Typological Asymmetries in Underapplication Opacity: A Gestural Account

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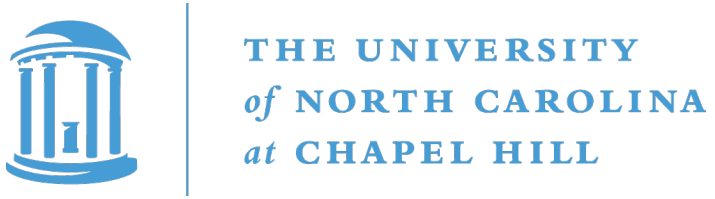
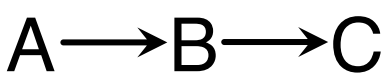
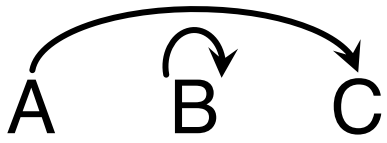


Introduction

- **Underapplication opacity** (McCarthy 1999, Baković 2007, 2011): phonological process does not occur when it 'should have' based on its structural description

- **Chain shifts** and **saltations** are both types of underapplication opacity





Introduction

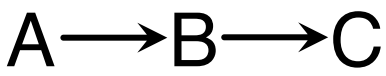
- Both are difficult to capture in output-oriented Optimality Theory (Kirchner 1996, McCarthy 1999, Tesar 2013, a.m.o.) and Harmonic Grammar (Albright et al. 2008, Hayes & White 2015)
  - Chain shift: If /A/ → [B] and /B/ → [C], why not /A/ → B → [C]?
  - Saltation: If /A/ → B → [C], why not /B/ → [C]?

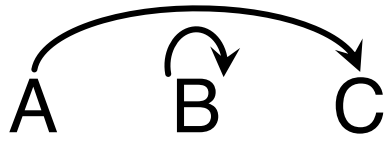
- Both are attested among vowel- and consonant-manipulating phonological patterns, albeit in typologically asymmetrical ways

- Today: examining typological asymmetries in **consonant lenition** patterns exhibiting underapplication opacity

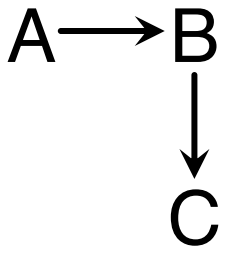
Proposals

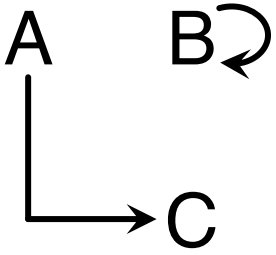
- Proposal: Chain shifts and saltations can be characterized as one-dimensional or two-dimensional
- **One-dimensional** (1D) processes involve changes along single phonological dimension (e.g. consonant stricture, vowel height)





- **Two-dimensional** (2D) processes involve changes along two phonological dimensions (e.g. consonant stricture and voicing)





Proposals

- Typological asymmetry in opaque consonant lenition patterns:
  - Both 1D and 2D chain shifting consonant lenition patterns are attested
  - Attested saltatory consonant lenition patterns are all **2D**

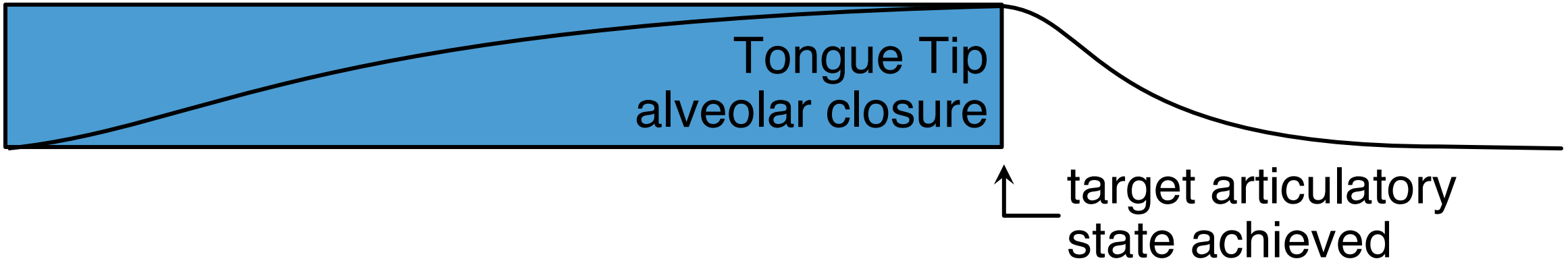
- Proposal: distinct representations of 1D and 2D consonant lenition processes in **gestural phonology** (Browman & Goldstein 1986, 1989, et seq.) predict lack of attestation of 1D saltation

Gestural Phonology

Gestures in Articulatory Phonology

(Browman & Goldstein 1986, 1989 et seq.)

- **Gestures**: dynamically-defined, goal-based units of phonological representation in Articulatory Phonology

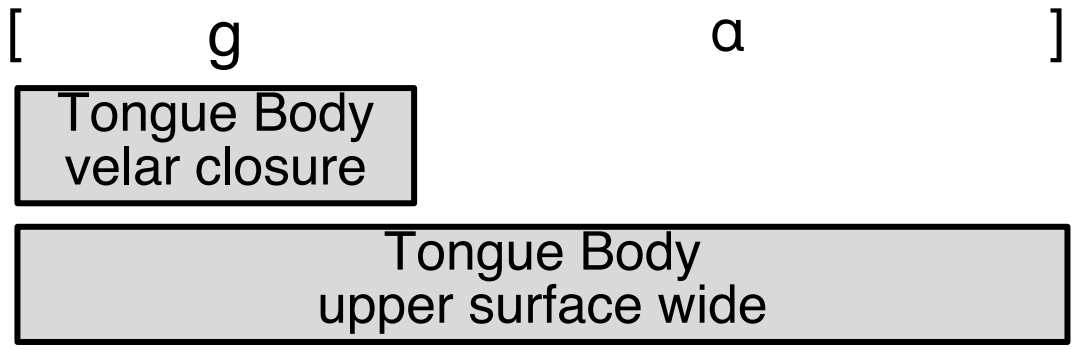


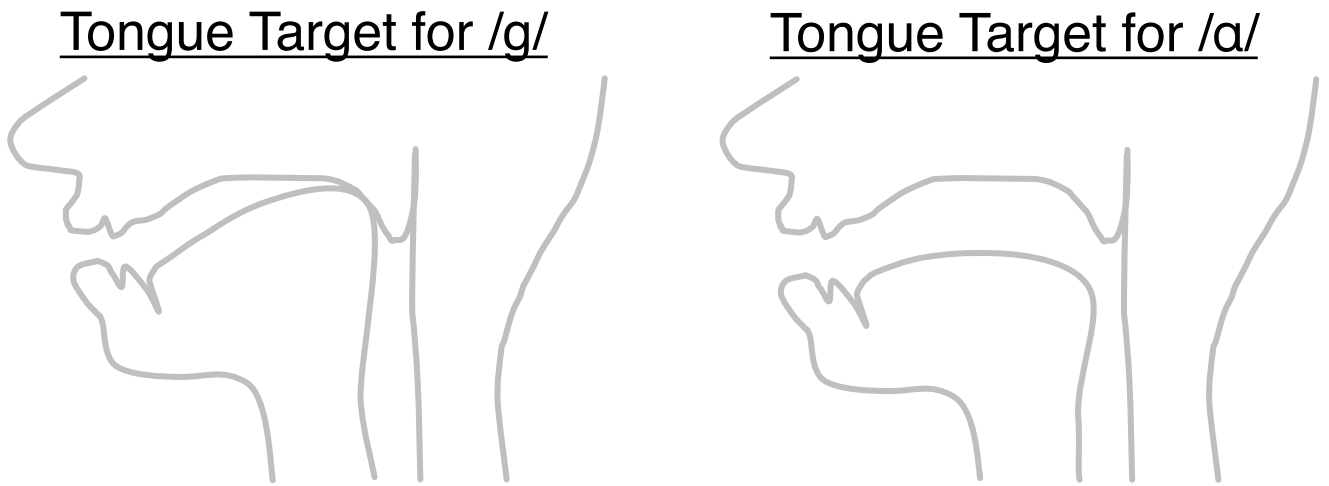
- While gesture is active, vocal tract articulator attempts to achieve specified target state
- Blending strength (α): ability to command vocal tract articulators

Gestural Blending Between Consonants and Vowels

- Consonant gestures are usually significantly temporally overlapped by surrounding vowel gestures

- Gestural overlap often places articulatory states in conflict with one another





Gestural Strength and Blending

- **Antagonistic** gestures: gestures with conflicting target articulatory states

- Antagonism resolved by **blending** target articulatory states of concurrently active gestures according to Task Dynamic Model of speech production (Saltzman & Munhall 1989, Fowler & Saltzman 1993)

