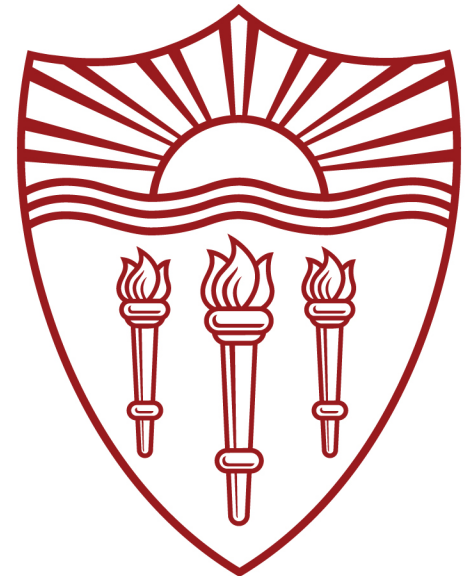


Deriving Apparent Exceptionality from Contrastive Gestural Strength

Strength in Grammar
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Introduction

- Exceptionality: two versions of same sound participate in phonological processes in different ways
- Example: exceptional application of palatalization

$/ti/_{1} \rightarrow [ci]$

$/ti/_{2} \rightarrow [ti]$

Dealing with Exceptionality

Contrast between /ti/₁ and /ti/₂ may be based on:

- Differences in underlying feature (under-)specification
- Morpheme/segment indexation (Pater 2000, 2009)
- Differences in activation level (Smolensky & Goldrick 2016)

Proposal:
Contrastive *gestural strength*
is responsible for cases of
apparent exceptionality

Advantages of Gestural Analysis of Apparent Exceptionality

- Gestural strength parameter setting is non-abstract; no derivational opacity
- Provides unified account of multiple exceptional processes in same language
- Gradient strength parameter setting provides account of processes in which segments undergo to intermediate degrees

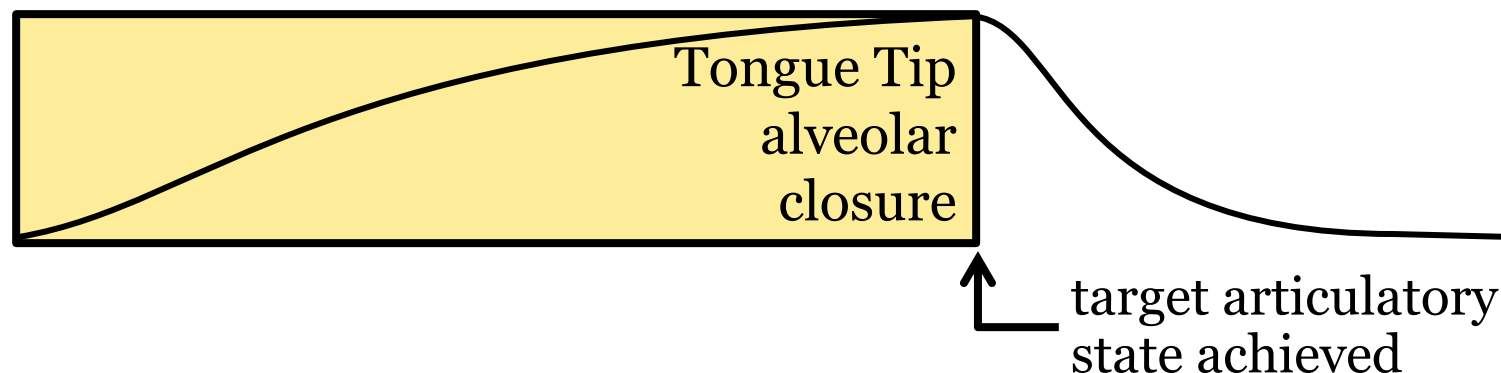
Overview

- Introduction to gestures and gestural strength
- Case studies of contrastive gestural strength
 - Barrow Inupiaq palatalization and dorsal assimilation
 - Coeur d’Alene Salish faucal harmony
- Issues with feature-based accounts of apparent exceptionality
 - Abstract phonemes and opacity
 - Constraint indexation

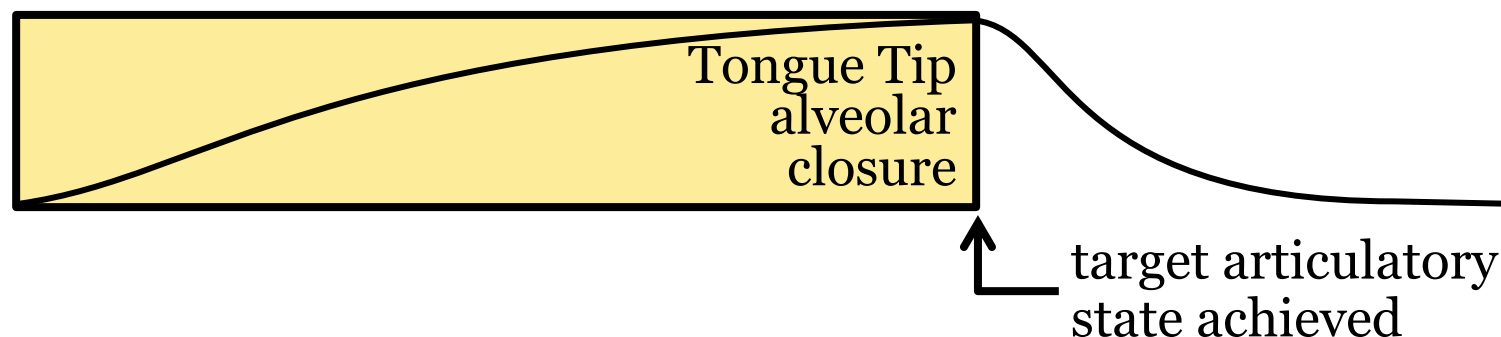
Gestures & Gestural Strength

Gestural Parameters

Gesture: dynamically-defined, goal-based unit of representation (Browman & Goldstein 1986, 1989)



