Is harmony in Uyghur really gradient?

Structuralist and early generative phonologists argued for categorical representations for conceptual reasons (Halle 1959; Chomsky and Halle 1968; Postal 1968). One clear prediction from this representational commitment is that, all else being equal, phonological alternations should produce sounds that are identical to their non-alternating counterparts (Zsiga 1997). However, a body of research has found that many phonological alternations produce sounds that are intermediate between two phonological categories (Charles-Luce 1985; Dinnsen 1985; Port and O'Dell 1985) These findings on the incomplete neutralization of contrast have resulted in vigorous debate, being leveraged by some to argue against the necessary discreteness of contrast in the phonological grammar (Port and Leary 2005; Roettger et al. 2014), while others have argued that these results could be spurious (Fourakis and Iverson 1984; Jassem and Richter 1989) or fall out from performance factors (Warner et al. 2004; Du 2023; Du and Durvasula in press). More specifically for current purposes, McCollum (2019a,b) contends that incomplete positional neutralization of contrasts in Uyghur backness harmony strongly supports the inclusion of gradient phonological representations. In this paper we experimentally evaluate McCollum's claims, arguing that backness harmony in Uyghur is in fact categorical.

Uyghur exhibits a pattern of progressive backness harmony, triggering contrast-neutralizing alternations between /ɑ/ and /æ/ (1a,b) and /u/ and /y/ (1c,d), as well an allophonic alternation between /i/ and [ɯ] (Nadzhip 1971; Hahn 1991; Mayer et al. 2022).

1. a. bɑl-lɑr-dɑ   'honey-PL-LOC'   c. jɑz-ʁuz-ʁu   'write-CAUS-GER'
    b. bæl-lær-dæ   'lower.back-PL-LOC'   d. kæt-kyz-gy   'leave-CAUS-GER'

McCollum (2019a,b) reports that the acoustic distinction between these alternating phonemic pairs is reduced in non-initial syllables. Specifically, he reports that the second formant, F2, of /ɑ u/ increases monotonically in non-initial syllables while F2 of their harmonic counterparts /æ y/ does not systematically vary by position. He interprets this result as evidence that backness harmony incompletely assimilates underlying front vowels, yielding surface back vowels that are incrementally more fronted. Further, the fact that harmony triggers a structure-preserving alternation between the voiced velar stop (1d) and the voiced uvular fricative (1c) is used to argue that this effect is not post-lexical or phonetic in nature. McCollum's results are significant because they suggest the potential inclusion of gradient representations with the lexical phonology.

In this study we attempted to replicate the pattern in McCollum (2019a,b) and further investigate positional backness in Uyghur, conducting a production study in Chunja, Kazakhstan with many of the same speakers that participated in McCollum (2019a,b). We elicited words of up to five syllables in length. Within this larger elicitation, we recorded words containing the alternating low vowels /ɑ æ/ (n=9,367 vowels) in the plural /-lAr/, locative /-DA/, perfective /-KAn/, and verbalizing /-lA-ʃ/ morphemes in syllables 2-5. If McCollum's claims are correct, then F2 of /ɑ/ should increase in non-initial syllables both within- and across-morphemes.

We modelled the data using a series of mixed effects linear regressions, predicting vowel F2 based on position with maximal random effects structure for item and subject. When the *overall* F2 data is considered without controlling for morpheme (Fig. 1a), the pattern

reported in McCollum (2019a,b) is replicated. The harmonizing /ɑ/ exhibits higher F2 in non-initial syllables ($\hat{\beta}_{F2} = 47\ Hz, p < 0.0001$), while positional effects for /æ/ are marginal. However, when morphemic context is controlled for (Fig. 1b), a different set of positional effects are evident - back vowels display far less fronting ($\hat{\beta}_{F2} = 12\ Hz, p = 0.002$) and front vowels display backing ($\hat{\beta}_{F2} = -24\ Hz, p = 0.01$). In turn, the pattern is consistent with non-initial centralization, with no clear evidence of asymmetric fronting. Differences in F2 depend on the quality of flanking consonants rather than position in the word. Consequently, the observed pattern in McCollum (2019a,b) is an artefact of the distribution of morphemes and related consonantal properties.

To determine which model best accounts for the data we compared the general and the morpheme-sensitive models for back and front vowel contexts separately using the Akaike Information Criterion (Akaike 1974). AIC estimates the amount of information lost by a given model, assigning lower values to models that better fit the data; Burnham et al. (2011) suggest that an AIC difference of more than 8 is an extremely large difference in model fit. AIC also penalizes models with more parameters. Despite an additional parameter in the morpheme-sensitive models, the morpheme-sensitive AIC values for both the front and back vowel contexts were substantially lower (back vowel context = -130, front vowel context = -125). In short, the morpheme-sensitive models provide a better explanation for F2 variance than the general models.
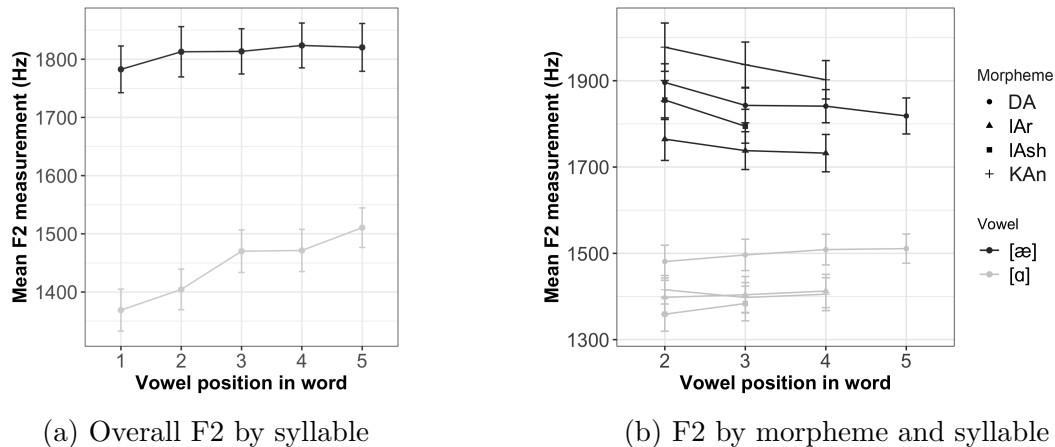

(a) Overall F2 by syllable   (b) F2 by morpheme and syllable

Figure 1: Mean F2 measurements

Though we replicated McCollum's (2019a,b) data, we argue that the putative pattern of asymmetric fronting observed derives from vowel-consonant interactions and not harmony, as it does not hold when segmental and morphemic context are held constant. This result suggests that Uyghur does not show evidence for gradient subphonemic assimilation. In fact, our results are consistent with categorical harmony followed by symmetric phonetic centralization. On the methodological front, our results highlight the need for careful morphological controls when comparing positional effects in order to minimize potential confounds. On the theoretical front, our results are consonant with claims that observed incomplete neutralizations are either artefactual or due to performance factors and needn't be incorporated into phonological representations.