

## 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 [i̠i̠] and [œe], 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 an emergence-of-the-unmarked (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<sup>h</sup> p<sup>m</sup> b f v*), the underlying sequence /ai/ surfaces as the diphthong [i̠i̠] (1a),<sup>1</sup> and /ae/ surfaces as [œe] (1b). The underlying monophthongal /a/ surfaces faithfully (1c).<sup>2</sup>

- |     |                   |               |            |
|-----|-------------------|---------------|------------|
| (1) | a. /kœhefa -ite / | b. /sefa -ẽ / | c. /sefa / |
|     | [kœhefi̠i̠te]     | [sefœẽ]       | [sefa]     |
|     | summer -PRD       | run out -CAUS | run out    |

A'ingae postlabial raising is theoretically interesting for two reasons. First, it constitutes a typologically rare phonological process whose phonetic or cognitive motivation is not obvious. 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  $[i̲i̲]$  and  $[o̲e̲]$  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. For example, the monophthongal  $a$  consists of three subsegments ( $a^1, a^2, a^3$ ), but the  $a$ -component of a diphthong – only of two ( $a^1, a^2, i^3, i^4$ ). Thus, 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 raising. 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 pressures. 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 generalizations (e. g. claims 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:  $i, i̲, e, a, o$ , which is a common inventory among Amazonian languages (Aikhenvald, 2012). Phonetically,  $i$  is high

and front; *i* – high and central (to back); *e* – (high-)mid and front; *a* – central and low; and *o* – back, high-mid (to high), and rounded. There are seven licit diphthongs in A’ingae (2).<sup>3</sup>

(2) LICIT DIPHTHONGS:      *ai̯*,      *ia̯*,      *o̯e*,      *o̯a*,      *o̯i*,      *i̯i*,      *a̯o*

All of the A’ingae diphthongs have *i̯* or *o̯* as their non-syllabic component. All the monophthongs and diphthongs have attested nasal counterparts.

The sequences \*[*ea*], \*[*ae*], \*[*ia*], and \*[*ai*] are not licit diphthongs and do not appear in surface forms. However, /*ea*/, /*ae*/, and /*ia*/ 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 /*ia*/ surface as [*i̯a*] (3a-b). Underlying /*ae*/ surfaces as [*a̯i̯*] (3c).<sup>4</sup> (No forms have the underlying sequence /*ai*/.)

(3)	a.	/ <i>koʔfe -ã</i> /	b.	/ <i>indzi -a</i> /	c.	/ <i>pa<sup>n</sup>ɟa -ẽ</i> /
		[ <i>koʔfi̯ã</i> ]		[ <i>indzi̯a</i> ]		[ <i>pa<sup>n</sup>ɟãi̯</i> ]
		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.	<i>ɟai̯</i>	b.	<i>sai̯</i>	c.	<i>tsaoʔpa</i>	d.	<i>taoʔpa</i>	e.	<i>koeʔhe</i>	f.	<i>ti̯i</i>
		sit		pull out		nest		bird hair		sun		splash

However, the *a*-initial diphthongs may not appear after a labial consonant, i. e. the sequences \**BaV̯* (where B stands for a labial consonant and V̯ for the second target of a diphthong) are illicit, which is evidenced by (i) distributional and (ii) derivational patterns. First, sequences \**BaV̯* do not appear in roots. On the other hand, common labial-diphthong sequences include *B<sub>o̯</sub>e* (5a-b) and *B<sub>i̯</sub>i* (5c-d).

- (5) a. *foesi*                      b. *voe*                      c. *opi*                      d. *fite*  
          other                      already                      cover                      help

Second, the underlying sequence /ai/ which may arise in morphologically complex forms (6a) and borrowings (6b-c) is changed or adapted to [i] after labial consonants.<sup>5</sup> The underlying sequence /ai/ in other environments surfaces faithfully (7).

- (6) a. /*kohefa -ite* /                      b. /*waita* / (Kichwa)<sup>6</sup>                      c. /*bailar* / (Spanish)  
          [ *kohefiite* ]                      [ (*rosa*)*viita* ]                      [ *biira* ]  
          summer -PRD                      calendula                      dance
- (7) a. /*na -ite* /                      b. /*airo* / (Secoya)<sup>7</sup>  
          [ *naite* ]                      [ *airo* ]  
          fruit -PRD                      mountain

The underlying sequence /ae/ which may arise in morphologically complex forms surfaces as [oe] (8a-c) after labial consonants. In other environments, it surfaces as [ai] (8d). I refer to the two processes /Bai/ → [Bi] and /Bae/ → [Boe] as postlabial raising.

