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Ordering Restrictions on Aspirated and Ejective Stops in Aymara¹

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The dialect of Aymara described in De Lucca 1987 exhibits an intricate pattern of wellformedness in the distribution of ejective and aspirated stops. This pattern reveals a dispreference for **p'** and **q'**: these sounds exist in the language's segment inventory, but are avoided under certain conditions. This dispreference for **p'** and **q'** mirrors a strong crosslinguistic generalization: in languages with ejective series, the series will be defective at the labial and uvular places of articulation before it is defective at any other place of articulation. These two observations combine to suggest an implicational hierarchy such that **p'** and **q'** are disfavored over all other ejective stops. In this paper I appeal to phonetic motivations behind the dispreferences for **p'** and **q'**, and provide an Optimality Theoretic analysis of the data.

Aymara is spoken by two to three million people in Peru, Bolivia, and Chile (Briggs 1985, Hardman 1985). De Lucca, a dictionary of 8000 forms, was published in Bolivia; the presence of roots containing both aspirated and ejective stops distinguishes this dialect from those described in other published sources (notably Deza Galindo 1989 and Ayala Loayza 1988, both Aymara dictionaries published in Peru).

Aymara has three series of oral stops/affricates, reproduced below:

| | | | | | |
|-----|----------------|----------------|-----------------|----------------|----------------|
| (1) | p | t | tʃ | k | q |
| | p ^h | t ^h | tʃ ^h | k ^h | q ^h |
| | p' | t' | tʃ' | k' | q' |

Roots are overwhelmingly of form (C)V(C)CV.

The language observes various restrictions on the type and location of aspirated and ejective consonants (earlier descriptions of these restrictions may be found in Martin-Barber in Hardman et al. 1974, Adelaar 1986, and especially Landerman 1994). For example, if an Aymara morpheme has a single ejective or aspirated stop, that stop will be the leftmost stop in the morpheme: *k'anta* 'spinning wheel', *q^hatu* 'market'; **kant'a*, **qat^hu* (I have converted De Lucca's orthography to IPA transcription). Although ejectiveness and aspiration must occur on the leftmost stop in a morpheme, that stop need not be morpheme-initial: *sirk'u* 'nerve', *hajp^hu* 'in the dark'. It is also the case that heterorganic ejectives do not cooccur morpheme-internally (**t'ak'a*), nor do homorganic aspirated and ejective stops (**q^hoq'a*, **t'ant^ha*); I suggest elsewhere (MacEachern, to appear) that these restrictions are due to laryngeal similarity effects.

Ejective and aspirated stops may cooccur morpheme-internally in the dialect of Aymara described here, but certain ordering restrictions are observed. If the initial stop in the root is a dental, palato-alveolar, or velar, then that sound will be ejective, and the second stop in the root will be aspirated:

| | | |
|-----|-----------------------------------|-------------------------|
| (2) | t'alp ^h a | 'wide' |
| | tʃ'ip ^h a | 'leather net' |
| | k'ip ^h a | 'said of late potatoes' |
| | k'it ^h a | 'fugitive' |
| | t'ink ^h a ² | 'tip' |
| | tʃ'ik ^h i | 'clever' |
| | t'aq ^h e | 'affliction' |
| | tʃ'oxq ^h e | 'solid' |

De Lucca includes 58 roots that fall into this category. Not all possible place of articulation combinations are attested, however, and some of these gaps do not appear to be accidental. For example, the lack of roots of form **t'...tʃ^h**, **tʃ'...t^h**, **k'...q^h** and **q^h...k'** may follow from prohibitions on the cooccurrence of similar, but non-identical coronal and back lingual articulations. This hypothesis is supported by the lack of Aymara roots of form **t^h...tʃ^h**, **tʃ^h...t^h**, **k^h...q^h**, and **q^h...k^h**. I do not pursue this here.

