A Q-THEORETIC SOLUTION TO A'INGAE POSTLABIAL RAISING

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ABSTRACT I document and analyze the typologically unusual process of postlabial raising in A'ingae: After labial consonants, the diphthongs /*ai*/ and /*ae*/ surface respectively as [*ɨi̯*] and [*o̯e*], revealing that C[+LABIAL]*a* sequences are marked. However, the monophthongal /*a*/ in the same environment surfaces faithfully as [*a*]. To capture these facts, I propose an analysis couched in Q-Theory, where one vocalic target of a diphthong corresponds to fewer subsegments than a monophthong. This predicts that diphthongs might show a TETU effect, while monophthongs surface faithfully. The prediction is borne out by A'ingae postlabial raising, contributing a novel argument for Q-Theoretic representations.

KEYWORDS diphthong, raising, labial, TETU, Cofán, gradient

1 INTRODUCTION

This paper documents and analyzes the typologically unusual process of postlabial raising in A'ingae (or Cofán, ISO 639-3: `con`). After labial consonants (*m* p^h *p* $^m b$ *f v*), the underlying sequence /*ai*/ surfaces as the diphthong [*ɨi̯*] (1a),[1] and /*ae*/ surfaces as [*o̯e*] (1b). The underlying monophthongal /*a*/ surfaces faithfully (1c).[2]

(1)	a. / *ko̯ehefa -ite* /	b. / *sefa -ẽ* /	c. / *sefa* /
	[*ko̯ehefɨi̯te*]	[*sefo̯ẽ*]	[*sefa*]
	summer -PRD	run out -CAUS	run out

A'ingae postlabial raising is theoretically interesting for two reasons. First, it constitutes a phonological process with no obvious phonetic or cognitive motivation. Thus, it contributes a new case study to the ongoing research on the limits of phonetic determinism in phonology (Hyman, 2001). Second, postlabial raising affects different diphthongs differently (1a-b) and it does not affect monophthongs (1c). To account for the difference between (1a) and

(1b), I demonstrate that there exists a weighting of feature IDENTITY constraints such that [*ɨi̯*] and [*o̯e*] are the optimal candidates given input /*ai*/ and /*ae*/, respectively. To account for the fact that the postlabial raising underapplies to monophthongal /*a*/, I adopt a Q-Theoretic (Garvin, Lapierre, and Inkelas, 2018; Garvin, Lapierre, Schwarz, et al., 2020; Inkelas and Shih, 2016, 2017) representation of vowels. In Q-Theory, one vocalic target of a diphthong corresponds to fewer subsegments than a monophthong. Assuming that each subsegment is independently subject to feature IDENTITY constraints, Q-Theory predicts that diphthongs might show emergence-of-the-unmarked (TETU) effects (McCarthy and Prince, 1994), while monophthongs surface faithfully. The prediction is borne out by A'ingae postlabial raising, contributing a novel argument for the subsegmental representations of Q-Theory.

The rest of the paper is structured as follows. Section 2 gives background on the language and its speakers. Section 3 describes A'ingae diphthongs and the pertinent phonological processes, including postlabial raising. Section 4 advances a Q-Theoretic analysis of postlabial rasing. Section 5 concludes.

2 LANGUAGE BACKGROUND

A'ingae (or Cofán, ISO 639-3: `con`) is an Amazonian language isolate spoken by the Cofán people in northeast Ecuador and southern Colombia. The language is endangered and under severe socioeconomic pressure. Despite the challenges, language attitudes among the Cofán are uniformly positive (Dąbkowski, 2021a).

All of the examples represent the Ecuadorian language variety and reflect the judgments of two native language consultants from Dureno, Sucumbíos. Negative claims (e. g. about the nonexistence of certain diphthongs and consonant-diphthong sequences) are based on the data available in Borman's (1976) dictionary.

