To appear in Boersma, P. and S. Hamann (eds.)

# Stress adaptation in loanword phonology: perception and learnability [*]

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## 1. The Problem: Learnability of interlanguage rankings

Under the widespread assumption that learning a phonological grammar means learning the language-specific rankings of phonological constraints, the framework of Optimality Theory forces us to ask not only what constraint rankings describe the data of a language, but also how those rankings could have been learned. The focus of this paper is cases in which the second question is not so easily answered. Language contact situations confront speakers with types of structures that are not found in their native language, and in these situations we often find systematic adaptation patterns that are fairly consistent across speakers of the same native language. Analyses of loanword adaptations patterns have often posited fairly intricate webs of constraint rankings in the production grammar which cannot be motivated by the data of either the native or the foreign language. One possible explanation of such apparently unmotivated rankings is that they reflect the universal default. If this is the case, we should expect the same rankings to emerge in all situations where evidence to the contrary is lacking. But as Peperkamp (in press) has argued, there appears to be cross-linguistic variation in adaptation patterns that cannot be attributed to the data of either of the languages in contact. This leaves us with a puzzle: if we find interlanguage production grammar rankings that are a product neither of universal grammar nor of input data, what is their source? In this paper I argue that several adaptation patterns that appear to involve unlearnable rankings of production grammar constraints are actually an effect of the perception grammar.

I will consider two cases of loanword adaptation which have been analyzed in terms of crucial rankings of production grammar constraints, among them a constraint mandating preservation of foreign word stress. In each case, while the proposed rankings account for the adaptation patterns, it is unclear how these rankings could have been learned from the

[*]This paper has benefited greatly from feedback from participants in my Fall 2003 seminar in language contact phonology, from colleagues at Stony Brook University, and from the NELS audience, and particularly from the careful comments of the editors of this volume. Special thanks are due to Christina Bethin, Dan Finer, and Yoonjung Kang.

ambient data. I argue that in neither case are unlearnable rankings necessary; rather, the adaptation patterns can be seen as effects of interference from the native language grammar–specifically, that portion of the grammar that maps the acoustic signal onto phonological representations. I assume (following Boersma 1998) that the perception grammar defines which aspects of the acoustic signal are linguistically significant, causing listeners to misinterpret certain aspects of the contact structures. In this bipartite model, the inventory of structures presented by the contacting language is often richer than that presented by the native language input (the richness of the stimulus). But the listener's perception grammar maps this input onto a more restricted set of phonological representations, providing the adapter with an impoverished base, or set of underlying representations (Boersma 2000, Lassettre and Donegan 1998).

The paper begins with a survey of several types of ranking puzzles in language contact, followed by consideration of the sorts of rankings that we would expect to find in language contact phonology. I then consider examples of the adaptation of stress in borrowed words. The source stress is maintained in both Huave words borrowed from Spanish (Davidson and Noyer 1996) and in Fijian words borrowed from English (Kenstowicz 2003). However, the two languages differ in terms of the strategies used to resolve conflicts between the original stress position and the stress position dictated by the native language grammar: such conflicts are resolved in Huave by deletion of segments and in Fijian by lengthening of vowels. These different adaptation patterns have been described in the literature in terms of different rankings of a production grammar constraint MatchStress (or MaxStress) directing that the position of the source stress should be maintained. But because this constraint is specific to loanwords, it is not clear how the early adapters could have learned its ranking. The contention of this paper is that the maintenance of source stress is not a function of the production grammar at all, but rather is determined by the native language perception/decoding principles which determine how foreign language stress is interpreted. In Huave, stress is demarcative, uniformly falling on the final syllable of the word, which causes Huave listeners to assume that stressed syllables are word-final in Spanish; thus, segmental material following the stressed syllable is lost when in the mapping from acoustic signal to lexical representation. Similar loss of posttonic material is found in the adaptation of Spanish words by speakers of K'ichee', which also has uniformly word-final stress; in contrast, in Selayarese, where the position of stress is affected by morphological structure, listeners maintain foreign material following the stress foot. In Fijian, stress signals to enhance lexical contrasts of vowel length. I argue that Fijian listeners hearing a stressed syllable in a position that is normally not stressed interpret this as an indication of underlying vowel length.

## 2. Ranking Puzzles in Language Contact Phonology

In the OT model of phonological acquisition, it has been proposed that the initial state involves a set of constraints in which markedness constraints are ranked above faithfulness constraints, ensuring that learners begin with the most restrictive grammar (Gnanadesikan

[1994] 2004), or that while constraints may initially be unranked, the ranking process favors M>>F rankings (Hayes [1999] 2004, Prince and Tesar [1999] 2004). Aside from the bias toward markedness over faithfulness constraints, the learner establishes a ranking based on input from the ambient language. Where the input data is not sufficient to establish an exhaustive ranking of all constraints, the final state of the grammar could conceivably impose only a partial ranking (Ross 1996, Boersma 1998), or learners could choose an arbitrary ranking of otherwise unrankable constraints (Tesar and Smolensky 2000, page 49); in the latter case, we need not assume that all learners would arrive at the same rankings. Given these assumptions, we can identify the following possible ranking patterns in the interlanguage grammar (the grammar that accounts for systematic behavior in loan adaptation and/or second language acquisition):

(1) Possible ranking patterns in SLA or loan adaptation:
   a. M >>F: putative default pattern
   b. F >> M: motivated by marked forms
   c. M >>M, F>>F: mysterious if not motivated by data

While M>>F rankings, as the default, need not be motivated by data, the other rankings are data-driven. But examination of language contact phonology reveals many examples of apparent production grammar rankings that are not obviously motivated by data other than language contact data:

*1. Differential Difficulty (M>>M):* In this case, one foreign language structure is mastered more quickly than another, even though neither appears in the native language. One example of this pattern from second language acquisition involves final obstruent devoicing, which is attested for a number of speakers whose native language (such as Mandarin Chinese and Tswana) allows no obstruent codas of any type, and whose target language allows both voiced and voiceless obstruent codas (Wissing and Zonneveld 1996, Grijzenhout and van Rooij 2001, Eckman 1981, Flege and Davidian 1984, Flege, McCutcheon, and Smith 1987, Yavas 1994, Broselow, Chen, and Wang 1998, Broselow 2004, Broselow and Xu 2004). The M>>M pattern also underlies much of the evidence for lexical strata, analyzed by Ito and Mester (1995) as involving subgrammars specific to core and peripheral vocabularies.

*2. Differential faithfulness (F>>F)*: In this case, certain aspects of contacting structures are preserved while others are lost. Thus, as discussed below, in borrowings from Spanish into Huave, the stress of the source word is preserved at the price of segmental unfaithfulness (Davidson & Noyer 1996), while in borrowings from Bahasa Indonesia into Selayarese, the source segmental structure is preserved while the source stress may be lost (Broselow 1999). Some F>>F rankings might be explained as the reflection of a universal perceptual similarity hierarchy (Steriade 2001), but some cases appear to violate proposed universal rankings. For example, as Kenstowicz (2003) points out, English initial voiced stops in words borrowed into Fijian are realized as prenasalized stops, violating the putative universal ranking of production grammar constraints Ident[nas] >> Ident[voi] proposed by Steriade (2001).

*3. Differential repair strategies (F>>F or M>>F):* In this case, the source language presents adapters with two or more structures that are equally impossible in the borrowing language, yet speakers use distinct repair strategies in adapting them. For example, in Wolof

borrowings from French, obstruent-sonorant onsets are repaired by a copy vowel inserted between the two consonants (*kalas* from French *klas* 'class'), but [s]-stop onsets are repaired by insertion of a default vowel before the two consonants (*estati* from French *staty* 'statue,' Fleischhacker 2000). Since Wolof has no complex onsets of either type, the native language provides no basis for distinguishing them. Similar patterns are found in numerous languages (Broselow 1993, Fleischhacker 2000).

*4. Ranking reversals (C1>>C2, C2>>C1):* Many of the preceding cases involve rankings that are not motivated by the native language data, but are at least not inconsistent with it. In other cases, interlanguage patterns require an actual reversal of the rankings of the native language, even though the contacting language does not appear to present evidence for the new ranking. Thus in Malayalam, single voiceless consonants do not occur intervocalically. In Malayalee English, English intervocalic voiceless stops are realized as voiceless geminates (Ident(voice)>> Ident(mora)) although in Malayalam, length distinctions are preserved in preference to voicing distinctions (Ident(mora)>>Ident(voice), Mohanan and Mohanan 2003).

Various possible sources of such 'hidden' rankings (Davidson 2000) include the role of frequency in the data (Broselow 2004); the native speaker's articulatory program (Ussishkin & Wedel 2003); and the role of perception (Silverman 1992, Yip 1993, Kenstowicz 2001, 2003, Kang 2003, Peperkamp 2003). The central claim of this paper is that what at first glance appear to be 'hidden' rankings in the production grammar (that is, rankings that are not in any obvious way learnable from the data) either emerge from input frequency, or reflect rankings in the native language perception grammar that have been learned from native language data.

In the next three sections I consider cases of loan adaptation differing in the extent to which source language stress is preserved, and in the sorts of unfaithfulness that are tolerated to facilitate stress preservation. Two of these cases have been analyzed in the literature in terms of a production grammar constraint (MATCHSTRESS or MAXSTRESS), which applies only to borrowed words. The postulation of a stress preservation constraint, along with the assumption that constraints can be freely ranked across languages, predicts a wide variety of possible loan adaptation patterns. I will argue that whether or not the source stress is maintained in loanwords is a function not of the rankings of production grammar constraints, but rather of the role played by stress in the native language.