The other side of the ordering restrictions on aspirated and ejective stops is that if the initial stop is labial or uvular, and the second stop is at an intermediate (i.e., dental, palato-alveolar, or velar) place of articulation, then the first stop in the root will be aspirated, and the second will be ejective (a few exceptions exist; these are discussed below). De Lucca includes 34 roots of this type.

| | | |
|-----|----------------------|------------------------------|
| (3) | p ^h ant'a | 'black coat' |
| | p ^h itʃ'i | 'coat pin' |
| | p ^h ank'a | 'rubble' |
| | q ^h ot'a | 'resin of some small plants' |
| | q ^h atʃ'u | 'fodder' |

The restrictions described above entail that, if the places of articulation of the stops are known, and if the number of aspirated and ejective features in a morpheme is known, then the location of the laryngeal features is (nearly always) predictable.

There is one set of data for which the statement above is not true. De Lucca includes a few forms with a labial stop, a uvular stop, and ejective and aspiration features. There are four possible arrangements of two stops and two laryngeal features:

| | |
|-----|-----------------------|
| (4) | q' ... p ^h |
| | q ^h ... p' |
| | p' ... q ^h |
| | p ^h ... q' |

Of the four patterns shown above, only two are attested. An exhaustive list of these forms is given below:

| | | |
|-----|---------------------------|---|
| (5) | q'ap ^h i | 'fragrance' |
| | q'ap ^h a/q'apa | 'active, diligent, agile' |
| | q ^h op'aki | 'meal with meat or fat' (Altiplano Central) |
| | q ^h op'i | 'potter' (Altiplano Norte) |

Notice that the roots of form **q^h ... p'** are singled out by De Lucca as being dialectal variants, while the roots of form **q' ... p^h** stand as representatives of the main dialect. There are no roots of form **p'... q^h** or **p^h...q'**; this gap may of course be accidental. I return to these facts later in this article.

There are also six forms with initial ejective uvulars which are followed by aspirated stops at intermediate (i.e., non-labial, non-uvular) places of articulation. However, four of these forms have alternate, regular pronunciations (i.e., an aspirated uvular followed by an ejective) in De Lucca or in Miranda 1970 (another Aymara dictionary published in Bolivia). The two residual forms are *q'aj^hi* 'beating of waves' (Manco Capaj dialect) and *q'at^hi* 'edge'; the expected forms are **q^haj^ti* and *q^hat'i*. I have no explanation for these roots; they do not necessarily indicate a milder dispreference for **q'** as opposed to **p'**, given that **q'** occurs about twice as frequently as **p'** in this language. In the remainder of this paper, I disregard these two forms.

I will now present my analysis; I assume familiarity with the principles of Optimality Theory (Prince and Smolensky 1993, McCarthy and Prince 1993) and Correspondence Theory (McCarthy and Prince 1995). I appeal to the following constraints in order to capture the data described above:

| | | |
|-----|-----------------------------|--|
| (6) | Ident[lar] | Correspondent segments in the Input and Output are identical with respect to laryngeal features. These include [asp] (representing aspiration) and [glott] (representing glottalization). |
| | Preserve[lar] | Laryngeal features present in the Input must also be present in the Output. |
| | Leftmost[lar] | Laryngeal features (asp, glott) should be at the beginning edge of the morpheme. One violation is counted for every segment intervening between the aspirated or ejective stop and the left edge of the morpheme: <i>sap^hi</i> incurs two Leftmost violations, <i>t^hant^ha</i> incurs three, and <i>t'inka</i> earns none (violations could alternatively be counted by some measure of temporal distance between word onset and aspiration/ejective release). |
| | Leftmost[ejec] _L | Ejectives should be at the beginning edge of the morpheme. Violations are counted as for Leftmost[lar]. |
| | *p' | Do not allow labial ejectives. |
| | *q' | Do not allow uvular ejectives. |

Before I proceed to establish the constraint rankings of Aymara, a few words on Preserve[lar] are in order. Recall that the location of ejective and aspiration features in Aymara is predictable. This suggests that there is a value attached to having features present in the Input also be present in the Output, even if those features reside on different segments in the Output (i.e., even when violations of Ident[lar] are involved). Preserve[lar] achieves this end; no provisions were made for this effect in McCarthy and Prince 1995, but the authors (p. 265) recognize that such an extension is necessary.