3 DESCRIPTION

A'ingae has the following five vowels: *i*, *ɨ*, *e*, *a*, *o*. This inventory is common among Amazonian languages (Aikhenvald, 2012). Phonetically, *i* is high and front; *ɨ* – high and central (to back); *e* – (high-)mid and front; *a* – central and low; and *o* – back, high-mid (to high), and rounded. All five vowels have nasal counterparts: *ĩ*, *ɨ̃*, *ẽ*, *ã*, *õ* (Repetti-Ludlow et al., 2019).

The licit diphthongs of A’ingae are given in (2).[3] The rare or marginal diphthongs are given in parentheses. All of the A’ingae diphthongs have *i̯* or *o̯* as their non-syllabic component. The diphthongs *ai̯*, *i̯a*, *ɨi̯*, *ao̯*, *o̯a*, *o̯e*, and *o̯i* have attested nasal counterparts.

(2)

i̯-CLOSING	*ai̯*	(*ei̯*)		*ɨi̯*
i̯-OPENING	*i̯a*	(*i̯e*)	(*i̯o*)	
o̯-CLOSING	*ao̯*			
o̯-OPENING	*o̯a*	*o̯e*	*o̯i*	

The sequences **ea*, **ae*, **ɨa*, and **aɨ* are not licit diphthongs and do not appear in any A’ingae roots. However, /*ea*/, /*ɨa*/, and /*ae*/ may appear in the underlying forms of morphologically complex words. When two consecutive input vowels do not form a licit diphthong, a phonological process converts one of the vowels such that the sequence conforms with the diphthong inventory of (2). Underlying /*ea*/ and /*ɨa*/ surface as [*i̯a*] (3a-b). Underlying /*ae*/ surfaces as [*ai̯*] (3c).[4] (No forms have the underlying sequence /*aɨ*/.)

(3) a. / *koʔfe -ã* /
[*koʔfi̯ã*]
play -CAUS

b. / *inʥɨ -a* /
[*inʥi̯a*]
green -ADN

c. / *pa^{n}ʥa -ẽ* /
[*pa^{n}ʥãĩ̯*]
hunt -CAUS

After a non-labial consonant, any of the A’ingae diphthongs is allowed, including the *a*-initial *ai* (4a-b) and *ao* (4c-d) as well as other diphthongs (4e-f).

(4) a. *ʤai̯* — sit
b. *sai̯* — pull out
c. *ʦao̯ʔpa* — nest
d. *tao̯ʔpats^{h}i* — soft
e. *ko̯eʔhe* — sun
f. *tɨi̯* — splash

However, the *a*-initial diphthongs may not appear after a labial consonant, i. e. the sequences *B*a*V (where B stands for a labial consonant and V for a vowel) are not licit and do not appear in roots. On the other hand, common labial-diphthong sequences include B*o͜e* (5a-b) and B*ɨ͜i* (5c-d).

(5)	a. *fo͜esɨ*	b. *vo͜e*	c. *opɨ͜i*	d. *fɨ͜ite*
	other	already	cover	help

The underlying sequence /*ai*/ which may arise in morphologically complex forms (6a) and in borrowings (6b-c) is changed or adapted to [*ɨ͜i*] after labial consonants.[5]

(6)	a. / *ko͜ehefa -ite* /	b. / *wa͜ita* / (Kichwa)[6]	c. / *ba͜ilaɾ* / (Spanish)
	[*ko͜ehefɨ͜ite*]	[(*ɾosa*)*vɨ͜ita*]	[*bɨ͜iɾa*]
	summer -PRD	calendula	dance

The underlying sequence /*ae*/ which may arise in morphologically complex forms changes to [*o͜e*] after labial consonants (7). I refer to the two processes /B*ai*/ → [B*ɨ͜i*] and /B*ae*/ → [B*o͜e*] as postlabial raising.

(7)	a. / *sefa -ẽ* /	b. / *atapa -ẽ* /	c. / *sema -ẽ* /	d. / *kaʔ^{m}ba -ẽ* /
	[*sefõ͜ẽ*]	[*atapõ͜ẽ*]	[*semõ͜ẽ*]	[*kaʔ^{m}bõ͜ẽ*]
	run out -CAUS	breed -CAUS	work -CAUS	face -CAUS

Finally, the prohibition against *a* after labials is restricted to *a* in diphthongs. Monophthongal /*a*/ is retained as [*a*] in the output (8).