- (8) a. /*sefa -ẽ* /                      b. /*atapa -ẽ* /                      c. /*sema -ẽ* /                      d. /*pa<sup>n</sup>ɟa -ẽ* /  
          [ *sefõẽ* ]                      [ *atapõẽ* ]                      [ *semõẽ* ]                      [ *pa<sup>n</sup>ɟãĩ* ]  
          run out -CAUS                      breed -CAUS                      work -CAUS                      hunt -CAUS

Finally, the prohibition against *a* after labials is restricted to *a* in diphthongs. Monophthongal /a/ is retained as [a] in the output (9).

- (9) a. /*sefa* /                      b. /*atapa* /                      c. /*sema* /  
          [ *sefa* ]                      [ *atapa* ]                      [ *sema* ]  
          run out                      breed                      work

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, ia/ → [iə] and /ae/ → [ai]. Then, I extend the analysis to postlabial raising.

First, I formalize the A'ingae diphthong inventory with the constraint LICIT, or LIC (10), which rules out illicit diphthongs (those not listed in 2). (The set of licit diphthongs is phonetically motivated by a combination of Vowel Dispersion Theoretic (Petersen, 2018) and other factors. A complete analysis of what constitutes a licit diphthong in A'ingae is outside of the scope of this paper.)

- (10) 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 (11) relativized to a particular feature penalizes output candidates which differ from the input with respect to that feature.

- (11) 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 (12). Note that *e* is –HIGH while *o* is +HIGH. The vowel *e* is –HIGH to distinguish it from the front high vowel *i*. The vowel *o* is +HIGH to reflect the fact that its phonetic value ranges from [o] to [u] and that it functions as the high back non-syllabic target in A'ingae diphthongs.

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, ia*/ → [i̠a] (13-14) and /*ae*/ → [a̠i̠] (15) were found using the Maxent Grammar Tool (Hayes, 2008).<sup>8</sup> IDH stands for IDENTITY(HIGH), IDR – for IDENTITY(ROUND), and IDB – for IDENTITY(BACK). The Maxent results are interpreted categorically, which matches the predictions of the model. (The relative weights assigned to the IDENTITY constraints will be fully justified with postlabial raising.)

(12)	<i>i</i>	<i>ɪ</i>	<i>e</i>	<i>a</i>	<i>o</i>					
H(IGH)	+	+	-	-	+					
B(ACK)	-	+	-	+	+					
R(OUND)	-	-	-	-	+					

  

(13)	<i>ea</i>	LIC	IDH	IDR	IDB	$\mathcal{H}$
i.	<i>ea</i>	17.7	14.5	9.7	6.9	17.7
ii.	<i>ia</i>		1			14.5
iii.	<i>oa</i>		1	1	1	31.1
iv.	<i>ii</i>			2	2	33.2

  

(14)	<i>ia</i>	LIC	IDH	IDR	IDB	$\mathcal{H}$
i.	<i>ia</i>	17.7	14.5	9.7	6.9	17.7
ii.	<i>ia</i>				1	6.9
iii.	<i>oa</i>			1		9.7
iv.	<i>ii</i>		1		1	21.4

  

(15)	<i>ae</i>	LIC	IDH	IDR	IDB	$\mathcal{H}$
i.	<i>ae</i>	17.7	14.5	9.7	6.9	17.7
ii.	<i>ai</i>		1			14.5
iii.	<i>ao</i>		1	1	1	31.1
iv.	<i>oe</i>		1	1		24.2

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 (16), where A stands for a low vowel.

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

Note that although \*BA is stated as a markedness constraint, it is not obvious what its phonetic motivation should be. I speculate that \*BA may have articulatory grounds: Using lips as an active articulator requires a relatively closed jaw position, which might be incompatible with the open jaw of low vowels (Garvin, 2021). Alternatively, A'ingae postlabial raising can be seen as a phonetically unnatural phonological process, such as postnasal devoicing or deaffrication (e.g. Hyman, 2001).

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 capture two key facts. First, postlabial raising does not affect monophthongs: /Ba/ → [Ba]. Second, different diphthongs undergo different raising processes: /Bai/ → [Bi̠i] but /Bae/ → [Bo̠e].

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 (17), it will incorrectly predict that monophthongs should also raise after labials (18). (The tableaux below are abbreviated, not showing the constraints IDENTITY(ROUND) and IDENTITY(BACK).)