## 3. Adaptation of Demarcative Stress

### 3.1. Production Grammar Analysis of Huave Adaptations

Huave, a language isolate spoken in southeastern Oaxaca State, Mexico, has borrowed a number of words from Spanish. Huave restricts stress to one of the two final syllables of the word, while Spanish words may have stress on any one of the three final syllables, creating conflicts between the Huave stress restrictions and the actual source stress. Davidson and

Noyer (1996) analyze the adaptation patterns of the San Mateo del Mar dialect of Huave in terms of ranked constraints of the production grammar, some of which cannot obviously be motivated by either the Huave or the Spanish data.

In Huave native vocabulary, stress falls on a final syllable when that syllable is closed, and on the penultimate syllable when the final is light. Huave has no vowel length contrast, so syllable weight is dependent on the presence or absence of a coda consonant. Because all stems of major lexical categories and all suffixes end in a consonant, final stress is the overwhelmingly predominant pattern in Huave.[1]

(2) Huave native vocabulary (Kreger and Stairs 1981):

| | |
|---|---|
| a. aráŋ | 'he does' |
| b. taraŋás | 'I did' |
| c. taraŋasán | 'we did' |
| d. ʃíke | 'I' |

Words have a single stress, with the exception of words containing a suffix or suffixes comprising more than two syllables, where a secondary stress falls on the root-final syllable and primary stress on the word-final syllable (Kreger and Stairs 1981, page xvii).

To describe the Huave facts, Davidson and Noyer posit the following constraints, each apparently undominated in the native grammar:

(3) Huave Constraints

a. TROCHAICFEET: Feet are bimoraic trochees (CV'CV or CVC')

b. ALIGN-R: The right edge of a Prosodic Word is aligned with the right edge of a foot

c. FREE-V: A word should not end in a vowel.

Interestingly, these three constraints show different degrees of strength in borrowed words. The most nativized vocabulary items maintain the Huave pattern of final stressed and closed syllables, while still preserving the Spanish stress--if necessary, by deletion of segmental material in the final syllable of the source:

(4) Loans into Huave from Spanish, Stratum 1 (most nativized)

| Spanish | Huave | |
|---|---|---|
| garabáto | garabát | 'hook' |
| kardúmen | kardóm | 'flock' |
| márso | márs | 'March' |
| ígado | ík | 'liver' |

Davidson and Noyer attribute the maintenance of Spanish stress to a constraint MATCHSTRESS which is, along with Huave stress constraints and FREE-V, ranked above segmental faithfulness constraints in the core stratum:

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[1]Kreger and Stairs (1981) mention a single morpheme which falls outside the stress domain, the enclitic *an* 'only'.

(5) MATCH(STRESS): Stress falls on the same vowel in the source word as in the loanword (Davidson and Noyer 1996, page 69).

(6) Davidson and Noyer's production grammar, Stratum 1

| |garabáto| 'hook' | MATCH STRESS | TROCHAIC FEET, ALIGN-R | FREE-V | **MAX** |
|---|---|---|---|---|
| a. gara(báto) | | | *! | |
| ☞b. gara(bát) | | | | * |
| \|igado\| 'liver' | | | | |
| a. (íka)do | | *! | | |
| b. (íka) | | | *! | |
| ☞c. (ík) | | | | *** |

While the native vocabulary appears not to provide evidence for any ranking of FREE-V with respect to the stress constraints, the second stratum of more peripheral loanwords respects the stress constraints but not FREE-V:

(7) Huave from Spanish, Stratum 2:

| Spanish | Huave | |
|---|---|---|
| gwanábana | gwanába | 'sweet-sop' |
| mandádo | mandáda | 'command' |

The facts of this less nativized stratum can be described by assuming a second subgrammar in which the constraint enforcing segmental faithfulness (MAX), while still dominated by the Huave stress constraints, is ranked above FREE-V:

(8) Davidson and Noyer's production grammar, Stratum 2

| \|gwanábana\| 'sweet-sop' | MATCH STRESS | TROCHAIC FEET, ALIGN-R | **MAX** | FREE-V |
|---|---|---|---|---|
| a. gwa(nába)na | | *! | | |
| b. gwana(bána) | *! | | | |
| c. gwa(nában) | | *! | * | |
| ☞d. gwa(nába) | | | ** | * |
| e. gwa(náb) | | | **!* | |

And finally, the third stratum of least nativized loanwords exhibits violations of both native stress constraints and FREE-V, while still preserving the Spanish stress:

(9) Huave from Spanish, Stratum 3 (least nativized):

| Spanish | Huave | |
|---|---|---|
| mjérkoles | mjérkoles | 'Wednesday' |
| médiko | médiko | 'doctor' |

(10) Davidson and Noyer's production grammar, Stratum 3

| \|médiko\| 'doctor' | MATCH STRESS | **MAX** | TROCHAIC FEET, ALIGN-R | FREE-V |
|---|---|---|---|---|
| ☞ a. (médi)ko | | | * | * |
| b. (médik) | | *! | * | |
| c. (mé)dik | | *! | * | |
| d. (médi) | | *!* | | * |

The three strata therefore differ in their tolerance of MAX constraint violations (apocope): in stratum 1, apocope is tolerated to satisfy both the demand for right-aligned trochaic feet and final consonants (*garabát* from *garabáto, ík* from *ígado*); in stratum 2 apocope is tolerated to satisfy stress constraints but not the demand for final consonants (*gwanába* from *gwanábana*); in stratum 3, a loanword that has antepenultimate stress is fully segmentally faithful to the original (*médiko*). The three strata arise, Davidson and Noyer argue, from the differential ranking of the anti-deletion MAX constraints with respect to MATCHSTRESS >> TROCHAICFEET, ALIGN-R >> FREE-V. Although both apocope (*garabát* from *garabáto*) and non-trochaic stress (*médiko*) are possible in loans, there are no cases in which both cooccur in a single form, because to derive a form such as **médik* from *médiko* would require the ranking FREE-V>>MAX>>TROCHAICFEET,ALIGN-R, a reversal of the markedness constraint rankings. The Huave data are therefore consistent with Ito and Mester's (1995) claim that while faithfulness constraints can be ranked differently in the subgrammars associated with different lexical strata, the relative rankings of markedness constraints are constant across

strata. However, the ranking MATCHSTRESS >> TROCHAICFEET, ALIGN-R >> FREE-V is motivated by the loanword data rather than by any facts of the native language.

Additional complications ensue when we consider the treatment of Spanish complex onsets (forbidden in native Huave vocabulary), which are simplified by means of vowel insertion:

| | | | |
|---|---|---|---|
| (11) | pláto | polát | 'silver' |
| | brasáda | barasáda | 'unit of measure' (*basáda, *sáda) |

It is striking that while entire syllables may be deleted to preserve Spanish stress (*gwanába* from *gwanábana* 'sweet sop'), the strategy used to avoid complex onsets is insertion, rather than deletion. Davidson and Noyer elegantly describe these facts by ranking MATCHSTRESS and MAX(C,V) over *COMPLEXONSET, in turn ranked over DEP(V). This ranking makes vowel insertion the preferred repair strategy where there is a choice (as in the resolution of a complex onset violation). But the mandate that stress may neither leave its original syllable nor fall to the left of the penultimate syllable rules out vowel insertion as an option in posttonic position. Again, however, we must wonder how the original Huave adapters might have come up with such a ranking, in the absence of any evidence for either consonant deletion or vowel insertion in Huave. Thus, this analysis raises a number of thorny questions concerning the learnability of the constraint rankings:

1. How would Huave speakers arrive at the ranking MATCHSTRESS>>MAX(C) >> *COMPLEXONSET>>DEP(V) (M>>F>>M>>F)? This ranking is necessary to describe the pattern whereby segment deletion is used to maintain the Spanish stress, but vowel insertion is used to resolve complex onset violations. However, it is not clear how such a ranking might have been learned. Because Huave is a language in which all surface forms exhibit a regular stress pattern, the hypothesis of Richness of the Base requires us to assume that the stress constraints outrank any faithfulness constraints that would preserve lexically marked stress such as IDENT(STRESS)I-O (the typical M>>F ranking). Why, then, is MATCHSTRESS ranked so high? MATCHSTRESS could be argued to be an output-output constraint, a type which Hayes (1999) has argued is ranked high by default. But this simply moves the question to another level: if we assume that all O-O constraints are ranked high in the absence of evidence to the contrary, why should an O-O constraint demanding faithfulness to stress outrank O-O constraints demanding faithfulness to segments? The pattern of faithfulness to stress over faithfulness to segments is not universal, as we shall see in the discussion of Selayarese below, and therefore must be explained as an effect of either the Huave grammar or the Spanish input.

3. Why would Huave speakers rank stress constraints over FREE-V (M>>M)? This ranking describes the fact that adapters give up the requirement that words end in consonants before they give up the requirements that the stress foot be aligned with the right edge of the word. But what would motivate such a ranking, when both the stress constraints and FREE-V

are uniformly obeyed in Huave (for content words), and frequently violated in Spanish?[2]

### 3.2. A Perception-oriented Analysis of Huave Adaptations

In this section I argue that what appear to be the effects of apparently unlearnable constraint rankings in Huave loan adaptation are actually a reflection of the native language perception grammar. Specifically, I argue that the unambiguously demarcative function of stress in Huave leads listeners with little or no knowledge of Spanish to assume that stressed syllables are word-final. The resulting forms, in which posttonic material is not analyzed as part of the word, are lexicalized, leading to what appears to be posttonic deletion in the earlier strata. The increasing faithfulness to Spanish segments seen in later strata is a function of increasing contact with Spanish, which forces listeners to revise the perception grammar, allowing a wider range of word shapes. This in turn forces a revision of the production grammar.