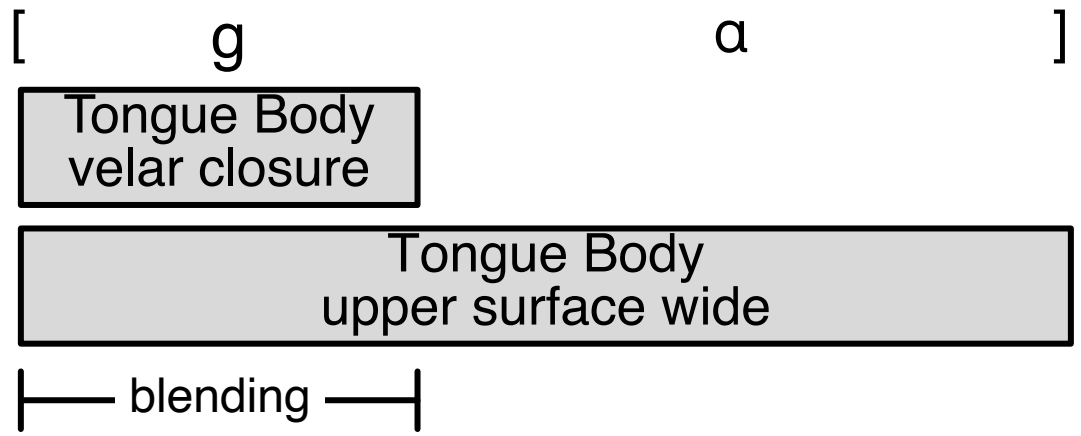
$$\frac{\text{Target}_1 * \alpha_1 + \text{Target}_2 * \alpha_2}{\alpha_1 + \alpha_2} = \text{Blended Target}$$

Gestural Overpowering
(Smith & O'Hara 2021)

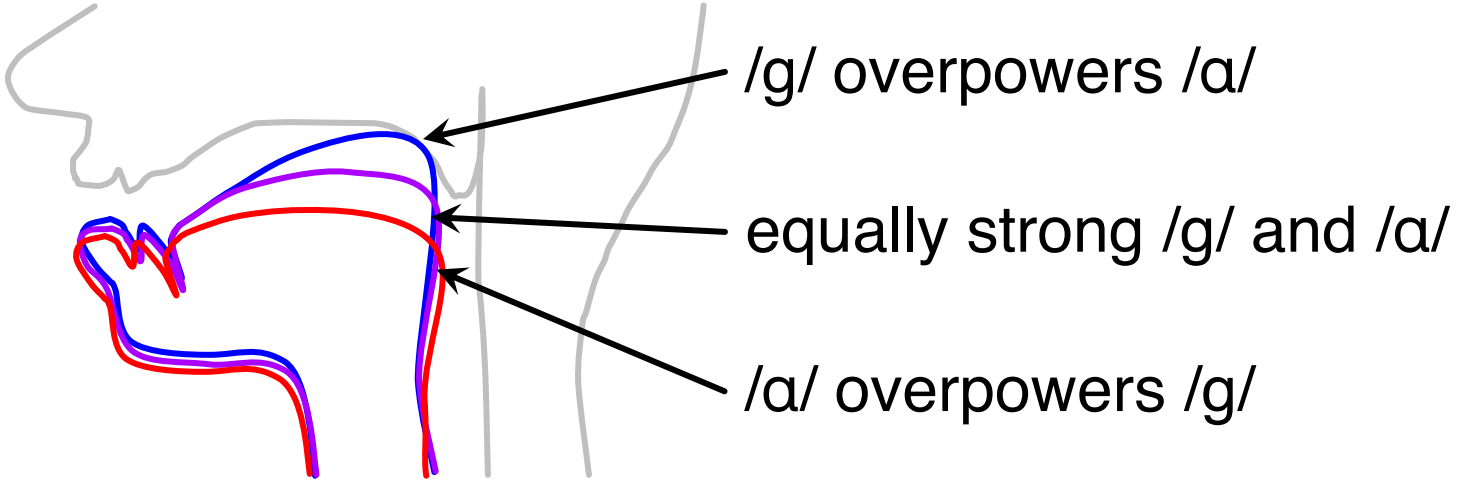
- When gestural strengths are roughly equal, blending produces intermediate target articulatory states
- Triggering full assimilation and resisting full assimilation depend on **overpowering** relationships between blended gestures:
  - For assimilation of X to Y, Y's gestural strength must be order of magnitude higher than that of X
  - For Z to resist assimilation to Y, Z's gestural strength must be order of magnitude higher than that of Y

$$Z_{100} \mapsto Y_{10} \mapsto X_{1}$$

Gestural Blending Between Consonants and Vowels



Blended tongue target for /g/ and /ɑ/

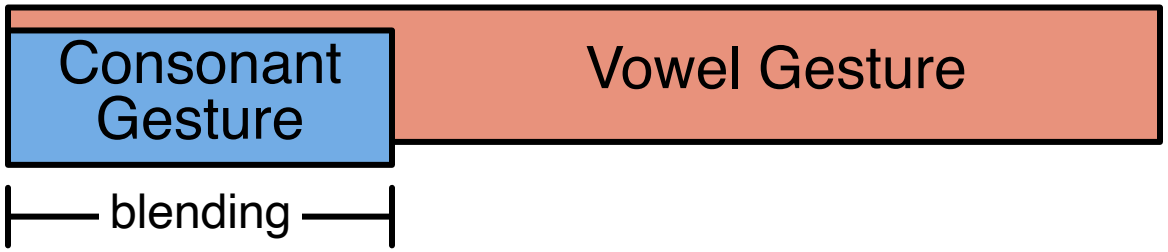


With different relative strength values, different outcomes of consonant-vowel overlap and blending can be achieved

Analysis: 2D Underapplication via Gestural Blending

Gestural Analysis of Lenition

- Lenition is result of overlap and blending between consonant and vowel gestures



- Phonological grammar (not pictured) determines that:
  - In prosodically strong positions, stops surface with high gestural strength and are not susceptible to lenition
  - In prosodically weak positions, stops surface with their intrinsic gestural strengths and are potentially susceptible to lenition via gestural blending

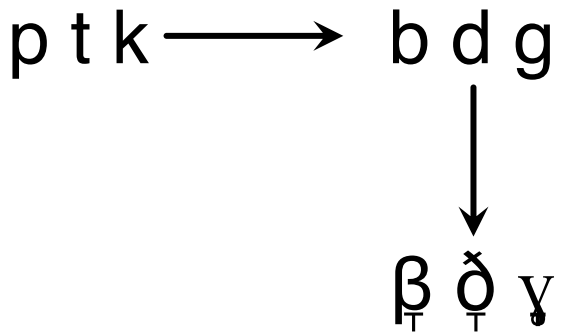
Gran Canarian Spanish

(Romance; Canary Islands, Spain; Broś 2016, Broś & Lipowska 2019, Broś et al. 2021)

- Voiceless and voiced stops contrast word-initially

- Post-vocalically, stops lenite:
  - Voiceless stops /p t k/ → voiced stops [b d g]
  - Voiced stops /b d g/ → approximants [β̞ ð̞ ɣ̞]

[plaja]	[lablaja]	‘beach’
[taro]	[dedaro]	‘jar’
[kama]	[lagama]	‘bed’
[bɾoŋka]	[unaβ̞ɾoŋka]	‘fight’
[dama]	[lað̞ama]	‘lady’
[gama]	[laɣ̞ama]	‘range’