(17)	Bai	LIC 17.7	*BA 15	IDH 14.5	$\mathcal{H}$
	i. Bai		1		15
	ii. Bi̠i			1	14.5

(18)	Ba	LIC 17.7	*BA 15	IDH 14.5	$\mathcal{H}$
	⊗ i. Ba		1		15
	⊙ <sup>*</sup> ii. Bi			1	14.5

If, on the other hand, \*BA has a weight low enough to correctly predict monophthongal faithfulness (20), it fails to predict diphthongal raising (19).

(19)	Bai	LIC 17.7	*BA 12.1	IDH 14.5	$\mathcal{H}$
	⊙ <sup>*</sup> i. Bai		1		12.1
	⊗ ii. Bi̠i			1	14.5

(20)	Ba	LIC 17.7	*BA 12.1	IDH 14.5	$\mathcal{H}$
	⊙ i. Ba		1		12.1
	ii. Bi̠i			1	14.5

To capture both the postlabial raising 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 affricate *ts*, for example, may be represented as  $(t^1, s^2, s^3)$  (Inkelas and Shih, 2017). The circumoralized nasal *<sup>b</sup>m<sup>b</sup>* 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 to the first target of the diphthong; the other two q's correspond to the second target. Thus, for example,  $ai = (a^1, a^2, i^3, i^4)$  and  $oe = (o^1, o^2, e^3, e^4)$ .<sup>9</sup> This correctly predicts that while A'ingae diphthongs are longer than monophthongs, one component of a diphthong is shorter than a monophthong.<sup>10</sup> Furthermore, I assume that changing the feature of one subsegment (q) between the input and the output incurs only one-third, or  $0.\bar{3}$ , 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 ( $3 \times 0.\bar{3} = 1$ ), but changing a feature of one vocalic target of a diphthong (which consists of two q's) incurs only two thirds of a violation ( $2 \times 0.\bar{3} = 0.\bar{6}$ ).<sup>11</sup> 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 monophthongs will not raise after labial consonants; raising the three subsegments of a monophthong incurs sufficiently many IDENTITY violations to rule it out (21).<sup>12</sup>



(21)	$Ba = B(a, a, a)$	LIC	*BA	IDH	IDR	IDB	$\mathcal{H}$
		17.7	12.1	14.5	9.7	6.9	
☞ i.	$Ba = B(a, a, a)$		1				12.1
	ii. $Bo = B(o, o, o)$			1	1		24.2
	iii. $Bi = B(i, i, i)$			1			14.5

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 (22).<sup>13</sup>

(22)	$Bai = B(a, a, i, i)$	LIC	*BA	IDH	IDR	IDB	$\mathcal{H}$
		17.7	12.1	14.5	9.7	6.9	
i.	$Bae = B(a, a, e, e)$	1	1	$0.\bar{6}$			39.5
ii.	$Boe = B(o, o, e, e)$			$1.\bar{3}$	$0.\bar{6}$		25.8
iii.	$Bie = B(i, i, e, e)$	1		$1.\bar{3}$			37.0
iv.	$Bai = B(a, a, i, i)$		1				12.1
☞ v.	$Bii = B(i, i, i, i)$			$0.\bar{6}$			9.7

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 [ $i\bar{i}$ ], but /ae/ surfaces as [ $o\bar{e}$ ]. The different outcomes are, I propose, a straightforward matter of phonological optimization given the inventory of possible diphthongs (modeled with LICIT).

In (22), the input *Bai* violates \*BA. Thus, the winning candidate cannot be fully faithful. The sequences *ae* and *ie* are not licit diphthongs, so *Bae* and *Bie* are therefore ruled out by LICIT. In *Boe*, both *o* and *e* violate IDENTITY(HIGH) (I assume that *o* is +HIGH) and *o*

additionally violates IDENTITY(ROUND). Therefore, the optimal candidate is *Bii* which only violates IDENTITY(HIGH).

In (23), the input *Bae* violates \*BA as well as LICIT. In the absence of a preceding labial consonant, /*ae*/ surfaces as [*aĩ*] (15). In the presence of a labial, however, *Bai* is ruled out by \*BA. *Bie* is ruled out by LICIT. In *Bii*, both *i* and *i* violate IDENTITY(HIGH). In *Boe*, *o* violates IDENTITY(HIGH) and IDENTITY(ROUND). Since IDENTITY(ROUND) has a lower weight than IDENTITY(HIGH), *Boe* is the optimal candidate.

