The internal structure of diphthongs: Prominence and sonority in the nucleus

Phonetically, sonority was shown to correlate strongly with intensity by Parker (2002). Sonority rises in complex onsets and falls in complex codas (Hooper 1976, Selkirk 1984, Parker 2011), and sonority reversals within a complex onset or coda are extremely rare. Considering the nucleus, though, we find languages with falling diphthongs (*ai*), rising diphthongs (*ia*) and with both, plus numerous cases of diphthongs with sonority plateaux (*ui, eo*). Cross-cutting this distinction is one based on prominence or intensity: some languages have what we will call *trochaic diphthongs* (*ía*) with an intensity peak on the first vowel, while others have what we may call *iambic diphthongs* (*iá*), with intensity on the second. *Falling iambic diphthongs* (*aí, aú*) are unattested. To explain this observation, we argue that diphthongs are organized parallel to feet and account for the cross-linguistic variation in peak positioning in diphthongs that we found by examining over 200 languages, with a set of Optimality-theoretic constraints.

Diphthongs rise in some languages (Crow), fall in most (Hawaiian, English), and contrastively rise and fall in others (Hmong, Italian, French). When we add in prominence (amplitude/intensity), we discover an asymmetry. In some languages, prominence coincides with sonority (Italian *ái iá*). The asymmetry comes with across-the-board prominence. Languages with a-t-b trochaic prominence allow falling (*ái, áu*), rising (*ía úa*), and contrasting diphthongs (*ái ía*: Hmong). But languages with a-t-b iambic prominence only allow *rising* diphthongs (*iá*), never *falling* (**aí*). No language has diphthongs that rise in intensity (Int↑) and fall in sonority (Son↓).

(1) Dipthongs, intensity and sonority

Int↓Son↓	Int↓Son↑	Int↓Son↓↑	Int=Son	Int↑Son↓
ái, áu Hawaiian	*ía, úa* Crow	*ái, ía* Hmong	*iá, uá; ái, áu* Italian	*aí, aú* *

We argue that diphthongs are inherently trochaic, i.e., that prominence is at the left edge, that prominence is realized as higher intensity, and therefore intensity is generally falling. Iambic, i.e., right-edge aligned prominence only occurs as a by-product of quality-sensitivity (see Kenstowicz 1997 for QS stress systems). Int↑Son↓ diphthongs are unattested because prominence is at the left edge of diphthongs unless quality sensitivity interferes. We thus get Int↑ only when driven by quality (French, Italian), deriving the asymmetry. Otherwise, prominence is strictly trochaic, regardless of inherent prominence (Crow, Hmong).

Quality-sensitivity is due to the Sonority-to-Intensity-Principle (SIP): 'Prominence coincides with sonority peaks'. This constraint is in potential conflict with several others. The strong preference for trochaic patterns is attributed to the nucleic equivalent of TROCHEE, which we label INT↓ 'The nucleus falls in intensity'. Crucially, there is no mirror image constraint, INT↑ ('The nucleus rises in intensity') that would favor rising intensity, i.e., prominence to the right. Some languages don't tolerate rising (English) or falling diphthongs (Crow), which we attribute to alignment of height features within the nucleus: ALIGNLEFT[low] and ALIGNLEFT[high].Violation of these constraints can be avoided by parsing a pair of vowels into two syllables rather than into one nucleus, i.e., as a diphthong. In our typology, the hiatus candidate represents avoidance of diphthongs in general (attainable as well by monophongization, as in Sanskrit or late Latin or by deletion of one of the vowels). We abstract away from this typological detail here and only include the candidate that adds a syllable boundary between two vowels. Accordingly, we use only ONSET as the constraint militating against any such solution.

(2) Con and Cand for a diphthong typology (capitalization indicates prominence)

Cand#	input	output	1: INT↓	2:AlignHi	3:AlignLo	4:Ons	5:SIP
1.1	ai	.Ai.		*		*	
1.2		.aI.	*	*		*	*
1.3		.a.i.				**	
2.1	ia	.Ia.			*	*	*
2.2		.iA.	*		*	*	
2.3		.i.a.				**	

The factorial typology of this system of constraints and candidates (generated in OTWorkplace - Prince / Merchant / Tesar) produces all attested patterns we have been able to find. Crucially, Int↑Son↓ diphthongs (e.g., *ai*) are harmonically bounded, as illustrated in the tableau in (2) and thus predicted never to occur.

The typology generated is given in (3). All language/diphthong types discussed above are accounted for. L6, of which Yokuts languages are an example, lacks diphthongs altogether. The latter language type could be divided into languages that avoid diphthongs by different means, as indicated above. This would require the inclusion of more candidates and constraints, but would not change the typology of diphthong types. The system overgenerates one language type (L5), which aligns low sonority vowels to the left and places prominence on the most sonorous vowel, i.e., to the right. We are confident that this is either an accidental gap or owed to our ignorance.

(3) Diphthong typology generated

Inputs->	ai	ia
L1 (Hmong)	.Ai.	.Ia.
L2 (Italian)	.Ai.	.iA.
L3 (Hawaiian)	.Ai.	.i.a.
L4 (Crow)	.a.i.	.Ia.
L5 (n.n.)	.a.i.	.iA.
L6 (Yokuts)	.a.i.	.i.a.

In conclusion, complex nuclei preferably have falling, trochaic intensity (*ái, ía*) and higher intensity tends to coincide with higher sonority (*ái* > *ía*). Diphthongs with rising intensity only come about in systems that are quality/sonority-sensitive. To understand diphthongs, we have to divorce sonority (vowel height) from prominence (amplitude/intensity). The absence of strictly iambic diphthongs from the typology is explained by the asymmetry of the constraint system. No constraint favors rising intensity, i.e., iambic diphthongs.