Before discussing the specifics of word adaptation, some information on the sociolinguistic context of the Huave adaptation patterns will be useful. As recently as 1961, 81% of Huave speakers in San Mateo del Mar were monolingual in Huave (Diebold 1961, page 104), and the community was "almost wholly preliterate" (Diebold 1961, page 105). For those speakers with knowledge of Spanish, "Spanish was acquired relatively late in life, rarely in childhood", and only 6% could be considered fully bilingual...subordinate bilingualism in San Mateo involves very imperfect reproduction of Spanish, with a heavy load of interference from Huave" (Diebold 1961, page 105). This situation has changed over the succeeding decades, so that at present, although "Huave is the language of everyday life...At least 90% of adults and 100% of children are now also completely fluent in Spanish; monolingual Huave speakers have become a negligible percentage of the population (this was not true 20 years ago)" (Kim and Park-Doob 2005). I will argue that the different strata of the Huave loanwords reflect the dramatic changes over time in adapters' familiarity with Spanish.

#### 3.2.1. Faithfulness to Stress vs. Faithfulness to Segments: Stratum 1

We begin by considering the most nativized words, which invariably end in stressed closed syllables (e.g., *ígado* is adapted as *ík* 'liver'). I propose that the preservation of source stress over the preservation of source segments, which is encoded by Davidson and Noyer as a ranking of MATCHSTRESS over MAX, is in fact an effect of a high-ranked perception grammar constraint:

(12) Perception Grammar Constraint:
ASSUMEWORDEDGE-V'C#: in mapping the acoustic signal to phonological representations, assume a word edge following each consonant preceded by a stressed vowel.

This constraint is one of a family of constraints aiding in the segmentation of the speech

[2]I assume that Huave speakers distinguish content and function words, and that the presence of vowel-final function words in Huave would not contribute to demotion of FREE-V. See Peperkamp 2004 for arguments that even infants distinguish content and function words, and that basic generalizations about stress are not disrupted by function words that interfere with general patterns.

string into words (see for example the perception grammar constraints proposed by Boersma (2000) which posit word boundaries at the beginning and end of an utterance). For Huave, ASSUMEWORDEDGE-V'C# is undominated, serving as a filter on possible phonological representations. The high ranking of ASSUMEWORDEDGE-V'C# would cause listeners to assume that material following the stress foot is either part of the following word, or noise without linguistic significance. (An example of such nonsignificant articulations in English would be release of a phrase-final consonant, or a labial closure following a phrase-final vowel, coincident with simply shutting the mouth. The final consonant in English 'nope' most likely represents misanalysis of this closure as a segment.) I assume that at the initial stages of Huave-Spanish contact, this constraint remained undominated in the Huave perception grammar, so that a Huave speaker first exposed to Spanish forms such as *[ígado]* 'liver' and *[garabáto]* 'hook' would posit a word boundary after each consonant following a stressed vowel (*íg#ado*, *garabát#o*). The forms identified as lexical items (|*ig*|, |*garabat*|) would then serve as input to the production grammar. Thus, the adapted forms *ík* and *garabát* would emerge not as a result of segment deletion in the production grammar, but as a result of a misanalysis of the lexical representation. It now becomes clear why final vowels are never deleted from Spanish forms with antepenultimate stress; for example, *médiko* 'doctor' never becomes **médik*. In Davidson and Noyer's account this is the reflection of the production grammar ranking TROCHFEET>>MAX >>FREE-V. In the perception-oriented account, apocope is a function of misparsing, not of the production grammar. The Huave perception grammar provides no reason to parse *médiko* as *médik#o.* If any misparsing occurred, the resulting form would be **méd* (on analogy with *ík* 'liver' from *ígado*). We begin by considering the most nativized words, which invariably end in stressed closed syllables (e.g., *ígado* is adapted as *ík* 'liver').

We must now consider whether the strategy of assuming that a stressed syllable marks the end of a lexical unit is a realistic one. A good deal of evidence suggests that even very young children make use of stress information in segmenting words, and that their segmentation patterns reflect the normal position of stress in a language (see for example Jusczyk 1999, Thiessen and Saffran 2003, Werker and Curtin 2005). The same principles have been shown to guide adults' segmentations, using a variety of experimental paradigms. For example, Cutler and Butterfield (1992) found that in both natural 'slips of the ear' and in experimental investigation of English listeners' segmentation of highly attenuated speech, "listeners tend to insert boundaries before strong syllables and delete them before weak syllables...the rhythmic properties of the input guide listeners' hypotheses about the placement of lexical boundaries in imperfectly perceived speech" (Cutler and Butterfield 1992, page 232). [3] Since initial contact with a foreign language, particularly in the absence of orthographic information, is a situation likely to lead to 'imperfectly perceived speech', it seems reasonable that Huave listeners should have segmented Spanish strings according

[3]The rankings of the segmentation constraints in the perception grammar of English and Huave listeners will of course differ, with ASSUMEWORDEDGE-V'C ranked low in the English perception grammar, but in both languages, constraints relating stress and word edges will play a role.

to Huave patterns.

However, in some cases this erroneous segmentation might entail positing that the remnant is also a word, which would appear to violate the Possible Word Constraint of Norris, McQueen, Cutler, and Butterfield (1995), who found that listeners had difficulty recognizing (for example) 'egg' in strings like *fegg*, where the remnant [f] is not a possible word. This principle militates against Huave listeners segmenting *garabáto* as *garabát#o*, since [o] would not fulfill the Huave requirement that all words contain a bimoraic foot. Later work, however, indicates that the Possible Word Constraint as originally stated is too strong; Cutler, Demuth, and McQueen (2002) found that Sesotho listeners were able to detect e.g. *rora* in *jirora*, even though the minimal word size in Sesotho is bisyllabic, and therefore *ji*, the remnant from segmentation *ji#rora*, is not a possible Sesotho word. We can therefore view the Huave faulty segmentations as analogous to the responses of the Sesotho subjects.[4]

I assume, therefore, that the least nativized loanwords represent words which entered the lexicon at a stage in which the Spanish forms were filtered through the native Huave perception grammar. At this stage, Huave ASSUMEWORDEDGE-V'C# was ranked more highly than, for example, the constraint that accounts for the results of Cutler and Butterfield (1992) showing the tendency of English speakers to posit a word boundary before a stressed syllable. At this stage Spanish forms are interpreted as consistent with Huave restrictions, and so provide no pressure to restructure the production grammar:

(13) Stratum 1 (*ígado → ik*)
a. perception grammar (=Huave native grammar)
ASSUMEWORDEDGE-V'C# >>
ASSUMEWORDEDGE-#STRESSEDSYLL (English)

A form such as *ígado* would emerge from the perception grammar in truncated form. (Below I concentrate only on the relationship between stress and truncation, ignore various segmental issues such as the Spanish [d/ð] alternation. I also take no stand on whether the change from [g] to [k] in the loanword is a function of misperception or misproduction.)

(14) input to perception grammar: 'liver'

| [ígado] | AssumeWordEdge-V'C# | Other Word Edge Constraints |
|---|---|---|
| a. \|igado\|# | *! | * |
| ☞b. \|ig\|# (or \|ik\|#) | | * |

The output of the perception grammar would then be submitted to the production grammar. Derivation of the Huave surface form is trivial, since the lexicalized form satisfies all Huave

[4]Peperkamp and Dupoux (2002) argue that adult speakers of languages in which stress is invariably utterance-final, exhibit 'deafness' to stress in other languages, manifested in their difficulty in distinguishing CVCV words differing only in the position of stress (as contrasted with their ability to perceive segmental contrasts in such words). These results appear to be inconsistent with our claim that Huave speakers use stress to determine word structure. But in Peperkamp and Dupoux's experimental paradigm, unlike in language contact, listeners were presented with already segmented 'words'.

constraints:

(15) input to production grammar

| \|ig\| | ALIGN-R, TROCHAICFEET | FREE-V | MAX |
|---|---|---|---|
| ☞a. ík | | | |
| b.í | | *! | * |

Because at this early stage all lexical representations were assumed to conform to Huave restrictions, there was no motivation to alter the ranking of constraints in the production grammar.

### 3.2.2. Posttonic Deletion vs. Pretonic Insertion

The asymmetry in pretonic and posttonic repair tactics, illustrated by vowel insertion in forms like *pólat* (Spanish *pláto* 'silver') and *barasáda* (Spanish *brasáda* 'unit of measure') but deletion in forms like *ik* 'liver' (Spanish *ígado*) is now unsurprising. Material was lost in positions where the perception grammar defined it as not part of the relevant word, or as not linguistically significant (e.g., as an effect of consonantal release), but preserved where the grammar defined it as potentially contrastive. On this account, preservation of perceived segments is the norm, and deletion results from incorrect identification of right word edges.