(8)	a. / *sefa* /	b. / *atapa* /	c. / *sema* /	d. / *kaʔ^{m}ba* /
	[*sefa*]	[*atapa*]	[*sema*]	[*kaʔ^{m}ba*]
	run out	breed	work	face

4 ANALYSIS I analyze the above diphthongal processes as output-oriented adjustments aimed at averting marked structures. I begin by presenting an OT analysis of the processes /*ea*, *ɨa*/ → [*i̯a*] and /*ae*/ → [*ai̯*]. Then, I extend the analysis to postlabial raising.

First, I formalize the A'ingae diphthong inventory with the constraint LICIT, or LIC (9), which rules out illicit diphthongs (those not listed in 2).[7]

(9) LICIT, or: LIC *Assign a violation mark for a sequence of two vowels which do not form a licit diphthong in the language.*

Second, the constraint IDENTITY (10) relativized to a particular feature penalizes output candidates which differ from the input with respect to that feature.

(10) IDENTITY(FEATURE), or: IDF *Assign a violation mark each time F(EATURE) has a different value in the input than in the output.*

Three binary features are sufficient to model the five contrastive vowels of A'ingae. I assume the featural specifications of (11). (Note that *e* is −HIGH while *o* is +HIGH.) To model the diphthongal processes of A'ingae, I adopt a weighted-constraint model of the grammar. The (rounded) constraint weights which correctly predict that /*ea*, *ɨa*/ → [*i̯a*] (12-13) and /*ae*/ → [*ai̯*] (14) were found using the Maxent Grammar Tool (Hayes, 2008). IDH stands for IDENTITY(HIGH), IDR – for IDENTITY(ROUND), and IDB – for IDENTITY(BACK). (The relative weights assigned to the IDENTITY constraints will be fully justified with postlabial raising.)

(11)	*i*	*ɨ*	*e*	*a*	*o*
H(IGH)	+	+	−	−	+
B(ACK)	−	+	−	+	+
R(OUND)	−	−	−	−	+

(12)	*ea*	LIC 17.5	IDH 14.2	IDR 6.9	IDB 3.6	$\mathcal{H}$
i.	*ea*	1				17.5
☞ ii.	*ia*		1			14.2
iii.	*oa*		1	1	1	24.7
iv.	*ei*		1		1	17.8

(13)	*ɨa*	LIC 17.5	IDH 14.2	IDR 6.9	IDB 3.6	$\mathcal{H}$
i.	*ɨa*	1				17.5
☞ ii.	*ia*				1	3.6
iii.	*oa*			1		6.9
iv.	*ie*				2	7.2
v.	*ɨi*		1		1	17.8

(14)	*ae*	LIC 17.5	IDH 14.2	IDR 6.9	IDB 3.6	$\mathcal{H}$
i.	*ae*	1				17.5
☞ ii.	*ai*		1			14.2
iii.	*ao*		1	1	1	24.7
iv.	*ie*		1		1	17.8
v.	*oe*		1	1		21.1

Now, I extend the analysis to postlabial raising. I propose that postlabial raising reveals a dispreference for sequences of a labial consonant followed by a low vowel, modeled with the constraint *C[+LABIAL]V[−HIGH], or *BA (15), where A stands for a low vowel. Note that, although I am stating *BA as a Optimality Theoretic constraint, it does not have an obvious phonetic motivation. For more examples of phonetically unnatural processes, such as postnasal devoicing or deaffrication, see e. g. Hyman (2001).

(15) *C[+LABIAL]V[−HIGH], or: *BA *Assign a violation mark for each low vowel after a labial consonant.*

The markedness constraint *BA penalizes labial-low sequences but the optimal repairs to the sequence are determined by the interaction of *BA with other constraints. Specifically, the complete analysis of postlabial raising still needs to captures two key facts. First, postlabial raising does not affect monophthongs: /B*a*/ → [B*a*]. Second, different diphthongs undergo different raising processes: /B*ai*/ → [B*ɨ͜i*] but /B*ae*/ → [B*o͜e*].