Gestural Parameters



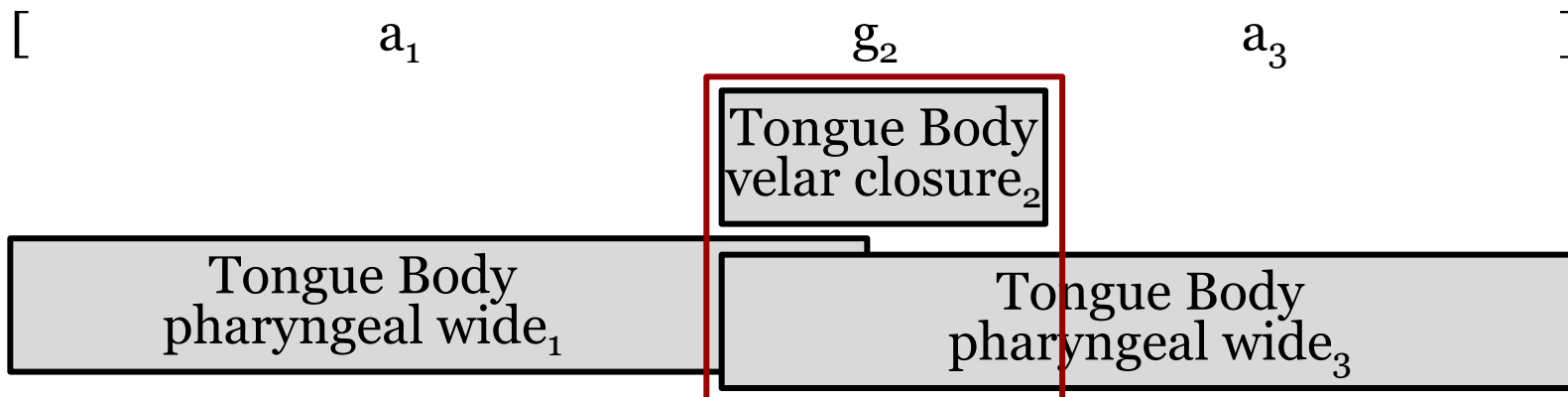
- Target articulatory state:
 - Constriction location
 - Constriction degree
- Stiffness (k): how quickly a gesture's target articulatory state is reached
- Ability to self-deactivate (Smith 2017a, 2017b)
- Strength (α): ability to command articulators

Gestural Strength & Blending

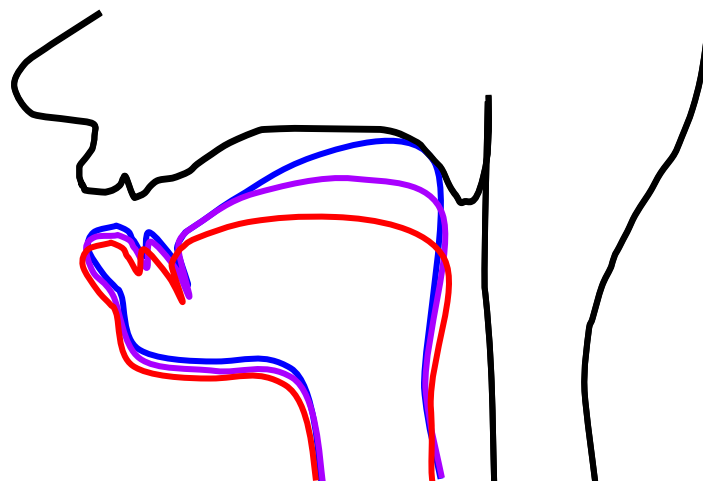
- Antagonistic gestures: gestures with conflicting target articulatory states
- Antagonism resolved by blending goal articulatory states of concurrently active gestures according to Task Dynamic Model of speech production (Saltzman & Munhall 1989)

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

Gestural Blending Between Consonants and Vowels



Blended tongue body postures for /a/ and /g/



Phonological Role of Gestural Strength

- Allophony of velar fricative in Navajo due to low gestural strength (Iskarous, McDonough, & Whalen 2012)
- Transparency in harmony due to high gestural strength (Smith 2016)
- Phonotactics restrictions on liquids in English due to gestural strength settings (Walker, Proctor, Smith, & Enzinger 2016)

Proposals: Contrastive Gestural Strength

- 1) Gestural strength serves a contrastive function in phonology
- 2) Contrastive gestural strength is responsible for cases of apparent exceptionality

Barrow Inupiaq

Vowel-Consonant Interactions in Barrow Inupiaq (Kaplan 1981)

- Coronal Palatalization:

$$\begin{array}{l} t \quad s, c \\ n \rightarrow \eta \quad / \quad i \quad (C) \quad ___ \\ l \quad \lambda \end{array}$$

- Dorsal Assimilation:

$$i \rightarrow a \quad / \quad ___ \left\{ \begin{array}{l} k \\ q \end{array} \right\}$$

Barrow Inupiaq

Stem	Coronal Palatalization	Dorsal Assimilation
iki	iki- <u>ɬ</u> u ‘and wound’	iki-k ‘wound.DUAL’
savik	savig- <u>ɬ</u> u ‘and knife’	savvi-k ‘knife.DUAL’
ini	ini-lu ‘and place’	inn <u>a</u> -k ‘place.DUAL’
kamik	kamig-lu ‘and boot’	kamm <u>a</u> -k ‘boot.DUAL’

data from Kaplan (1981)