It would not be surprising if missegmentation also occasionally led to loss of some pretonic material. While in Huave, a word can only be preceded by a phrase boundary, by V'C, or by V'CV (the latter following a function word), Spanish allows a wider range of options; thus the Huave speaker might be expected to occasionally misparse the left edges of words in running Spanish speech. We see extraneous material at the left edge in *arín*ʧ from Spanish *rán*ʧ*o* 'ranch', and the loss of pretonic material in forms like *nimál* 'animal' from Spanish *animál* and *maríl* 'yellow' from Spanish *amaríʎo* (Diebold 1961, page 107).[5] This truncation, if analyzed as part of the production grammar, would require the ranking ONSET (syllables must have onsets) >> MAX(V). But such a ranking would contradict the ranking required for the native vocabulary, which must permit vowel-initial words (which are relatively common). The adaptation pattern would therefore represent a reversal of the normal situation found in a stratified lexicon, in which the core vocabulary obeys a ranking of M>>F while the more peripheral vocabulary obeys the ranking F>>M, and the loss of the initial vowel could not be a function of nativization, but rather would represent an emergence of the unmarked effect. Such an effect does not, however, hold generally for Huave

[5]For the sake of clarity, I have adopted Davidson and Noyer's (1997) transcription system in rendering Diebold's forms. Diebold transcribes these forms as *àríi*ʧ, *nìmál* and *màríìl*, respectively.

loanwords–see, for example, *asét* 'oil'.[6] Given the sporadic nature of initial deletion, the best analysis appears to be as misparsing rather than as an effect of the production grammar.

### 3.2.3. Requirement for Right-aligned Stress Foot vs. Requirement for Final Consonant

In the account sketched above, the most nativized (stratum 1) loanwords represent an early stage in which Huave speakers segmented Spanish strings in terms of Huave word structure, and their erroneously segmented forms were then lexicalized. However, increasing contact with speakers of Spanish would inevitably have confronted Huave speakers with lexical, syntactic, and metalinguistic evidence for words of shapes that were incompatible with Huave restrictions, resulting in the restructuring of both the perception and (consequently) the production grammars. As we saw above, the first restriction to go is the requirement that all words end in a consonant *(*resulting in forms like *gwanába* 'sweet-sop' from *gwanábana*), while the last restriction to be abandoned is the requirement that all words end in a bimoraic trochaic foot (*médiko* 'doctor'). The relative strength of these requirements is described in Davidson and Noyer's 1997 account in terms of the ranking of the stress constraints over FREE-V. I will argue that their relative strengths are actually a function of the input to the adapters–that is, the extent to which each is violated in the Spanish data.

While Spanish words may violate both the Huave stress constraints and FREE-V, they do so with differing degrees of frequency. Eddington (2000) finds, among the 4,829 most frequent Spanish words, 59% are vowel-final (2,850/4,829) while 41% (1,979/4,829) are consonant-final. Therefore, the majority of Spanish words end in vowels, violating FREE-V. In contrast, a majority of Spanish words obey the requirement that words end in a right-aligned bimoraic trochaic foot. This requirement is satisfied by slightly more than 68% of the words in Eddington's corpus: words ending in V'CV total 51.6% (2,494/4,829) and words ending in V'C total16.5% (798/4,829). In contrast, fewer than a third of the words in Eddington's corpus violate the stress constraints; these are of three types, words with antepenultimate stress (5.6%, or 274/4,829); consonant-final words with penultimate stress (1085, or 22.4%), and vowel-final words with final stress (178, or 3.6%). Therefore, the input to Huave speakers will contain more forms consistent with the Huave stress constraints than forms consistent with the requirement that words be consonant-final:

(16) Percentage of Spanish words consistent with Huave constraints
a. stress constraints: 68%
b. FREE-V: 41%

As Huave speakers begin to recognize words ending in vowels, they will begin to create a perception grammar distinct from that motivated solely by the native language data. Such a grammar will admit the possibility of words ending in V'CV. They will hear a relatively smaller number of words that do not end in a bimoraic foot, and misanalysis of such forms should persist longer. In particular, words like *médiko*, which constitute only 5.6% of the input, will take longer to become established as possible lexical representations. It seems likely that such words are characteristic of the pronunciation of bilinguals who have developed two clearly distinct grammars, one of which (the Huave grammar) imposes

[6] In Diebold's transcription, *àsét* (Diebold 1961, page 107).

predictable stress on all words, and the second of which (the Spanish grammar) maintains lexically marked stress.

### 3.3. Other Languages with Demarcative Stress: K'ichee' and Selayarese

Davidson and Noyer's (1997) account of stress preservation as a function of the ranking of MATCHSTRESS leads us to expect that various rankings of this constraint could be found in different language contact situations. In contrast, the alternative analysis developed above ascribes stress preservation to specific properties of the borrowing language: the perception grammar of Huave speakers leads them to missegment foreign language utterances. In order for such missegmentation to arise, certain conditions are required, both phonological and sociolinguistic. First, the borrowing language must have clearly demarcative stress, oriented toward the word edge, while the source language must allow stress in positions farther from word edge than are possible in the borrowing language. Second, borrowing must occur under conditions that do not present borrowers with unambiguously segmented speech: generally, through an aural route rather than through orthography, through connected speech rather than citation forms, and in a situation in which listeners have limited knowledge of the source language and little explicit instruction or correction from speakers of the source language. We would expect that give the same conditions, other languages should exhibit similar deletion of segmental material peripheral to the stress. We now consider two additional cases of loan adaptation into languages with demarcative stress, one in which source stress is routinely preserved, and one in which it is not.

#### 3.3.1. K'ichee'

K'ichee', a member of the Quichean branch of eastern Mayan, is similar to Huave in allowing only words ending in stressed closed syllables. Like Huave, K'ichee' has also borrowed heavily from Spanish. Isaacs and Wolter (2003) present the following data from the Nahualá dialect spoken in western Guatemala:

(17)

| Spanish | K'ichee' | |
|---|---|---|
| atáke | atá:k | 'attack' |
| baráto | barát | 'barracks' |
| kadéna | kadé:n | 'chain' |
| gánas | gá:n | 'desire' |
| mansána | mansá'n | 'apple' |
| antónia | tó'n | 'Antonia' |
| durásno | turá's | 'peach' |

As in Huave, the position of Spanish stress is maintained in words borrowed into K'ichee',

and the position of stressed syllable is rendered final by deletion of segmental material.[7] The similarities to Huave are striking–and are expected given the account sketched above, in which uniformly demarcative stress leads to misparsing of words that do not conform to the native language correspondence between stress position and word boundary position. However, an alternative account of the correspondence between the Huave and K'ichee' adaptations are possible: that MATCHSTRESS is universally highly ranked, by default. We now turn to a third language which shows that this cannot be the case.

### 3.3.2. Selayarese

In many ways, the stress system of Selayarese is quite similar to that of Huave; both prefer a trochaic foot at the right edge of the word, ranking TROCHAICFOOT and ALIGN-R(WORD,FOOT) high. However, Selayarese differs from Huave in that Selayarese codas do not contribute to syllable weight, so all feet are bisyllabic, yielding penultimate stress:

(18) Selayarese native stress (Basri1999, Broselow 1999)

| | |
|---|---|
| sampúlo | 'ten' |
| bálaŋ | 'creek' |
| kalihára | 'ant' |

Selayarese has borrowed a large number of words from Bahasa Indonesia (BI). While many BI words also have penultimate stress, the BI prohibition on stressed schwa leads in some cases to final stress. As the forms below illustrate, Selayarese borrowers ignore the source stress of BI words, assigning them stress according to Selayarese restrictions. (Because Selayarese lacks schwa, BI schwa is realized as a full vowel in Selayarese, though the quality of this vowel is not entirely predictable. For discussion of the segmental changes motivated by Selayarese segmental and syllable structure restrictions, see Basri 1997, Broselow 1999).

(19)

| Bahasa Indonesia | Selayarese | |
|---|---|---|
| gəmúk | gómmoʔ | 'fat' |
| sədəkáh | sidákka | 'alms' |
| səbáb | sábaʔ | 'cause' |
| bənáŋ | bánnaŋ | 'thread' |

The Huave strategy of deleting posttonic material would obviously not be viable for Selayarese speakers, since their goal is penultimate stress. However, Selayarese speakers could in principle use vowel insertion to bring loan words with final stress into conformity with the native stress restrictions-- as they in fact do with borrowed subminimal forms, such as *bom* 'bomb,' which is realized as *bóʔo*ŋ. It is not obvious why BI *bənáŋ*, for example, should not also be realized with vowel insertion (**baná*ʔ*a*ŋ*)*, which would both preserve the source stress and place it in the normal Selayarese penultimate position. But insertion of segments is used only in monosyllabic words; in longer words, Selayarese speakers simply

[7] The Spanish stressed vowel is realized as either a long vowel or a glottalized vowel (represented as *v'* by Isaacs and Wolter).

shift the original stress to the normal Selayarese position (*bánna*ŋ).[8] We can describe this pattern by the ranking TROCHAICFOOT, ALIGN-R >> DEP >> MATCHSTRESS (since if MATCHSTRESS is part of the grammar of Huave, it must be part of the grammar of all languages). The ranking TROCHAICFOOT>>DEP is consistent with the facts of Selayarese, which indeed has no words smaller than two syllables. But the low ranking of MATCHSTRESS would need to be explained.

