# Variability of Languages in Time and Space

# Phonological Typology, Consonant and Vowel inventories

- Motivation for Linguistic Typology
- Phonetics and Phonology
- Consonant and Vowel Inventories
- Segmental Processes
- Linguistic quiz to the end

*Anja Nedoluzhko*

# Linguistic Typology

# Linguistic Typology - Motivation

Linguistic analysis and comparison of language features on a large number of languages

- gives awareness of what is
  - possible
  - possible and frequent
  - almost or fully impossible
- lets us combine features, find correlations, implications
  - few consonants ≈ simple sillables
  - nasal vowels → oral vowels
    - *Example:* Many languages have only oral vowels (Spanish, German) and many languages have both oral and nasal vowels (French, Portuguese), but no language has only nasal vowels: the existence of nasal vowels implies the existence of oral vowels.
- helps us understand phonological data in a given language
  - *I've seen this before… Typically it goes like this…*

# Linguistic Typology - Motivation

- Informs what is common/uncommon

  > Odden 2013: „It is very difficult to refuse a claim of the form „X is more common than Y," except if a very detailed numerical study is undertaken."

  – 'basic' SVO word order
  – anaphoricity of the definite article
  – unstressed vowel reduction, length and stress correlation
  – labialized u and ü

- Markedness

  – a comparative concept
  – marked = something atypical, variants, special cases
  – *Example:* In phonology, not all segments have equal status

# Markedness

**X is marked** (**relative to Y**):

[ʕ] is more marked than [q]
[q] is more marked than [k]

⬇

pharyngeals are marked sounds relative to other sounds of the world's languages

|  | velar | uvular | pharyngeal |
|---|---|---|---|
|  | ŋ | N | |
| k | g | q | ɢ | |
| x | ɣ | χ | ħ |
|  |  | ʁ | ʕ |
|  | ɰ | | |

stop consonants: unmarked system

voiceless uvular plosive or stop used in more than 50 languages (some dialects of English and German, Biblical Hebrew)
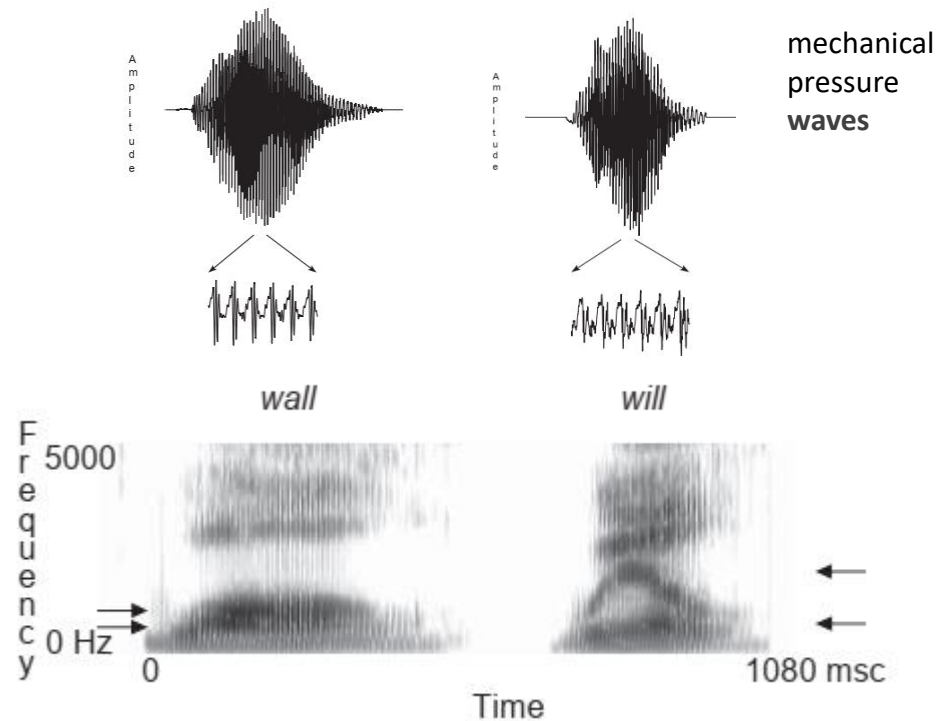
voiced pharyngeal fricative used in no more than 15 languages (some dialects of Arabic, Hebrew)

