Gradient morphophonology: Evidence from Uyghur vowel harmony

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Phonology is often conceptualized as the domain of qualitative, discrete sound patterns while phonetics is the domain of quantitative, gradient patterns (Keating 1988; Cohn 1993, 2006; Zsiga 1995; Kingston 2007; Ernestus 2011 a.o.). As a consequence, morphophonological alternations are modelled as substitutions of one categorical sound for another, excluding the possibility of gradient alternations. Cohn (2006:36) argues, "morphophonemic alternations are at the very core of what most phonologists think of as phonology…If these sorts of cases are shown to involve gradience, this would strike at the core of our understanding of the phonology, since these are the least disputable candidates for 'being phonology.'" In this paper I argue that morphophonology may indeed be gradient, marshaling evidence from backness alternations in Uyghur vowel harmony that exhibit asymmetric gradience not reducible to phonetic reduction or interpolation.

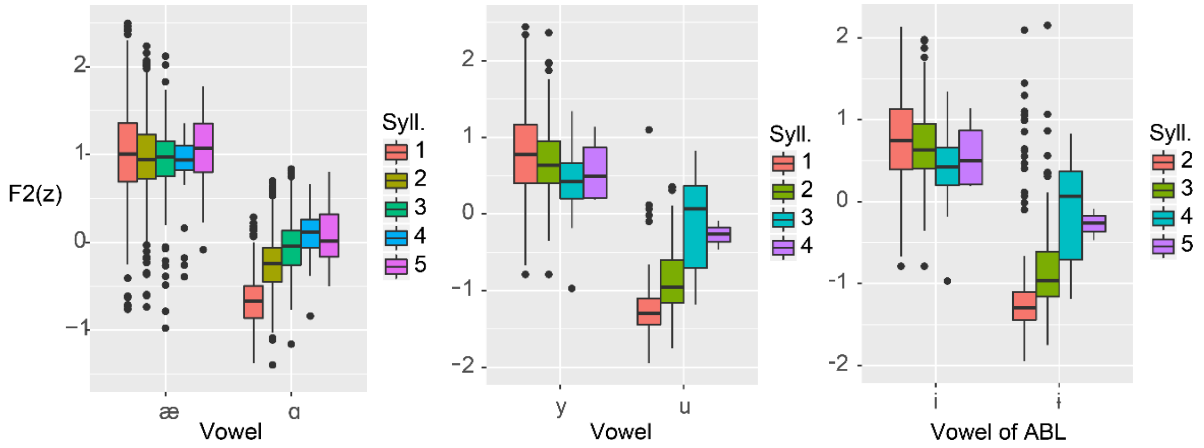
Uyghur has a nine-vowel inventory /ɑ æ e o ø ɨ i u y/ with marginal /e/. In non-initial syllables, ɑ - æ, ɨ - i, and u - y alternate for harmony (Yakup 2005; cf. Hahn 1991), as demonstrated in (1). In (1a,b), the low vowel of the locative suffix and the high vowel of the ablative suffix alternate for root backness. In (1c), rounding harmony optionally applies, producing [back] and optionally [round] harmonic high vowels.

(1)	a.	bɑɬ-dɑ	honey-LOC
		bæl-dæ	waist-LOC
	b.	bɑɬ-dɨn	honey-ABL
		bæl-din	waist-ABL
	c.	ʒoɬ-dun ~ ʒoɬ-dɨn	road-ABL
		køl-dyn ~ køl-din	lake-ABL

Zsiga (1997:234-235) contends that categorical alternations should result in vowels that are phonetically indistinguishable from non-alternating vowels. Thus, if the alternations in (1) are categorical, underlying trigger vowels in the initial syllable and derived vowels in non-initial syllables should not exhibit any acoustic differences for F2. To test this, I conducted a production study with 9 Uyghur speakers, examining F2 of [±back] vowels (n=6,839) in both underlying trigger and derived target positions. Stimulus items were shown as randomly ordered pictorial prompts. Speakers were trained to associate certain visual cues with grammatical categories, producing paradigms of inflected nouns of up to 5 syllables in length.