We see the same disregard for source stress in another class of words. Many Selayarese roots end in [r], [l], or [s], none of which is a possible coda (Mithun and Basri 1986, Broselow 1999). When one of these consonants occurs in root-final position, it is followed by a copy of the preceding vowel. Words with a final epenthetic vowel take stress on the antepenultimate syllable:

(20) lámbere 'long'
sússulu 'burn'
maŋkásara 'Makassar'
sáhala 'profit'

Note that the epenthetic vowel fails to appear before a vowel-initial (nonclitic) suffix (cf. *lámbere/lambéra*ŋ 'longer'), in contrast to underlying vowels, which always appear (*tirére/tireré-a*ŋ 'thirsty/thirstier').

This association of antepenultimate stress with a final epenthetic vowel in native vocabulary has been analyzed by ranking HEAD-DEP, which directs that an epenthetic vowel may not be part of the main stress foot (Alderete 1999) above ALIGN-R. This ranking favors the formation of a bisyllabic foot containing only underlying vowels over the formation of a perfectly right-aligned foot:

(21) HEAD-DEP: Stress foot includes only underlying vowels (Alderete 1999)

| \|lamber\| | HEAD-DEP | ALIGN-R |
|---|---|---|
| a. lam (bére) | *! | |
| ☞b. (lámbe) re | | * |

This pattern is also respected in loanwords, which take antepenultimate stress with a final epenthetic vowel, regardless of the stress of the source:

(22) Bahasa Indonesia Selayarese
sénter séntere 'flashlight'
kəlás kálasa 'class'

[8]The one exception is *koráʔa*ŋ 'Koran' (Hasan Basri, personal communication). Clearly, there are sociolinguistic factors that could mandate greater faithfulness in this case.

| | | |
|---|---|---|
| bərás | bérasa | 'rice' |
| bələbás | balábasa | 'ruler' |

The Selayarese speakers could easily have preserved the source stress by adapting BI *kəlás* (for example) as **kalása* rather than *kálasa.* There would be nothing objectionable in the surface form **kalása;* as the minimal pair *sáhala* 'profit' (from root |sahal|) and *sahála* 'sea cucumber' (from |sahala|) shows, the presence of [r,l,s] surrounded by identical vowels is a necessary but not a sufficient condition for antepenultimate stress.

Again, we could describe this pattern by a production grammar ranking HEAD-DEP, TROCHAICFOOT >> ALIGN-R, DEP >> MATCHSTRESS. But we would need to explain how Selayarese speakers would have converged on this ranking-- particularly since, as we know from the Huave case, low ranking of MATCHSTRESS is not universal. Let us therefore consider the ways in which the Selayarese situation differs from the Huave situation.

First of all, Selayarese speakers are very likely to have a good command of Bahasa Indonesia, the lingua franca of Indonesia, and the language of formal education. Second, while stress serves unambiguously in Huave to mark word edges, the role of stress in Selayarese is not nearly so straightforward. Clearly, the epenthetic forms muddy the relationship between stress and word edges. An additional complicating factor is the presence of clitics, which fall outside the stress domain, though they still participate in certain aspects of word-level phonology (Basri et. al, 2000). Clitic attachment may result in stress as far back as the preantepenult:

(23) géle -ma - kaŋ 'we are no longer...'

A sequence of three syllables, only the first of which is stressed, could correspond to any of the following morphological structures in Selayarese (though the interpretation in (20c) is possible only if the onset of the third syllable is one of [r,l,s] and if the vowels of the two poststress syllables are identical):

(24) Possible grammatical structures for σσσ (where {,} indicate PWd edges)
a. σσ)} # {(σ.. (separate grammatical words)
b. (σσ)}- σ # (grammatical word plus clitic)
c. (σσ)σ}# (root plus epenthetic vowel)

Thus, Selayarese listeners, unlike Huave listeners, cannot use stress to reliably demarcate words, and cannot disregard segmental material following the stress foot (indeed, such material may encode lexical contrast in Selayarese, as in *bótoro* 'gamble' vs. *bótolo* 'bottle'). Rather than simply using stress to recover native language word structure, Selayarese listeners must attend to both stress and segmental structure.

The Selayarese adapters' cavalier treatement of foreign stress may seem surprising given that stress in principle can function to signal lexical contrast in Selayarese; stress is the only cue distinguishing epenthetic from nonepenthetic roots (as in the minimal pair *sáhala*

(from |sahal|) 'profit' vs. *sahála* (from |sahala|) 'sea cucumber').[9] But in fact, the functional load of this contrast is extremely low; this minimal pair may be the only one, and the vast majority of words of the shape ...V r,l,s V# (where the last two vowels are identical) are epenthetic forms, with antepenultimate stress.

### 3.4. Interim Summary

We have seen that in two languages with clearly demarcative, word-edge stress (Huave and K'ichee'), posttonic material tends to be truncated in loan adaptation. We trace this not to a ranking of production grammar constraints, but rather to the tendency of such words to be misparsed in the perception grammar. We now turn to another case of loanword adaptation that has been analyzed similarly to the Huave case, involving a high-ranking production grammar constraint mandating source stress. In Fijian, stress does serve as a signal of lexical contrast. However, stress falls predictably on long vowels, and I will argue that vowel length, not source stress, is what Fijian listeners attend to.

## 4. Adaptation of Lexically Contrastive Stress

### 4.1. Stress and Length: Production Grammar Analysis

In the adaptation of loanwords in Fijian, analyzed by Schütz (1978, 1983, 1999) and Kenstowicz (2003), source stress is preserved not by unfaithfulness to segments but by unfaithfulness to vowel length. Here again I will argue that the preservation of stress is not an effect of MATCHSTRESS, but rather a reflection of speakers' misinterpretation of the source words, guided by their perception grammar.

In Fijian, as in Huave, main stress falls on a final heavy syllable, otherwise on the penult (Schütz 1978, 1983, 1999, Kenstowicz 2003, Hayes 1995. Note, however, that Schütz (1999, page 146) argues that it is the rightmost foot of a phrase, rather than of each word, that is most prominent). We can therefore assume that Fijian, like Huave, has high-ranked TROCHAICFEET and ALIGN-R. Fijian differs from Huave in that where syllable contrasts in Huave resided in the presence or absence of a syllable coda, Fijian has only open syllables, but does employ a contrast between long and short vowels. Secondary stress in Fijian falls on all long vowels giving rise to contrasts such as that between (14b) and (14c). Strings of lighted syllables are organized into bisyllabic trochaic feet, as in (14d):

[9] We should expect listeners whose language uses stress in this way to be sensitive to foreign stress (as argued by Peperkamp and Dupoux 2002, Peperkamp 2004).

(25) Fijian Native Vocabulary (Schütz 1999, Kenstowicz 2003, Hayes 1995)[10]

| | | |
|---|---|---|
| a. | ma(káwa) | 'old' |
| b. | (màða)(wá:) | 'worthless' |
| c. | (mà:)(ðáwa) | 'week' |
| d. | (kàmba)(tá-ka) | 'climb with it' (Hayes 1995, p. 144) |

The requirement of a bimoraic trochee at the right edge of a word forces shortening of a vowel in penultimate position in native vocabulary:

(26) a. (síβi) 'exceed' (from |si:βi|)
b. (sì:)(βí-ta) 'exceed, trans.' (Hayes 1995, p.145, from Dixon 1988)

Note that lengthening the final vowel would be an alternative means of satisfying the right edge bimoraic foot requirement (**(si:)(βí:)*). Although this would produce an acceptable word structure (cf. *(ndrè:)(ndré:)* 'difficult', Scott 1948, page 739), this option is not chosen; vowels are never lengthened in native vocabulary.

We do see lengthening, however, in loans from English. When English stress falls on the penultimate syllable, the English stressed vowel can serve as the head of a bisyllabic foot, as in (27a), but when stress falls on the final syllable, the stressed vowel must be lengthened to retain stress, as in (27b):

(27) English Stress Preservation

| | | | |
|---|---|---|---|
| a. | | pa(ʧáma) | 'pajama' |
| | | ta(βáko) | 'tobacco' |
| b. | | mba(zá:) | 'bazaar' |
| | | ŋgi(tá:) | 'guitar' |
| | (vs. | (ʧéli) | 'jelly') |

When the English stress falls on the antepenultimate syllable, we see one of two patterns. Either the stressed vowel is lengthened, forming a foot on its own, as in (17a), or the final vowel is lengthened, making the antepenult the head of a bisyllabic foot, as in (17b):

(28) English Antepenultimate Stress:

| | | |
|---|---|---|
| a. | (kò:)(lóni) | 'colony' |
| | (tà:)(féta) | 'taffeta' |
| b. | (kàli)(kó:) | 'calico' |
| | (pòli)(ó:) | 'polio' |

Thus, the English main stress vowel always receives some stress, although the main stress of the Fijian adaptation may fall on an originally unstressed vowel (as in *kò:lóni* 'colony'). We should note that (as pointed out by Schütz 1978, page 25) that not all tense English vowels are realized in Fijian as long (for example, 'eagle' is *ikéli*, not **ì:kéli* and 'deacon'

[10]Much previous work employs Fijian orthography, in which *c* represents a voiced interdental fricative, *j* a palatal affricate (derived, at least historically, from |ti|), and *v* a voiced bilabial fricative, while *b,d,q* represent voiced prenasalized labial, dental, and velar stops, respectively. The reader is referred to Schütz 1978 for discussion of the impact of loanwords on the segmental inventory of Fijian.

is *ndìkonési*, not **ndì:konési* 'deaconess'). Thus, Fijian borrowers do not appear to identify the English tense/lax contrast as equivalent to their long/short contrast. In this they differ from Japanese borrowers, as illustrated by Japanese ʧ*i:pu* 'cheap' vs. ʧ*ikiN* 'chicken';[11] this difference is no doubt related to the intimate relationship between vowel length and stress which holds in Fijian but not in Japanese.