# Phonetics

**Phonetics** is the manifestation of language sound

- Acoustic properties of language sounds

  - The tools of phonetic analysis provide very detailed and precise information about the amplitude, frequency and time characteristics.
  - Expanded view of the vowel part of the waveforms shows differences in the overall shape of the time-varying waveforms.
  - Too much information – a lot of information needs to be discarded to get at something more general and useful.
  - **Spectogram**: reducing the absolute amplitude properties of a wave at an exact time to a set of (less precise) amplitude characteristics in different frequency and time areas
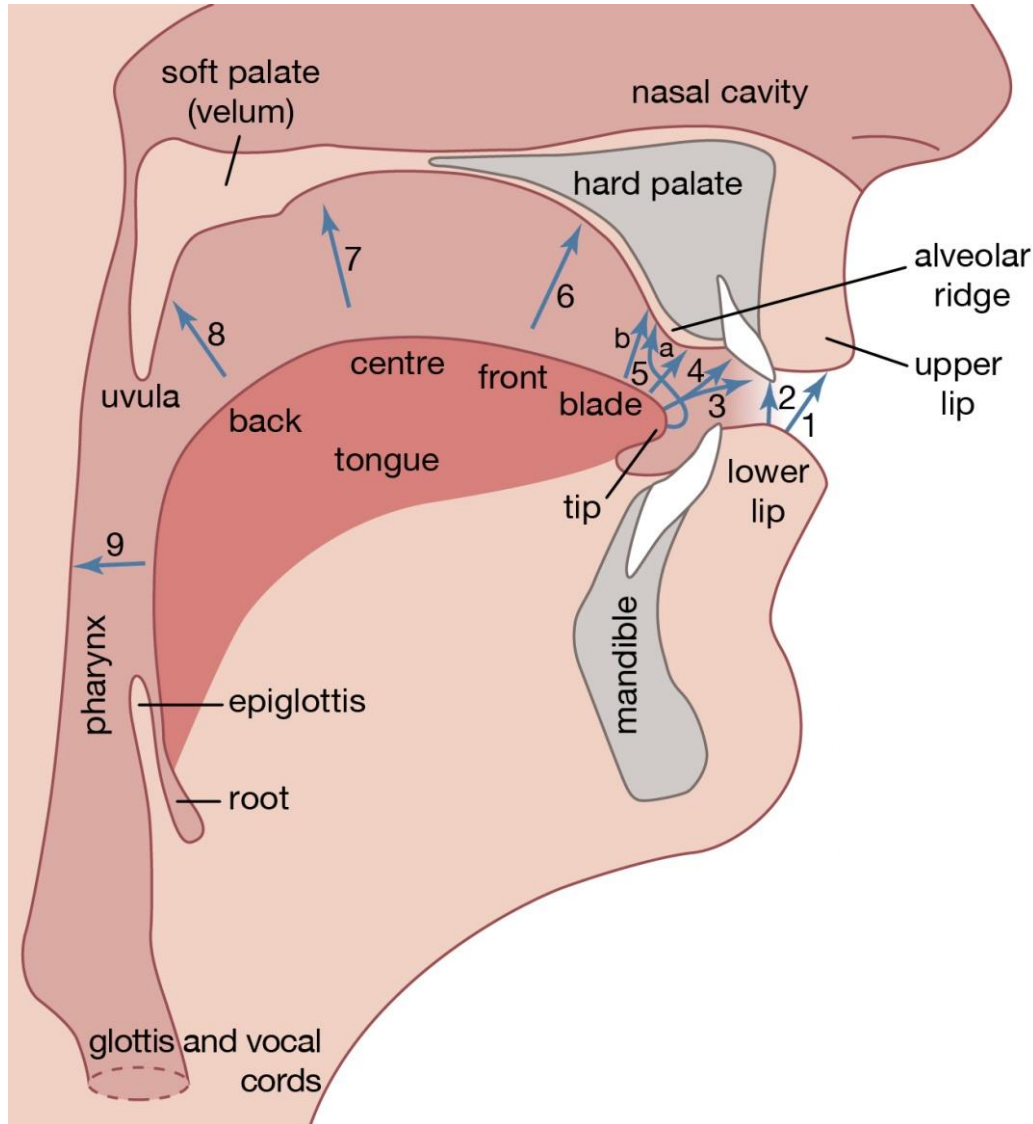
mechanical pressure **waves**

*wall*  *will*

# Phonetics

**Phonetics** is the manifestation of language sound

- Acoustic properties of language sounds
- Articulatory properties of language sounds
  - At what place in the mouth the sounds are formed and how they are formed
  - *Example:* Consonants are formed in the vocal tract in various places. Obstacles place and intensity define the sound quality.

# Articulatory Phonetics



**CONSONANTS**

(1) Bilabial
(2) Labiodental
(3) Dental and interdental
(4) Alveolar
(5) Postalveolar
    (a) Retroflex
    (b) Palato-alveolar
(6) Palatal
(7) Velar
(8) Uvular
(9) Pharyngeal

# Phonetics

**Phonetics** is the manifestation of language sound

- Acoustic properties of language sounds
- Articulatory properties of language sounds
  - At what place in the mouth the sounds are formed and how they are formed
  - *Example:* Consonants are formed in the vocal tract in various places. Obstacles place and intensity define the sound quality.
  - Systematic limits on what sounds and combination of sounds are possible in a human language
  - Transcription: Systems of symbols and their phonetic properties, e.g. International Phonetic Alphabet (IPA)

# International Phonetic Alphabet (IPA)

## CONSONANTS (PULMONIC)

© 2018 IPA

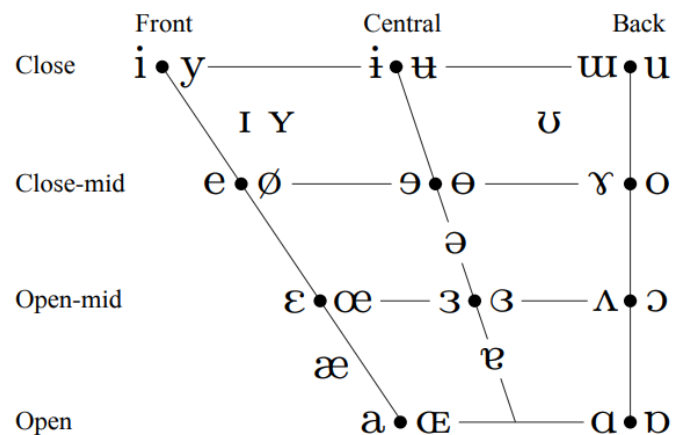| | Bilabial | Labiodental | Dental | Alveolar | Postalveolar | Retroflex | Palatal | Velar | Uvular | Pharyngeal | Glottal |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Plosive | p b | | | t d | | ʈ ɖ | c ɟ | k g | q ɢ | | ʔ |
| Nasal | m | ɱ | | n | | ɳ | ɲ | ŋ | ɴ | | |
| Trill | ʙ | | | r | | | | | ʀ | | |
| Tap or Flap | | ⱱ | | ɾ | | ɽ | | | | | |
| Fricative | ɸ β | f v | θ ð | s z | ʃ ʒ | ʂ ʐ | ç ʝ | x ɣ | χ ʁ | ħ ʕ | h ɦ |
| Lateral fricative | | | | ɬ ɮ | | | | | | | |
| Approximant | | ʋ | | ɹ | | ɻ | j | ɰ | | | |
| Lateral approximant | | | | l | | ɭ | ʎ | ʟ | | | |

