Vowel contours in ABC+Q: the role of q

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1 Introduction

- The participation of diphthongs in vowel harmony and disharmony parallels that of complex consonants (e.g. ^{n}d or ʧ) and contour tones (e.g. H͡L) in many respects: diphthongs act like units in some processes, but like sequences of independent elements in others.
- Study of behavior of diphthongs and glides in vowel harmony (based on findings by Rhomieux, in prep.)
- This paper: applies ABC+Q to the analysis of diphthongs.
- ABC+Q: the marriage of Agreement by Correspondence (Hansson 2001; Rose & Walker 2004) and Q theory (Inkelas & Shih 2013a,b; Shih & Inkelas 2014)

- Focus of this paper: ability of q-level correspondence to capture behavior of diphthongs in harmony and disharmony patterns (see Rhomieux ms.)
  - the common 'invisibility' of the margins of diphthongs to vowel harmony patterns
  - creation of diphthongs as the result of vowel-consonant correspondences across segment boundaries
  - parallels among diphthongs, tone contours, other complex segments

- Similarity (from ABC) + segmental decomposition (from Q theory) offers unified account of the behavior of diphthongs and other complex segments.

2 Q theory

Q theory: each vowel and consonant is subdivided into three quantized 'q' subsegments

(1) Q(q^1 q^2 q^3), where Q varies over V, C and each 'q' is a uniform feature bundle

[a]:	V(a a a)	[k]:	C(k k k)	[â]:	V(á à à)
[ai]:	V(a a i)	[k^h]:	C(k k h)	[ǎ]:	V(à á á)
[ia]:	V(i a a)	[nd]:	C(n d d)	[â]:	V(à á à)

(2) Phonetic grounding of 'q' subsegments (cf. 'landmarks' of Gafos 2002:271):

q^1 ≈ transition into target constriction
q^2 ≈ target constriction
q^3 ≈ transition away from target constriction

(3) Relation to Aperture theory (Steriade 1993):

A_0A_{max}	A_{max}
|	|
Place	Place
/d/	/a/

3 ABC+Q

- Novel contribution of ABC+Q: correspondence among similar entities can be stated either at the Q level or at the q level:

CORR-qq	Similar subsegments correspond
IDENT-qq	Corresponding subsegments are identical, in some respect
CORR-QQ	Similar segments (segments with similar sequences of q's) correspond
IDENT-QQ	Corresponding segments are identical (overall all the q's they contain), in some respect

4 Vowel harmony: transparency at the q level

- Common pattern cross-linguistically (Rhomieux, in prep.): high portion of a diphthong acts transparent to palatal, labial, or ATR harmony…
  - neither triggering, undergoing, or interfering with the harmony process,
  - even though monophthongs of the same quality participate fully in the pattern

(4) Turkish: only the first component of a [VI] diphthong is relevant in progressive labial and palatal harmony, triggered on suffixes by the rightmost vowel in a stem

	front		back	
i/ɯ	e.ri.-di g**ij**.-di	'melt-PAST' 'put on-PAST'	kɯz.-lɯ k**ɯj**.-dɯ	'girl-ASSOC' 'mince-PAST'
e/a	an.ne.-li b**ej**.-li	'mother-ASSOC' 'sir-ASSOC'	el.ma.-lɯ sa.r**aj**.-lɯ	'apple-ASSOC' 'palace-ASSOC'
y/u	ør.ty.-ly t**yj**.-ly	'cloth cover-ASSOC' 'feather-ASSOC'	ku.ju.-lu h**uj**.-lu	'well-ASSOC' 'temperament-ASSOC'
ø/o	jøn.-ly k**øj**.-ly	'aspect-ASSOC' 'village-ASSOC'	bal.kon.-lu k**oj**.-lu	'balcony-ASSOC' 'cove-PL'

1. All of the diphthongs in the 'back' column are internally disharmonic for [back] and, in some cases, [rd].
2. Dots indicate syllable boundaries; diphthongs are bolded.
3. Monophthongal [i] in root normally triggers [-back, -round] suffix harmony (e.g. *eridi* 'melt-PAST').
4. Turkish does not contrast tautosyllabic [ai] and [aj], etc.[1] Transcription using [j] follows tradition.