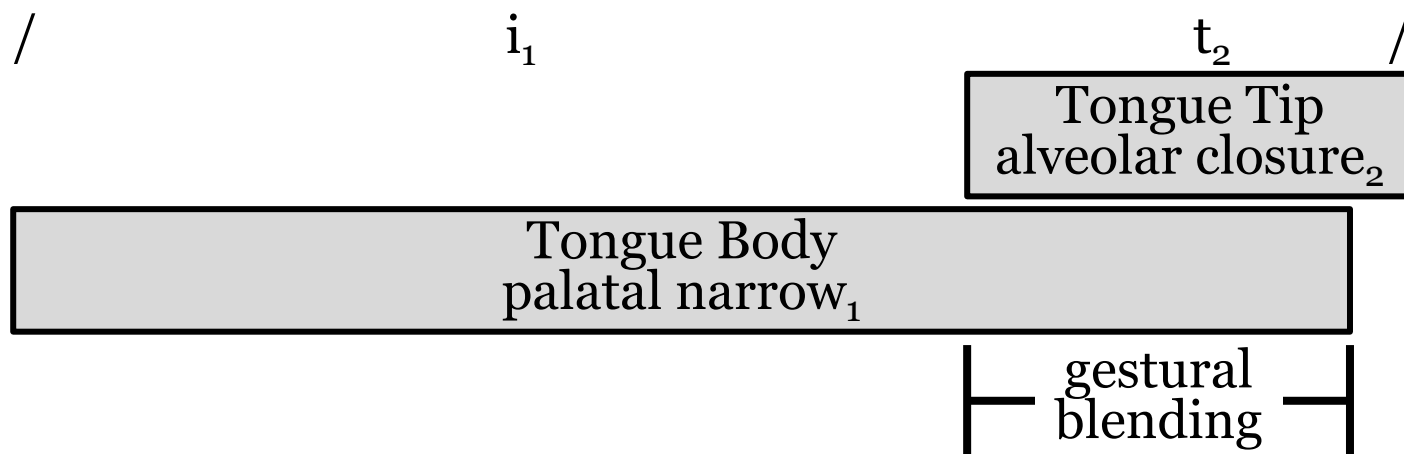
Barrow Inupiaq: Two /i/ Phonemes

- Kaplan (1981) & Archangeli & Pulleyblank (1994) argue that Barrow Inupiaq has two /i/ phonemes

Proposal:
Two /i/ phonemes contrast with respect to gestural strength

- Strong /i/ triggers coronal palatalization, resists dorsal assimilation
- Weak /i/ does not trigger coronal palatalization, undergoes dorsal assimilation

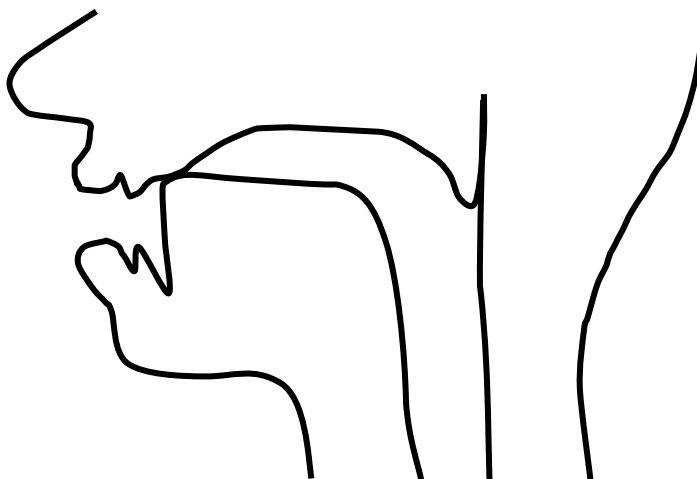
Gestural Representation of Coronal Palatalization