Symbols to the right in a cell are voiced, to the left are voiceless. Shaded areas denote articulations judged impossible.

## CONSONANTS (NON-PULMONIC)

| Clicks | Voiced implosives | Ejectives |
|---|---|---|
| ⊙ Bilabial | ɓ Bilabial | ʼ Examples: |
| ǀ Dental | ɗ Dental/alveolar | pʼ Bilabial |
| ǃ (Post)alveolar | ʄ Palatal | tʼ Dental/alveolar |
| ǂ Palatoalveolar | ɠ Velar | kʼ Velar |
| ǁ Alveolar lateral | ʛ Uvular | sʼ Alveolar fricative |

## OTHER SYMBOLS

## VOWELS



10

# Phonetics and Phonology

- **Phonetics** – the manifestation of language sound
  - Acoustic properties of language sounds
  - Articulatory properties of language sounds
  - Transcription: International Phonetic Alphabet (IPA)

- **Phonology** – the study of sound systems
  - Looking for a way to represent just the essentials of language sounds, as *mental objects* which grammars can manipulate.
  - Reduces the great mass of phonetic information to a *cognitive minimum*, to a sequence of discrete segments.
  - Sounds (phonemes) are symbolic sounds, cognitive abstractions, which *represent but are not the same* as physical sounds.

# Phonemes

- The smallest distinct acoustic unit in a language that may distinguish meaning of larger units
- A phoneme does not convey meaning itself
  - different phonemes if meaning changes

    *p*in, *t*in, *k*in, *f*in, *th*in, *s*in, *sh*in

    di*m*, di*n*, di*ng*, di*d*, di*g*, di*sh*, di*ck*

    *p*in, p*e*n, p*a*n, p*u*n, p*ai*n, p*i*ne, p*aw*n

  - NOT different phonemes if meaning does not change
    - alveolar vs. dental R
    - different place of articulation in *ž, t* etc.

# Phonetics and Phonology: Practice

- Are the following statements from phonetics or from phonology?
  - The sounds in the word *frame* change continuously
  - Towards the end of the word *frame*, the velum is lowered
- Why is it undesirable to use the most precise representation of the physical properties of a spoken word in discussing rules of phonology?
- Give the phonetic symbols for
  - Dental nasal
  - Labio-dental fricative
  - Velar plosive (stop)
- How many phonemes are there:
  - *sit, judge, trap, fish, bite, ball, up, ox, through, often*

# Phonemic Inventories Databases

- SPA, Stanford Phonology Archive (Vihman, 1974)
  - first computerized database of phonological segment inventories, inspired by Joseph Greenberg's research on universals and his personal archive of data,
  - includes descriptions of phonemes, allophones and comments on phonological contexts for 197 languages.
- UPSID, UCLA Phonological Segment Inventory Database (Maddieson 1984, 1997)
  - statistical survey, phonemic inventories,
  - 451 languages in the last version
  - http://web.phonetik.uni-frankfurt.de/upsid.html
- Phonemic inventories within WALS (Maddieson 2013)
  - 564 languages
  - http://wals.info/
- The Database of Eurasian Phonological Inventories (Nikolaev, 2018)
  - collection and analysis of information on segmental inventories of Eurasian languages
  - https://eurphon.info/
- **PHOIBLE database** (Moran et al. 2014, updated in 2019)
  - segment inventories of 1,672 languages
  - IPA realizations
  - https://phoible.org/