(5) V(a^1 a^2 i^3) q^3 is irrelevant in harmony, neither triggers, blocks, nor undergoes

(6) If the latter part of [aj] and [i] are featurally comparable, why does [aj] not trigger front harmony?
One answer: Maybe the high vocoid in Turkish [aj] is phonologically a consonant, and the harmony rule is stated over vowels.
Rebuttal: Being a consonant does not preclude participation in Turkish palatal harmony (Clements & Sezer 1982):

o	sol-lu	'left-ASSOC'	sol̯-ly	'note 'sol'-ASSOC'
a	at-lɯ	'horse-ASSOC'	sa.at-li	'time-ASSOC'

Structural position, rather than segment type, appears to be the more important factor (see Rhomieux, in prep.).

[1] Some sources report a contrast between tautosyllabic [i] and [ij], the latter deriving historically from "iğ" (*ig > iɣ > iɯ̯ > ij).

(7) CORR-v^2v^2 Central (q^2) vocalic subsegments correspond (correspondence is local and pairwise (Rhodes 2012; cf. Hansson 2007), enforced between the closest two elements in the correspondence set)
IDENT-qq-[back] Corresponding subsegments agree in backness

- *q^3 is irrelevant to harmony, which affects only segment 'centers'*
- *Separate constraints, not given here, ensure that Turkish diphthongs are always of the form V(v_i v_i i); Turkish lacks rising sonority diphthongs, or for that matter triphthongs.)*

(8) Pasiego: stressed vowels trigger anticipatory height harmony on unstressed, non-low vowels

- The first part (v^1) of a rising diphthong is a harmony trigger
- The last part (v^3) of a falling diphthong is not, nor is a simple intervocalic glide (McCarthy 1984, Rhomieux ms.).

a.	molér	'to grind'	muljénda	'grinding'
	bebér	'to drink'	bibjéndu	'drinking'
b.	krejér	'to believe'	*krijér	
	koxájs	'take_2p.pl.subj'	*kuxájs	

(9) CORR-v^1v^2 Vocalic subsegments other than v^3 correspond
IDENT-qq-[back] Corresponding subsegments agree in height

- Independent constraints ensure that only unstressed non-low vowels change in quality

Unrestricted CORR-qq: diphthongs participate in harmony

(10) Oroch (Tolskaya 2008, 2014) RTR harmony: any pair of adjacent q segments is compelled to correspond and agree.

Oroch vowel inventory

Neutral	-RTR	+RTR
i/ii	u/uu	ʊ/ʊʊ
		ɔ/ɔɔ
æ	ə/əə	a/aa

Setting aside the separate question of front vowel neutrality, all q components of vowels in Oroch are equally subject to harmony: CORR-vv is the operative correspondence constraint.

- /i/ and /æ/ are neutral (transparent) with respect to RTR harmony
- The [i] and [æ] components of diphthongs like /iu/ are also transparent to [RTR] harmony.
- This is a feature-driven transparency, unlike what is seen in Turkish, where transparency is a result of structural position.
- The two diphthongs that consist solely of two non-neutral vowels (/əu/, /aʊ/) agree internally in their values for [RTR] and participate fully in [RTR] harmony.

Extension to transparency in reduplication:

(11) Only the first half of a light (monomoraic) diphthong is preserved in Tohono O'odham partial reduplication (Miyashita 2011; see also Fitzgerald 2000):

a.	kais	'rich'	ka-kais	'rich (pl. subj.)'
b.	piast	'party'	pi-piast	'parties'

- Could be analyzed as a TETU effect (McCarthy & Prince 1994) — reduplicated diphthong monophthongized due to markedness constraints
- Also (possibly more?) amenable to a Corr-v^1v^1 analysis.
  - TETU account would predict both [ai] and [ia] diphthongs to monophthongize to the same unmarked target (presumably [i], or perhaps [a])
  - Position-sensitive CORR-q^1q^1 account correctly predicts that the copy vowel will match v^1 of the base in quality.

