# A theory of subfeatural representations: the case of rounding harmony in Laal

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**Supplementary materials**

## Appendix A:
## Attested cases of doubly triggered rounding harmony

a. *singular*                 *plural* /-u, -ur/

| | | | |
|---|---|---|---|
| bínàn | 'okra' | /bɨ̂nn-ú/ | bûnnú |
| bɨg-ál | 'bark' | /bɨg-ū/ | būgū |
| ɓɨr-à | 'fish hook' | /ɓɨr-ú/ | ɓùrú |
| ɓɨ̄g-āl | 'tree sp.' | /ɓɨ̄g-ùr/ | ɓùgùr |
| círám | 'tree sp.' | /círm-ú/ | cúrmú |
| dɨlām | 'type of house' | /dɨlm-ú/ | dùlmú |
| màl | 'skilled artisan' | /mɨl/ ~ /mɨl-ù/ | mɨl ~ mùlù |
| síb-l-ál | 'lie' | /síb-ùr/ | súbùr |
| sɨm-à | 'fishing net' | /sɨm-ú/ | sùmú |

b. *singular*                 *plural* /-o, -or/

| | | | |
|---|---|---|---|
| bàg-à | 'antelope sp.' | /bàg-r-ó/ | bògró |
| báág | 'ostrich' | /báɔ́g-ó/ | bóógó |
| ɓàg-ál | 'head' | /ɓàg-ór/ | ɓògór |
| bǎl | 'fish sp.' | /bàl-ò/ | bòlò |
| málɨ̀m | 'Koranic teacher' | /mâlm-ó/ | môlmó |
| màm-ál | 'grandchild' | /màm-ór/ | mòmór |
| màm-ál wūj | 'fish sp.' | /màm-ór wūjā/ | mòmór wūjā |
| mɔ́g-ɔ́l | 'mouse' | /mɔ́g-ór/ | mógór |
| ɲām ɟām | 'antelope sp.' | /ɲə̄m ɟə̀m-ó/ | ɲə̄m ɟòmó |
| pàb | 'cobra' | /pàb-ó/ | pòbó |
| sààb | 'fabric, garment' | /sààb-ó/ | sòòbó |
| sám | 'boa' | /sóm-ò/ | sómò |
| sāām | 'skin' | /sóóm-ó/ | sóómó |
| tàb | 'fish sp.' | /tàb-ó/ | tòbó |
| wàár | 'genet' | /wòòr-ó/ | wòòró |

c. *plural*                 *singular* /-o/

| | | | |
|---|---|---|---|
| ndààm-à | 'Ndam people' | /ndə̀ə̀m-ó/ | ndòòmó |

## Appendix B:
## Words included in the Laal study

(a)

| condition | | $n$ | | | $n$ |
|---|---|---|---|---|---|
| ə | | 10 | də̀rə́l | 'fish sp.' | 5 |
| | | | lə̀r | 'traps sp.' | 2 |
| | | | də̀gə́n | 'drag me' | 2 |
| | | | gə̄rī | 'tree sp. (PL)' | 1 |
| B | | 22 | | | |
| | Bə | 12 | ɓə̂n | 'pinch' | 6 |
| | | | mə̀gə̀n | 'my lower back' | 2 |
| | | | ɓə̀gjə̀r | 'fish sp.' | 2 |
| | | | pə̀gjə́l | 'quarrel' | 2 |
| | əB | 10 | gə́m | 'fish sp.' | 6 |
| | | | gə̀m | 'fever' | 1 |
| | | | kə́m | 'fish sp. (PL)' | 3 |
| BəB | | 3 | mə̀mlə̀l | 'my grandchild' | 3 |
| U | | 9 | sə̀gú | 'tree sp. (PL)' | 4 |
| | | | kə́rù | 'fish sp.' | 5 |

(b)

| condition | $n$ | | | $n$ |
|---|---|---|---|---|
| ə | 12 | gə̀gíɲ | 'disagree' | 2 |
| | | gə̄rī | 'tree sp. (PL)' | 2 |
| | | nə̀rə́l | 'my son' | 2 |
| | | lə̀r | 'wait' | 3 |
| | | tə̀grə̀ | 'sieve (GERUND)' | 3 |