# Multiple Phonemic Inventories

- Phoneme analysis is a non-deterministic process
- Phonological descriptions of a particular language's speech sounds may have different sets of contrastive phonemes when analyzed by different linguists (or sometimes even by the same linguist throughout his career)
  - NLP models give also different outputs, but mostly comparable
- *Example:* in PHOIBLE
  - 9 inventories for English (39 to 45 segments)
  - 4 inventories for German (39 to 41 segments)
  - 5 inventories for Spanish (25 to 45 segments)
- Reasons for differences
  - different dialects
  - different attitudes
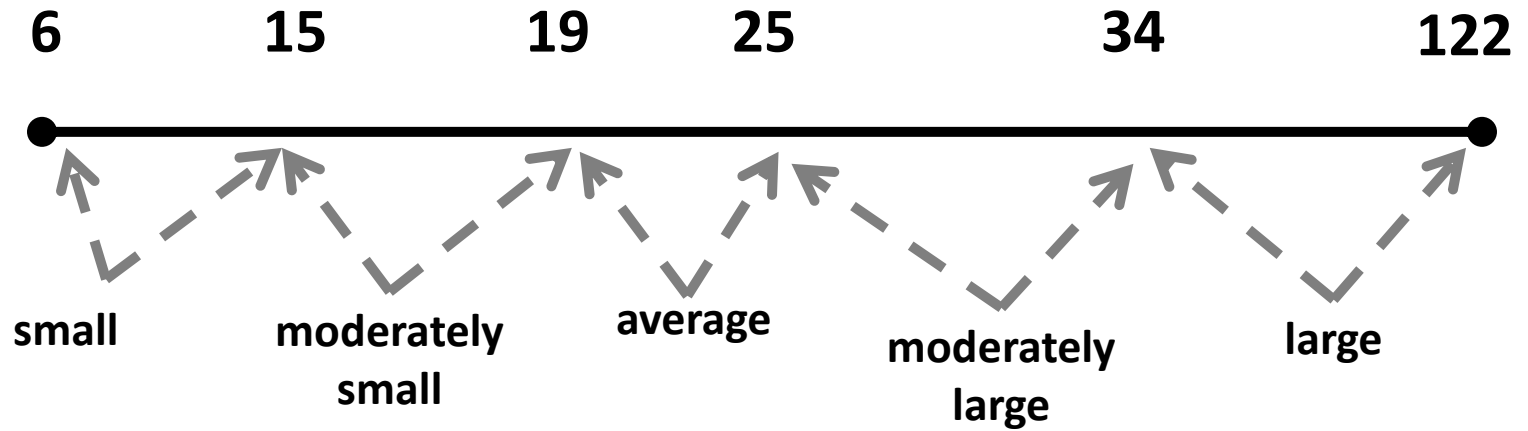
# Vowels vs. Consonants

- Vowels are sounds with no audible noise produced by constriction in the vocal tract
  - make syllables
- Consonants are sounds with audible noise produced by a constriction in the vocal tract
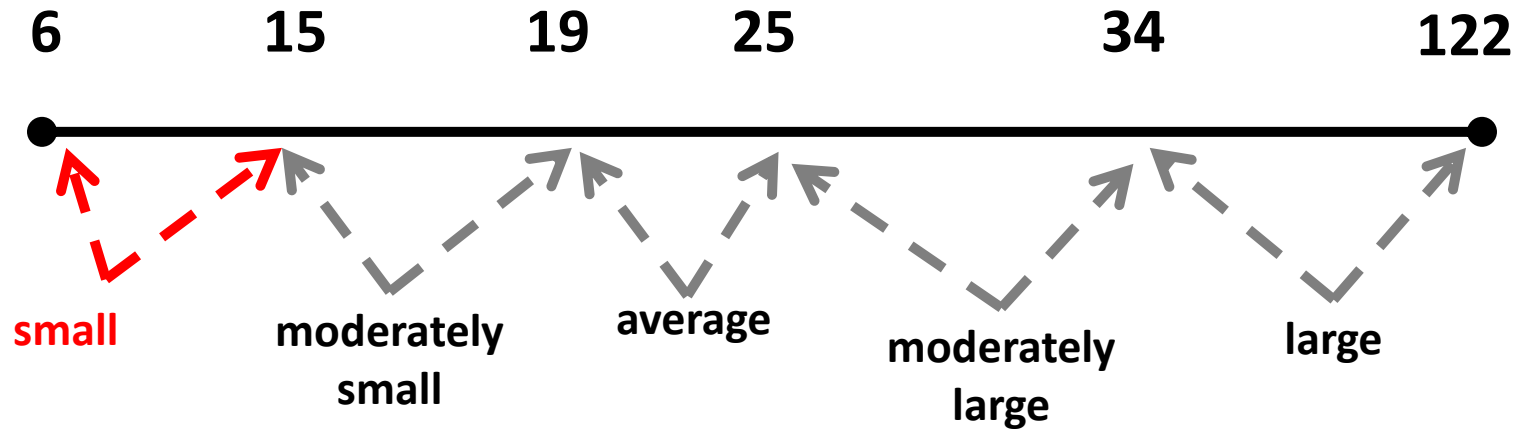  - obstacle
    - degree of this obstacle

a

p

y      w

s
z
f

yes      well

r          l

cs. *krk*    cs. *vlk*
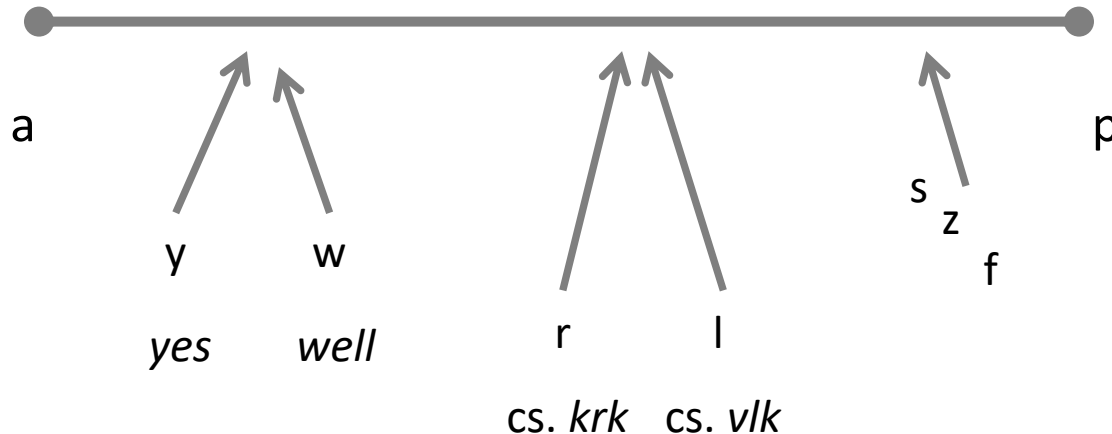
- The solution is convention
  - Typological research is still possible