The first fact is challenging because—unless something more is said about the difference between monophthongs and diphthongs—the constraint *BA targets the two equally. This means that if *BA has a weight high enough to correctly predict diphthongal outputs (16), it will incorrectly predict that monophthongs should also raise after labials (17). (The tableaux below are abbreviated, not showing the constraints Identity(Round) and Identity(Back).)

(16)	B*ai*	Lic 17.5	*BA 15	IdH 14.2	$\mathcal{H}$
i.	B*ai*		1		15
☞ ii.	B*ɨi*			1	14.2

(17)	B*a*	Lic 17.5	*BA 15	IdH 14.2	$\mathcal{H}$
☹ i.	B*a*		1		15
💣 ii.	B*ɨ*			1	14.2

If, on the other hand, *BA has a weight low enough to correctly predict monophthongal faithfulness (19), it fails to predict diphthongal raising (18).

(18)	B*ai*	Lic 17.5	*BA 11.8	IdH 14.2	$\mathcal{H}$
💣 i.	B*ai*		1		11.8
☹ ii.	B*ɨi*			1	14.2

(19)	B*a*	Lic 17.5	*BA 11.8	IdH 14.2	$\mathcal{H}$
☞ i.	B*a*		1		11.8
ii.	B*ɨ*			1	14.2

To capture both the postlabial raising in seen diphthongs as well as its underapplication to monophthongs, I adopt the subsegmental representations of Q-Theory (Inkelas and Shih, 2016). Q-Theory posits that each segment (Q) consists of multiple—most commonly three—subsegments representing closure (q^1), hold (q^2), and release (q^3). In segments with one articulatory target, the three q's are identical. For example, the low vowel segment (Q) *a* is represented with three subsegments (q) as (a^1, a^2, a^3). Internally complex segments have multiple articulatory targets. In Q-Theory, the different targets are mapped onto different q's. The geminate *ts*, for example, may be represented as (t^1, s^2, s^3) (Inkelas and Shih, 2017). The circumoralized nasal $^bm^b$ may be represented as (b^1, m^2, b^3) (Garvin, Lapierre, and Inkelas, 2018; Garvin, Lapierre, Schwarz, et al., 2020).

I model A'ingae diphthongs with four q's. The first two q's correspond the the first target of the diphthong; the second two q's correspond to the second target. Thus, for example, *ai̯* = (a^1, a^2, i^3, i^4) and *o̯e* = (o^1, o^2, e^3, e^4). This correctly predicts that while A'ingae diphthongs are longer (and heavier[8]) than monophthongs, one vowel of a diphthong is shorter than a monophthong. Furthermore, I assume that changing the feature of one subsegment (q) between the input and the output incurs only one-third, or $0.\overline{3}$, of a violation of the respective IDENTITY constraint. Under this assumption, changing a feature of a monophthongal vowel (which consists of three q's) incurs a full violation ($3 \times 0.\overline{3} = 1$), but changing a feature of one vocalic target of a diphthong (which consists of two q's) incurs only two-thirds of a violation ($2 \times 0.\overline{3} = 0.\overline{6}$).[9] This predicts that a monophthongal vowel may surface faithfully, while the same vowel in a diphthong exhibits a TETU effect. The prediction is borne out by the A'ingae postlabial raising.

If *BA is has an appropriately low weight, this correctly predicts that low monophothongs will not raise after labial consonants; raising the three subsegments of a monophthong incurs sufficiently many IDENTITY violations to rule it out (20).[10]

(20)	B*a* = B(*a*, *a*, *a*)	LIC 17.5	*BA 11.8	IDH 14.2	IDR 6.9	IDB 3.6	$\mathcal{H}$
☞ i.	B*a* = B(*a*, *a*, *a*)		1				11.8
ii.	B*o* = B(*o*, *o*, *o*)			1	1		21.1
iii.	B*ɨ* = B(*ɨ*, *ɨ*, *ɨ*)			1			14.2

However, postlabial raising will affect diphthongs, where the low vowel portion has only two subsegments. With fewer subsegments come fewer Identity violations, allowing the activity of *BA to emerge (21).