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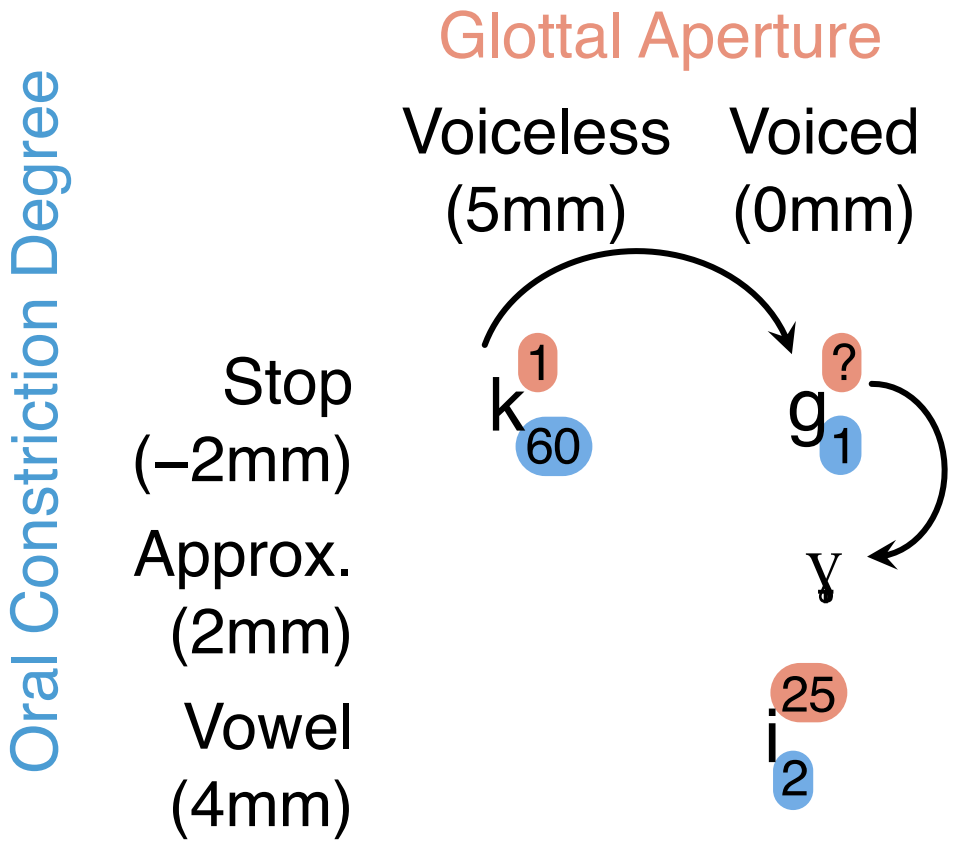
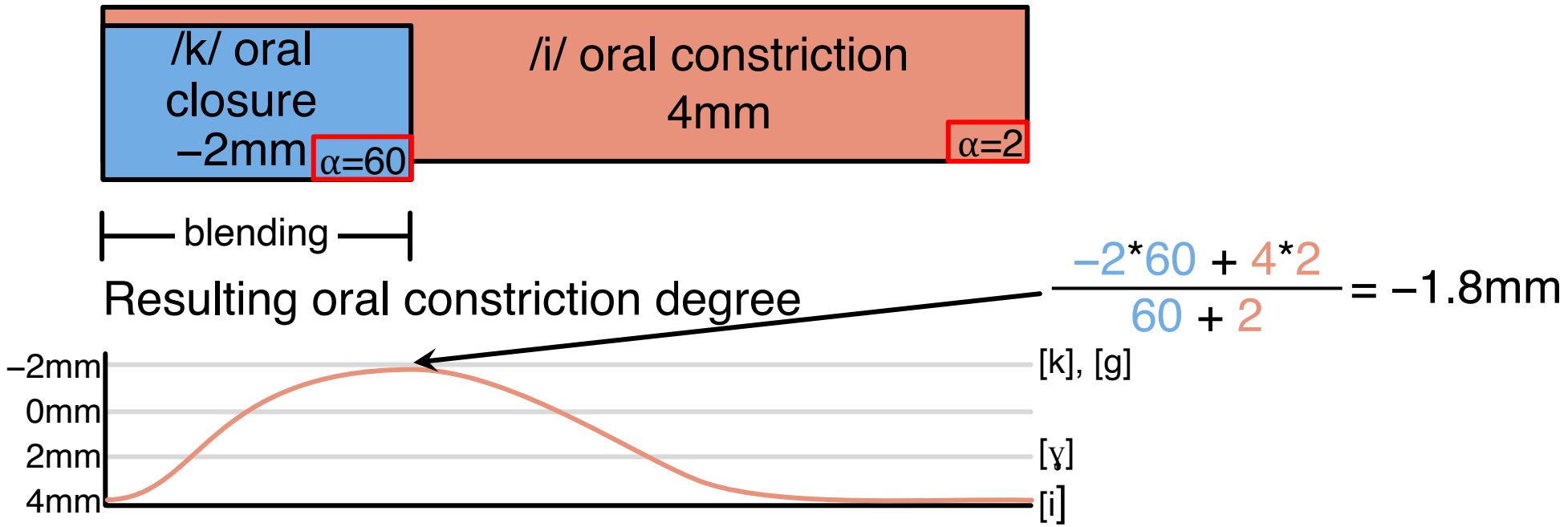


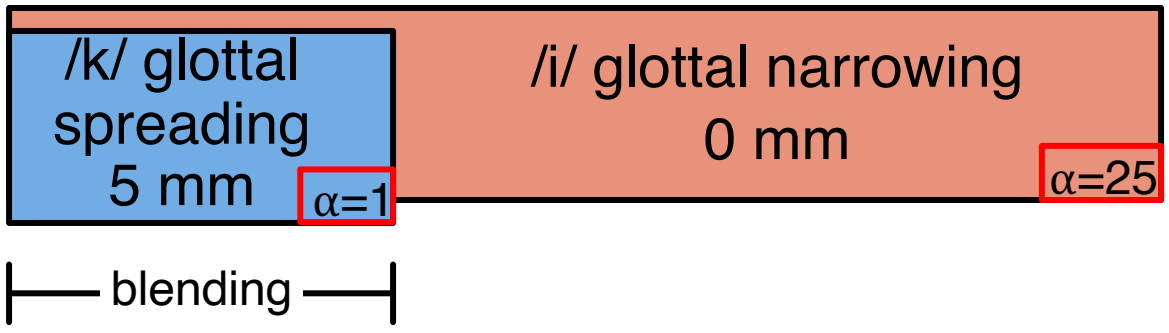
Gran Canarian Spanish: /k/→[g]

- In weak positions, /k/ remains a stop in order to surface as [g]
- Oral constriction degree of /k/ does not change, so the strength of /k/'s oral gesture must **overpower** that of overlapping vowel /i/



Gran Canarian Spanish: /k/→[g]

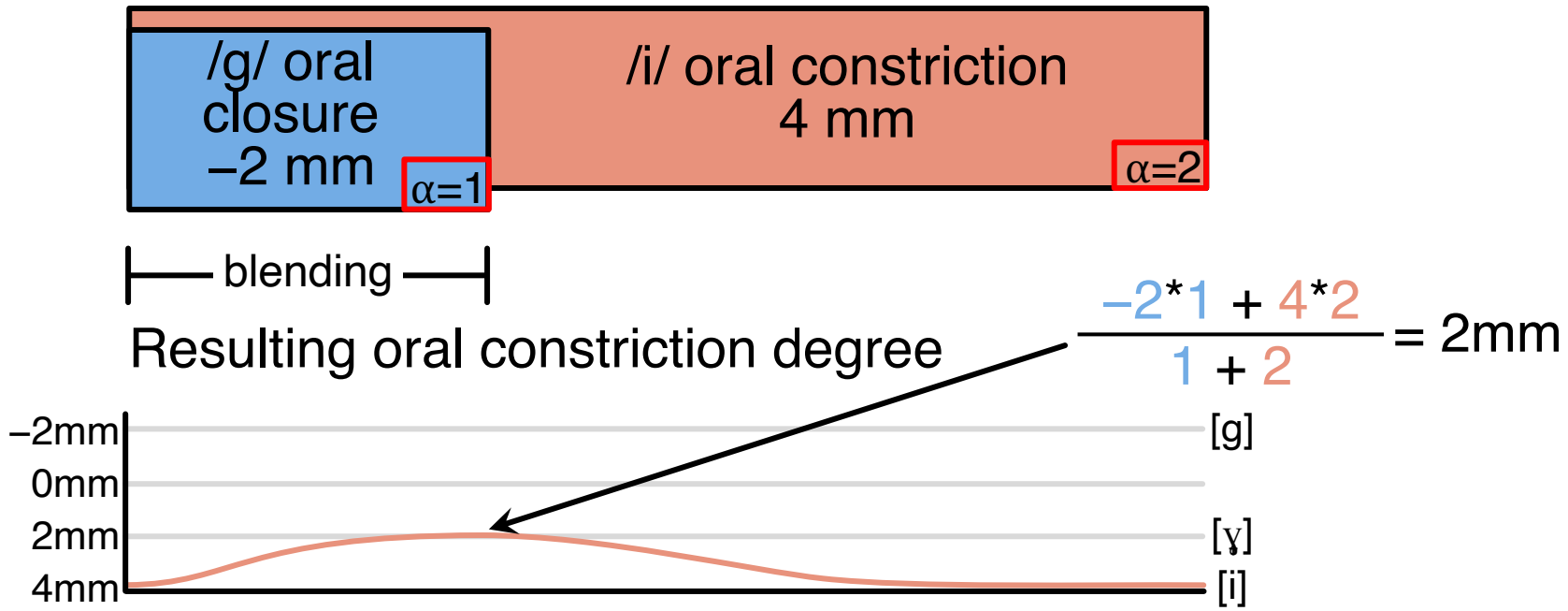
- In weak positions, /k/ voices to become [g]
- To undergo voicing, glottal narrowing gesture of vowel /i/ must overpower glottal spreading gesture of voiceless stop /k/