These five constraints are subject to the following ranking in Aymara: Preserve[lar] >> Leftmost[lar] >> {*p', *q'} >> {Leftmost[ejec], Ident[lar]}. Curly braces indicate that the rankings of the enclosed constraints have not been definitively established. I provide motivations for these rankings below.

Preserve[lar] must outrank Leftmost[lar] in order to allow forms such as *saphi* 'root' and *seq'e* 'new liquor'. The tableau in (7) illustrates selection of the output *seq'e*. The exclamation point indicates a fatal violation; shaded cells signal information which is irrelevant, due to the presence of an earlier, fatal violation.

(7)

| | /seq'e/ | Preserve[lar] | Leftmost[lar] |
|---|---------|---------------|---------------|
| → | seq'e | | ** |
| | seqe | *! | |

The tableau in (8) introduces *p', *q', and Ident[lar]; the lack of a column divider between the markedness constraints indicates that they are not yet ranked with respect to one another. Although the segments p' and q' are disfavored, we saw in (5) that they are not prohibited; (8) shows that the dispreferred ejectives will surface even when the input contains another segment capable of hosting aspiration or ejectiveness. Forms such as *p'ita* 'knitted/crocheted fabric' and *q'ata* 'anklebone' (**pit'a*, **qat'a*) show that Leftmost[lar] must outrank *p' and *q'. (8) details the selection of *p'ita* as the winning candidate. I have proposed a non-transparent input for this form in order to illustrate that laryngeal features cannot surface in violation of the morpheme structure constraints of the language — in this case, the generalization that says laryngeal features must surface on the leftmost stop of the morpheme. The tableau for *q'ata* would be similar.

(8)

| | /pit'a/ | Preserve[lar] | Leftmost[lar] | *p' | *q' | Ident[lar] |
|---|---------|---------------|---------------|-----|-----|------------|
| → | p'ita | | | * | | ** |
| | pita | *! | | | | * |
| | pit'a | | **! | | | |

Of course, there exist many highly-ranked constraints that are not listed in the tableaux given here. For example, *k'ita* could not be the winning candidate in (8) because it violates Ident[place] (a constraint requiring Input and Output correspondents to be identical for place features; I do not discuss this constraint here). Similarly, **s'eqe* is not a viable winner in (7) because Aymara fricatives cannot be ejective; the constraints prohibiting ejective fricatives are undominated in most languages.

The tableau in (9) introduces Leftmost[ejec], *p', and *q'. *p' and *q' must outrank Leftmost[ejec] and Ident[lar] in order to account for forms such as *p^hat'a* 'digging' and *q^hot'i* 'cataract'; the production of *p^hat'a* is shown in (9) below (again, I choose a non-transparent input):

(9)

| | /pʰatʰa/ | Preserve[lar] | Leftmost[lar] | *p' *q' | Leftmost[ejec] | Ident[lar] |
|---|----------|---------------|---------------|---------|----------------|------------|
| → | pʰatʰa | | ** | | ** | ** |
| | pata | **! | | | | ** |
| | pʰatʰa | | ** | *! | | |

I conclude that the following rankings have been established for Aymara: Preserve[lar] >> Leftmost[lar] >> {*p', *q'} >> {Leftmost[ejec], Ident[lar]}.

Let us now reconsider Leftmost[ejec]. The reader may be wondering why Leftmost[ejec] has been held distinct from Leftmost[lar], which describes the preference of both aspiration and glottalization to be at the beginnings of morphemes. I will now show that both constraints are necessary to account for the data discussed here.

Consider an analysis with only two Leftmost constraints, where Leftmost[asp] has replaced Leftmost[lar]. Given these constraints, Leftmost[ejec] would have to outrank Leftmost[asp] in order to obtain *kʰitʰu* 'disordered mess' rather than **kʰitʰu*.

(10)

| | /kʰitʰu/ | Preserve[lar] | Leftmost[ejec] | Leftmost[asp] |
|---|----------|---------------|----------------|---------------|
| → | kʰitʰu | | | ** |
| | kitu | **! | | |
| | kʰitʰu | | **! | |

*p' would have to outrank Leftmost[ejec] in order to produce *pʰatʰa* in place of **pʰatʰa*.

