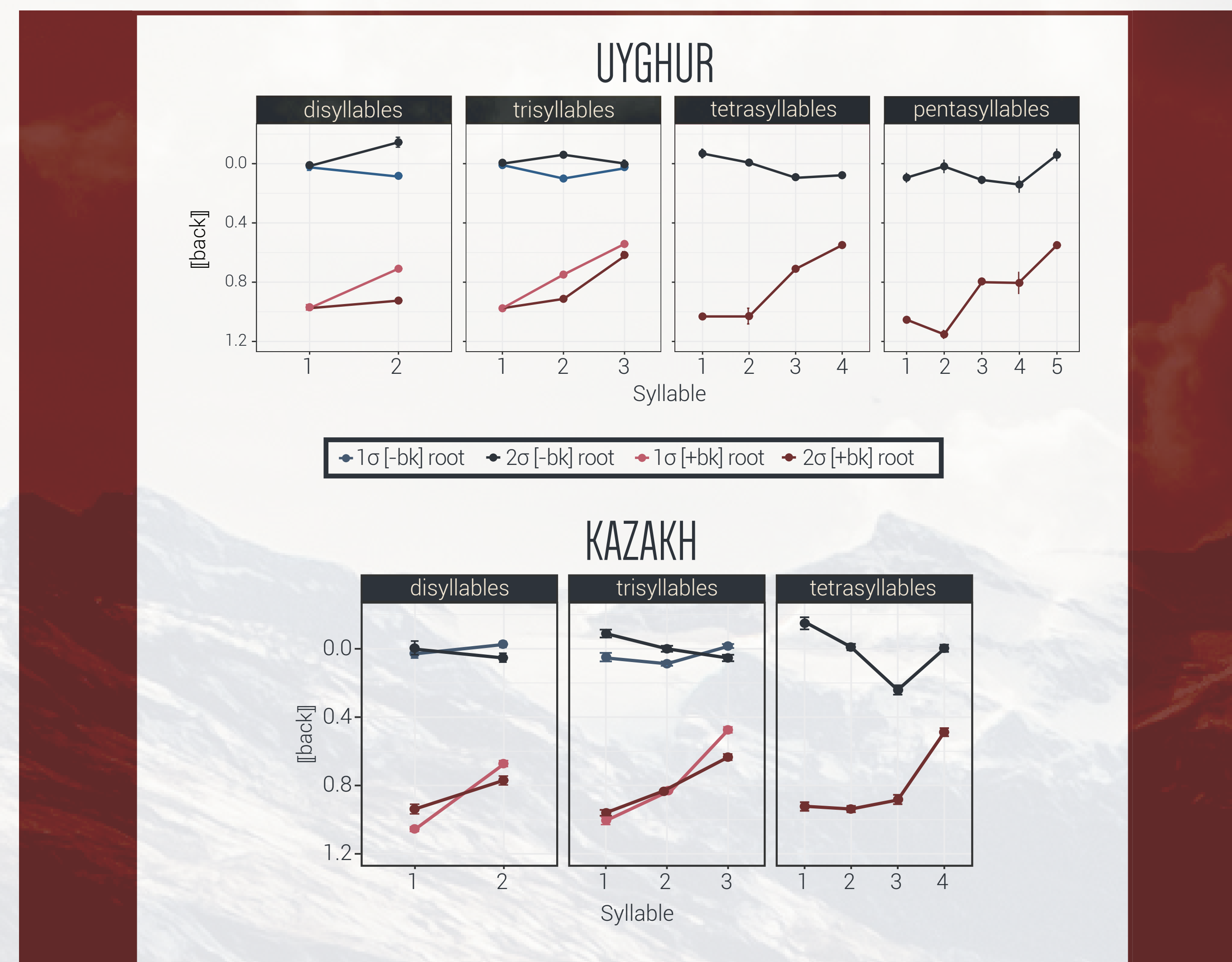


# MODELING GRADIENT MORPHOPHONOLOGY IN HARMONIC GRAMMAR

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## GRADIENT HARMONY

Although phonology is typically assumed to the domain of categorical sound patterns, backness harmony in Uyghur and Kazakh only gradiently assimilates non-initial vowels (McCollum 2019a,b).