Resulting oral constriction degree

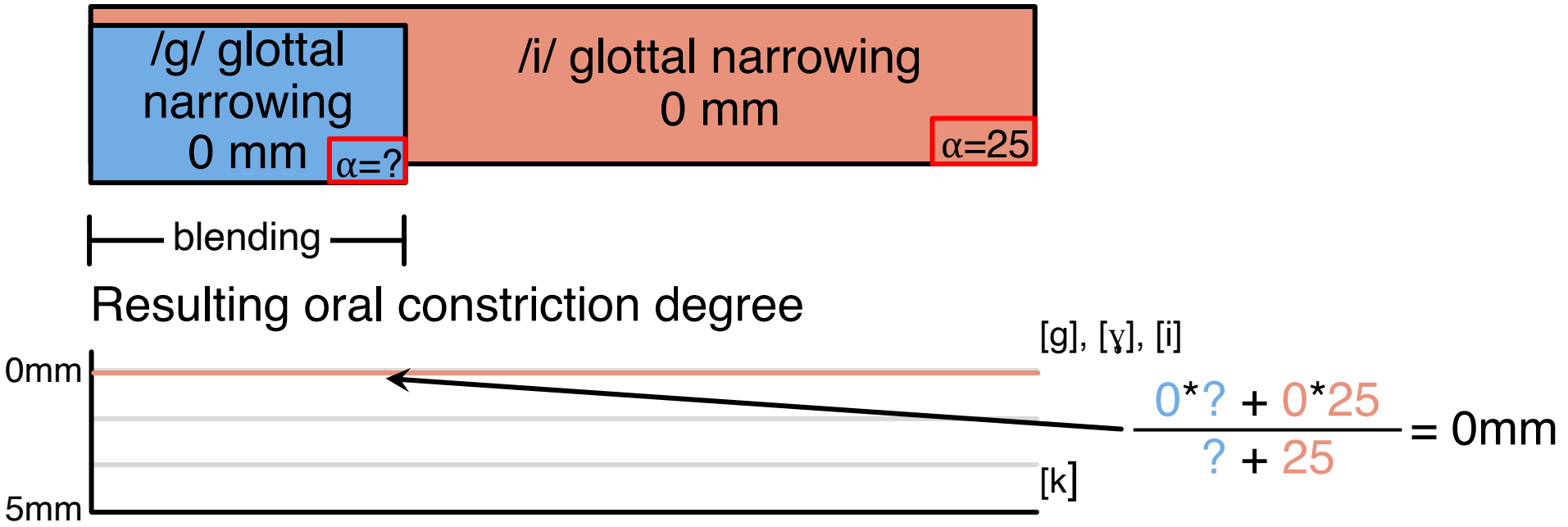
Gran Canarian Spanish: /g/→[ɣ̞]

- In weak positions, voiced stop /g/ lenites to approximant [ɣ̞]
- Voiced stop partially matching openness of /i/ due to oral gesture half as strong as that of vowel



Gran Canarian Spanish: /g/→[ɣ̞]

- In weak positions, voiced stop /g/ lenites to approximant [ɣ̞]
- Glottal gestures of /g/ and /i/ are not antagonistic, so /g/'s glottal gesture need not be high strength



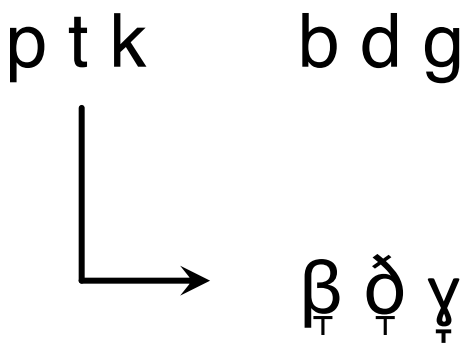
Campidanian Sardinian

(Romance; Sardinia, Italy; Bolognesi 1998, Hayes & White 2015, Katz & Pitzanti 2019)

- Voiceless and voiced stops contrast word-initially

- Intervocalically, voiceless stops lenite:
  - Voiceless stops /p t k/ → approximants [β̞ ð̞ ɣ̞]
  - Voiced stops /b d g/ remain voiced stops

[piʃːi]	[belːuβ̞iʃːi]	‘nice fish’
[trintaduzu]	[sːuð̞rintaduzu]	‘the thirty-two’
[kuatːru]	[dɛɣ̞uatːru]	‘of four’
[bĩu]	[sːubĩu]	‘the wine’
[dominiɣu]	[donːjadominiɣ̞u]	‘every Sunday’
[gɔma]	[dɛgɔma]	‘of rubber’



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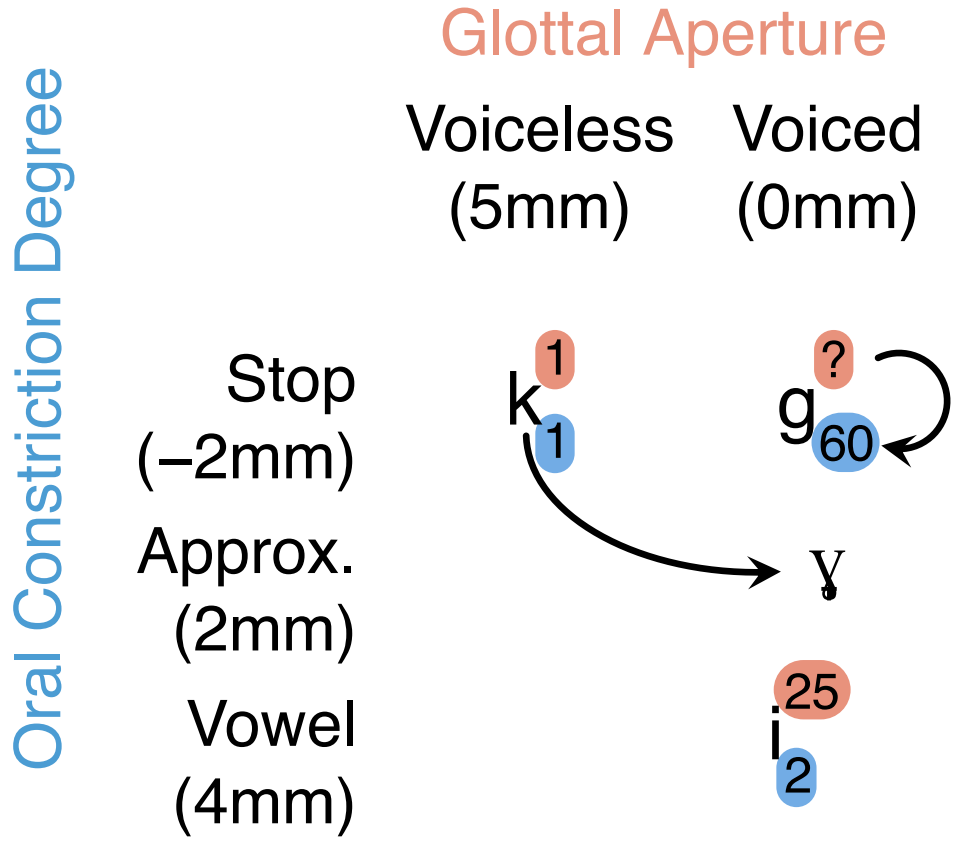
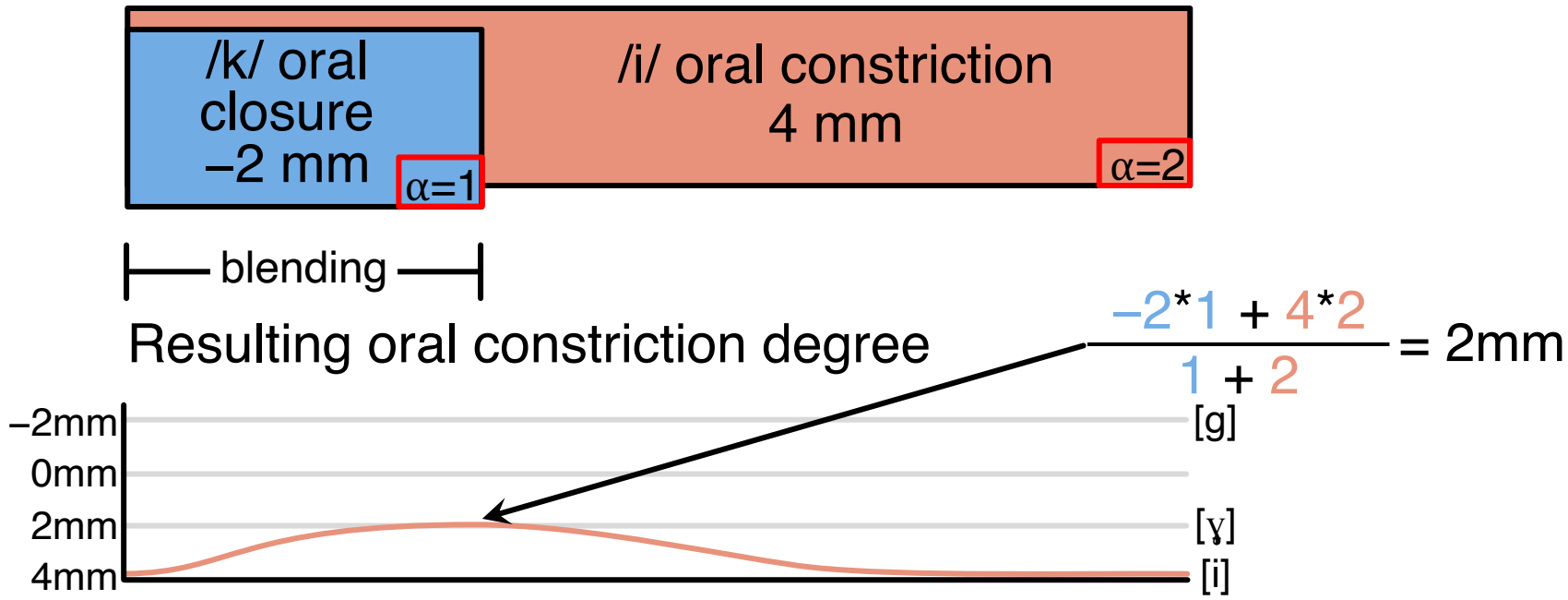


