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: The sequences /*ai*/ and /*ae*/ surface after labial consonants as diphthongal [*ɨi̯*] and [*o̯e*], respectively. The monophthongal /*a*/ surfaces faithfully as [*a*]. To account for these facts, I combine a weighted-constraint grammar with a Q-Theoretic representation of vowels, where one vocalic target of a diphthong corresponds to fewer q's than a monophthong (Schwarz et al., 2019). The model predicts an interaction between the number of q's and constraint weights, as borne out by the A'ingae postlabial raising, providing a novel argument for Q-Theory.

KEYWORDS diphthong, raising, Q-Theory, unnatural, 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*/ as surfaces as [*o̯e*] (1b). The underlying monophthongal /*a*/ surfaces faithfully (1c).

(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, the process 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 weighing of feature IDENTITY constraints such that [ɨ͡i̯] and [o̯͡e] 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 (Inkelas and Shih, 2016, 2017) representation of vowels. In Q-Theory, one vocalic target of a diphthong corresponds to fewer q's than a monophthong (Schwarz et al., 2019). I propose that each q is independently subject to feature IDENTITY constraints, deriving the fact that /*a*/ undergoes raising only in diphthongs. Combining Q-Theory with a weighted-constraint model of the phonological grammar predicts that the number of q's should interact with constraint weights. This prediction is borne out by the A'ingae postlabial raising, providing 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 in A'ingae (or Cofán, ISO 639-3: `con`) is an Amazonian language isolate spoken by the Cofán people in northeast Ecuador and southern Colombia. In the 16th century, the Cofán used to live in the Eastern Andean Cordilleras. Due to a history of migration, A'ingae shows a mixture of typical Amazonian and Andean features. 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 that 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 canonical Amazonian five-vowel system (Aikhenvald, 2012): *i ɨ e a o*. 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 their nasal counterparts: *ĩ ɨ̃ ẽ ã õ* (Repetti-Ludlow et al., 2019).

The legal diphthongs of A'ingae are given in (2).[2] The rare or marginal diphthongs are given in parentheses. All of the A'ingae diphthongs have *i̯* or *o̯* as their non-syllabic component. Most of the diphthongs 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 legal 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 legal 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).[3] (No forms have the underlying sequence /*aɨ*/.)

(3)

a. / *koʔfe -ã* /	b. / *indʑɨ -a* /	c. / *pa^{n}dʑa -ẽ* /
[*koʔfi̯ã*]	[*indʑi̯a*]	[*pa^{n}dʑãi̯*]
play -CAUS	green -ADN	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. *dʒai̯*	b. *sai̯*	c. *tsao̯ʔpa*	d. *tao̯ʔpats^{h}i*	e. *ko̯eʔhe*	f. *tɨi̯*
sit	pull out	nest	soft	sun	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 legal and do not appear in roots. On the other hand, common labial-diphthong sequences include B*o̯e* (5a-b) and B*ɨi̯* (5c-d).

(5) a. *fo̯esɨ*
other

b. *vo̯e*
already

c. *opɨi̯*
cover

d. *fɨi̯te*
help

The underlying sequence /*ai*/ which may arise in morphologically complex forms (6a) and in borrowings (6b-c) is changed or adapted to [*ɨi̯*] after labial consonants.[4]

(6) a. / *ko̯ehefa -ite* /
[*ko̯ehefɨi̯te*]
summer -PRD

b. / *wai̯ta* / (Kichwa)[5]
[(*ɾosa*)*vɨi̯ta*]
calendula

c. / *bai̯laɾ* / (Spanish)
[*bɨi̯ɾa*]
dance

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

(7) a. / *sefa -ẽ* /
[*sefõ̯ẽ*]
run out -CAUS

b. / *atapa -ẽ* /
[*atapõ̯ẽ*]
breed -CAUS

c. / *sema -ẽ* /
[*semõ̯ẽ*]
work -CAUS

d. / *kaʔ^{m}ba -ẽ* /
[*kaʔ^{m}bõ̯ẽ*]
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* /
[*sefa*]
run out

b. / *atapa* /
[*atapa*]
breed

c. / *sema* /
[*sema*]
work

d. / *kaʔ^{m}ba* /
[*kaʔ^{m}ba*]
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 LEGAL, or LG (9), which rules out illicit diphthongs (those not listed in 2).