| condition | *n* | | | *n* |
|---|---|---|---|---|
| B | 60 | | | |
|   Bə | 47 | mə̀g | 'lower back' | 1 |
| | | pə́grí | 'think of me (ASSOC)' | 1 |
| | | pə̄nàr | 'his nose' | 1 |
| | | bə̄rī | 'back' | 2 |
| | | mə̀l | 'be straight' | 2 |
| | | mə̀lí | 'tongues' | 2 |
| | | pə́d | 'pass' | 2 |
| | | pə̀gjɔ́l | 'quarrel' | 2 |
| | | pə̄nà | 'your nose' | 2 |
| | | bə̀g | 'mat sp.' | 3 |
| | | ɓə̀glə̀l | 'my head' | 3 |
| | | ɓə̀nə̀ | 'glue (GERUND)' | 3 |
| | | mə̀lə̀l | 'my tongue' | 3 |
| | | pə́grə́n | 'think of me' | 3 |
| | | ɓə́l | 'not yet' | 4 |
| | | ɓə̂n | 'glue, stick' | 4 |
| | | pə̄nì | 'my nose' | 4 |
| | | ɓə̀ | 'head (GEN)' | 5 |
|   əB | 13 | gɔ́m | 'fish sp.' | 1 |
| | | gə̀m | 'fever' | 2 |
| | | nə̀m | 'my brother' | 3 |
| | | tɔ́bí | 'tell' | 3 |
| | | kɔ́m | 'fish sp. (PL)' | 4 |
| BəB | 3 | mə̀mlə̀l | 'my grandchild' | 3 |
| U | 6 | sə̀gó | 'tree sp. (PL)' | 1 |
| | | dɔ́nù | 'tree sp. (PL)' | 5 |

*Table VI*
ə-words.  (a)  speaker KD; (b) speaker AK.

(a)

| condition | | *n* | | | *n* |
|-----------|---|-----|---|---|-----|
| ɨ | | 23 | dìgɲál | 'fish sp.' | 6 |
| | | | dɨ̄gɨ̄ɲ | 'fish sp. (PL)' | 6 |
| | | | sɨ́gál | 'ear' | 1 |
| | | | sɨ́gɨ́ | 'ears (PL)' | 2 |
| | | | ɗìgìn | 'be heavy (PL)' | 2 |
| | | | dɨ̄gā | 'bad' | 1 |
| | | | dìgà | 'pickaxe' | 2 |
| | | | ɗɨ̄lā | 'fish sp.' | 2 |
| | | | bɨ̀là | 'empty' | 1 |
| B | | 64 | | | |
| | Bɨ | 52 | mɨ̄rā | 'cows' | 2 |
| | | | mɨ̄n-nǎŋ | 'our face' | 1 |
| | | | ɓìgál | 'tree sp.' | 1 |
| | | | bìgà | 'shell' | 1 |
| | | | bìgál | 'pubis' | 2 |
| | | | bìglìl | 'my pubis' | 3 |
| | | | bìgí nùrú | 'our pubis' | 1 |
| | | | bìglàl | 'his pubis' | 1 |
| | | | mɨ̄g | 'pass (PL)' | 3 |
| | | | bɨ̀l | 'trash' | 1 |
| | | | mɨ́ná | 'thing' | 4 |
| | | | bínàn | 'gombo, okra' | 1 |
| | | | ɓɨ́rà | 'fish hook' | 1 |
| | | | mìdál | 'evening' | 1 |
| | | | mìlìl | 'my eye' | 1 |
| | | | mìlàl | 'his eye' | 1 |
| | | | mín(í) | 'eyes' | 2 |
| | | | mɨ̄rgā | 'beers' | 1 |
| | | | mírííl | 'plant sp.' | 1 |
| | | | ɓɨ̀lál | 'speech' | 4 |
| | | | ɓɨ̀dɨ́l | 'one' | 1 |
| | | | píríl | 'catch me' | 5 |
| | | | pínán | 'millet shaft' | 2 |
| | | | pír | 'catch' | 3 |
| | | | pɨ̄lā | 'debt' | 2 |
| | | | pɨ̄l | 'refuse' | 2 |
| | | | ɓɨ̀l | 'hole' | 1 |
| | | | bɨ̄rgā | 'hurry' | 1 |
| | | | ɓɨ́lá | 'speak' | 2 |

| condition | *n* | | | *n* |
|---|---|---|---|---|
| ɨB | 12 | lìbár | 'plunge' | 4 |
| | | nìmíl | 'kin' | 1 |
| | | nɨ̄mɨ̄n | 'salt' | 1 |
| | | sìmà | 'fishing net' | 2 |
| | | tɨbà | 'tobacco' | 2 |
| | | dìmíl | 'Bagirmi' | 2 |
| ɨCB | 1 | lɨ̀gmà | 'horses' | 1 |