Kenstowicz (2003) analyzes the Fijian adaptation patterns by a ranking reminiscent of that posited for Huave: TROCHAICFEET, ALIGN-R, and MAXSTRESS (=Davidson & Noyer's MATCHSTRESS) dominate faithfulness constraints (in this case, DEPMORA: do not add a mora). The contrast between the patterns illustrated in (17a) and (17b) is accounted for by a constraint that minimizes the perceptual difference between source and output:

(29) PP-2: a short unstressed V may not be realized as a long stressed V.

Kenstowicz assumes that the 'colony' pattern represents the default. However, the 'calico' pattern can be derived with the same grammar, if we assume that Fijians analyze the final V of 'calico' as underlyingly long, so that PP-2 allows it to be stressed:

(30) Kenstowicz's production grammar, 'colony'

| \|koloni\| | TROCHFEET, ALIGN-R | MAX STRESS | DEP MORA | PP-2 |
|---|---|---|---|---|
| ☞a.(kò:)(lóni) | | | * | |
| b. (kòlo)(ní:) | | | * | *! (i → í:) |
| c. ko (lóni) | | *! | | |

(31) Kenstowicz's production grammar, 'calico'

| \|kaliko:\| | TROCHFEET, ALIGN-R | MAX STRESS | DEP MORA | PP-2 |
|---|---|---|---|---|
| a.(kà:)(líko) | | | *! | |
| ☞b.(kàli)(kó:) | | | | |
| c. ka (líko) | | *! | | |

This analysis provides an elegant account of this complex array of data. However, it leaves unanswered some of the same sorts of questions we have been pondering:

[11] This contrast is generally realized in English by some combination of spectral and durational cues, depending on the dialect (Escudero 2001, Escudero and Boersma 2004).

1. Given that lengthening is never attested in native vocabulary, what evidence would have caused Fijians to rank MAXSTRESS above DEPMORA, and DEPMORA over PP-2 (as required to prevent the lengthening of unstressed vowels, choosing (e.g.) *ta(βáko)* 'tobacco' over **(tá:)(βáko)*?

2. Why do we find two different patterns for adaptation of proparoxytones like *(kò:)(lóni)* 'colony' and *(kàli)(kó:)* 'calico'?

3. Why do we find an asymmetry between Fijians' interpretations of English pretonic tense vowels/diphthongs and final tense vowels/diphthongs? Kenstowicz (2003) notes that an English tense vowel before the English main stress is always realized as long (*ò:méka* 'omega', *tò:píto 'torpedo'*), while an English tense vowel in final position may be realized as either long or short (*kàlikó:* vs. *tò:píto*, *kò:lóni*).

### 4.2. Stress and Length: A Perception-oriented Analysis

In Kenstowicz's analysis, Fijians correctly perceive English stress, and their production grammar constraints are ranked so as to preserve the English main stress, by vowel lengthening if necessary. In contrast, Schütz (1978, 1983) proposes that "English words are interpreted in Fijian in terms of an important phonological unit: the *accent group*" (Schütz 1983, page 566). Both Kenstowicz and Schütz assume that lengthening is an effect of the imperative to maintain similarity between the stress patterns of the English and Fijian forms (see Schütz 1983, page 570: "For cases in which merely changing the placement of accent (and hence grouping) would not improve the prosodic fit, syllables can be lengthened to attract the accent.") My proposal is that instead, Fijians perceive English stress as length in certain contexts–that is, in mapping the acoustic signal of English words onto the phoneme categories of their native language, Fijians use prominence patterns to decode phonemic length contrasts. A Fijian vowel may be stressed either by virtue of occupying a prominence-conferring position (head of a bisyllabic foot), or by being long. Therefore, in Fijian, any vowel that is stressed and is not in a prominence-conferring position must be long. Because the grouping of syllables into feet is predictable (in shorter words, but see section 4.3 for discussion of longer words), I assume that underlying representations for words of up to three syllables generally encode length contrasts rather than footing contrasts, which are assigned by the production grammar on the basis of the underlying arrangement of long and short vowels in a word.

On this account, Fijians hear a final stressed vowel (as in *mbazá:* 'bazaar') as long because in Fijian, the only way a final vowel can achieve greater prominence than the vowel preceding it is by virtue of being long. In contrast, a penultimate stressed vowel (as in *taβáko* 'tobacco') need not be analyzed as long, because it occurs in a prominence-conferring position. The variation seen in stressed antepenultimate vowels (as in *kàlikó:* 'calico' vs. *to:píto* 'torpedo' or *kò:lóni* 'colony') also makes sense: as Schütz (1983) points out, the Fijian grammar provides two possible routes to prominence in this position: as head of a bisyllabic foot (as in (*kàli)(kó:*)) or as a long vowel (as in (*kò:)(lóni*)).

The asymmetric behavior of pretonic and posttonic vowels also falls out from this account. While we see variation in the lengthening of final posttonic vowels (*kàlikó:* 'calico' vs. *to:píto* 'torpedo'), tense vowels immediately preceding the English main stressed syllable are consistently lengthened, as in *ò:méka*, while lax prestressed vowels, as in *paʧáma*, are not. Lax vowels, of course, are unstressed in English, while tense vowels in prestress position receive some degree of stress. Apparently, Fijian listeners interpret the different

prominence patterns of words like ‘omega’ and ‘pajama’ in accord with the principles of Fijian grammar, which does not allow adjacent stressed monomoraic syllables (Schütz 1978, 1983). The secondary prominence on the initial syllable of ‘omega’ translates to the Fijian pattern illustrated by *(mà:)(ðáwa)* ‘week’; the last two (strong-weak) syllables form a bisyllabic trochaic foot, and the antepenultimate syllable receives stress by virtue of its long vowel. In contrast, the closest analogue to the prominence pattern of ‘pajama’, with a single stress in penultimate position, is found in words like *ma(káwa)* ‘old’.

We can formalize these observations in a set of perception grammar constraints which allow Fijian speakers to recover length by consideration of the relative prominence of vowels in a word. (For the moment, we will equate prominence with stress, though this will be refined shortly).

(32) Fijian Perceptual Mapping Constraints:
a. FINALVLONG: If the final V is more prominent than the preceding V, then assume it is long.
b. CLASH→LONG: If two prominent vowels are adjacent, assume the first V is long (that is, a stress clash signals length).
c. *LONGV: Assume all vowels are short.

Consider first contrasts in bisyllabic words like ŋg*itá:* ‘guitar’ vs. *fí*β*a/*β*í*β*a* ‘fever’. The input to the perception grammar is the source pronunciation; because information about the specific source pronunciation is unavailable, the input representation is an approximation. The perception grammar will map the source form to underlying representations which in turn serve as inputs to the production grammar; these underlying representations encode the significant contrasts of the borrower’s language.

(33) inputs to perception grammar: ‘guitar’, ‘fever’

| [gɨtá] | FINALVLONG | CLASH→LONG | *LONGV |
|---|---|---|---|
| a. \|ŋgi:ta:\| | | | **! |
| b. \|ŋgita\| | *! | | |
| c. \|ŋgi:ta\| | *! | | * |
| ☞d. \|ŋgita:\| | | | * |
| [fívə] | FINALVLONG | CLASH→LONG | *LONGV |
| a. \|fi:βa:\| | | | *!* |
| ☞b. \|fiβa\| | | | |
| c. \|fi:βa\| | | | *! |
| d. \|fiβa:\| | | | *! |

These same constraints will derive the contrast between proparoxytones with unstressed vs. stressed initial vowels; the perceived length of secondarily stressed vowels before the main stressed vowel is on this account a function of CLASH→LONG.

(34) inputs to perception grammar: English ‘pajama’, ‘omega’

| [pədʒámə] | FINALVLG | CLASH→LONG | *LONGV |
|---|---|---|---|
| ☞ a. \|patʃama\| | | | |
| b. \|pa:tʃama\| | | | *! |
| c. \|patʃama:\| | | | *! |
| d. \|pa:tʃama:\| | | | *!* |
| [òmégə] | | | |
| a. \|omeka\| | | *! (ò,é) | |
| ☞ b. \|o:meka\| | | | * |
| c. \|omeka:\| | | *! (ò,é) | * |
| d. \|o:meka:\| | | | **! |

The constraints above also predict the final lengthening in ‘calico’ if we assume that listeners perceive the final full vowel of ‘calico’ as more prominent than the reduced penultimate vowel:

(35) input to perception grammar: English 'calico'

| [kælɨko] | FINALVLG | CLASH→LONG | *LONGV |
|---|---|---|---|
| a. \|kaliko\| | *! (o>ɨ) | | |
| b. \|ka:liko\| | *! (o>ɨ) | | * |
| ☞ c. \|kaliko:\| | | | * |
| d. \|ka:liko:\| | | | **! |

However, as noted above, not all words with stress patterns similar to 'calico' are adapted with final lengthening; alongside *kàlikó:* 'calico' we find *kò:lóni* 'colony'. We can account for this variability in the interpretation of poststress vowels if we assume that the information Fijian speakers use in determining the relative prominence of vowels includes finer phonetic details, such as inherent length differences. Schütz's (1978) corpus of Fijian loanwords contains fifteen words which are trisyllabic in English, have initial stress in English, and are realized as trisyllabic in Fijian (that is, do not undergo vowel insertion). Of these fourteen, five follow the 'colony' pattern of initial lengthening (36a), seven follow the 'calico' pattern of final lengthening (36b), and three have no lengthening, thereby losing the original English stress (36c):