Campidanian Sardinian: /k/→[ɣ̞]

- In weak positions, /k/ voices and lenites to surface as [ɣ̞]
- To undergo approximantization, strength of /k/'s oral gesture must be half that of vowel /i/



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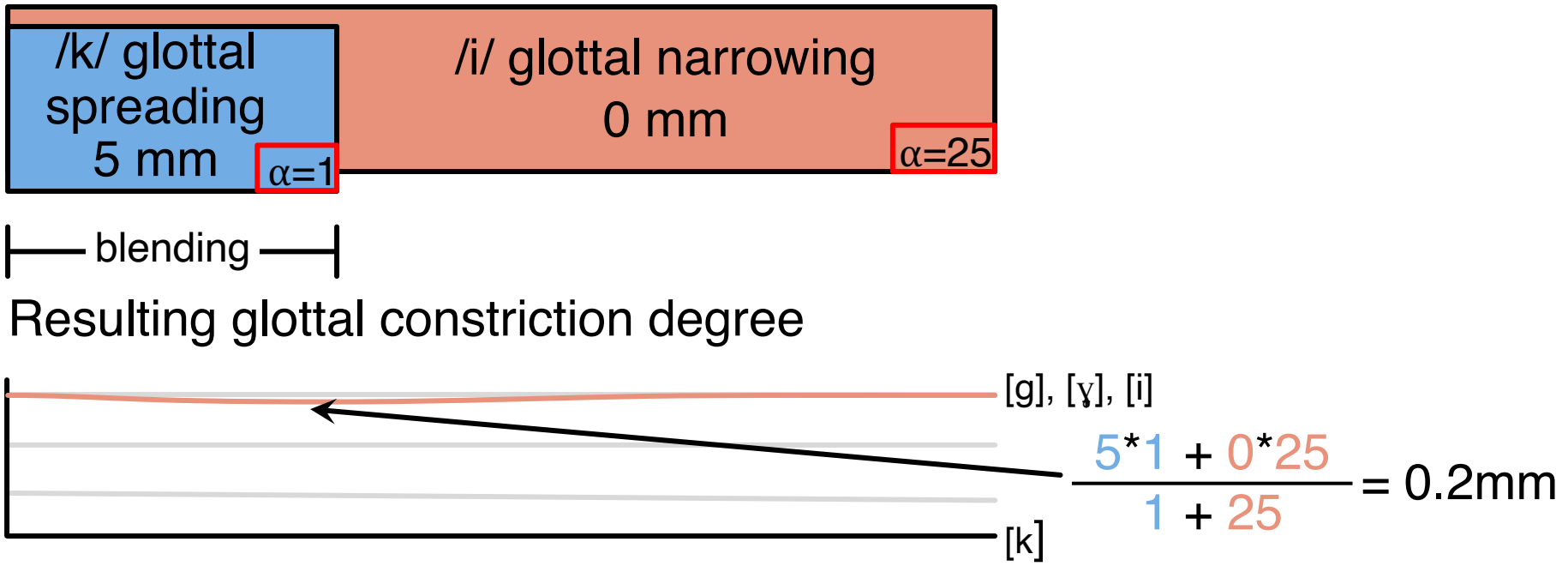

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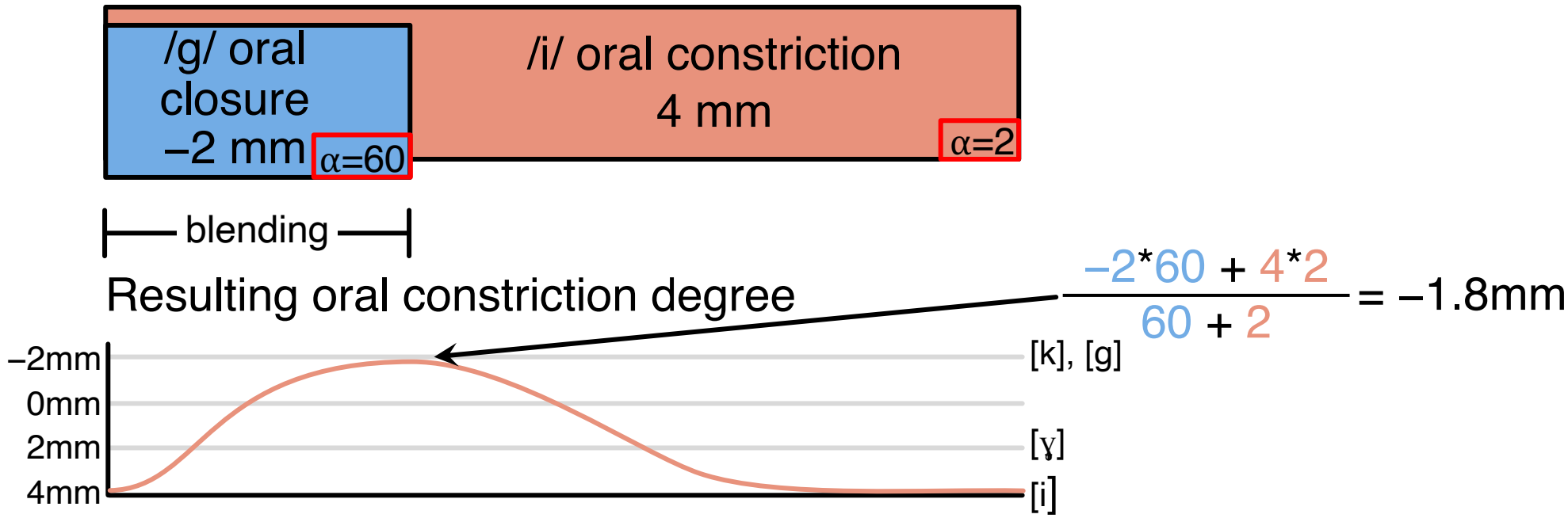