(b)

| condition | *n* | | | *n* |
|---|---|---|---|---|
| ɨ | 41 | dìg | 'be bad (PL)' | 3 |
| | | dɨ̄gā | 'be bad' | 3 |
| | | dɨ̄gɨ̄ɲ | 'fish sp. (PL)' | 2 |
| | | dìgɲál | 'fish sp.' | 1 |
| | | dɨ̄g | 'draw water' | 1 |
| | | dɨ̄gɨ | 'draw water (GERUND)' | 1 |
| | | dɨ̄lɨ̀ | 'cut (GERUND PL)' | 1 |
| | | gíg | 'doubt' | 1 |
| | | gíná | 'net sp.' | 1 |
| | | kɨ̀n | 'arrive (PL)' | 1 |
| | | lɨ̀gɨ | 'braid (GERUND PL)' | 2 |
| | | lɨ̀r | 'wait' | 1 |
| | | nìŋɨ̀ | 'throw (GERUND PL)' | 1 |
| | | sìg | 'how many/much' | 3 |
| | | sɨ̄g | 'stand (PL)' | 3 |
| | | sɨ̀gí | 'ears' | 2 |
| | | sɨ̀glà | 'your ear' | 1 |
| | | sɨ̀glàn | 'its ear' | 2 |
| | | sɨ̀glɔ̀l | 'my ear' | 1 |
| | | síŋ | 'stamp (PL)' | 3 |
| | | sír | 'drink' | 2 |
| | | sɨ̀rɨ̀ | 'drink (GERUND)' | 2 |
| | | tɨ̄n | 'lie down' | 1 |
| | | tírí | 'beams' | 2 |

| condition | | *n* | | | *n* |
|---|---|---|---|---|---|
| B | | 97 | | | |
| | Bɨ | 48 | bɨ̀l | 'trash' | 5 |
| | | | bɨ̀n mɨ̄n | 'my forehead' | 2 |
| | | | bɨ́nàn | 'okra' | 3 |
| | | | ɓɨ̀dɨ́l | 'one' | 3 |
| | | | ɓɨ̀l | 'hole' | 4 |
| | | | ɓɨ̀lál | 'speech' | 3 |
| | | | ɓɨ̀lāj | 'holes' | 1 |
| | | | mɨ̄lā | 'eye' | 1 |
| | | | mɨ̀lɨ̀ | 'stab (GERUND PL)' | 4 |
| | | | mɨ́n nɨ̀ | 'my eyes' | 1 |
| | | | mɨ́ná | 'thing' | 3 |
| | | | mɨ̄rā | 'cow' | 7 |
| | | | mɨ̄rgā | 'alcohol (PL)' | 1 |
| | | | mɨ́rííl | 'plant sp.' | 1 |
| | | | pɨ̄l | 'refuse (PL)' | 2 |
| | | | pɨ́r | 'catch' | 4 |
| | | | pɨ̀rɨ̀ | 'catch (GERUND)' | 1 |
| | | | mɨ̀ɨ̀rnǎŋ | 'curse (PL) us (INCL)' | 1 |
| | | | mɨ̀ɨ̀rnɨ̀rí | 'curse (PL) them' | 1 |
| | ɨB | 49 | ɗɨ̄b | 'forge' | 1 |
| | | | ɗɨ̄m | 'Bagirmi people' | 5 |
| | | | ɗɨ̀mɨ́l | 'Bagirmi' | 3 |
| | | | ɗɨ́b | 'hit' | 3 |
| | | | ɗɨ́bàn | 'hit it' | 1 |
| | | | ɗɨ̀bɨ̀ | 'hit (GERUND)' | 5 |
| | | | ɗɨ̄m | 'moor' | 1 |
| | | | ɗɨ̀mɨ̀ | 'moor (GERUND)' | 5 |
| | | | lɨ̀mɨ̀ | 'measure (GERUND)' | 3 |
| | | | nɨ̀bɨ̀ | 'smoke fish (GERUND PL)' | 1 |
| | | | nɨ̄mɨ̄n | 'salt' | 6 |
| | | | nɨ̀mɨ́r | 'my sister' | 1 |
| | | | sɨ̀mà | 'fishing net' | 4 |
| | | | tɨ́màn | 'its paw | 1 |
| | | | tɨ́már | 'his hand' | 2 |
| | | | tɨ́mɨ́ | 'hands' | 2 |
| | | | tɨ́mɨ́r | 'my hand' | 5 |
| U | | 1 | gɨ́nù | 'net sp. (PL)' | 1 |

*Table VII*
ɨ-words. (a) speaker KD; (b) speaker AK.