### Is backness harmony in these languages phonological or phonetic?

#### Evidence for phonological

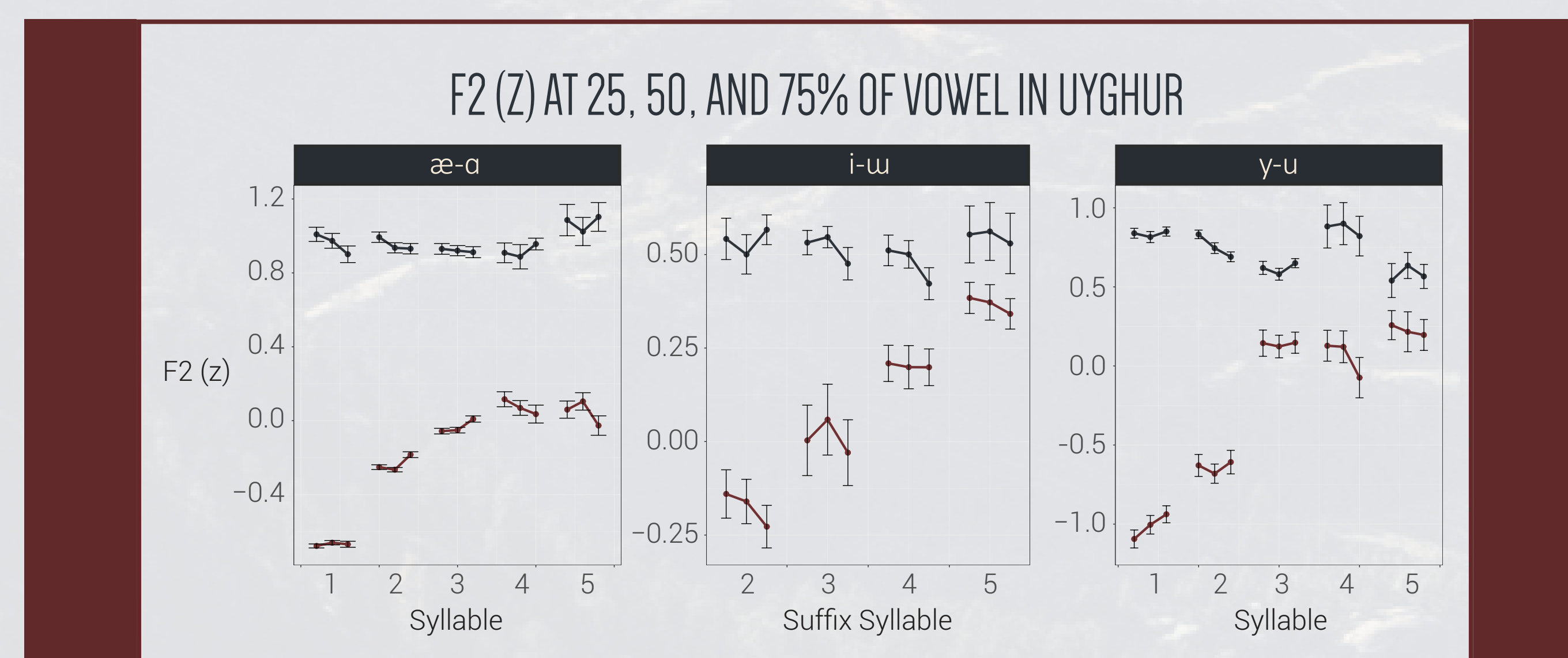
- triggers structure-preserving dorsal consonant alternations
- morphology-sensitive
- has exceptions
- is iterative

#### Evidence for phonetic

- assimilation is gradient

#### The trajectory of gradience is not consistent with known phonetic forces.

- is not symmetrical ( $\neq$ centralization)
- no within-syllable shifts; attested in different contexts ( $\neq$ interpolation)



## ANALYSIS

To account for gradience, the phonological grammar must have access to gradient representations, indicated by  $[[\ ]]$ , in both GEN and CON.

$[[bk]]$  values were normalized; 1 =  $\sigma_1$  mean of [+bk] member of pair; 0 =  $\sigma_1$  mean of [-bk] member of pair.