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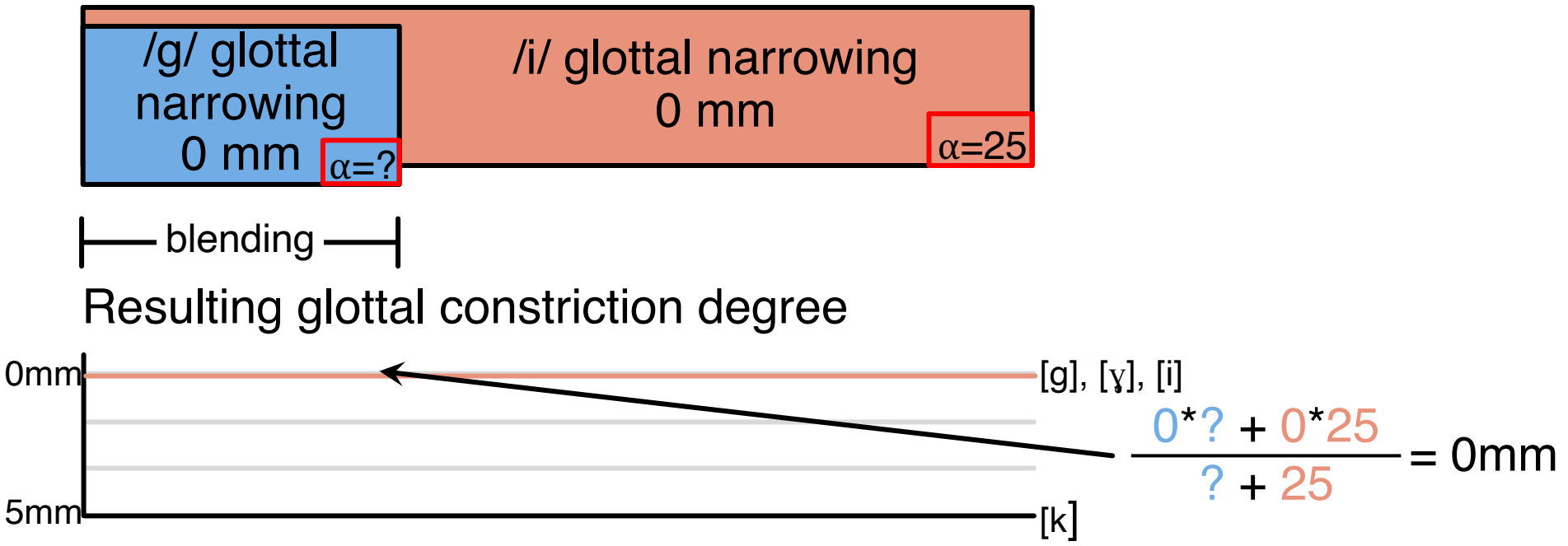
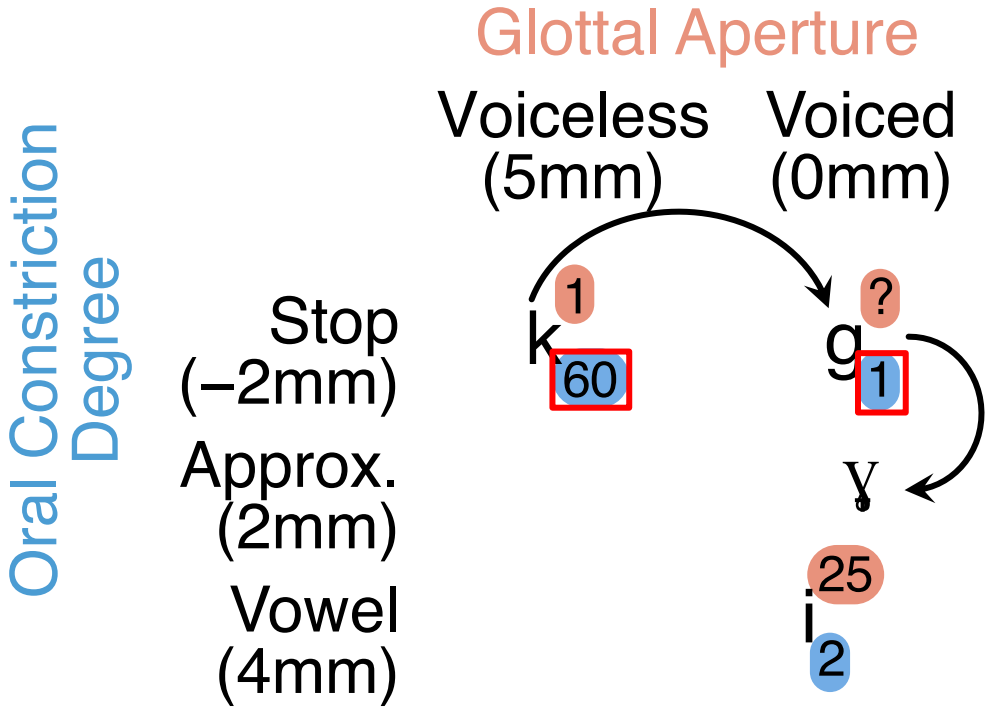
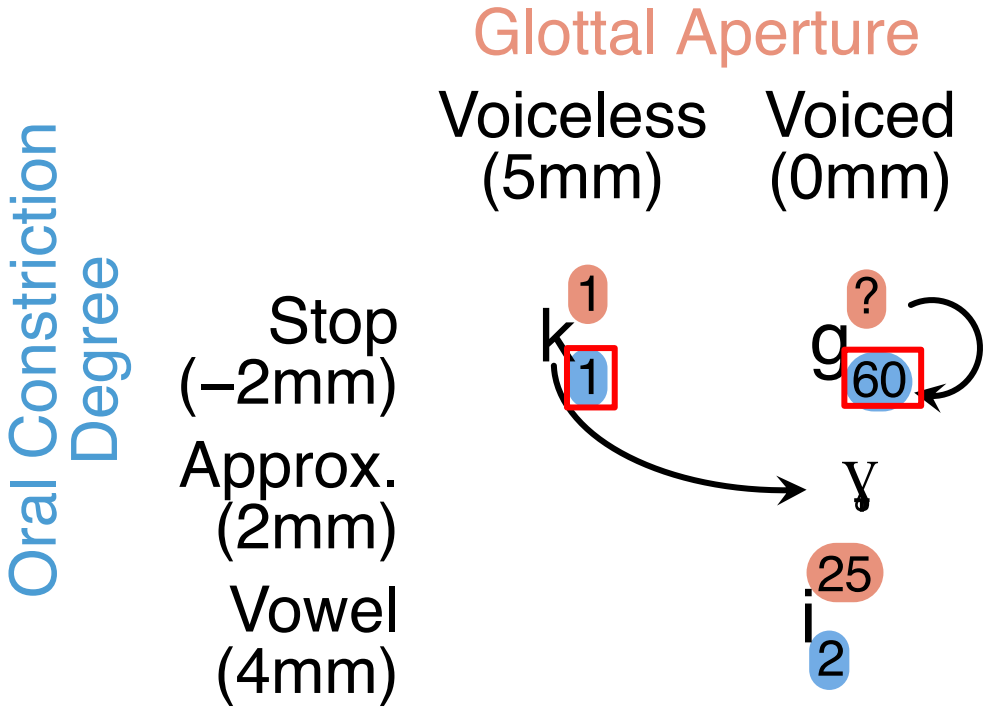


Comparing 2D Chain Shifting and Saltatory Consonant Lenition

- Set of gestural strengths necessary to derive chain shifting and saltatory voicing + approximantization (2D) lenition are symmetrical
- In both patterns, weak stop series approximantizes while strong stop series resists





Analysis: 1D Underapplication via Gestural Blending

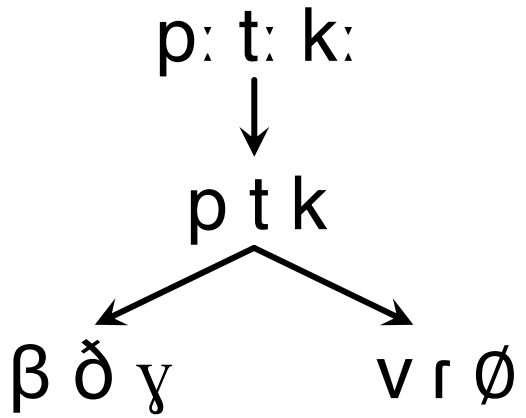
Finnish and Proto-Finnic

(Finno-Ugric; Finland; Hakulinen 1961, Duncan 2010, Beesley & Kartunnen 2003)

Consonant gradation in onsets of closed syllables:

- Geminate stops /pː tː kː/ → singleton stops [p t k]
- Modern Finnish: singleton stops /p t k/ → [v ɾ ∅] (mostly)
- Proto-Finnic: singleton stops /p t k/ → [β ð ɣ]

Partitive	Genitive	
[ripaː]	[rivan]	‘handle’
[sotaː]	[soran]	‘war’
[likaː]	[lian]	‘dirt’
[tipːaː]	[tipan]	‘drop’
[rotːaː]	[rotan]	‘rat’
[tukːaː]	[tukan]	‘hair’



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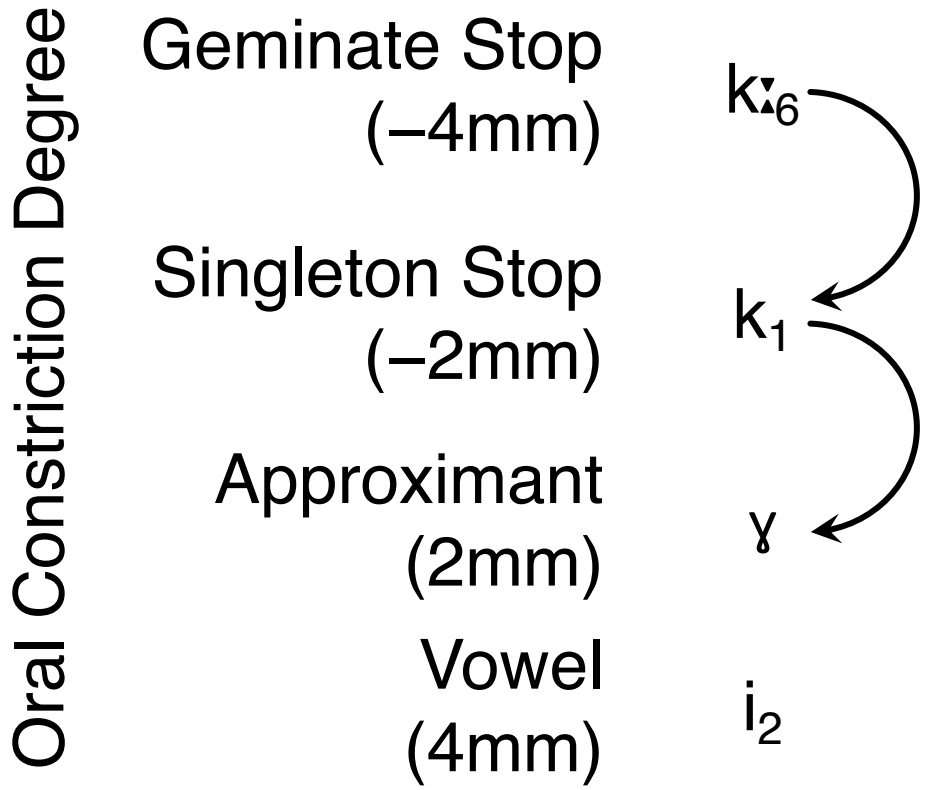
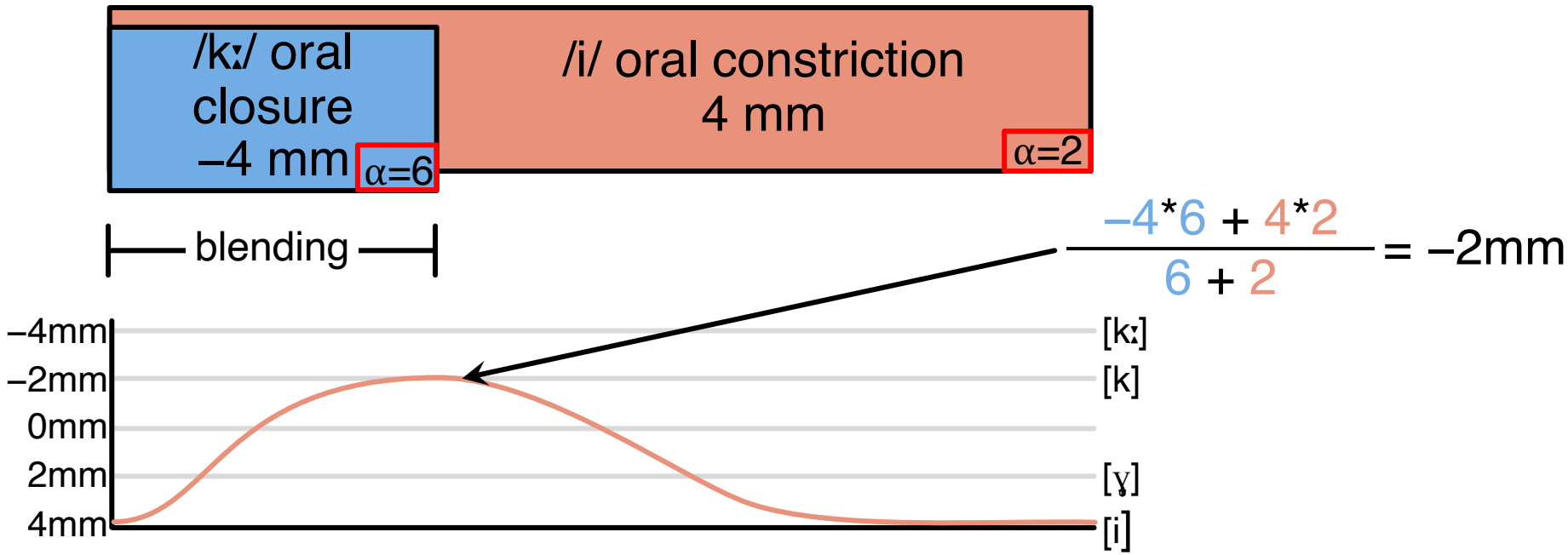