Tongue position for /i/

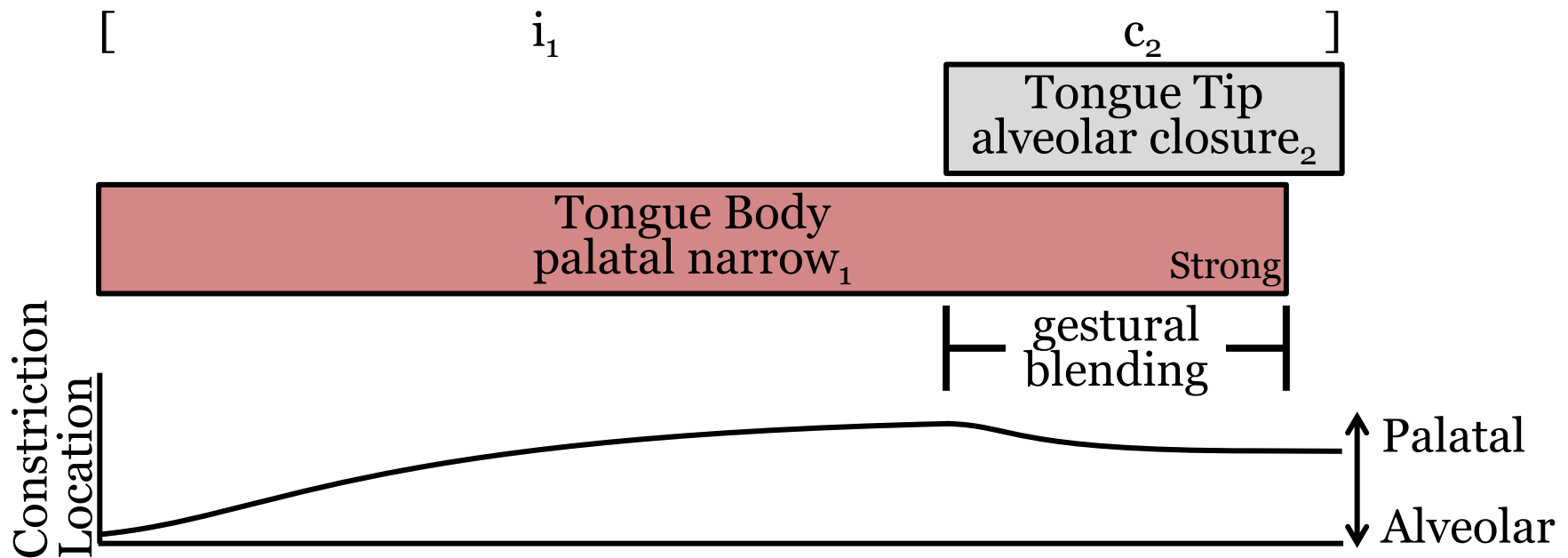


Tongue position for /t/



Gestural Representation of Coronal Palatalization

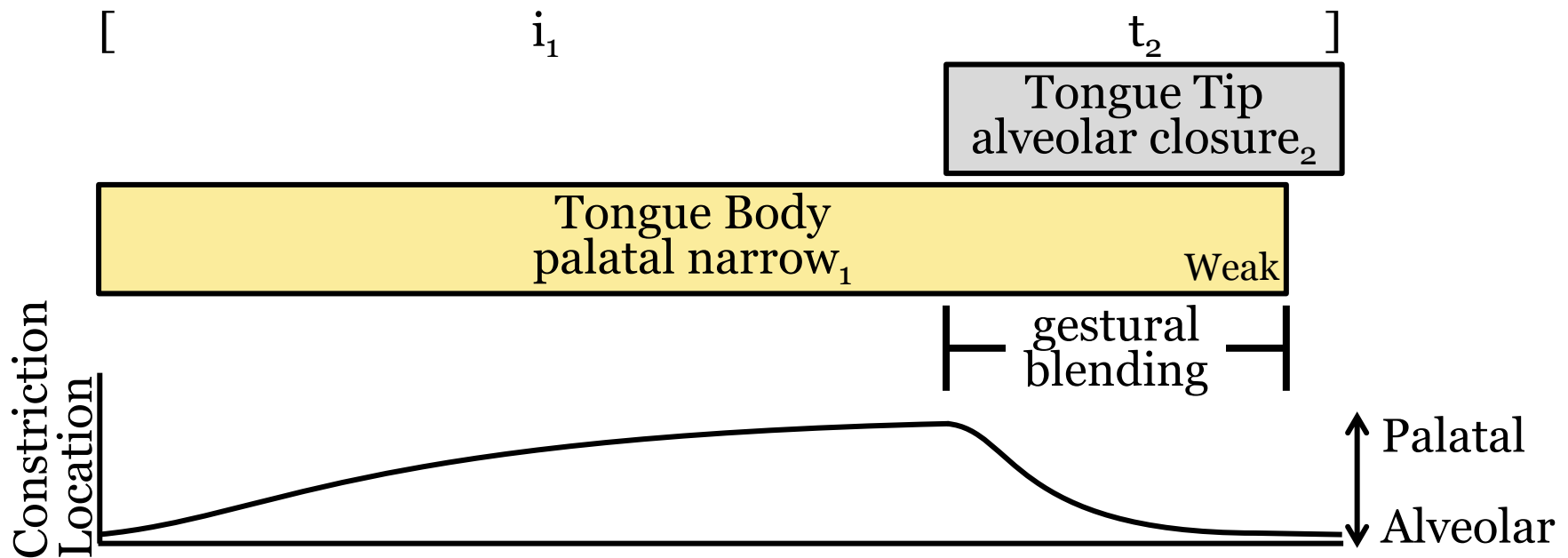
- Strong /i/ palatalizes following coronal:



- Achievement of strong palatal constriction favored over achievement of weak alveolar constriction
- Result: palatalized consonants [c], [ɲ], [ʎ]

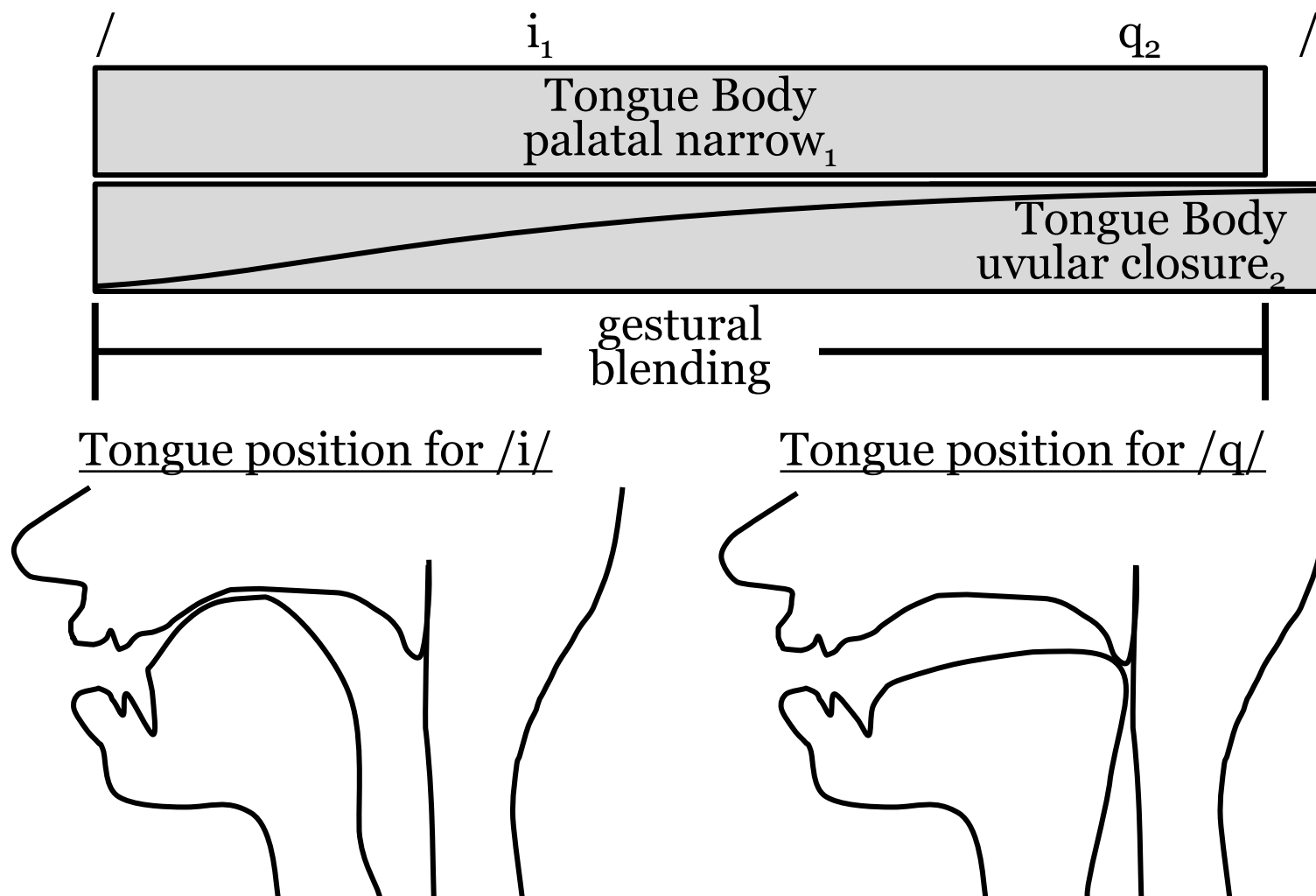
Gestural Representation of Coronal Palatalization