(21)	B*ai* = B(*a, a, i, i*)	Lic 17.5	*BA 11.8	IdH 14.2	IdR 6.9	IdB 3.6	$\mathcal{H}$
i.	B*ae* = B(*a, a, e, e*)	1	1	$0.\overline{6}$			38.7
ii.	B*oe* = B(*o, o, e, e*)			$1.\overline{3}$	$0.\overline{6}$		23.5
iii.	B*ɨe* = B(*ɨ, ɨ, e, e*)	1		$1.\overline{3}$			36.4
iv.	B*ai* = B(*a, a, i, i*)		1				11.8
☞ v.	B*ɨi* = B(*ɨ, ɨ, i, i*)			$0.\overline{6}$			9.5
vi.	B*ei* = B(*e, e, i, i*)		1			$0.\overline{6}$	14.2

Thus, the adoption of Q-Theory's subsegmental representations for diphthongs captures the first key fact of A'ingae postlabial raising.

The second key fact of A'ingae postlabial raising pertains to the different outcomes of the *BA-triggered repair. After labial consonants, /*ai*/ surfaces as [*ɨi̯*], but /*ae*/ surfaces as [*o̯e*]. The different outcomes are, I propose, a straightforward matter of phonological optimization given the inventory of possible diphthongs (modeled with Licit).

In (21), the input B*ai* violates *BA. Thus, the winning candidate cannot be fully faithful. B*ei* is also ruled out by *BA (I assume that *e* is −high; see 11). The sequences *ae* and *ɨe* are not licit diphthongs, so B*ae* and B*ɨe* are therefore ruled out by Licit. In B*oe*, both *o* and *e* violate Identity(High) (I assume that *o* is +high) and *o* additionally violates Identity(Round). Therefore, the optimal candidate is B*ɨi* which only violates Identity(High).

In (22), the input B*ae* violates *BA as well as Licit. In the absence of a preceding labial consonant, /*ae*/ surfaces as [*ai̯*] (14). In the presence of a labial, however, B*ai* is ruled out by

*BA. B*ɨe* is ruled out by LICIT. B*ei* is, again, ruled out by *BA. In B*ɨi*, both *ɨ* and *i* violate IDENTITY(HIGH). In B*oe*, *o* violates IDENTITY(HIGH) and IDENTITY(ROUND). Since IDENTITY(ROUND) has a lower weight than IDENTITY(HIGH), B*oe* is the optimal candidate.

(22)	B*ae* = B(*a, a, e, e*)	LIC 17.5	*BA 11.8	IDH 14.2	IDR 6.9	IDB 3.6	$\mathcal{H}$
i.	B*ae* = B(*a, a, e, e*)	1	1				29.3
☞ ii.	B*oe* = B(*o, o, e, e*)			$0.\overline{6}$	$0.\overline{6}$		14.1
iii.	B*ɨe* = B(*ɨ, ɨ, e, e*)	1		$0.\overline{6}$			27.0
iv.	B*ai* = B(*a, a, i, i*)		1	$0.\overline{6}$			21.3
v.	B*ɨi* = B(*ɨ, ɨ, i, i*)			$1.\overline{3}$			19.0
vi.	B*ei* = B(*e, e, i, i*)		1		$0.\overline{6}$	$0.\overline{6}$	18.8

Thus, the proposed relative constraint weights correctly capture the fact that after labial consonants /*ai*/ surfaces as [*ɨ͡i*], but /*ae*/ surfaces as [*o͡e*].

5 CONCLUSION In conclusion, I document the typologically novel process of postlabial raising in A'ingae. Since postlabial raising is not predicted on phonetic or cognitive grounds, the process contributes to the ongoing study of unnatural phonology.