Constraints:

- \* $[[bk]]$ : for output vowel t with  $[[bk]]=u$ , assign u violations
- Id-IO $[[bk]]$ : for input-output vowel pair V, with  $/V/_{[[bk]]=w}$  and  $[V]_{[[bk]]=x}$ , assign |w-x| violations
- \* $[[+bk]][[-bk]]$ : for a vowel in syllable y with  $[[bk]]_y = z$ , if  $z_{y+1} < z_y$  assign  $(z_{y+1} - z_y)^2$  violations

For convenience, all  $[[bk]] = \{0, 0.1, 0.2 \dots 1\}$

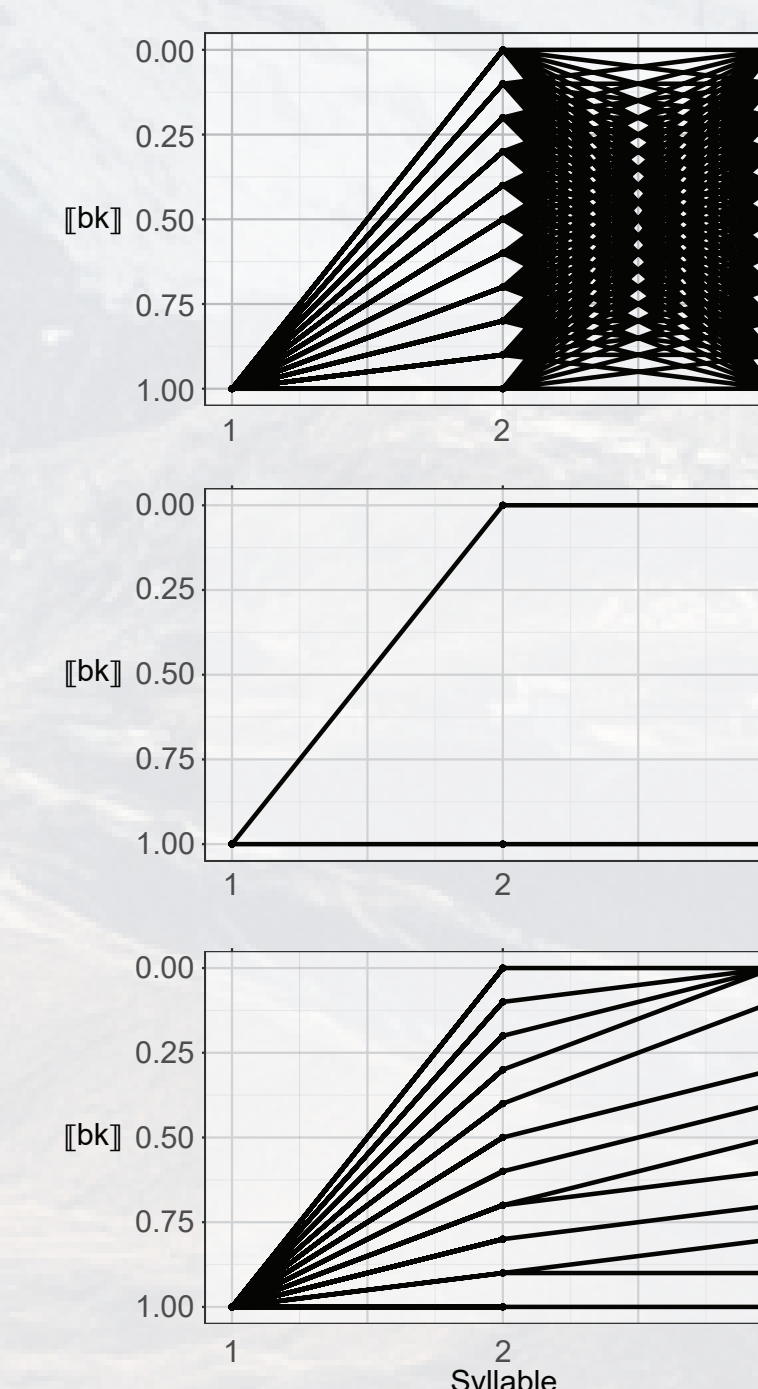
For a three-syllable word, e.g. Uyghur [bal-lar-da] 'honey-PL-LOC', assuming positional faithfulness in  $\sigma_1$ , 121 outcomes are possible (top).

OT predicts only 2 of 121 possible three-syllable patterns, categorical harmony or no harmony (middle).

- Strict domination precludes sub-phonemic gradience

HG predicts 13 of 121 possible three-syllable patterns (bottom).

