. Furthermore, it was shown that the ordering proposed by Clements was essentially correct. This has implications for those working with contrastive hierarchies (e.g. Dresher & Zhang 2000, Dresher 2001, 2003, Mackenzie 2003), whose works often appear to imply the choice of features at a given point in the contrastive specification process (the

SDA) to be essentially unconstrained.[36] Patterns of adaptation in the languages looked at in this paper suggest, on the contrary, that available hierarchies are more limited. Furthermore, I argued that the accessibility hierarchy needed to be a 'built-in' part of Universal Grammar, since Polynesian languages are almost wholly lacking in internal phonological and phonetic alternations, and therefore the internal hierarchies required to inform similarity assessments are largely unlearnable under assumptions prevalent in current cue-based acquisition models (Dresher 2003).

Clements' model was enriched in several key areas: firstly, I expanded the scope of 'contingent accessibility' (already utilized in Clements 2001) to include the requirement that [spread] was only accessible as a contrastive feature when a supporting feature [GW] was also active. Whether other features are also subject to the same conditional accessibility is a topic of ongoing research. Secondly, following similar proposals in Avery & Rice 1989, Ghini 2001, the notion of 'required activation' was also proposed, such that accessing certain features was only possible if supporting features were also activated. The result of this enrichment was an acceptance of more structure – including some limited redundant structure – as present in the underlying phonology than supposed in Clements' system. However, the cost of this added representational baggage was augmented by a deeper understanding of otherwise puzzling adaptation strategies and featural dependencies.

Finally, it was argued that similarity must be assessed taking into account feature structure at all levels of representation, including those features required to capture surface phonological alternations. This implies that real understanding of nativization processes must pay careful consideration to fine phonetic detail present in both host and donor languages.

## References

Andrews, Edmund & Irene D. Andrews. 1944. *A comparative dictionary of the Tahitian language.* New York: AMS Press.

Andrews, Lorrin. 1974. *A dictionary of the Hawaiian language.* Tokyo: Charles E. Tuttle Company.

Avery, Peter & William J. Idsardi. 2001. Laryngeal dimensions, completion and enhancement. In T. Allen Hall (ed.) *Distinctive Feature Theory*, 41-70. Berlin: Mouton de Gruyter.

Avery, Peter & Keren Rice. 1989. Segment structure and coronal underspecification. *Phonology* 6: 79-200.

Bauer, Winifred. 1997. *The Reed Reference Grammar of Māori*. Auckland: Reed Books.

Biggs, Bruce. 1966. *English-Maori Dictionary.* A. H. & A.W. Reed, Wellington.

Biggs, Bruce. 1969. *Let's learn Maori: a Guide to the Study of the Maori language.* A. H. & A. W. Reed, Wellington.

Broe, Micheal. 1993. Specification theory and Ngbaka cooccurrence constraints. Ms. Northwestern University.

Browman, Catherine P. & Louis Goldstein. 1989. Articulatory gestures as phonological units. *Phonology* 6.2: 201-251.

Buse, Jasper & Raututi Taringa. 1996. *Cook Islands Maori Dictionary.* Canberra: Australian National University.

Coppenrath, Hubert & Paul Prevost. 1974. *Grammaire approfondie de la langue Tahitienne.* Papeete: Librairie Pureora.

Churchward, C. Maxwell. 1959. *Tongan Dictionary*. London: Oxford University Press.

Clements, G. N. 1985. The geometry of phonological features. *Phonology Yearbook* 2: 225-252.

Clements, G. N. 2001. Representational economy in constraint-based phonology. In T.Allen Hall (ed.) *Distinctive Feature Theory*, 71-146. Berlin: Mouton de Gruyter.

Davies, John. 1978. *A Tahitian and English Dictionary*. New York: AMS Press.

Dresher, B. Elan. 2001. The logic of contrast. Ms. University of Toronto.

Dresher, B. Elan. 2003. On the acquisition of phonological contrasts. Ms. University of Toronto.

Dresher, B. Elan & Xi Zhang. 2000. Contrast in Manchu vowel systems. Paper presented at the 1st International Conference on Manchu-Tungus Studies (ICMTS 1), University of Bonn, August 28 – September 1, 2000.

Elbert, Samuel. 1970. *Spoken Hawaiian.* Honolulu: University of Hawai'i Press.

Elbert, Samuel H. & Mary K. Pukui. 1979. *Hawaiian Grammar*. Honolulu: University of Hawai'i Press.

[36] E. Dresher (p.c) disputes this claim, noting that unconstrained feature orderings is not an explicit claim in any of these papers. However, it is also true that in none of these works is the notion that feature hierarchies need to be constrained addressed in any meaningful way. In fact, these authors often point to the range of underlying representations afforded by contrastive specification as a major strength of this representational system.