Only diphthongs are targeted by postlabial raising, and they are differently affected: After labials, /*ai*/ surfaces as [*ɨ͡i*], but /*ae*/ surfaces as [*o͡e*]. The different outcomes are, I argue, a consequence of phonological optimization given the language's phonological inventory and a dispreference for low vowels after labial consonants.

The monophthongal /*a*/ is does not undergo postlabial raising. To capture this underapplication, I adopt the subsegmental representations of Q-Theory. The monophthongal *a* is longer and consists of more subsegments than the *a*-component of diphthongs. Thus, unfaithfulness to the features of the latter incurs fewer IDENTITY violations, creating conditions in which the activity of *BA may emerge. Thus, the A'ingae postlabial raising bears out a new prediction of Q-Theory.

Finally, by allowing subsegments to incur partial constraint violations, Q-Theory has been demonstrated to have some of the same capacity for modeling gradient phonology as the Gradient Symbolic Representations framework (Rosen, 2016; Smolensky and Goldrick, 2016). The subsegments of Q-Theory, however, are phonetically motivated and discrete, making it a more restrictive of the two frameworks.

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[1]The following glossing abbreviations have been used: ADN = adnominalizer, CAUS = causative, IPFV = imperfective, PRD = periodic.

[2]Although the language conspires against *a*-initial suffixes, (1a-b) are not derived environment effects, as evidenced by the phonological restrictions in roots (4-5).

[3]Repetti-Ludlow et al. (2019) find only six diphthongs in their data: *ai̯*, *o̯e*, *o̯a*, *o̯i*, *ɨ̯i*, *ao̯*. For an argument for including *i̯a* among the diphthongs, see Dąbkowski (2019, 2021b).

[4]The causative suffix CAUS has three phonologically determined allomorphs: *-ña* CAUS after monosyllabic roots; *-ã* CAUS after *e*-, *i*-, and *ɨ*-final polysyllables; and *-ẽ* CAUS after *a*- and *o*-final polysyllables. The nasality introduced by the allomorphs of the causative is orthogonal to the problem at hand.

[5]There are lexical exceptions to this process. For example, a consultant reports (23a). Compare with (23b) reported in Borman's (1976) dictionary.

(23) a. / *ʧarapa -ite* /
[*ʧarapai̯te*]
turtle -PRD

b. / *ʧarapa -ite* /
[*ʧarapɨi̯te*]
turtle -PRD

This might suggest that for at least some speakers /B*ai*/ → [B*ɨi̯*] is not entirely productive anymore. Nonetheless, the dictionary data suggest that the process was fully productive until quite recently.

[6](Scott AnderBois, p.c.; Chango A. and Potosí C., 2009)

[7]The set of licit diphthongs is phonetically motivated by a combination of Vowel Dispersion Theoretic (Petersen, 2018) and other factors outside of the scope of this paper.

[8]Representing diphthongs with a greater number of q's than monophthongs predicts that diphthongs are heavier than monophthongs (Schwarz et al., 2019). A'ingae diphthongs attract stress (24), so the prediction is borne out. (For more on the relevance of diphthongs to stress assignment, see Dąbkowski, 2019, in press.)

(24) a. *ˈfetʰa -ʔhe*
open -IPFV

b. *fɨˈⁿdɨi̯ -ʔhe*
sweep -IPFV

[9]These mechanics differ earlier work in Q-Theory, where constraints can refer specifically to q's or Q's, but the violations they incur are nevertheless full, not partial.

[10]I do not explicitly consider candidates where feature-identical q's in the input have different features in output, such as B(*ɨ, a, a*), or B(*o, o, a*). I assume that identical q's stand in a correspondence relations (Rose and Walker, 2004) in the input /B(a_1, $a_{1,2}$, a_2)/ and that a high-ranked faithfulness constraint preserves these correspondences in the output, ruling out candidates such as B($ɨ_1$, a_2, a_2), or B(o_1, o_1, a_2).