- Weak /i/ does not palatalize following coronal:



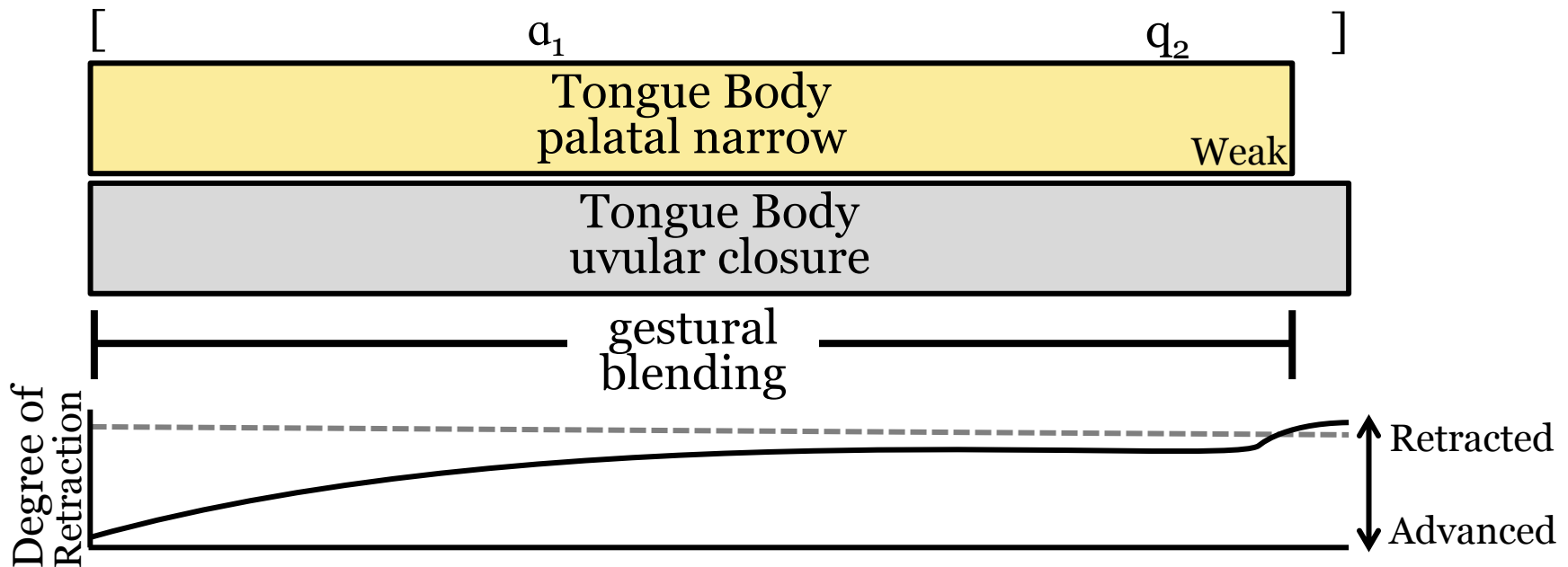
- Achievement of strong alveolar constriction favored over achievement of weak palatal constriction
- Result: coronal consonants [t], [n], [l]