Summary

(12) Pasiego, Turkish, Oroch suggest a scale of $v^2 > v^1 > v^3 >$ c for likelihood of V harmony participation (see Rhomieux, in prep.). One possible implementation:

CORR-v2v2	Central ('target') subsegments correspond	(Turkish)
CORR-v1v2	Nonfinal v subsegments correspond	(Pasiego)
CORR-vv	All v subsegments correspond	(Oroch)
CORR-cv	All subsegments correspond	(see below)

5 Diphthongization as repair for unstable qq correspondence

The creation of diphthongs provides a useful window into the internal structure of vowels.

- Diphthongization often arises in a context-free manner (e.g. stressed tense vowels)
- Diphthongization can also be triggered by assimilation to a nearby consonant or vowel, via CORR-cv

(13) Back umlaut in Old English: short /i, e, æ/ assimilated in [back] to a following unstressed back vowel (/u/ or /a/), resulting in the diphthongs /ĭo, ĕo, æ̆a/ (e.g. Hogg 2011:149-150). Hogg: back umlaut restricted to applying when "only a single consonant intervenes. In all dialects that consonant must not be a palatal and in [West Saxon] only labials and liquids permit the change":

s**eo**fon	'seven',
eorðb**eo**fung	'earthquake'
t**eo**lað	'he strives for'
bīl**eo**fa	'food'

(14) Diphthongization: tricky in segment-based approaches…

- SPE
- classical ABC
- most implementations of Optimality Theory

…none of which were developed with contour segments as a central focus.

(15) Hogg: Back Umlaut is (back) vowel epenthesis, using SPE-style rules.
Bakovic (2000): vowel diphthongization is epenthesis (in standard OT)
Miglio & Morén (2003): vowel diphthongization is vowel fission (in standard OT).

- Internally harmonic diphthongs which arise from partial assimilation, as in OE Back Umlaut, are bipartite but not clearly bisegmental per se, any more than a short vowel with a contour tone is bisegmental.
- The segment epenthesis analysis is motivated only by the inability of the theory to represent segment-internal contours.

(16) Autosegmental approaches: at an advantage? Hallmark of theory is many-to-one and one-to-many linkage between melodic elements and timing units:

```
      V                 V        V
      /\                |        |
  Root  Root          Root     Root
    |     |             |        |
   [e]   [i]           [e]      [i]
short diphthong     long diphthong
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(17) *Process* of diphthongizing a vowel is more difficult for autosegmental approaches (Hayes 1990). Consider Old French Diphthongization: /eː, oː/ → [ei, ou] (Hayes 1990). If (9b) is the starting point, changing the value of /e/ to [+high] would incorrectly raise the entire vowel:

```
V  V          V  V
 \/            \/
Root    →     Root
  |             |
 [e]           [i]
```

For long vowels, delinking the Root node from V2 and inserting [+high] (9d) would fail to capture the fact that roundness is preserved in that position, incorrectly predicting /eː oː/ → *[ei, oi]:

```
V  V          V     V
 \/            |     |
Root    →    Root  Root
  |            |     |
 [o]          [o]   [i]
```

Partial diphthongization is not what these representations were designed to capture, leading Hayes to essentially abandon autosegmental theory altogether in favor of a coindexation approach that could be seen as a forerunner of ABC.

6 Diphthongization in ABC+Q

- ABC+Q: hybrid approach which can capture both the segmental and the subsegmental behavior of diphthongs.
- In ABC+Q, diphthongization = the redistribution of features across the (monophthongal) v subsegments of a V(v v v) segment.
- Partial diphthongization, as in Old French: v^3 changes in just one feature, leaving v^1 and v^2 unaffected.
- Assimilatory diphthongizations, as in Old English back umlaut: in which CORR-v-σ-v compels structurally adjacent v subsegments to correspond across a syllable boundary, resulting in v^3-v^1 correspondence.

  CORR-v-σ-v
  IDENT-vv-[back]

(18) *sefon → seofon*

V(e e e)CV(o o o) → V(e e o_i)CV(o_i o o)

7 Case study of diphthongization: Huave (Kim 2008)

- Huave: diphthongization arises from assimilation between adjacent v and c subsegments, under conditions of featural similarity.
- Kim (2008): Huave diphthongization is a repair for two different phonotactic constraints involving local vc subsegment pairs.

(19) Huave: five vowel system (i e a o u).

- Root-final consonants exhibit contrastive underlying palatality.
- Palatality disagreements within VC rimes cause dipthongization (Kim 2008):[2]

(20)

		non-palatal	palatal
[+back] V	u, o, a	sap puk	sap^{pal} → saip puk^{pal} → puik
[+front] V	i, e	mik → miok chip → chiop	pek^{pal} tip^{pal}

(21) ABC+Q analysis of Huave diphthongization:

CORR-v::c	A vocalic q must correspond to an immediately following consonantal q (within the syllable rime)[a]
IDENT-qq-[pal]	Corresponding q's are identical in palatality

[2] Palatal /t/ does not cause a back vowel to diphthongize; see discussion in Kim 2008 about the nature of palatality on coronals vs. noncoronals

/ V(i i i)C(k k k) /	CORR-v::c	Ident-qq-[pal]	IDENT-IO-C	IDENT-IO-V	
a. V(i i i_x)C(k_x k k)		W1			*q corr, faithful*
b. V(i i i_x)C(k_y k k)	W1				*No corr, faithful*
c. V(i i i_x)C($k^j{}_x$ k k)			W1		*q corr, c assimilates to v*
☞d. V(i i o_x)C(k_x k k)				1	*q corr, v assimilates to c*[b]

[a]*The restriction to the syllable rime can be captured either in the CORR constraint or by a separate 'limiter' constraint of the kind in Bennett 2013.*
[b]*On why /i/ changes to [o] (rather than another vowel), see Kim 2008.*

8 Comparisons to contour tone behavior

(22) Tonal contours can arise from partial assimilation across a syllable boundary of one tone to another, e.g. Yoruba (a) and Haya (b)

a. /rárà/ → [rárâ] 'elegy' (H.L → H.HL; Akinlabi & Liberman 2001).

Tone anticipation in Haya

H-L → HL-L / __ %

b. / mu-kónò / → mù-kônò 'arm' (H.L → HL.L; Hyman 2007:20)

(23) Tonal contours can arise through CV disagreement, as in Suma (Gbaya, Central African Republic; Bradshaw 1999:8) imperfective verbs

a. **Non-depressors**
ɓúk 'applaud'
dáŋ 'mount'
rɛ́m 'be able to'
nɔ́y 'boil'

b. **Depressors**
bǒm 'be blind'
gǎy 'reprimand'
dǐk 'be sonorous'
vǎy 'bet'

c. bom + *imperfective* H → **bǒ**m, *bóm

By deconstructing the segment into subsegments, ABC+Q can capture parallels of this kind between tonal contours and diphthongs.

9 Summary

- The role of diphthongs in harmony systems motivates a representation in which the components of a diphthong are independent of one another.
- Strictly segmental theories, such as *SPE* or standard ABC, lack the ability to refer to subsegments.