- All patterns exhibit monotonically decreasing backness

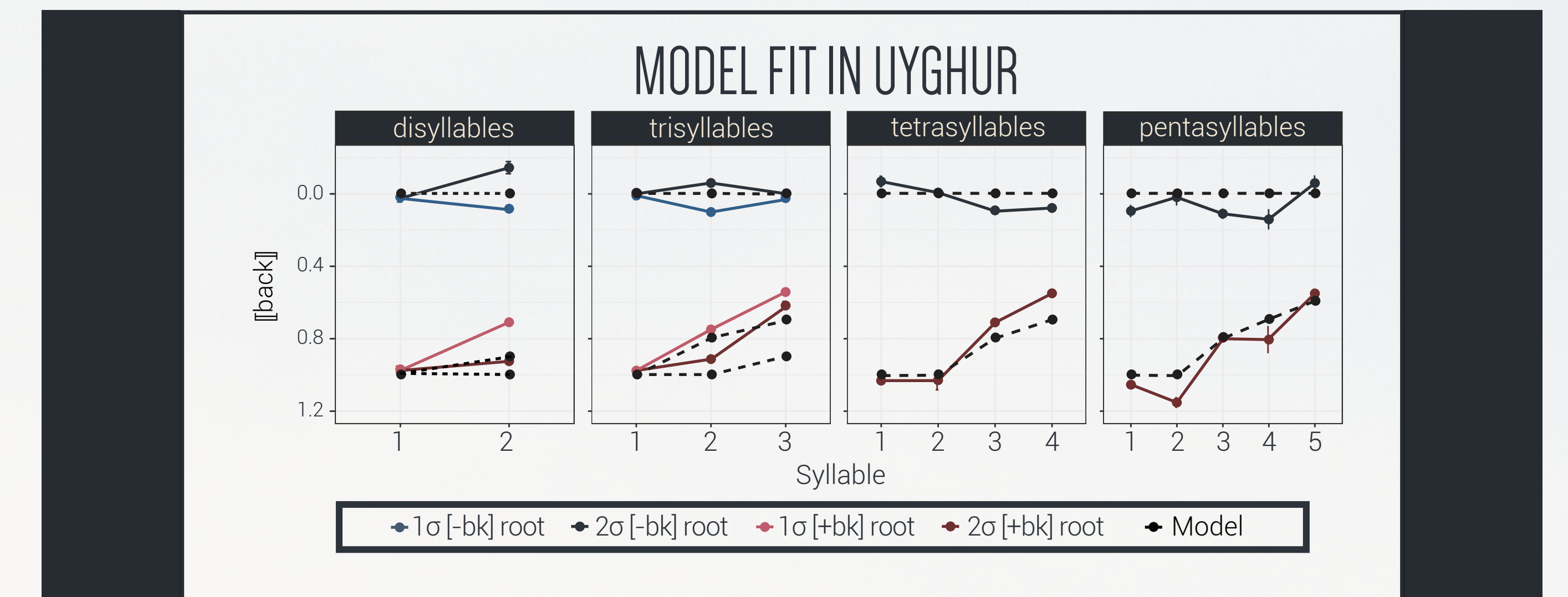


Uyghur /bal-lær-dæ/ → [bal-lar-da]

|     | $[[1]]-[[0]]-[[0]]$<br>/bal-lær-dæ/   | * $[[+bk]][[-bk]]$<br>20 | * $[[bk]]$<br>3  | Id-IO $[[bk]]$<br>0 | Harmony |
|-----|---------------------------------------|--------------------------|------------------|---------------------|---------|
|     | $[[1]]-[[0]]-[[0]]$<br>bal-lær-dæ     | $20(-1) = -20$           | $3(-1) = -3$     | $0(-0) = 0$         | -23     |
|     | $[[1]]-[[0.1]]-[[0]]$<br>bal-lær-dæ   | $20(-0.82) = -16.4$      | $3(-1.1) = -3.3$ | $0(-0.1) = 0$       | -19.7   |
| ... |                                       |                          |                  |                     |         |
|     | $[[1]]-[[0.8]]-[[0.6]]$<br>bal-lar-da | $20(-0.08) = -1.6$       | $3(-2.4) = -7.2$ | $0(-1.4) = 0$       | -8.8    |
| ☞   | $[[1]]-[[0.8]]-[[0.7]]$<br>bal-lar-da | $20(-0.05) = -1$         | $3(-2.5) = -7.5$ | $0(-1.5) = 0$       | -8.5    |
|     | $[[1]]-[[0.8]]-[[0.8]]$<br>bal-lar-da | $20(-0.04) = -0.8$       | $3(-2.6) = -7.8$ | $0(-1.6) = 0$       | -8.6    |
| ... |                                       |                          |                  |                     |         |
|     | $[[1]]-[[1]]-[[1]]$<br>bal-lar-da     | 0                        | $3(-3) = -9$     | $0(-2) = 0$         | -9      |

Mean values for  $[[\pm bk]]$  by syllable, root type (mono- or disyllabic), and word length were used to fit the model (14 word types in Uyghur, 12 in Kazakh).