Gestural Representation of Dorsal Assimilation



Gestural Representation of Dorsal Assimilation

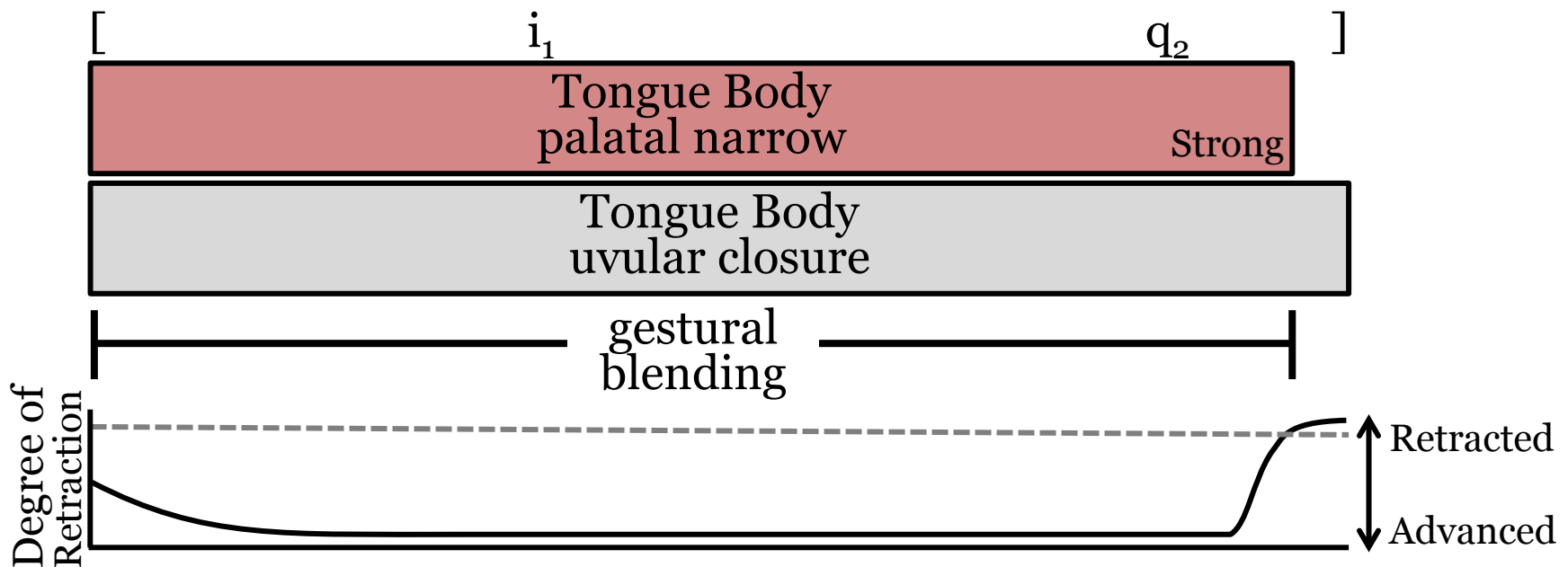
- Weak /i/ retracted by following dorsal consonant:



- Achievement of uvular constriction favored over achievement of weak palatal constriction
- Result: back vowel [a]

Gestural Representation of Dorsal Assimilation

- Strong /i/ resists retraction by dorsal consonant:



- Achievement of strong palatal constriction favored over achievement of weak uvular constriction
- Result: front vowel [i]

Summary: Gestural Analysis of Barrow Inupiaq

- Recruits independently necessary element of gestural representation to account for cases of apparent exceptionality
- Captures relationship between palatalization and dorsal assimilation processes with single gestural strength parameter
- Eliminates reliance on purely abstract phonemes, derivational opacity, and special grammatical exceptionality mechanisms

Alternative Analyses in Feature-Based Phonology

Abstract Vowel in Barrow Inupiaq

- Kaplan (1981): weak [i] is underlyingly abstract schwa

	a	u	i	ə
high	-	+	+	-
back	+	+	-	-

- Archangeli & Pulleyblank (1994): weak [i] is underspecified

	a	u	i ₁	i ₂
low	+			
back			-	
round		+		

- Late rule merges abstract vowel with /i/

Ordered Rules

Ordering Dorsal Assimilation before rule merging
/i/ and /ə/ generates desired surface forms:

Input	/iki-k/	/ənə-k/
Dorsal Assimilation	—	ən <u>ɔ</u> -k
[i] Neutralization	—	<u>i</u> nɔ-k
Output	[iki-k] 'wound (dual)'	[inɔ-k] 'place (dual)'

Ordered Rules

Ordering Coronal Palatalization before rule merging /i/ and /ə/ generates desired surface forms:

Input	/iki-lu/	/ənə-lu/	
Coronal Palatalization	iki- <u>ɰ</u>	—	} Counter-feeding Opacity
[i] Neutralization	—	<u>i</u> ni-lu	
Output	[iki-ɰu] 'and wound'	[ini-lu] 'and place'	

Alternative Analyses: Derivational Opacity

- Analyses relying on absolute neutralization/underspecification with counterfeeding opacity are incompatible with parallel frameworks (McCarthy 1999)
- Gestural strength account: no counterfeeding opacity or absolute neutralization
 - Contrastive element (gestural strength parameter α) persists from underlying to surface form
 - Compatible with parallel frameworks

Alternative Analysis: Lexical Exceptionality

- Lexical exceptionality via constraint indexation (Pater 2000, 2009): weak and strong /i/ differentiated by constraint indices
- Exceptional triggering of palatalization:
PALATALIZE_X >> IDENT(high) >> PALATALIZE
- Exceptional resistance to dorsal assimilation:
IDENT(back)_Y >> ASSIMILATE >> IDENT(back)

Issues with Morpheme Indexation

- Indexation of a *morpheme* to a constraint motivating palatalization predicts uniform /i/ behavior within a morpheme
- Morpheme will contain all palatalizing /i/ vowels,

OR

Morpheme will contain all non-palatalizing /i/ vowels

- Not predicted: morphemes with both types of /i/, such as [ilvi-ʎʎi] ‘and you, in your turn’ (*[iʎvi-ʎʎi], *[ilvi-lli])

Alternative Analysis: Segmental Exceptionality

- Possible solution: constraint indices borne by segments rather than entire morphemes (Temkin Martinez 2010)

- Exceptional triggering of palatalization:

$\text{PALATALIZE}_X \gg \text{IDENT}(\text{high}) \gg \text{PALATALIZE}$

- Exceptional resistance to dorsal assimilation:

$\text{IDENT}(\text{back})_Y \gg \text{ASSIMILATE} \gg \text{IDENT}(\text{back})$

- Barrow Inupiaq inventory: /ɑ/, /u/, /i_{XY}/, /i/

Issues with Segment Indexation

- Indexation of $/i_{XY}/$ to both PALATALIZE and IDENT(back) is accidental
- Also predicted: system in which PALATALIZE and IDENT(back) are not indexed to same set of $/i/$ vowels

PALATALIZE_X >> IDENT(high) >> PALATALIZE

IDENT(back)_Y >> ASSIMILATE >> IDENT(back)