(11)

| | /pʰatʰa/ | Preserve[lar] | *p' | Leftmost[ejec] | Leftmost[asp] |
|---|----------|---------------|-----|----------------|---------------|
| → | pʰatʰa | | | ** | |
| | pata | **! | | | |
| | pʰatʰa | | *! | | ** |

However, these rankings would produce incorrect **pitʰa* in place of *pʰita*. The exclamation point in front of the arrow indicates that an incorrect candidate has been selected.

(12)

| | /pʰita/ | Preserve[lar] | *p' | Leftmost[ejec] | Leftmost[asp] |
|----|---------|---------------|-----|----------------|---------------|
| | pʰita | | *! | | |
| | pita | *! | | | |
| !→ | pitʰa | | | ** | |

Similar arguments concerning *qʰata* (**qatʰa*) could be made with respect to *q'. I conclude that both Leftmost[lar] and Leftmost[ejec] are necessary to account for the ordering restrictions observed in this dialect of Aymara.

Of course, it is true that the system of Leftmost constraints could be made symmetrical by adding Leftmost[asp] to existing Leftmost[ejec] and Leftmost[lar]. I have refrained from doing this for two reasons: first, the Aymara data does not suggest that such a constraint is necessary, and second, I suspect that this asymmetry is real — Leftmost[lar] has a basis in auditory (processing) factors while Leftmost[ejec] has a basis in production (ease of articulation) factors (I

discuss this later). I do not know what a genuine production basis for Leftmost[asp] might be.

Reconsider the data given in (5). There are very few forms on which to rest this part of the analysis, but the data that does exist indicates that the main dialect forms (*q'ap^{hi}* and *q'ap^{ha}*) are consistent with a constraint ranking in which *p' dominates *q', as can be seen in (13) below (again, I assume a non-transparent input).

(13)

| | /q ^h ap'i/ | Preserve[lar] | Leftmost[lar] | *p' | *q' | Leftmost[ejec] |
|---|-----------------------|---------------|---------------|-----|-----|----------------|
| → | q'ap ^{hi} | | ** | | * | |
| | q ^h ap'i | | ** | *! | | ** |
| | qapi | **! | | | | |

Now consider the forms *q^hop'aki* and *q^hop'i*, which De Lucca labels as existing in the Altiplano Central and Altiplano Norte dialects, respectively. As (14) illustrates, these forms are consistent with a ranking in which *q' dominates *p'.

(14)

| | /q ^h op'i/ | Preserve[lar] | Leftmost[lar] | *q' | *p' | Leftmost[ejec] |
|---|-----------------------|---------------|---------------|-----|-----|----------------|
| → | q ^h op'i | | ** | | * | ** |
| | q'op ^{hi} | | ** | *! | | |
| | qopi | **! | | | | |

Of course, the ranking shown in (14) is inconsistent with the ranking shown in (13) — I would not expect dialects containing *q^hop'aki*, for example, to also contain *q'ap^{hi}*.

I will now comment on possible functional motivations for the Leftmost, *p', and *q' constraints. With respect to the Leftmost constraints, it is well known that languages tend to allow a greater range of contrasts in initial position (Trubetsky 1969, Steriade 1995). Such a tendency serves word delimitation functions and helps to position the most valuable information (i.e., the information that distinguishes among the greatest number of contrasts) early in the speech stream. Extensive psycholinguistic evidence exists showing that lexical decisions are made faster when the recognition point — the moment at which a form can be distinguished from all other forms in the hearer's lexicon — lies earlier in a word (Tyler and Wessells 1983, Marslen-Wilson 1984, Marslen-Wilson 1987, Emmorey 1987). Thus, placing expanded contrasts at the beginnings of morphemes speeds lexical decisions; placing expanded contrasts at the ends of morphemes would not speed lexical decisions, although it would also aid in word delimitation.

The basis for a distinct Leftmost[ejec] constraint is harder to determine. There may be a production advantage to positioning ejective consonants at well-spaced intervals; data in Kingston 1985 suggest that larynx height readjusts rather slowly, following ejective consonants. Leftmost[ejec] would serve this end, although it is clearly not the only constraint that could do so.