(9) LEGAL, or: LG *Assign a violation mark for a sequence of two vowels which do not form a legal 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 model the five contrastive vowels of A'ingae. I assume the featural specifications of (11). To model the diphthongal processes of A'ingae, I adopt weighted-constraint model of the grammar. I assign a high weight to LEGAL and lower weights to the IDENTITY(HIGH), IDENTITY(ROUND), and IDENTITY(BACK), in descending order. This correctly predicts that /*ea*, *ɨa*/ → [*i̯a*] (12-13) and /*ae*/ → [*ai̯*] (14). (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*	LG 5	IDH 4	IDR 3	IDB 2	$\mathcal{H}$
i.	*ea*	1				5
☞ ii.	*ia*		1			4
iii.	*oa*		1	1	1	9
iv.	*ei*		1		1	6

(13)	*ɨa*	LG 5	IDH 4	IDR 3	IDB 2	$\mathcal{H}$
i.	*ɨa*	1				5
☞ ii.	*ia*				1	2
iii.	*oa*			1		3
iv.	*ie*				2	4
v.	*ɨi*		1		1	6

(14)	*ae*	LG 5	IDH 4	IDR 3	IDB 2	$\mathcal{H}$
i.	*ae*	1				5
☞ ii.	*ai*		1			4
iii.	*ao*		1	1	1	9
iv.	*ie*		1		1	6
v.	*oe*		1	1		7

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.

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

The markedness constraint above only formalizes the observation that BA sequences are dispreferred. However, it depends on the rest of the phonological grammar when the BA sequences are avoided and what repairs they undergo when they are. This is to say, 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*ɨ̯i*] but /B*ae*/ → [B*o̯e*].

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*	LG 5	*BA 5	IDH 4	$\mathcal{H}$
i.	B*ai*		1		5
☞ ii.	B*ɨi*			1	4

(17)	B*a*	LG 5	*BA 5	IDH 4	$\mathcal{H}$
☹ i.	B*a*		1		5
💣 ii.	B*ɨ*			1	4

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*	LG 5	*BA 3	IDH 4	$\mathcal{H}$
💣 i.	B*ai*		1		3
☹ ii.	B*ɨi*			1	4

(19)	B*a*	LG 5	*BA 3	IDH 4	$\mathcal{H}$
☞ i.	B*a*		1		3
ii.	B*ɨ*			1	4

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 that each segment (Q) consists of multiple—most commonly three—subsegments (q). 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 *ʦ*, for example, may be represented as (t^1, s^2, s^3) (Inkelas and Shih, 2017). The circumoralized nasal $^b m^b$ may be represented as (b^1, m^2, b^3) (Garvin, Lapierre, and Inkelas, 2018).

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.[6] Thus, for example, *ai̯* = (a^1, a^2, i^3, i^4) and *o̯e* = (o^1, o^2, e^3, e^4). Representing diphthongs with a greater number of q's than monophthongs predicts that diphthongs are heavier than monophthongs (Schwarz et al., 2019). Diphthongs attract stress (20), so the prediction is borne out. (For more on the relevance of diphthongs to stress assignment, see Dąbkowski, 2019, in press.)

(20) a. *ˈfetʰa -ʔhe*
open -IPFV

b. *fɨˈⁿdɨi̯ -ʔhe*
sweep -IPFV

Finally, 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. Thus, 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 ($2 \times 0.\overline{3} = 0.\overline{6}$).[7]

If *BA is assigned an appropriately low weight, this correctly predicts that low monophothongs will not raise after labial consonants (21).[8]

(21) B(*a, a, a*)	LG 5	*BA 3	IDH 4	IDR 3	IDB 2	$\mathcal{H}$
☞ i. B(*a, a, a*)		1				3
ii. B(*o, o, o*)			1	1		7
iii. B(*ɨ, ɨ, ɨ*)			1			4

However, postlabial raising will affect diphthongs, where the low vowel has fewer q's. With fewer q's come fewer IDENTITY violations, allowing the activity of *BA to emerge (22).