(36) English Trisyllabic Proparoxytones

| | | |
|---|---|---|
| a. | Fijian (σ:)(σσ) | |
| | colony | (kò:)(lóni) |
| | company | (kà:)(mbáni) |
| | taffeta | (tà:)(féta) |
| | Lucifer | (lù:)(séfa) |
| | governor | (kò:)(βána) |
| b. | Fijian (σσ)(σ:) | |
| | calico | (kàli)(kó:) |
| | polio | (pòli)(ó:) |
| | radio | (rèti)(ó:) |
| | editor | (èndi)(tá:) |
| | battery | (mbàti)(rí:) |
| | motorcar | (mòto)(ká:) |
| | pinafore | (vìni)(vó:) |
| c. | Fijian σ(σσ) | |
| | officer | o(βísa) |
| | cylinder | si(lída) |
| | vinegar | βi(níŋga), βi(níka)[12] |

The choice of strategy is not entirely random. First, final [o] is always long in the adapted form. There are good phonetic reasons why [o] might be more often interpreted as underlyingly long than final [i] (or [ɪ]) or schwa. As is well established, English vowels exhibit inherent length differences independent of the increased length conferred by stress or intonation. Average durations for American English (using Crystal and House's notation) are presented below:

(37) American English V durations (Crystal and House 1988):

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ɔɪ | > au | > ai | > o | > ɔ | > ʉ | > a | > ei | > æ | > ɜ | > u | > i | > ... |
| 298 | 202 | 160 | 155 | 146 | 138 | 134 | 133 | 131 | 116 | 114 | 107 | ...msec |

Thus, while 'calico' and 'colony' are similar in their prosodic structures, they differ in the inherent durations of their final vowels, with [o] on average nearly 50ms longer than [i] (even assuming a source pronunciation with a tense final [i]).

Evidence exists that inherent vowel length differences of this type, though not linguistically significant in English, may influence speakers of other languages. Peng and Ann (2001) have found, in Singapore English, Nigerian English, and the English of Spanish speakers, pronunciations like *illusTRAtor, frusTRAted, exerCISE, CHInese, autoBIography*. Based on a survey of such unfaithful stressings, they conclude that "If a multisyllabic word develops a primary stress placement distinct from L1, primary stress in L2 falls on the syllable whose vowel lasts the longest" (Peng and Ann 2001, page 14).

The lengthening of final [o] in words like 'calico' and the lack of lengthening of the

[12]Schütz (1983, page 571) points out that "vowel lengthening is common for English words ending in -r" as in motoka: 'motorcar', but that some forms "have become standardized without compensatory lengthening, and as a result, the prosodic fit seems rather loose."

prosodically similar final [i] in words like ‘colony’ can now be seen as an interpretation of relative prominence based in part on inherent duration of the English vowels, as compared to the expected duration of the corresponding Fijian vowel categories with which they are identified. The Fijian listeners’ task in interpreting an unfamiliar trisyllabic word is to determine which syllable, if any, contains a long vowel. The final vowel of ‘calico’ is significantly longer than the penultimate vowel, but the final vowel of ‘colony’ is shorter–too close to its reduced neighbor to be identified as long. The initial vowel of ‘colony’, on the other hand, is inherently longer than the other two vowels of the word, and this length difference is further enhanced by the main stress on this vowel, making it a good candidate for analysis as an underlyingly long vowel. We can encode this pattern by means of one additional constraint in our perception grammar:

(38) ANTEPENULTVLONG: If neither the final nor the penultimate vowel is significantly more prominent than the antepenultimate V, then assume the antepenultimate V is long.

The tableau below illustrates the mapping of the source words to underlying representations. bringing ANTEPENULTVLONG into play. In ‘calico’ (realized as *(kàli)(kó:)*) the initial vowel receives the durational enhancement of main stress, but the final vowel has the benefit of inherently greater length, making them comparable. In ‘colony’(realized as *(kò:)(lóni)*), on the other hand, the initial vowel has the advantage over the remaining vowels in the word both in terms of stress-based prominence and inherent duration. The initial vowel of ‘vinegar’ (realized as β*i(ní*ŋ*ga))*, in contrast, is too short relative to the other vowels to be perceived as underlyingly long:

(39) inputs to Fijian perception grammar: English proparoxytones ‘calico’, ‘colony’, ‘vinegar’

| [kæ’lɬko] | FINALVLG | CLASH→LONG | ANTEPVLG | *LONGV |
|---|---|---|---|---|
| a. \|kaliko\| | *! (o>ɬ) | | √(æ ≈ o) | |
| b. \|ka:liko\| | *! (o>ɬ) | | | * |
| ☞c. \|kaliko:\| | | | √(æ ≈ o) | * |
| d. \|ka:liko:\| | | | | **! |
| [kɔ’ləni] | | | | |
| a. \|koloni\| | | | *! (ɔ >ə,i) | |
| ☞ b.\|ko:loni\| | | | | * |
| c. \|koloni:\| | | | *! (ɔ > ə,i) | * |
| d. \|ko:loni:\| | | | | **! |
| [vɪ’nəgə] | | | | |
| ☞a. \|βiniŋga\| | | | | |
| b. \|βi:niŋga\| | | | | *! |
| c. \|βiniŋga:\| | | | | *! |
| d. \|βi:niŋga:\| | | | | *!* |

While in principle any vowel of a trisyllabic form could be long in the underlying representation, the Fijian production grammar limits the positions in which length contrasts are manifested. Recall that long vowels are shortened in penultimate position when they precede a short vowel, as illustrated in (26) *síβi* ‘exceed’ (the underlying long vowel surfaces in *sì:βí-ta* ‘exceed, trans.’). Furthermore, Schütz (1999) notes a tendency for prepenultimate vowels to shorten where their shortening makes possible incorporation of the long syllable into a bimoraic foot. This shortening is illustrated in the form *vakata:kila:* ‘reveal it’ in which “the first vowel...retains its length only in a formal pronunciation” (Schütz 1999, page 140, note 4); “in faster speech” this form is pronounced as *(vaka)(taki)(la:)* (Schütz 1999, page 145). Thus even though the perception grammar constraints above make possible the analysis of a loanword on first encounter as *V:-V-V:*, such a structure would most likely be altered to *V-V-V:* in less formal speech, with this structure serving as the input to subsequent listeners.

The underlying representations that emerge from the perception grammar, submitted to the production grammar, will result in the footings below:

(40) inputs to Fijian production grammar: ‘calico’, ‘colony’, ‘vinegar’

| \|kaliko:\| | ALIGN-R | TROCHAICFEET, BIMORAIC | MAXMORA | PARSESYLL |
|---|---|---|---|---|
| ☞a. [(kàli)(kó:)] | | | | |
| b. [(kà)(líko:)] | | *! | | |
| c. [ka (líko:)] | | *! | | * |
| \|ko:loni\| | | | | |
| a. [(kò:lo)(ní)] | | *!* | | |
| ☞ b. [(kò:)(lóni)] | | | | |
| c. [ko:(lóni)] | | | | *! |
| \|βiniŋga\| | | | | |
| a. [(βìni)(ŋgá)] | | *! | | |
| b. [(βì)(níŋga)] | | *! | | |
| ☞c. [βi(níŋga)] | | | | * |

In summary, the account above implements the generalization that upon encountering new words, the Fijian listener must determine the position of lexically contrastive length, by listening for prominence in positions where prominence is not automatic. The interpretation of greater-than-expected relative length as signaling prominence is reasonable in terms of the Fijian prosodic system; Scott (1948) describes stressed short vowels as “half long” (Scott 1948, page 743). Once the English forms have been mapped to Fijian underlying representations encoding contrastive length distinctions, the production grammar of Fijian will assign stress precisely as it does with native vocabulary. In this account, there is no need to assume loan-specific constraints or rankings, since the task is the same for all new vocabulary, whether native or foreign: to map the acoustic signal onto an underlying representation which encodes lexically contrastive information, and to assign stress on the basis of that information.

### 4.3. Comparison of the Production-oriented and Perception-oriented Accounts

We are now in a position to compare analyses of Fijian loanword adaptation. In Kenstowicz’s analysis, the Fijian listener correctly perceives the position of main stress in the English word. The production grammar limits the degree of perceptual deviance between underlying and phonetic forms–specifically, by triggering lengthening of the English main

stressed vowel if necessary to preserve stress on that vowel. The constraints of the production grammar refer only to phonological categories such as long vs. short, stressed vs. unstressed, and participate in crucial ranking relationships that are motivated solely by the loanword data. The second analysis, in contrast, assumes that lengthening of vowels in loanwords is an effect of a perception grammar which allows listeners to recover from the acoustic signal those aspects of the native language that are contrastive (such as vowel length). The representation provided by the perception grammar then serves as input to the production grammar, which assigns stress according to Fijian principles. The constraints of the perception grammar may refer to fine-grained, non-categorical aspects of phonetic detail, such as relative vowel duration, predicting the possibility of variation in words with similar English stress patterns but different relative inherent vowel durations, as seen in *kò:lóni* 'colony' vs. *kàlikó:* 'calico' vs. β*iníŋga* 'vinegar'.