Regarding the markedness bases of the *p' and *q' constraints, various scholars (Haudricourt 1950, Wang 1968, Greenberg 1970) have noted that ejectives tend to occur at back rather than forward places of articulation; Fordyce 1980 showed that this holds true over a large language sample, and Maddieson 1984 established that it was primarily bilabial ejectives that were disfavored. The following reasons for the dispreference for p' have been suggested by other

scholars: (1) The bursts of bilabial stops are relatively weak (Zue 1980) due to the lack of a downstream resonating chamber (Kawasaki 1981). (2) Ejectives involve compression of the air in the supraglottal chamber. Because bilabial constrictions involve the largest supraglottal chamber, the compressive effect will correspondingly be least significant in **p'** (various authors beginning with Wang 1968 have noted this, but see especially Javkin 1977). (3) A strong compressive effect will be difficult to achieve in bilabial stops because they expose the greatest amount of yielding cheek wall surface (see Kingston 1985, who follows Ohala and Riordan 1979 on the significance of passive compliance of the vocal tract walls).

Factors just cited for the dispreference of **p'** would seem to indicate that **q'** should be a preferred articulation: the oral chamber is quite small during uvular production, indicating that laryngeal compression should have a very salient effect. The Aymara data, however, suggest that uvular ejectives are dispreferred. It may be because maintaining a uvular seal during ejective production is difficult when the supraglottal chamber is small, and both of the articulators involved are soft (the tongue dorsum, and the uvula and lower velum). The elevated oral pressure characteristic of ejectives might tend to make the uvular closure slip, resulting in a uvular affricate or fricative.

I have proposed that the ranking Preserve[lar] >> Leftmost[lar] >> {*p', *q'} >> {Leftmost[ejec], Ident[lar]} accounts for the ordering restrictions found in Aymara. Presumably *t', *tʃ', *k', etc. also exist in Aymara, but are outranked by all of the constraints given above. The possibility arises that *p' and *q' universally outrank markedness constraints for ejectives at other places of articulation. If this were true, we would expect languages with defective ejective series to be defective at the bilabial and uvular places of articulation before they are defective at any other place of articulation. This question is slightly complicated by the fact that languages strongly tend to have ejectives only at places of articulation where another stop series is instantiated (Greenberg 1970; Fordyce 1980 proposes the 'ejective-to-plain' hierarchy to describe the tendency of languages to have ejectives only where they also have plain voiceless stops). Assuming that this characteristic is accounted for by other features of the grammar, the prediction made by my analysis is that if a language lacks an ejective at some place of articulation where another stop series is instantiated, then the missing ejectives will be bilabial and/or uvular; if both **p'** and **q'** are missing, then ejectives at other places of articulation may also be absent.

A review of the data in Maddieson 1984 and Ruhlen 1975, 1976 bears out this prediction.³ Of the nearly 100 languages in Ruhlen and the roughly 35 languages in Maddieson with **p'** and/or **q'** (of course, most of Maddieson's languages also appear in Ruhlen), only a handful are described as lacking or having marginally-attested ejective stops at places of articulation present in another stop series of the language (dental, alveolar, palatal, velar, or labiovelar, with or without a secondary articulation). I will argue that none of these languages present a robust counterexample to my claim. By contrast, several Na-Dene languages (Chipewyan, Haida, etc.), several Mayan languages (Aguacatec, Huastec, etc.), several Northeast Caucasian languages (Andi, Bagvali, etc.), West Circassian, Mazahua, Gununa-Kena, Ossetic, etc. all include ejectives at intermediate places of articulation, but are missing **p'** and/or **q'**, although labial and/or uvular stops of other series are present.

The nearest exceptions to the generalization I have given are Huambisa (an Andean language of the Jivaro family), Chol (Mayan), Tewa (Tanoan), Osage (Siouan), Teco (Mayan), and Berta (Nilo-Saharan: Chari-Nile). I will now briefly

comment on why I do not consider any of these six languages to constitute a strong counterexample to the claim made above.

Huambisa (Beasley and Pike 1957) is listed as having only **p'** in the ejective series, although **t** and **k** are also present in the language. However, **p'** is found only as an expressive interjection among men.