(22) B(*a, a, i, i*)	LG 5	*BA 3	IDH 4	IDR 3	IDB 2	$\mathcal{H}$
i. B(*a, a, e, e*)	1	1	$0.\overline{6}$			$10.\overline{6}$
ii. B(*o, o, e, e*)			$1.\overline{3}$	$0.\overline{6}$		$7.\overline{3}$
iii. B(*ɨ, ɨ, e, e*)	1		$1.\overline{3}$			$10.\overline{3}$
iv. B(*a, a, i, i*)		1				3
☞ v. B(*ɨ, ɨ, i, i*)			$0.\overline{6}$			$2.\overline{6}$
vi. B(*e, e, i, i*)		1			$0.\overline{6}$	$4.\overline{3}$

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 Legal) and the dispreference for postlabial low vowels (modeled with *BA).

In (22), the input B*ai* violates *BA. Thus, the winning candidate cannot be fully faithful. B*ei* is also ruled out by *BA. The sequences *ae* and *ɨe* are not legal diphthongs, so B*ae* and B*ɨe* are therefore ruled out by Legal. In B*oe*, both *o* and *e* violate Identity(High) and *o* additionally violates Identity(Round). Therefore, the optimal candidate is B*ɨi* which only violates Identity(High).

In (23), the input B*ae* violates *BA as well as Legal. In the absence of a preceding labial consonant, /*ae*/ goes to [*ai̯*] (14). In the presence of a labial, however, B*ai* is ruled out by *BA. B*ɨe* is ruled out by Legal. 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.

(23)	B(*a, a, e, e*)	Lg 5	*BA 3	IdH 4	IdR 3	IdB 2	$\mathcal{H}$
i.	B(*a, a, e, e*)	1	1				8
☞ ii.	B(*o, o, e, e*)			$0.\overline{6}$	$0.\overline{6}$		$4.\overline{6}$
iii.	B(*ɨ, ɨ, e, e*)	1		$0.\overline{6}$			$7.\overline{6}$
iv.	B(*a, a, i, i*)		1	$0.\overline{6}$			$5.\overline{6}$
v.	B(*ɨ, ɨ, i, i*)			$1.\overline{3}$			$5.\overline{3}$
vi.	B(*e, e, i, i*)		1		$0.\overline{6}$	$0.\overline{6}$	$6.\overline{3}$

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

5 CONCLUSION

In conclusion, I documented 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 [*ɨ͜i*], but /*ae*/ surfaces as [*o͜e*]. The different outcomes, I argue, are a consequence of phonological optimization for the closest diphthong, given the language’s phonological inventory and a dispreference for low vowels after labial consonants.

The monophthongal /*a*/ is does not shift after labial consonants. To capture this underapplication of postlabial raising, I adopt the subsegmental representations of Q-Theory. The monophthongal *a* consists of three subsegmental q’s. The *a*-component of diphthongs, on the other hand, consists only of two. Thus, altering the features of the latter incurs fewer IDENTITY violations, creating conditions in which the activity of *BA may emerge.

Combining Q-Theory with a weighted-constraint model of the grammar predicts an interaction between the number of q’s and the weights of the constraints. The prediction is borne out by A’ingae post-labial raising, providing a novel argument for Q-Theory.

Finally, by allowing subsegments to incur partial constraint violations, Q-Theory is shown 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]Repetti-Ludlow et al. (2019) find only six diphthongs in their data: *a͡i o͡e o͡a o͡i ɨ͡i a͡o*. For an argument in favor of including *i͡a* among the diphthongs, see Dąbkowski (2019, 2021b).

[3]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.

[4]There are lexical exceptions to this process. For example, a consultant reports (24a). Compare with (24b) reported in Borman's (1976) dictionary.

(24) a. / *ʧaɾapa -ite* /
[*ʧaɾapa͡ite*]
turtle -PRD

b. / *ʧaɾapa -ite* /
[*ʧaɾapɨ͡ite*]
turtle -PRD

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

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

[6]The proposed account does not hinge on this assumption. Diphthongs can be modeled as consisting of three q's, e. g. *a͡i* = (a^1, a^2, i^3) (Inkelas and Shih, 2017), as long as the number of q's corresponding to the first vocalic target of a diphthong is lower than the number of q's in a monophthong.

[7]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.

[8]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 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).