- Autosegmental theory, with its many-to-one associations between feature bundles and timing units, was a step in the right direction, but its formalism had limits (Hayes 1990).
- This problem is solved by Q theory, which eliminates many-to-one associations in favor of splitting segments into subsegments which can but need not agree with one another featurally.
- ABC+Q, the marriage of Q theory and ABC, has the descriptive power to model subsegmental behavior and thus to capture the parallels in behavior among diphthongs, contour tones, and other contour segments.

10 Predictions and implications.

- ABC permits correspondence to be stated at any level from the segment up: mora, syllable, foot, string, word
- ABC+Q extends the range of units down to the subsegment, enabling components of diphthongs (and tone contours) to interact independently in harmony patterns.
- Both ABC and ABC+Q predict that correspondence at the segmental level should be able to duplicate diphthongs (and contour tones) in their entirety, in harmony or reduplication scenarios

  CORR-VV
  IDENT-VV

- We have not as yet found a case where diphthongs spread as wholes in vowel harmony.
- But: the predictions are borne out for diphthongs in reduplication, and for contour tones

Diphthong reduplication

(24) Whole diphthong duplication in outright reduplication, as in Kikuyu (Peng 1993:18):

a.	tɛrɛm-a	tɛr-a+tɛrɛm-a	'trample (a little)'
	tɛɛhór-a	tɛɛh-a+tɛɛhór-a	'tear (a little)'
b.	β**oi**k-a	β**oi**k-a+β**oi**k-a	'march (a little)',
	t**ɛi**θí-a	t**ɛi**θ-a+t**ɛi**θí-a	'help (a little)'

(25) Whole diphthong duplication in echo reduplication in Ma-sa secret language (Southern Min, reported by Chung 1996): onset of second copy replaced with [s], but (falling-sonority) diphthongs are preserved (Yip 2003:784):

a.	'wood'	lim > lim sim	
	'slow'	ban > ban san	
b.	'ramp'	kya > kya sya	(*not* kya-sa)
	'to hang'	kwa > kwa swa	(*not* kwa-sa)

(26) This is as predicted by CORR-VV, applying to representations like these:

C(k k k)V(i a a)
C(k k k)V(u a a)

Tone contour assimilation

(27) Changzhi exhibits whole-contour tone assimilation. The diminutive suffix acquires exactly the same complex tonal contour as the preceding syllable (Yip 1989, Bao 1990, Duanmu 1994):

a.	/kuə$_{213}$ -tə$^{ʔ}_{535}$/	→	[kuə$_{213}$ -tə$^{ʔ}_{213}$]	'pan-DIM'
b.	/səŋ$_{24}$ -tə$^{ʔ}_{535}$/	→	[səŋ$_{24}$ -tə$^{ʔ}_{24}$]	'rope-DIM'
c.	/ti$_{535}$ -tə$^{ʔ}_{535}$/	→	[ti$_{535}$ -tə$^{ʔ}_{535}$]	'bottom-DIM'
d.	/k^{h}u$_{44}$ -tə$^{ʔ}_{535}$/	→	[k^{h}u$_{44}$ -tə$^{ʔ}_{44}$]	'pants-DIM'
e.	/təu$_{53}$ -tə$^{ʔ}_{535}$/	→	[təu$_{53}$ -tə$^{ʔ}_{53}$]	'bean-DIM'

ABC+Q account of Shih & Inkelas (2014):

CORR-VV
IDENT -VV [tone]

Complex consonant copy

- In Q theory, a complex consonant like the affricate /ʧ/ is a contour: C(t t ʃ) (Inkelas & Shih 2013)
- Outright consonant harmony itself is rare, but …
- … Consonant copy in partial reduplication duplicates complex consonants with no issue.

(28) Koasati punctual reduplication (infix *Có:*): unusual in its nonlocality, but completely typical of consonant copy in that the affricate "c" ([ʧ]) is copied wholesale, just as the simplex consonants are (Kimball 1991:325; data cited from Yu 2007).

'to be narrow'	lapátkin	→	lapát-l̲ó:-kin	
'to be circular'	taháspin	→	tahas-tó:-pin	
'to be angled'	copóksin	→	copok-có:-sin	*copok-ʃó:-sin, *copok-tó:-sin
'to be a hill'	cofóknan	→	cofok-có:-nan	*cofok-ʃó:-nan, cofok-tó:-nan

(29) This is as predicted by CORR-CC, applying to representations like these:

C(t t ʃ)

Clearly, correspondence theory needs to be able to duplicate contour segments. Whether the prediction of full contour assimilation (i.e. wholesale diphthong 'spreading') is correct for vowel harmony per se remains to be seen.

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