In four of the other languages, one of the relevant sounds is extremely marginal. In Chol and Tewa, an ejective at an intermediate place of articulation is missing, but the matching non-glottalic stop is quite rare. Chol (Warkentin and Brend 1974) has two full series of aspirated and ejective stops, except that it lacks **t'**, although it has **t^h**. However, **t^h** is very rare. Similarly, Tewa (Hoijer and Dozier 1949) has **tj** but lacks matching **tj'**; however, the authors report that **tj** was only found in one morpheme (*tju* 'younger sibling'). The rareness of the relevant plosives (**t^h** in Chol and **tj** in Tewa) suggests two possibilities: either the plosives may not be fully integrated into the segment inventories of the languages under consideration, or the lack of matching ejectives is accidental (crosslinguistically, ejectives tend to be less frequent than the corresponding plosives).

Osage (Wolff 1952) is said to have **p'** and **k'** but lack **t'**, although it has **t**. However, Wolff notes that **k'** is reconstructed to Proto-Siouan ***kq**, while Proto-Siouan ***pq** and ***tq** normally become Osage **p** and **t**, respectively. The only **p'** mentioned in the article is in *tap'ok'e*, which is labelled as an allomorph of *tap^hok^{he}* (glossing as 'he hit(s) it'). These facts suggest that **p'** is extremely rare, and perhaps not even distinctive.

Teco (Kaufman 1969) has only marginal **t'**, although **t** is attested. (This language is actually in line with the generalization given above; I note it here because the marginality of **t'** is unexpected.)

Finally, regarding Berta, Triulzi et al. 1976 claim the following stops for its inventory (**dʒ** is also present):⁴

| | | | |
|------|-----------|----------|-----------|
| (15) | p' | | k' |
| | b | d | g |

According to the generalization given above, we would expect unattested **t'** to also be present in the segment inventory. However, the authors note that **p'** and **k'** are "weakly glottalized and often approach [p, k] in realization"; because the language does not have a voiceless plosive series, there is no need to maintain a contrast between **k'** and **k** or **k^h**, for example. Furthermore, "[t]he fricative /θ/ seems to fill the position of the missing **t'** in the stop series" (Triulzi et al. 1976:520). Weakly glottalized segments will be less subject to the functional dispreferences for **p'** described above; in the absence of phonetic data on this dialect group, I consider Berta a weak counterexample to the generalization made above.⁵

I conclude that a study of the largest crosslinguistic surveys available to me reveals no strong counterexamples to the generalization stated above: no language will have **p'** or **q'** unless it also has ejectives at all other places of articulation for which stops are attested. This typological generalization is mirrored by the emergence of the unmarked in a small corner of the Aymara lexicon. In that language, ejective features generally appear as near the beginnings of morphemes as possible. However, this rule is violated just in case the following three points hold true: (1) assigning ejective features to the leftmost stop in the morpheme would create an ejective labial or uvular segment, (2) another host for the ejective feature can be found, and (3) the constraint requiring aspiration and ejective features to be

leftmost can be appeased by other means (i.e., by placing aspiration before ejectiveness). These observations find a unified explanation in the statement that **p'** and **q'** are disfavored over all other ejective stops.

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² Martin-Barber in Hardman et al. 1974 reports that /n/ is realized as [ŋ] before uvulars and sometimes before velars. I have not altered these segments from De Lucca's orthography, where they are **n**.

³ Greenberg 1970 states that Amharic and some other Semitic Ethiopian languages have **k** and **q'** (but no **q**), rather than **k** and **k'**. Such a language would constitute a solid counterexample to my claim. However, Greenberg does not cite his sources for this observation; the sources I have checked do not indicate that this is true of any Semitic Ethiopian languages.

⁴ Interestingly, there appears to be a great deal of dialectal variation in the ejective series in Berta. None of my other sources for this language (Andersen 1993, Cerulli and Reidhead in Tucker and Bryan 1966) provide inventories that would constitute counterexamples to my claim; all are missing **p'**.

⁵ I am also pursuing references on the Lezghian language Agul (Kumykh), which has an extensive stop series including **p'**, **t'**, **k'**, **q'**, and **q^w'**, but may be missing **k^w'**, although **k^w** is attested.

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