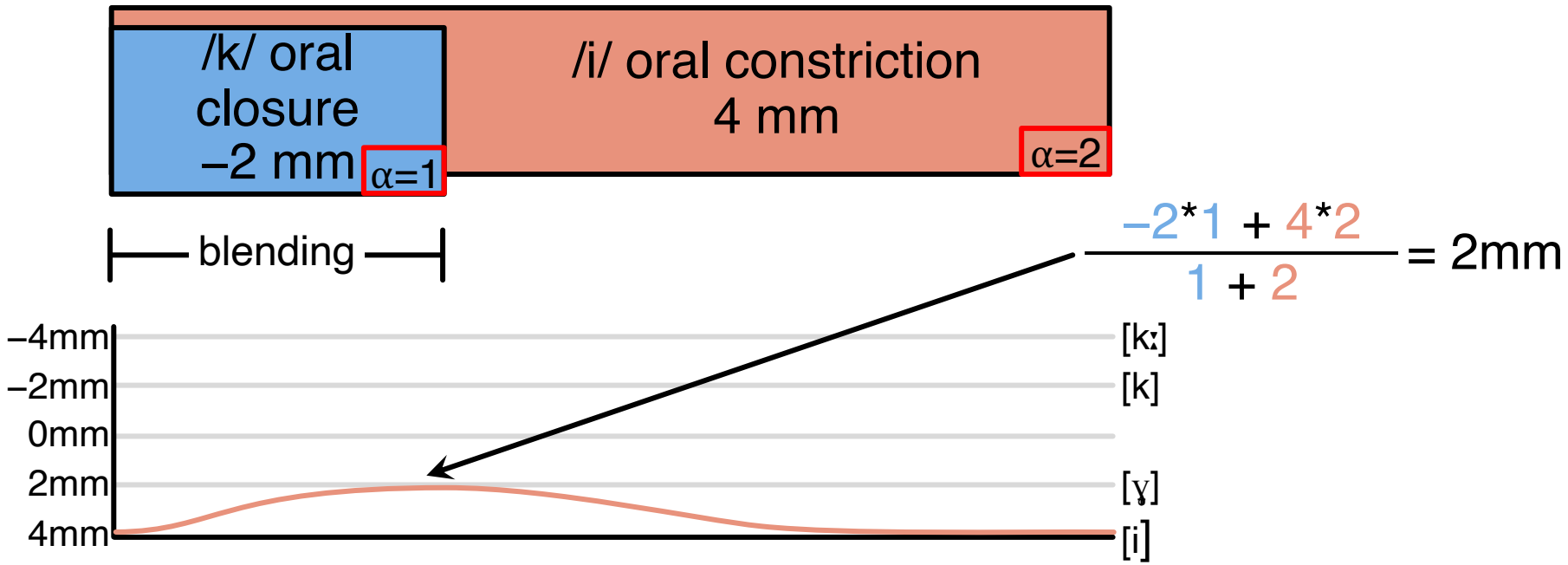
Proto-Finnic: /kː/→[k]

- In weak positions, /kː/ degeminates to surface as [k]
- Blending oral constriction gestures of /kː/ and /i/ mostly favors target state of /kː/ due to greater (but not overpowering) strength

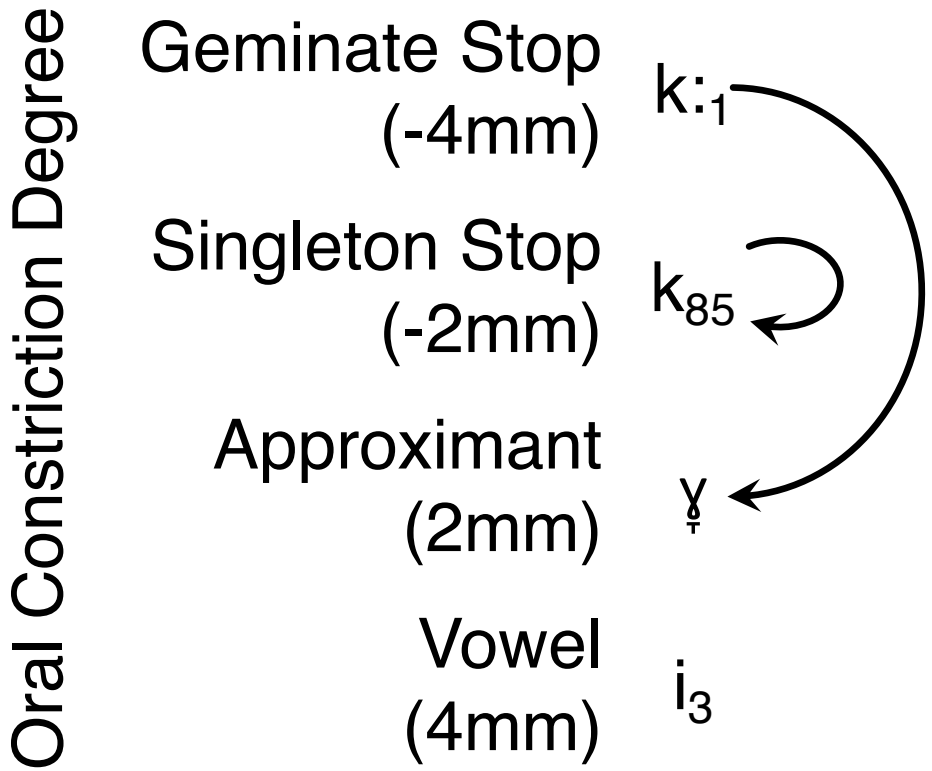


Proto-Finnic: /k/→[ɣ̥]

- In weak positions, /k/ lenites to surface as [ɣ̥]
- Blending oral constriction gestures of /k/ and /i/ mostly favors target state of /i/ due to greater (but not overpowering) strength



What About Unattested 1D Saltation?