In a mixed effects model with fixed effects for initial vowel backness and roundness, syllable number, target vowel, coarticulatory effects of flanking consonants, and random effects for speaker, the by-syllable shift in F2 for front vowels was slight (β= -0.06z), but the interaction of syllable and initial vowel backness was much larger (β= 0.27z). In essence, derived [+back] vowels undergo a stepwise shift forward in the vowel space, resulting in surface productions that are not phonetically equivalent to either underlying [+back] or [-back] vowels. In contrast, the production of [-back] vowels across syllables does not result in any distinguishable phonetic difference, in conformity with Zsiga's claim. These results are plotted in (2-4). In (2) and (3), the F2 value of [ɑ] and [u] increases by syllable number. In contrast, the F2 of [æ] and [y] is consistent across syllables. In (4), the ablative suffix, the most indicative form for the ɨ - i alternation, exhibits this same pattern of asymmetric fronting. Moreover, a follow-up perception study indicates that the magnitude of these shifts is perceptible by Uyghur speakers.

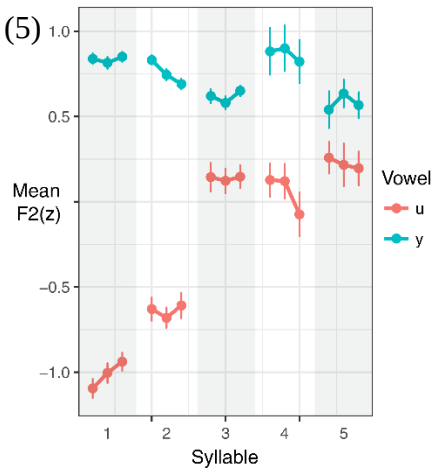
The results can be interpreted with a phonetic or a phonological explanation. If these shifts are phonetic, there are several possible accounts: reduction or interpolation to a default articulatory setting. First, phonetic models of reduction predict symmetrical reduction of



gestural stiffness by-position (Beckman et al 1992; Vayra & Fowler 1992; Fourgeron & Keating 1997; Johnson & Martin 2001), but the effect is Uyghur is asymmetrical and dependent on phonological backness. Furthermore, many models of reduction predict that shorter vowels are more likely targets for reduction (Lindblom 1963), but problematically, non-initial vowels are longer than initial vowels, and final syllables are stressed in Uyghur (Yakup & Sereno 2016).

Second, Keating (1988) and Cohn (1993) contend that some systematic shifts may derive from phonetic interpolation across phonologically underspecified units. This analysis would require all non-initial vowels to be underspecified for [back], in addition to a default articulatory setting specified for [-back] (Gick et al. 2004) at the right edge of the word. According to Cohn (1993), we should find a cline within- and between-syllables if asymmetric fronting is phonetic. If, on the other hand, the effect is phonological, then we should find plateaus within each vowel. In (5), which plots mean F2 at the 25%, 50%, and 75% points for [u] and [y], we find plateaus within each syllable but significant shifts between syllables. In fact, the most cline-like positional [u] of (5) is the initial, underlying vowel. Like in (3), F2 of [u] shifts across-syllables, but here we see no systematic effects within each syllable. Additionally, under this analysis one might expect F1 and F2 of all vowels, irrespective of phonological backness, to converge on a single acoustic target corresponding to the default articulatory setting, but no such shift is evident in the data. Finally, if all non-initial vowels do not receive a phonological specification, there is no explanation for why both derived and underlyingly specified vowels trigger categorical consonantal alternations (e.g. sæl̲læ-l̲ær-g̲æ ‘turban-PL-DAT’ vs. pɑɬ̲tɑ-ɬ̲ɑr-ʁ̲ɑ ‘axe-PL-DAT’).

(5)



I thus conclude that gradient fronting in Uyghur is phonological. The most straightforward analysis is that [+back] gradiently spreads, petering out throughout the word (cf. McPherson & Hayes 2016 for a different notion of petering out). In other words, the outputs of harmony in Uyghur are not discrete variables, 0 and 1, but rather may be continuous variables between those two categorical endpoints, e.g. [0.8 back]. Further, by allowing outputs to be gradient, constraints like *([+bk][-bk]), *[+bk], and Id-IO[bk] produce a restrictive typology in Harmonic Grammar. If phonology may be gradient, the analysis of Uyghur offers insight into other cases of incomplete neutralization, like word-final devoicing and nasal place assimilation.