# Appendix C:
# *T*-test results

| | Hz | | ERB | | | | |
|---|---|---|---|---|---|---|---|
| condition | F2 | ΔF2 | F2 | ΔF2 | *t* | *df* | *p* |
| ə | 1598 | | 18.99 | | | | |
| ə/B__ | 1287 | −311 | 17.23 | −1.76 | −3.7 | 24.5 | 0.001** |
| ə/__B | 1417 | −181 | 18.04 | −0.95 | 2.1 | 19.9 | 0.049* |
| əB | 1342 | −256 | 17.57 | −1.42 | 3.4 | 21.5 | 0.003** |
| ə/__...U | 1426 | −172 | 18.10 | −0.89 | 2.0 | 18.0 | 0.059 |
| ɨ | 1635 | | 19.22 | | | | |
| ɨ/B__ | 1291 | −344 | 17.25 | −1.97 | −8.6 | 59.9 | $5.40\mathrm{e}^{-12}$*** |
| ɨ/__B | 1378 | −257 | 17.80 | −1.42 | 4.1 | 18.1 | $6.67\mathrm{e}^{-4}$*** |
| ɨB | 1306 | −329 | 17.35 | −1.87 | 8.5 | 56.0 | $1.10\mathrm{e}^{-11}$*** |

*Table VIII*
*T*-test results for speaker KD.

| | Hz | | ERB | | | | |
|---|---|---|---|---|---|---|---|
| condition | F2 | ΔF2 | F2 | ΔF2 | *t* | *df* | *p* |
| ə | 1583 | | 18.96 | | | | |
| ə/B__ | 1295 | −288 | 17.30 | −1.66 | −5.6 | 20.0 | $9.96\mathrm{e}^{-6}$*** |
| ə/__B | 1333 | −250 | 17.54 | −1.42 | 3.9 | 22.8 | $7.79\mathrm{e}^{-4}$*** |
| əB | 1304 | −279 | 17.35 | −1.61 | 5.9 | 18.0 | $1.54\mathrm{e}^{-5}$*** |
| ə/B__B | 1158 | −425 | 16.44 | −2.52 | 8.4 | 10.0 | $7.72\mathrm{e}^{-6}$*** |
| ə/__...U | 1473 | −110 | 18.38 | −0.58 | 1.7 | 13.7 | 0.12 |
| əB | 1304 | | 17.35 | | | | |
| ə/B__B | 1158 | −146 | 16.44 | −0.91 | −4.1 | 4.7 | 0.011* |
| ɨ | 1688 | | 19.49 | | | | |
| ɨ/B__ | 1281 | −407 | 17.24 | −2.25 | −14.6 | 79.7 | $2.20\mathrm{e}^{-16}$*** |
| ɨ/__B | 1292 | −396 | 17.29 | −2.20 | 12.5 | 87.7 | $2.20\mathrm{e}^{-16}$*** |
| ɨB | 1287 | −401 | 17.27 | −2.22 | 15.4 | 75.0 | $2.20\mathrm{e}^{-16}$*** |

*Table IX*
*T*-test results for speaker AK.

## Appendix D:
## Box plots and vowel plots

Figures 11–14 contain box plots and vowel plots for the collapsed [əB] and [ɨB] categories for the data in Figs. 3, 4, 6 and 7 in the paper.
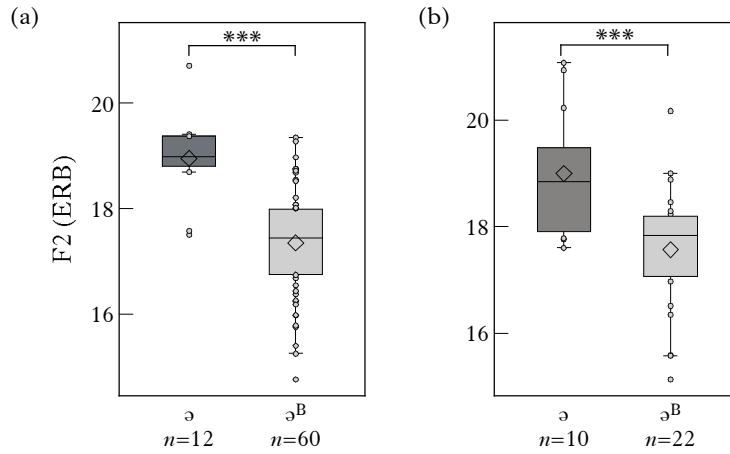