- Possible high front vowel inventory: $/i_X/$, $/i_Y/$, $/i_{XY}/$, $/i/$

Issues with Segment Indexation

- Additional processes in Barrow Inupiaq rely on distinction between strong and weak /i/:
 - Weak /i/ retraction to [u]
 - Weak /i/ syncope
- Number of possible indexed vowels in inventory = 2^n , where n = number of indexed constraints

Contrasting Featural and Gestural Analyses of Barrow Inupiaq

- Appealing to contrastive gestural strength rather than potentially disjoint sets of segment-to-constraint indexations unifies behavior of strong /i/ and weak /i/
- Avoids explosion of possible segment inventories predicted by constraint indexation

Coeur d'Alene Salish Faucal Harmony

Coeur d'Alene Salish Faucal Harmony (Doak 1992, Bessell 1998)

Vowels surface as retracted variants before faucal
(uvular and pharyngeal) consonants

Non-Faucal Context

Faucal Context

[t^siʃ-t] 'it is long'

[t^sɛʃ-ɑlq^w] 'he is tall'

[dli^m] 'he galloped hither'

[t^ʃ-dlɑ^m-ɑlq^w] 'train'

[sɛtt^ʃ-nt^s] 'he twisted it'

[nɛʔ-sɑtt^ʃ-ɛʔqs-n] 'crank (on a car)'

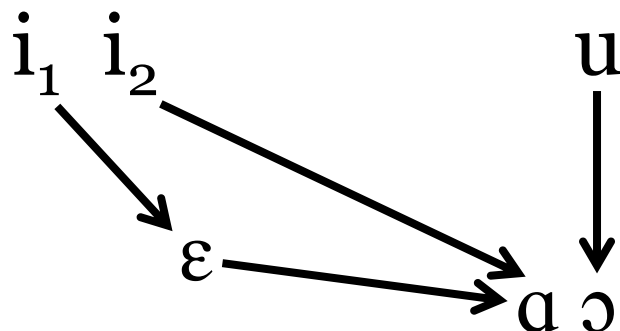
[ʔɛ-niʔ-kus-ɛlst^ʃn] 'hair curls
back from forehead'

[ʔɑt-kɔs-qn] 'his hair is curled'

data from Doak (1992) & Bessell (1998)

Coeur d'Alene Salish Faucal Harmony

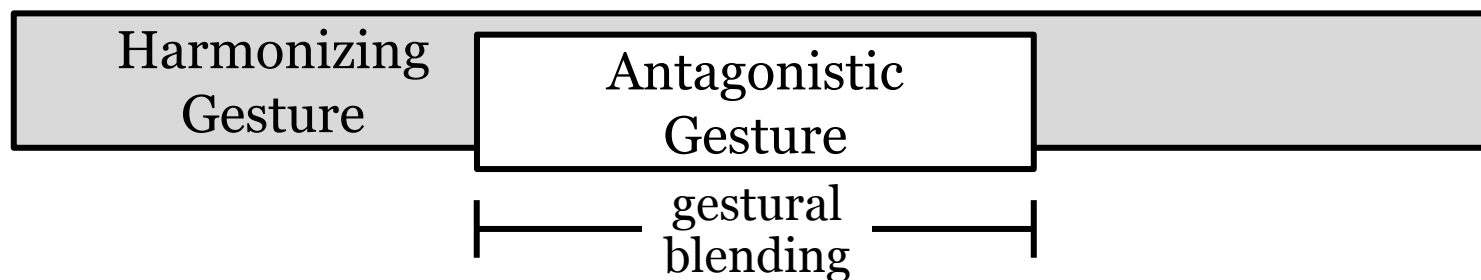
Vowel shift in domain of faucal harmony:



- $/\epsilon/$, $/i_2/$, $/u/$ all fully undergo faucal harmony
- $/i_1/$ undergoes faucal harmony to an intermediate degree

Transparency in Harmony as Gestural Antagonism (Smith 2016)

Transparency: result of competition between two concurrently active *antagonistic* gestures

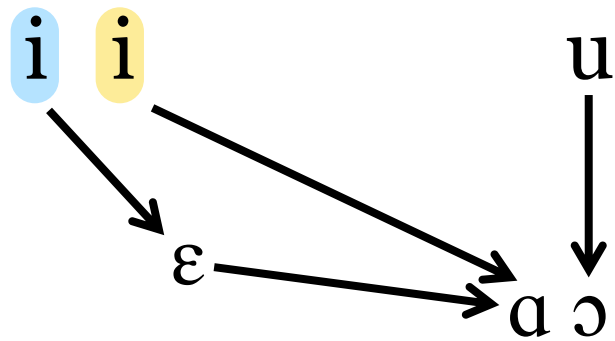


Resulting state of vocal tract for some variable:



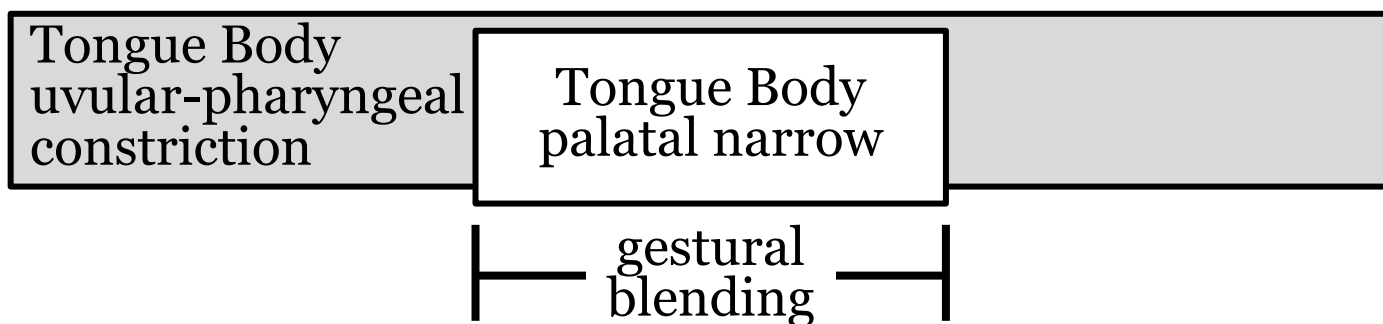
Coeur d'Alene Salish

Faucal Harmony: Proposals



- Faucal harmony is result of overlap by harmonizing tongue body retraction gesture
- Medium-strength /**i**/ partially resists (remains transparent to) effect of retraction gesture due to similar gestural blending strengths
- Weak /**i**/ is fully overpowered by retraction gesture when gestural blending occurs