# WALS: Consonant Inventories

| 6 | 15 | 19 | 25 | 34 | 122 |
|---|----|----|----|----|-----|

small    moderately small    average    moderately large    large

# WALS: Consonant Inventories

**6**       **15**       **19**      **25**       **34**       **122**

**small**     **moderately small**     **average**     **moderately large**     **large**

*only 6 consonants*
*( /p, t, k, b, d, g/ )*

Rotokas

Papua New Guinea

| LANGUAGE | FEEDBACK |
|---|---|

### A language of Papua New Guinea

| | |
|---|---|
| **ISO 639-3** | roo |
| **Population** | 4,320 (Wurm and Hattori 1981). |
| **Location** | Bougainville Province, Central Bougainville district, central mountains. 28 villages. |
| **Language Maps** | Papua New Guinea, Map 13 |
| **Language Status** | 5 (Developing). Statutory language of provincial identity in Bougainville Autonomous Region (2007, Education Plan, Section 1.1.3), not yet implemented (2012). |
| **Classification** | North Bougainville, Rotokas |
| **Dialects** | Aita, Atsilima, Pipipaia. |
| **Typology** | SOV. |
| **Language Development** | Literacy rate in L1: 50%–75%. Literacy rate in L2: 50%–75%. Dictionary. Grammar. NT: 1982. |
| **Language Resources** | OLAC resources in and about Rotokas |
| **Writing** | Latin script [Latn]. |