At this point one might reasonably object that if a production grammar can account for the Fijian patterns, there is no motivation for adding another component to the model. But in fact, much of the analysis in the preceding section would be necessary to Kenstowicz's analysis as well. Given a proparoxytone with no underlying long vowels, Kenstowicz's grammar would always derive the *kò:lóni* 'colony' pattern. In order to derive the *kálikó:* 'calico' pattern, it is crucial that Fijian listeners analyze the final vowel of 'calico' as long. Thus, along with the production constraint MAXSTRESS, the production analysis must contain an implicit perceptual component that identifies certain source vowels as underlyingly long.

However, Kenstowicz provides two additional arguments for the account of Fijian stress based on a production grammar which preserves the English stress position. The first concerns words longer than three syllables. Kenstowicz discusses words like *(tále)*β*i(sóni)* 'television' which, in contrast to native forms like *li(námu))nráu)* 'arm-2dual possessor' (Hayes 1995, page 144), allow two adjacent unstressed syllables. The tolerance of stress lapse is, Kenstowicz argues, in conflict with the native language grammar, which would favor the footing **ta (lé*β*i)(sóni)*; therefore, the actual footing of 'television' must be explained as a function of the stress conserving constraint. This argument depends on the assumption that the native language grammar provides a default footing pattern for strings of light syllables, an assumption challenged by Schütz (1983), who argues that "Longer forms, especially those with an uneven number of syllables, offer the potential for alternate groupings, dependent upon accent placement" (Schütz 1983, page 569). Indeed, there seems to be consensus among writers on Fijian that stress patterns in native vocabulary containing strings of more than four light syllables are not predictable; for example, Hayes (1995), citing forms such as *(mbáti)ka(si*β*i)* 'kind of fish', characterizes Fijian as "a language with predictable primary stress but phonemic secondary stress" (Hayes 1995, page 144), and as Kenstowicz (2003, page 9) concedes that "To the extent that these items are no longer decomposed in the minds of Fijian speakers, there is a precedent for the lapses observed in loans." In other words, Fijian speakers cannot predict the footing pattern of new words consisting of more than three light syllables, and must therefore listen for cues to (lexically contrastive) footing in new words. It therefore seems reasonable that Fijian listeners hearing English 'television' would interpret the prosodic pattern of this word as indicating that the first two syllables form a bisyllabic foot. This is precisely the position of Schütz (1983), who argues that in longer borrowings, "We assume that one grouping sounds closer to the English model than the other" (Schütz 1983, page 569).

A second argument for Kenstowicz's stress preservation analysis concerns the

treatment of forms with epenthetic vowels. While trisyllabic forms with initial stress may undergo lengthening of either the initial or the final syllable (*kò:lóni* vs. *kàlikó:*), initially-stressed words that become trisyllabic through medial epenthesis invariably lengthen the final syllable:[13]

(41) Bisyllables with medial epenthesis

| | |
|---|---|
| (wísi)(kì:) | 'whiskey' |
| (ndòke)(tá:) | 'doctor' |
| (sìsi)(tá:) | 'sister' |
| (ráka)(βí:) | 'rugby' |

Kenstowicz's (2003) analysis of the data in (41) makes use of a high-ranked constraint *v', which bans stress on epenthetic vowels. The most direct way to preserve stress on the initial vowel in a word like 'whiskey' would be to lengthen it. But lengthening the initial vowel would force the epenthetic vowel into the head of a bisyllabic foot, resulting in the nonoccurring realization **(wì:)(síki),* which violates *v'. Therefore, Fijians choose the alternate route of lengthening the final vowel, which allows the initial syllable to be head of a bisyllabic foot: *(wìsi)(kí:)*. Kenstowicz appeals to these facts as an argument against a perceptual account of lengthening, pointing out that "not all long vowels in Fijian adaptations can be attributed to a putative equation of stress = length at the level of the perceptual scan (Silverman 1992). We therefore conclude that the main stress of English is translated as a stress in Fijian rather than as a length that in turn attracts a stress"(Kenstowicz 2003, page 10).

Indeed, it seems highly unlikely that the final vowels of all forms with medial epenthesis would be consistently perceived as longer than the preceding (stressed) vowel, as required to explain the lengthening of final vowels in loanwords in the perception-based analysis outlined above. However, this final lengthening is precisely what would be expected if words like 'whiskey' are perceived by the Fijian listener as trisyllabic forms. This is the proposal advanced by Schütz (1978), who argues that "each English consonant that is not a followed by a vowel is interpreted as a Fijian CV syllable" (Schütz 1978, page 18). Schütz presents two arguments for this view. First, the unaccented syllable of a bisyllabic foot is typically reduced, even in native vocabulary, so that the phonetic distance between C and CV is fairly small: "certain syllables are so reduced that their phonetic manifestation is merely a lengthened consonant" (Schütz 1978, page 14). Second, the choice of epenthetic vowel is dependent on the preceding consonant, with a preference for [u] after labials and [i] after coronals. This suggests "that the release of a certain consonant in this class is perceived as a particular vowel" (Schütz 1978, page 22). In a production-oriented approach, the choice of epenthetic vowel is an effect of the mandate to minimize the perceptual distance between

[13]The sole exception to this generalization is *si(líva)* 'silver'. Schütz's 1978 corpus contains no parallel words with final stress in the source pronunciation.

the (accurately perceived) English form and the output of the Fijian production grammar. The perception-oriented approach advocated here would view this instead as an effect of the interpretation of the English phonetics in terms of Fijian lexical categories. Because, for example, an unstressed syllable [si] may be realized (noncontrastively) as a lengthened [s] in Fijian, the Fijian listener maps the [s] of 'whiskey' to the sequence [si] in underlying representation. On this view, the final vowel of 'whiskey' is clearly longer than what is perceived as the preceding (highly reduced) vowel, and should be analyzed as long. Words like 'whiskey' are thus similar to words like *(kàli)(kó:)* 'calico'.

This proposal is consistent with the adaptation patterns of words like 'beacon' or 'belt', with an initial stressed syllable followed by either an unstressed vowel plus an epenthetic vowel, or by two epenthetic vowels. Such forms, by hypothesis, will be perceived as trisyllabic. We would expect the initial vowel to be perceived as clearly longer than the two following vowels (and therefore, by ANTEPENULTVLONG, as long), just as in words like *(kò:)(lóni)* 'colony'. Indeed, words of this type always lengthen the initial vowel:

(42) Epenthetic forms with antepenultimate lengthening

| | | |
|---|---|---|
| a. | (bì:)(kéni) | 'beacon' |
| | (bò:)(nísi) | 'bonus' |
| b. | (mbè:)(léti) | 'belt' |
| | (fi:)(límu) | 'film' |

As Schütz (1990, page 121) points out, these words are subject to the same tendency toward shortening that affects prepenultimate vowels in native vocabulary; Schütz cites shortened forms *beleti* 'belt', *bikeni* 'beacon' and *bonisi* 'bonus'.

In contrast to epenthetic forms with initial English stress, forms with a stressed vowel followed by a single epenthetic vowel do not lengthen the stressed vowel:

(43) Epenthetic forms without lengthening

| | |
|---|---|
| mba (lúni) | 'balloon' |
| ŋga (rátʃi) | 'garage' |

Again, these facts are consistent with the theory outlined above, since there is no perception grammar constraint that would force a penultimate vowel followed by a less prominent vowel to be analyzed as long.

At this point we should ask why Fijian speakers behave differently from Huave speakers, since in both languages the right edges of words are invariably aligned with the main stress foot. In other words, stress in Fijian serves to signal phonemic vowel length contrasts, but also to mark the edges of words. Why, then, do Fijians not attend to stress in the same way that Huave speakers do, assuming a word boundary at the right edge of the stress foot? One possible answer is that the languages are actually quite different in terms of the relationship between stress and word edge: while Huave appears to have one clearly perceptible stress per word, Fijian has a rich system of secondary stress which makes the strategy of projecting word edges after stressed syllables a risky one.

## 5. Conclusion

One great virtue of the Optimality Theoretic approach is that it forces us to ask not

only whether a grammar is consistent with a set of data, but also how that grammar could have been learned. In the cases discussed above, asking this question has led us to consider alternative analyses of the data which shed light on the division of labor between the production and perception modules of the grammar. We have now seen that loan adaptation in two languages that have been described by means of a crucially ranked constraint demanding stress preservation in loanwords are amenable to an analysis in which the mapping from the acoustic signal to underlying phonological representations is mediated by the native language perception grammar. This mapping accounts for the facts of loanword stress using only rankings (of both perception and production grammar constraints) that are motivated by the native language data. In Huave, the preservation of source stress was argued to reflect the demarcative function of Huave stress, while source stress preservation in Fijian was argued to be a byproduct of the identification of stress with length.

Our larger conclusion is that what at first appeared to be unlearnable rankings in the production grammar are actually a reflection either of input frequency or of the workings of a perception grammar. This approach has several desirable consequences. First, we can eliminate loan-specific constraints like MATCHSTRESS from the grammar. This in turn allows us to make much stronger predictions about the range of possible adaptation patterns. For example, a model that includes a MATCHSTRESS constraint in the repertoire of production grammar constraints predicts that all combinations of native stress system and stress conservation in loanword adaptation should be logically possible, due to free ranking of MATCHSTRESS. In contrast, a model such as the one proposed above ties the treatment of stress in loanwords to the function of stress in the native language. We would not expect, for example, to find a language that is like Huave in all respects except that it ranks MATCHSTRESS low.

Much work obviously remains to be done in developing a complete model of native language perception/decoding processes, but language contact phonology provides a rich source of insights into this aspect of language.

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