Gestural Representation of Faucal Harmony



Tongue position for /i/

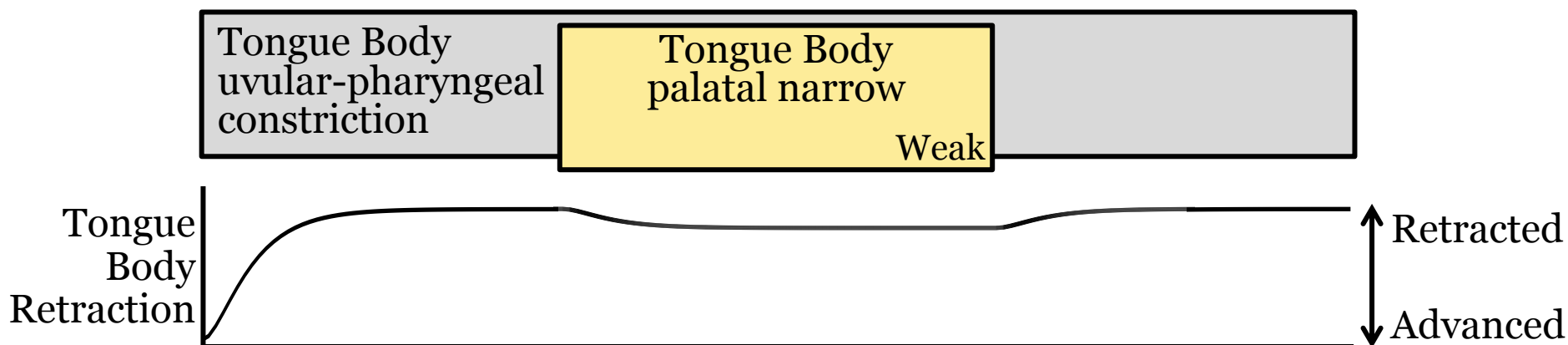


Tongue position for /q/



Full Retraction of Weak /i/

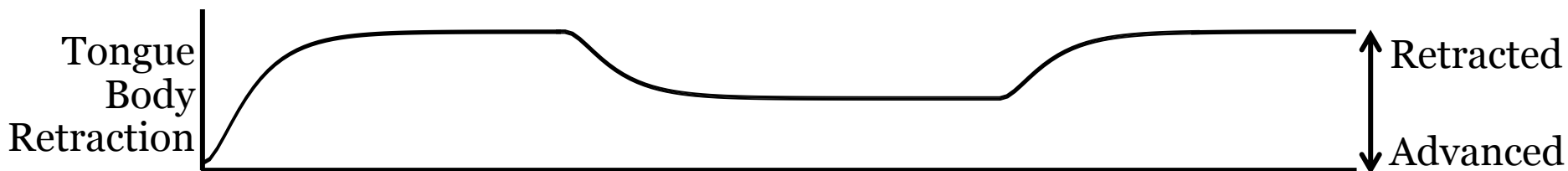
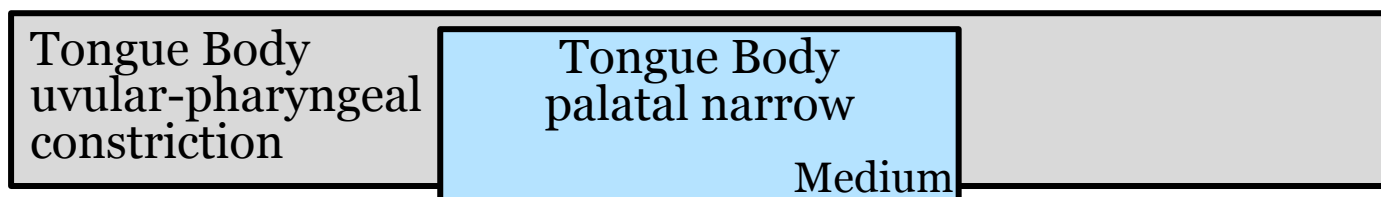
- Weak /i/ is fully overpowered by harmonizing retraction gesture:



- Surfaces as fully retracted [ɑ]

Partial Transparency of Medium-Strength /i/

- Medium-strength /i/ partially resists (remains transparent to) effect of retraction gesture due to similar gestural blending strengths:



- Surfaces as partially retracted [ϵ]

Summary: Gestural Analysis of Coeur d'Alene Salish

- Gestural strength parameter setting preserved from input to output
- Gradient gestural strength:
 - Produces full retraction of /i₂/, /ε/, and /u/ from low gestural strength
 - Produces partial transparency of /i₁/ from medium gestural strength

Conclusion & Looking Forward

Conclusion

- Contrastive gestural strength accounts for patterns of apparent exceptionality without relying on:
 - Abstract underlying phonemes
 - Opaque rule ordering
 - Exploding number of constraint indices
- Provides unified account of multiple processes in Barrow Inupiaq that make reference to two sets of high front vowels
- Provides account of segments that undergo process to different degrees, as in Coeur d'Alene Salish

Work in Progress & Future Work

- Broader typology of contrastive strength:
 - Contrastive strength for vowels other than /i/
 - Contrastive strength for consonants
- Manipulation of gestural strength by phonological grammar:
 - Gestural strength varying by prosodic position
 - Gestural strength interacting with temporal organization
 - Phonotactic restrictions based on gestural strength