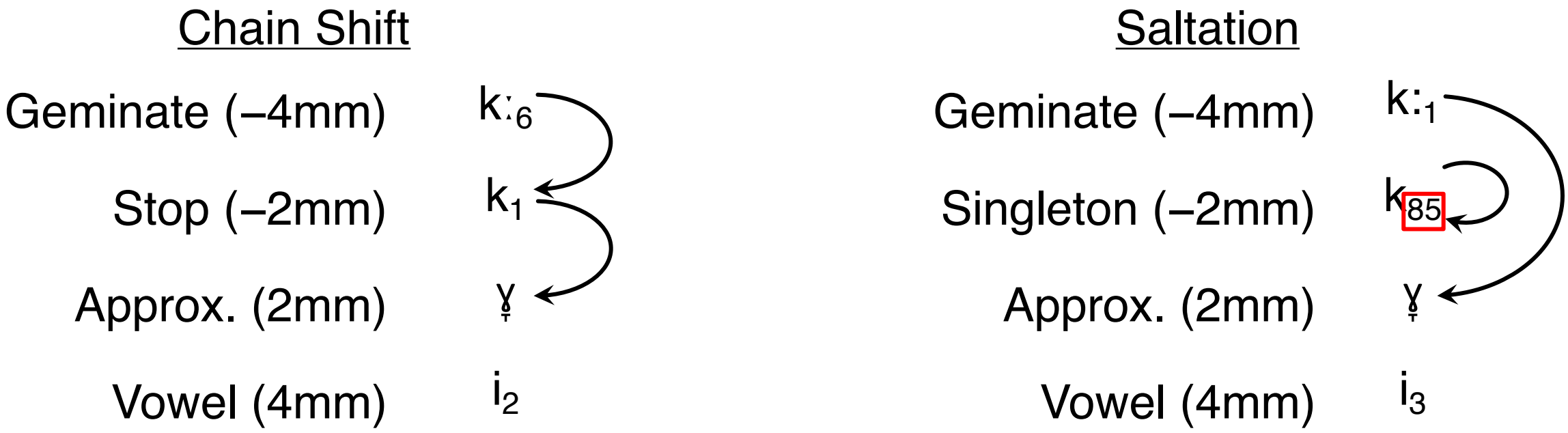


With more extreme strengths, saltatory 1D lenition can also be generated:

- Geminate /kː/ lenites to fricative [ɣ̞] when overlapped by vowel with somewhat stronger oral constriction gesture
- Voiceless stop /k/ fully resists assimilation to the vowel by overpowering its oral constriction gesture

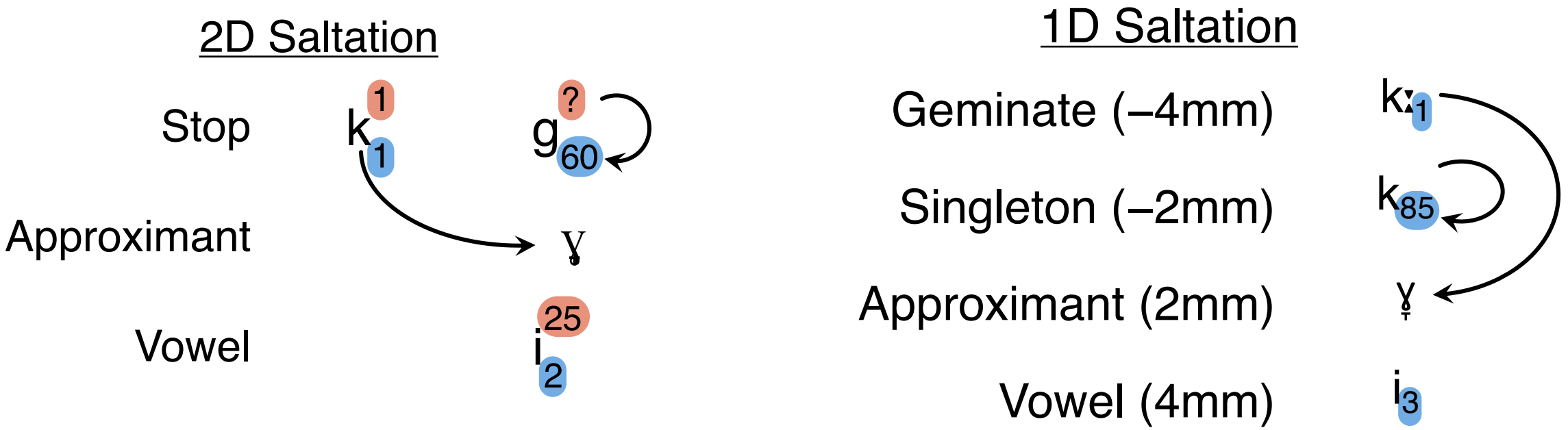
Comparing 1D Processes

- 1D chain shifting lenition does not require high gestural strengths
- 1D saltatory lenition requires /k/ to **overpower** /i/ in order to completely resist lenition
- Result: higher maximum strength for 1D saltation



Beyond Overpowering Chains

- 2D processes and 1D saltation have similar number of overpowering relationships, but 1D saltation requires higher gestural strengths
- In both 1D saltation and 2D chains, singleton stops must overpower /i/
- In 1D saltation, /i/ must be stronger to cause lenition of geminate stops, resulting in singleton stop strength being even greater to overpower it



Typology of Derivationally Opaque Consonant Processes

- Patterns requiring more extreme gestural strengths are harder to learn than those requiring less extreme strengths (Smith & O'Hara 2021)
- Harder-to-learn patterns are predicted to be less typologically frequent

	Chain Shift	Saltation
1D	max(α)=6 Finnish Irish Florentine Italian Polish	max(α)=85 **Unattested**
2D	max(α)=60 Gran Canarian Spanish Danish Kayardild Mwera	max(α)=60 Campidanian Manga Kanuri German Polish

Conclusion

- Chain-shifting and saltatory cases of underapplication opacity can be characterized as either one-dimensional or two-dimensional
- Assuming gestural phonological representations, 2D chain shifts and saltations are represented similarly, but their 1D counterparts are not
- 1D saltations require more extreme gestural strengths and are therefore expected to be harder to learn than other opaque patterns
- 1D saltation patterns appear to be unattested across both vowel and consonant processes, including consonant lenition

References

Albright, Adam, Magri, Giorgio, & Michaels, Jennifer (2008) Modeling Doubly Marked Lags with a Split Additive Model. In H. Chan, H. Jacob, & E. Kapia (Eds.), *Proceedings of the 32nd Annual Boston University Conference on Language Development* (pp. 36–47). Cascadilla Press.

Baković, Eric (2007) A revised typology of opaque generalisations. *Phonology*, 24, 217–259.

Baković, Eric (2011) Opacity and Ordering. In J. Goldsmith, J. Riggle, & A. C. L. Yu (Eds.), *The Handbook of Phonological Theory* (Second Edition, pp. 40–67). Blackwell Publishing.

Beesley, Kenneth R. and Karttunen, Lauri (2003) *Finite State Morphology.* Stanford, CA: CSLI Publications

Bolognesi, Roberto (1998) *The phonology of Campidanian Sardinian: a unitary account of a self-organizing structure*. PhD dissertation, University of Amsterdam.

Broś, Karolina (2016) Between phonology and morphosyntax: voicing and spirantisation in the Spanish of Gran Canaria. In: Jolanta Szpyra-Kozłowska and Eugeniusz Cyran (ed.), *Phonology, its Faces and Interfaces. Series: Sounds – Meaning – Communication.* 173-200. Peter Lang.

Broś, Karolina, & Lipowska, Katarzyna (2019) Gran Canarian Spanish non-continuant voicing: gradiency, sex differences and perception. Phonetica. Special Issue on Constancy and Variation in Speech 76 (2-3), 100-125.

References

Broś, Karolina, Żygis, Marzena, Sikorski, Adam and Wołłejko, Jan (2021) Phonological contrasts and gradient effects in ongoing lenition in the Spanish of Gran Canaria. *Phonology* 38(1), 1-40.

Browman, Catherine P., & Goldstein, Louis (1986) Towards an Articulatory Phonology. *Phonology Yearbook*, 3, 219–252.

Browman, Catherine P., & Goldstein, Louis (1989) Articulatory gestures as phonological units. *Phonology*, 6(2), 201–251.

Duncan, Liisa (2010) Consonant Gradation in Finnish Dialects. *Toronto Working Papers in Linguistics*. Retrieved from https://twpl.library.utoronto.ca/index.php/twpl/article/view/13655

Fowler, Carol A, & Saltzman, Elliot (1993) Coordination and Coarticulation in Speech Production. *Language and Speech*, *36*, 171–195.

Hakulinen, L. (1961) *The Structure and Development of the Finnish Language*. Bloomington: Indiana University Publications.

Hayes, Bruce and White, James (2015) Saltation and the P-map. *Phonology,* 32, 267-302.

Katz, Jonah & Pitzanti, Gianmarco, (2019) The phonetics and phonology of lenition: A Campidanese Sardinian case study, *Laboratory Phonology* 10(1), p.16.

References

Kirchner, Robert (1996) Synchronic Chain Shifts in Optimality Theory. *Linguistic Inquiry*, *27*(2), 341–350.

McCarthy, John J. (1999) Sympathy and phonological opacity. *Phonology*, *16*, 331–399.

Saltzman, Elliot, & Munhall, Kevin G. (1989) A Dynamical Approach to Gestural Patterning in Speech Production. *Ecological Psychology*, *1*(4), 333–382.

Smith, Caitlin, & O'Hara, Charlie (2021) Learnability of derivationally opaque processes in the Gestural Harmony Model. In *Proceedings of the Society for Computation in Linguistics: Vol. 4* (pp. 396–400).

Tesar, Bruce (2013) *Output-Driven Phonology: Theory and Learning*. Cambridge University Press.