*Figure 11*
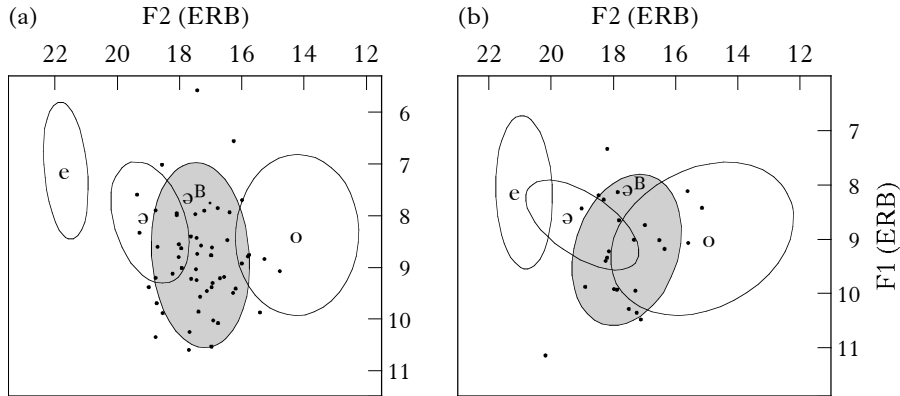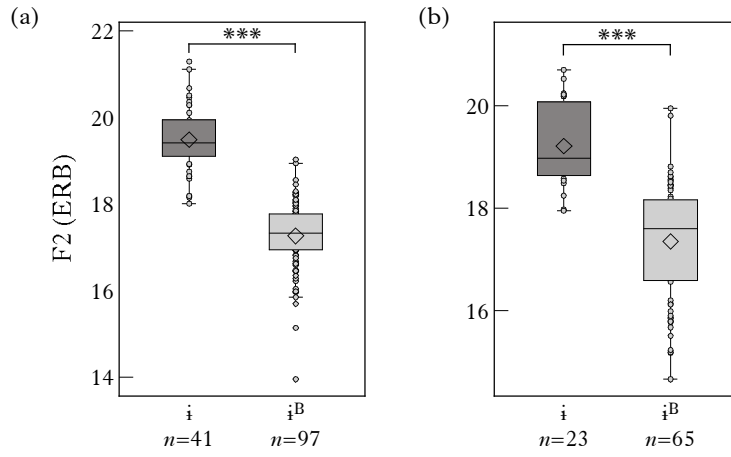Overall effect of B condition on F2 of [ə]: (a) speaker AK; (b) speaker KD.



*Figure 12*
[əB] (= [ə]/B __ and [ə]/__B) plotted against [e], [ə] and [o]:
(a) speaker AK; (b) speaker KD.

*Figure 13*

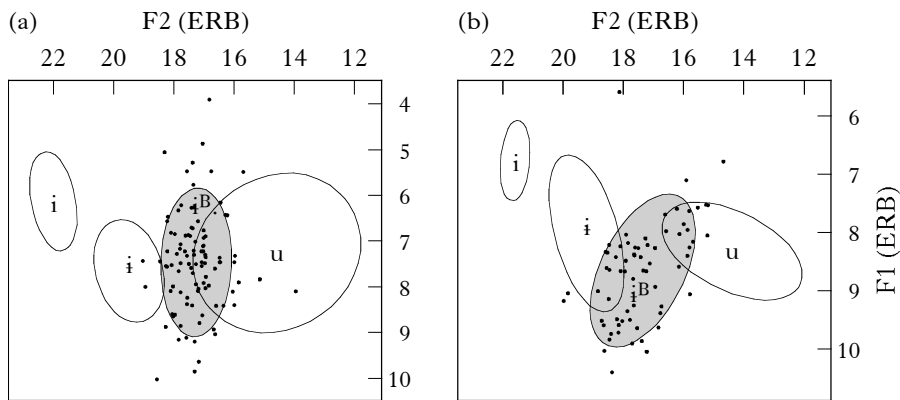Overall effect of B condition on F2 of [ɨ]: (a) speaker AK; (b) speaker KD.



*Figure 14*

[ɨᴮ] (= [ɨ]/B __ and [ɨ]/__ B) plotted against [i], [ɨ] and [u]:
(a) speaker AK; (b) speaker KD.