Frisch, Stefan, Micheal Broe & Janet Perrehumbert. 1997. Similarity and Phonotactics in Arabic. *Rutgers Optimality Archive* 223.
Ghini, Mirco. 2001. Place of Articlation First. In T. Alan Hall (ed) *Distinctive Feature Theory,* 147-176. Berlin: Mouton de Gruyter.
Haas, M. 1947. Some French words in Tunica. Reprinted in *Language, Culture and History*. Essays by M. Haas, selected and introduced by A. S. Dil. Stanford, Stanford University Press, 1978, 89-92.
Harlow, Ray. 1996. *Māori*. München: Lincom Europa.
Harlow, Ray. 2002. *Māori Reference Grammar.* Auckland: Pearson Education New Zealand Ltd.
Hawkins, Emily A. 1982. *Pedagogical Grammar of Hawaiian – recurrent problems.* Honolulu: The University Press of Hawaii.
Hua'ōlelo, Kōmike, Hale Kuamo'o & 'Aha Pūnana Leo. 2003. *Māmaka Kaiao – A modern Hawaiian vocabulary.* Honolulu: University of Hawai'i Press.
Hyman, Larry. 1970. The role of borrowing in the justification of phonological grammars. *Studies in African Linguistics* 1: 1-48.
Jacobs, Haike & Carlos Gussenhoven 2000. Loan Phonology: Perception, Salience, the Lexicon and OT. In Joost Dekkers (ed) *Optimality Theory – Phonology, Syntax and Acquisition.* London: Clarendon Press.
Jaussen, Tepano. 1969. *Grammaire & Dictionnaire de la langue tahitienne.* Paris: Publications de la Société des Océanistes.
Kenstowicz, Michael. 2001. The Role of Perception in Loanword Adaptation. Ms. MIT. (To appear in *Linguistique Africaine* 20)
Kenstowicz, Michael. 2003. Salience and Similarity in Loanword Adaptation – a case study of Fijian. Ms. MIT.
Krupa, Viktor. 1968. *The Maori Language.* Moscow: Nauka Publishing House.
Krupa, Viktor. 1982. *The Polynesian Languages.* London: Routledge & Kegan Paul.
Lemaitre, Yves. 1973. *Lexique du Tahitien contemporain.* Paris: Orstom.
Lynch, John. 1998. *Pacific Languages: an introduction.* Honolulu: University of Hawai'i press.
Lovy, R. D. & L. J. Bouge. 1953. *Grammaire de la langue Tahitienne.* Paris: Musée de l'Homme.
Mackenzie, Sara. 2003. Similarity and Contrast in Consonant Harmony Systems. Ms. University of Toronto.
Maddieson, Ian. 1984. *Patterns of Sounds.* Cambridge: CUP.
Marck, J. 2000. *Topics in Polynesian language and culture history.* Canberra: ANU Press.
McCarthy, John. 1988. Feature geometry and dependency: a review. *Phonetica* 45: 84-108.
Mohanan, K. P. 1991. On the bases of radical underspecification. *Natural language and Linguistic Theory* 9.2: 285-326.
Ngata, H. M. 1993. *English-Māori dictionary.* Wellington: Learning Media Ltd.
Padgett, Jay. 2002. Feature classes in phonology. *Language* 8.1: 81-110.
Paradis, Carole. 1988. On constraints and repair strategies. *The Linguistic Review* 6, 71-97.
Paradis, Carole & Darlene La Charité. 1997. Preservation and minimality in loanword adaptation. *Journal of Linguistics* 33: 379-430.
Paradis, Carole & Jean-François Prunet (eds.). 1991. *Phonetics and Phonology,* vol. 2: *The special status of coronals: internal and external evidence.* San Diego: Academic Press.
Paradis, Carole & Jean-François Prunet 2000. Nasal vowels as two segments: evidence from borrowings. *Language* 76.2: 324-357.
Prince, Alan & Paul Smolensky 1993. *Optimality Theory: Constraint interaction in Generative Grammar.* Ms. Rutgers University & John Hopkins University.
Ryan, P. M. 1995. *The Reed dictionary of modern Māori.* Auckland: Reed Books.
Schütz, Albrt J. 1994. *The Voices of Eden.* Honolulu: University of Hawai'i Press.
Silverman, Daniel. 1992. Multiple scansions in loanword phonology: evidence from Cantonese. *Phonology* 9, 289-328.
Shumway, Eric B. 1971. *Intensive course in Tongan.* Honolulu: University of Hawaii Press
Sperlich, Wolfgang. 1997. *Tohi Vagahau Niue – Niue Language Dictionary.* Honolulu: University of Hawai'i Press.
Steriade, Donca. 2001. The phonology of perceptibility effects: the P-Map and its consequences for constraint organization. Ms. MIT.
Tu'inukuafe, Edgar. 1992. *A simplified dictionary of modern Tongan.* Auckland: Polynesian Press.
Usisshkin, Adam & Andrew Wedel 2003. Gestural motor programs and the nature of phonotactic restrictions: evidence from loanword phonology. Ms. University of Arizona.
Vaux, Bert. 1998. The laryngeal specifications of fricatives. *Linguistic Inquiry* 29: 497-511.
Walsh, D. S. & Bruce Biggs. 1966. *Proto-Polynesian Word List I.* Auckland: Linguistic Society of New Zealand.
Wight, Kathleen. 1997. *Illustrated Hawaiian Dictionary.* Honolulu: The Bess Press.
Yip, Moira. 1993. Cantonese loanword phonology and Optimality Theory. *Journal of East Asian Linguistics* 2, 261-291.