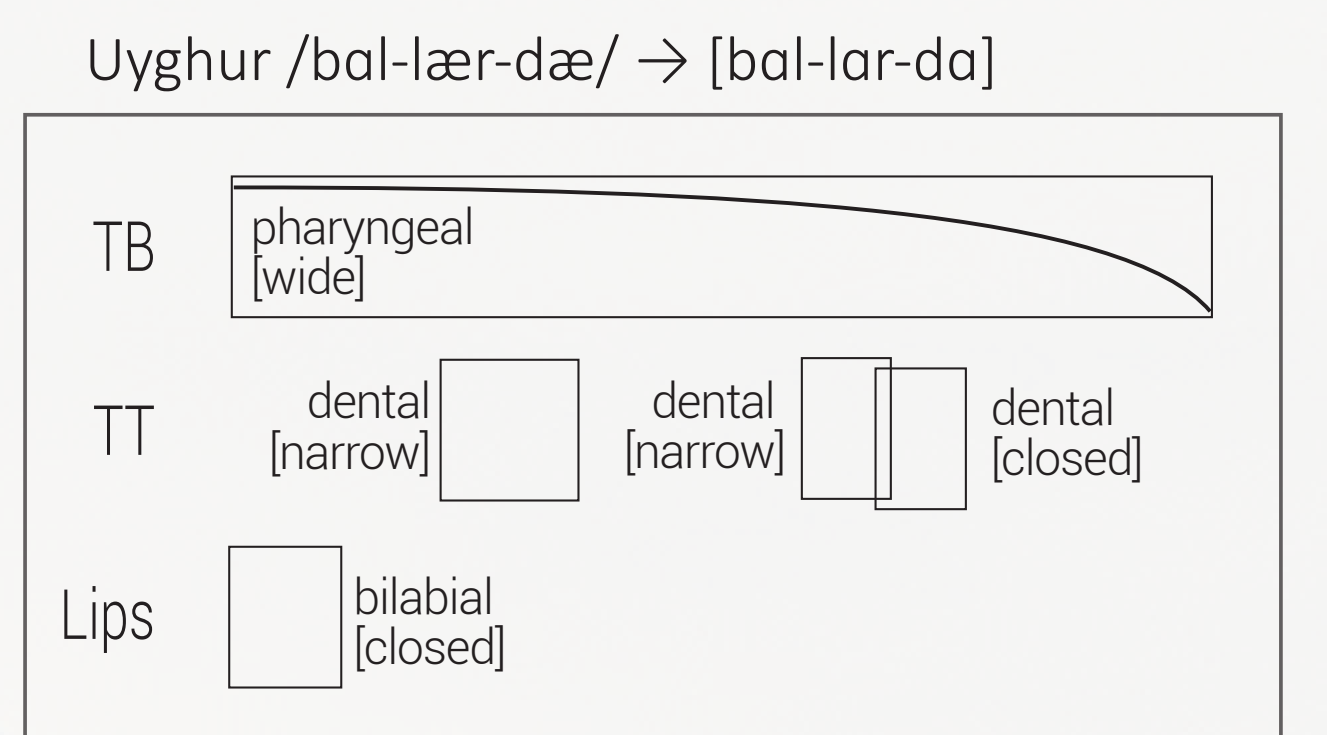
Weights were assigned using Excel's Solver add-in to minimize error between predicted and actual means.



## DISCUSSION

### Articulatory Phonology

In Smith's (2018) Gestural Phonology model, the only constraint on gestural deactivation is the cosine function. This predicts that intersyllabic backness should be monotonically decreasing (=66 patterns).



Gestural deactivation predicts syllable-internal fronting (unattested).

It is unclear how to model this partial assimilation of vowels.

- Does the gesture return to its default state at the end of the word?
- Does the gesture extend beyond the word?
- Are the relevant gestures composed of multiple sub-gestures (Nam 2007)?

### General Discussion

If gradient harmony is phonological, this suggests that harmony should not be modeled autosegmentally.

If gradience is incorporated into the phonological analysis, should we conflate phonology and phonetics (Browman & Goldstein 1989, 1990; Flemming 2001)?

The absence of within-syllable shifts supports an analysis with segments rather than continuous time or subsegments.

## REFERENCES

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