(23)	<i>Bae</i> = B( <i>a, a, e, e</i> )	LIC	*BA	IDH	IDR	IDB	$\mathcal{H}$
	i. <i>Bae</i> = B( <i>a, a, e, e</i> )	1	1				29.8
	ii. <i>Boe</i> = B( <i>o, o, e, e</i> )			0.6̄	0.6̄		16.1
	iii. <i>Bie</i> = B( <i>ĩ, i, e, e</i> )	1		0.6̄			27.4
	iv. <i>Bai</i> = B( <i>a, a, i, i</i> )		1	0.6̄			21.8
	v. <i>Bii</i> = B( <i>ĩ, i, i, i</i> )			1.3̄			19.3

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

5 CONCLUSION In conclusion, I document the typologically novel process of postlabial raising in A'ingae. Only diphthongs are targeted by postlabial raising, and different diphthongs are affected differently: After labials, /*ai*/ surfaces as [*ĩĩ*], but /*ae*/ surfaces as [*oẽ*]. This results, I argue, from phonological optimization given the language's phonological inventory and a dispreference for low vowels after labial consonants (\*BA).

The monophthongal /*a*/ 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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<sup>1</sup>The following glossing abbreviations have been used: ADN = adnominalizer, CAUS = causative, PRD = periodic.

<sup>2</sup>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).

<sup>3</sup>Repetti-Ludlow et al. (2019) analyze *ia* as disyllabic and propose that its monosyllabic productions reflect reduction. For an argument for analyzing *ia* as a diphthong, see Dąbkowski (2021b).

<sup>4</sup>The causative suffix CAUS has three phonologically determined allomorphs: *-ña* CAUS after monosyllabic roots; *-ã* CAUS after *e-*, *i-*, and *i*-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.

<sup>5</sup>There are lexical exceptions to this process. For example, a consultant reports (24a). Compare with (24b) reported in Borman's (1976) dictionary.

<p>(24) a. /<i>ʃarapa -ite</i> /                  [ <i>ʃarapaṽite</i> ]                  turtle -PRD</p>	<p>b. /<i>ʃarapa -ite</i> /                  [ <i>ʃarapĩite</i> ]                  turtle -PRD</p>
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This might suggest that for at least some speakers /*Bai*/ → [*Biĩ*] is not entirely productive anymore. Nonetheless, the dictionary data suggest that the process was fully productive until quite recently.

<sup>6</sup>(Scott AnderBois, p.c.; Chango A. and Potosí C., 2009)

<sup>7</sup>(Scott AnderBois, p.c.)

<sup>8</sup>The constraint weights were calculated with all the licit and relevant illicit diphthongs as candidates. For reasons of space, only a subset of those is explicitly shown in the tableaux.

<sup>9</sup>Diphthongs arising in morphologically complex words involve two monophthongal vowels in the input. I assume that the two vowels fuse into one and undergo q-reduction, i. e.  $a+i = (a^1, a^2, a^3)(i^1, i^2, i^3) \rightarrow aṽi = (a^1, a^2, i^3, i^4)$ , along with or before postlabial raising.

<sup>10</sup>Alternatively, diphthongs could be represented as  $aṽi = (a^1, a^2, i^3)$  or  $(a^1, i^2, i^3)$ . Any of these representations would yield correct predictions as long as one component is a diphthong is shorter (corresponds to fewer q's) than a monophthong. Which is representation is the most suitable for A'ingae diphthongs is outside of the scope of this paper.

<sup>11</sup>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.

<sup>12</sup>I do not explicitly consider candidates where feature-identical q's in the input have different features in output, such as B(*i*, *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*<sub>1</sub>, *a*<sub>1,2</sub>, *a*<sub>2</sub>)/ and that a high-ranked faithfulness constraint preserves these correspondences in the output, ruling out candidates such as B(*i*<sub>1</sub>, *a*<sub>2</sub>, *a*<sub>2</sub>), or B(*o*<sub>1</sub>, *o*<sub>1</sub>, *a*<sub>2</sub>).

<sup>13</sup>I do not explicitly consider candidates where different q's in the input have the same value in the output, such as B(*a*, *a*, *a*, *a*) or B(*i*, *i*, *i*, *i*). I assume they are ruled out by a high-ranking version of the OBLIGATORYCONTOURPRINCIPLE which prevents reducing the number of vocalic targets in a diphthong.