18

# WALS: Consonant Inventories

| 6 | 15 | 19 | 25 | 34 | 122 |
|---|---|---|---|---|---|

**small**    **moderately small**    **average**    **moderately large**    **large**
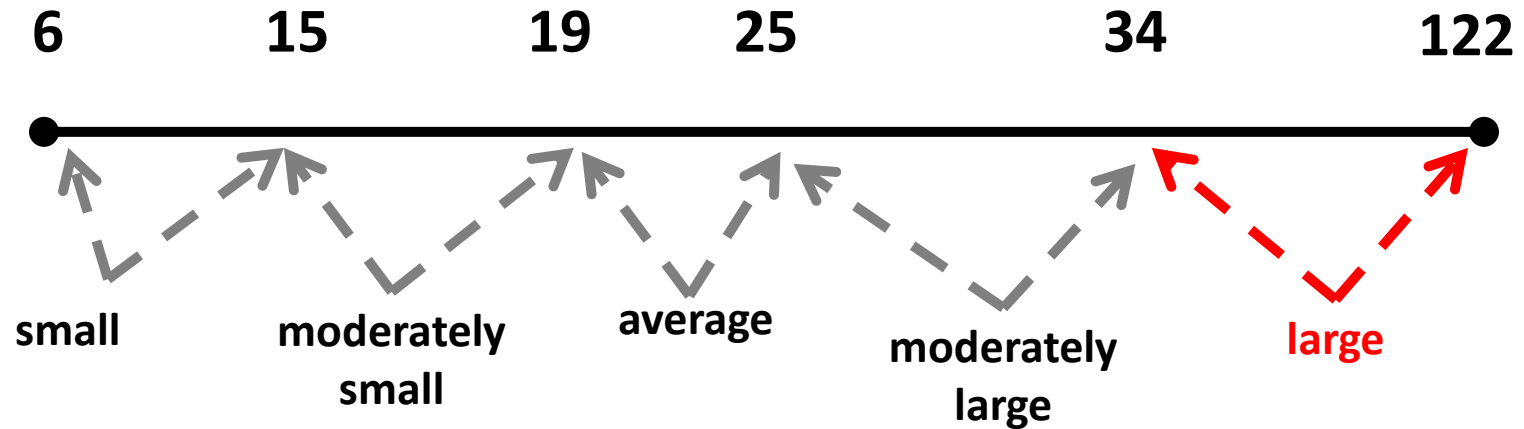
- !Xóõ (Taa, Lone Tree)
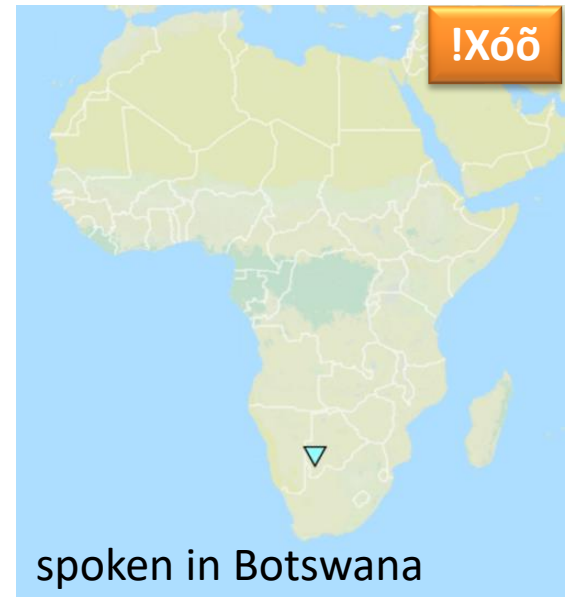- spoken in Botswana
- Tuu languages
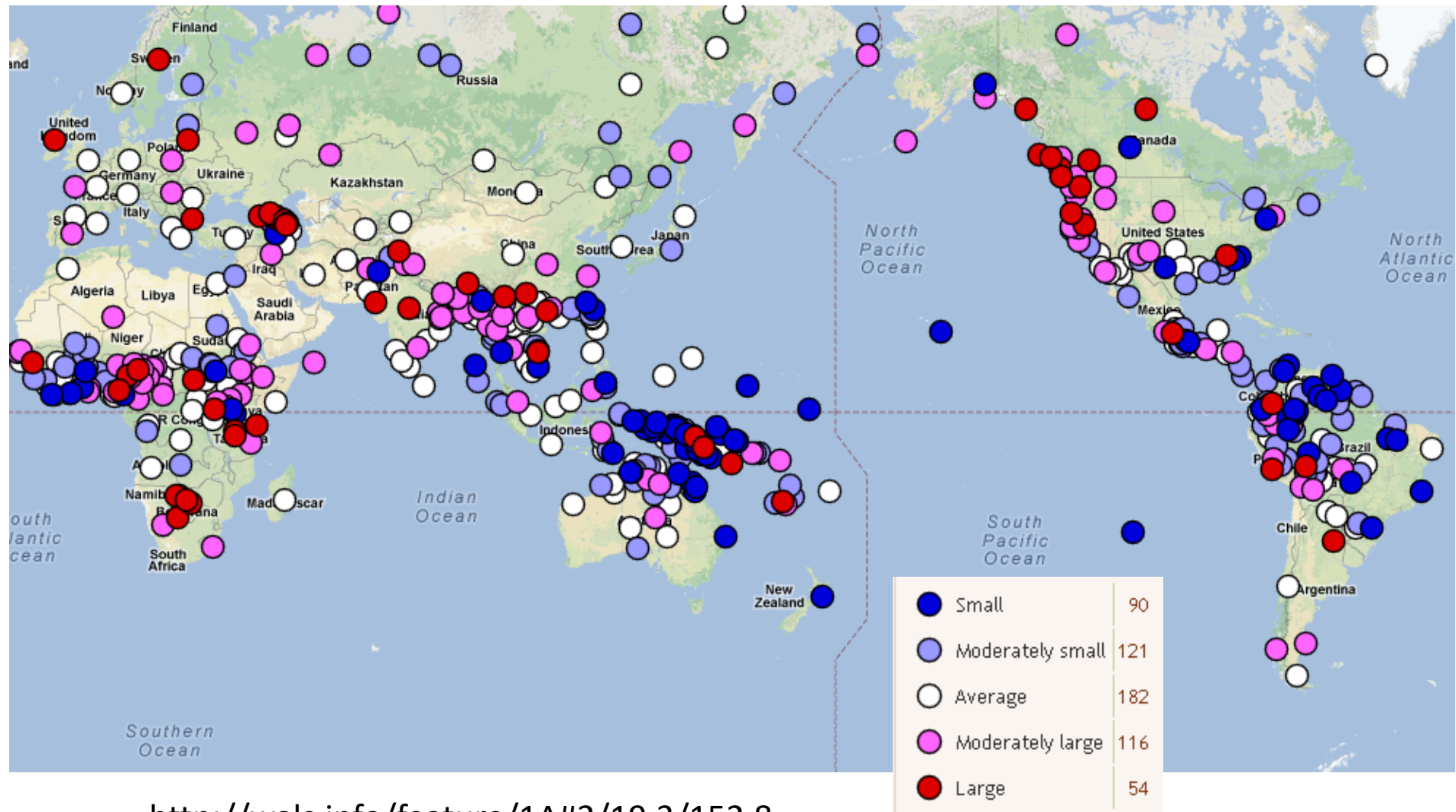
**?** *Why so many?*

**Clic sounds** – in many languages of Southern Africa, articulated with two points of contact in the mouth, one forward and one at the back

*How to pronounce click sounds?*
https://www.youtube.com/watch?v=31zzMb3U0iY

!Xóõ

spoken in Botswana

# WALS: Consonant Inventories



| | | |
|---|---|---|
| ● | Small | 90 |
| ● | Moderately small | 121 |
| ○ | Average | 182 |
| ● | Moderately large | 116 |
| ● | Large | 54 |

http://wals.info/feature/1A#2/19.3/152.8

# Typology for Consonant Inventories: Correlations

Hypothesis (Lindblom - Maddieson, 1988): There is an overall relationship between the size of a consonant inventory and the kind of consonants it includes.

Languages with special consonants by consonant inventory size

| C's inventory size | special C's | glottalized C's |
|---|---|---|
| small | 8.7% | 8.7% |
| moderately small | 13.1% | 10.7% |
| average | 22.1% | 21.5% |
| moderately large | 27.4% | 39.3% |
| large | 40.7% | 66.7% |

# Typology for Consonant Inventories

- Place of articulation: Most languages have one laryngeal consonant, 'easier' pronounced (/h/ > /ʔ/ > /ħ/)

- Manner of articulation: stops > fricatives, nasals



- Most languages have at least one fricative (Klamath only /s/)

- Most languages have glides /w j/ – but in some languages, /w j/ do not contrast with high vowels

- Most languages have at least one nasal (some n. American languages lack them)
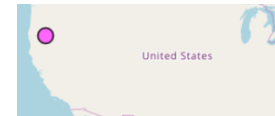
# Vowel Quality Inventories

- Three scales
  - Front – Central – Back
  - Close – Mid – Open
  - Rounded - Unrounded

- Typological issues
  - *Example:*

    Front rounded vowels > back unrounded vowels

    (inventories like English are unusual)

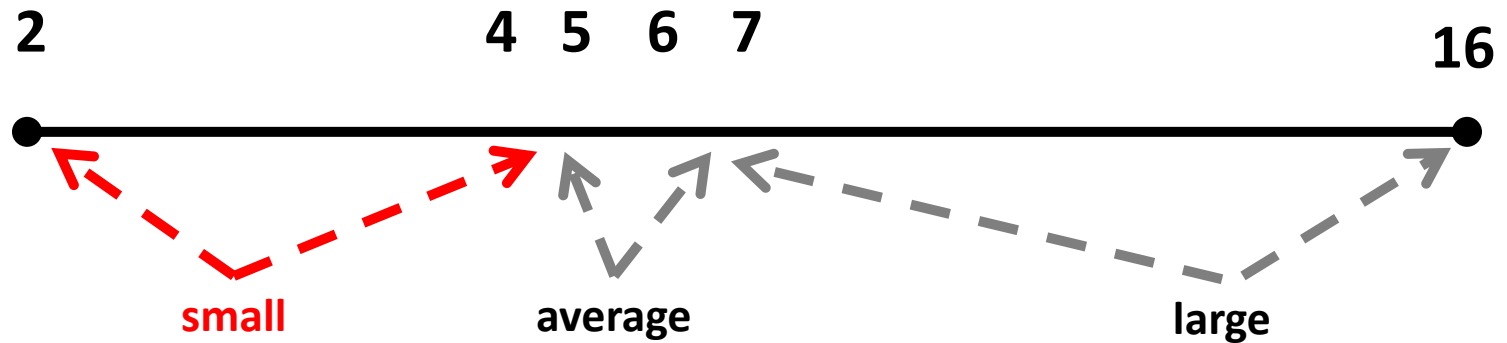- No correlation between vowel and consonant inventories (Justeson-Stephens, 1984)
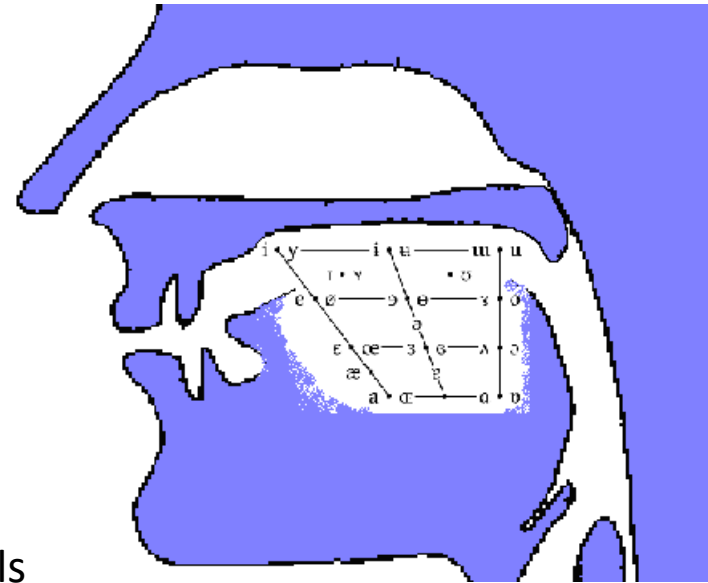
VOWELS

| | Front | Near front | Central | Near back | Back |
|---|---|---|---|---|---|
| Close | i • y | | ɨ • ʉ | | ɯ • u |
| Near close | | ɪ • ʏ | | • ʊ | |
| Close mid | e • ø | | ɘ • ɵ | | ɤ • o |
| Mid | | | | ə | |
| Open mid | | ɛ • œ | ɜ • ɞ | ʌ • ɔ | |
| Near open | | æ | ɐ | | |
| Open | | a • ɶ | | ä | ɑ • ɒ |

Vowels at right & left of bullets are rounded & unrounded.

# Vowel Quality Inventories

**2**                     **4  5  6  7**                         **16**

**small**                **average**                 **large**

Yimas (Papua New Guinea): 2

24

# Vowel Quality Inventories

**2**          **4  5  6  7**                                              **16**

**small**          **average**                                    **large**

Yimas (Papua New Guinea): 2

French

German

# Vowel Quality Inventories



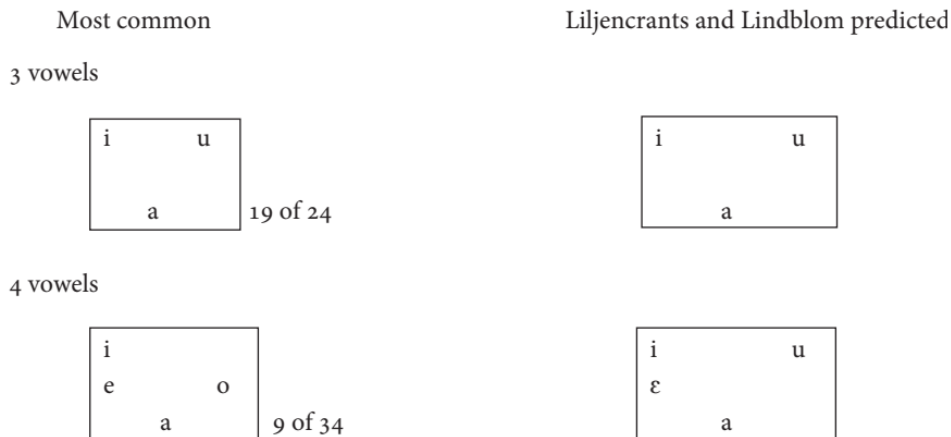| | | |
|---|---|---|
| 🔵 | Small (2-4) | 93 |
| ⚪ | Average (5-6) | 288 |
| 🔴 | Large (7-14) | 183 |

https://wals.info/chapter/2
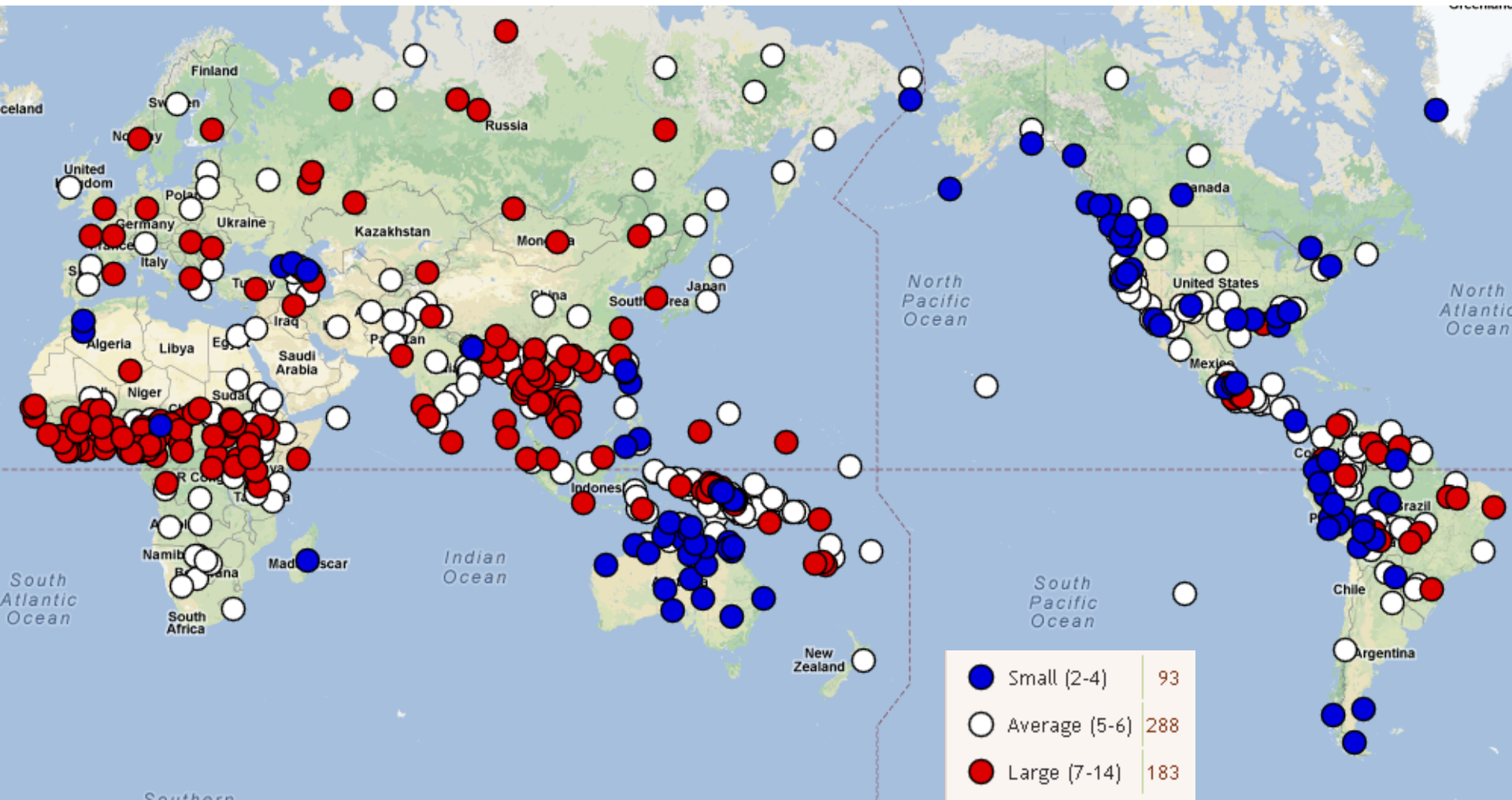
# Why such inventories and not others?

- Why are phoneme inventories such as they are?
- Most of research proposes explanations based on speech production and/or perception
    - *Perceptual factors*
    - *Articulatory factors* } often compete *(maximization of perceptual distinctness and minimization of articulatory effort)*
- Liljencrants and Lindblom (1972): Adaptive Dispersion Theory

> Phoneme inventories are preferable to the extent they possess contrasts that are maximally distinct in the perceptual domain.

Most common | Liljencrants and Lindblom predicted

3 vowels

| i | u |
| | |
| | a | 19 of 24

| i | u |
| | |
| | a |

4 vowels

| i | |
| e | o |
| | a | 9 of 34

| i | u |
| ɛ | |
| | a |

# Frequency Distributions Within Languages: Consonants

- There is a strong correlation between the typologically most common consonants and their frequency within languages



Intralanguage vs. Interlanguage Consonant Frequency
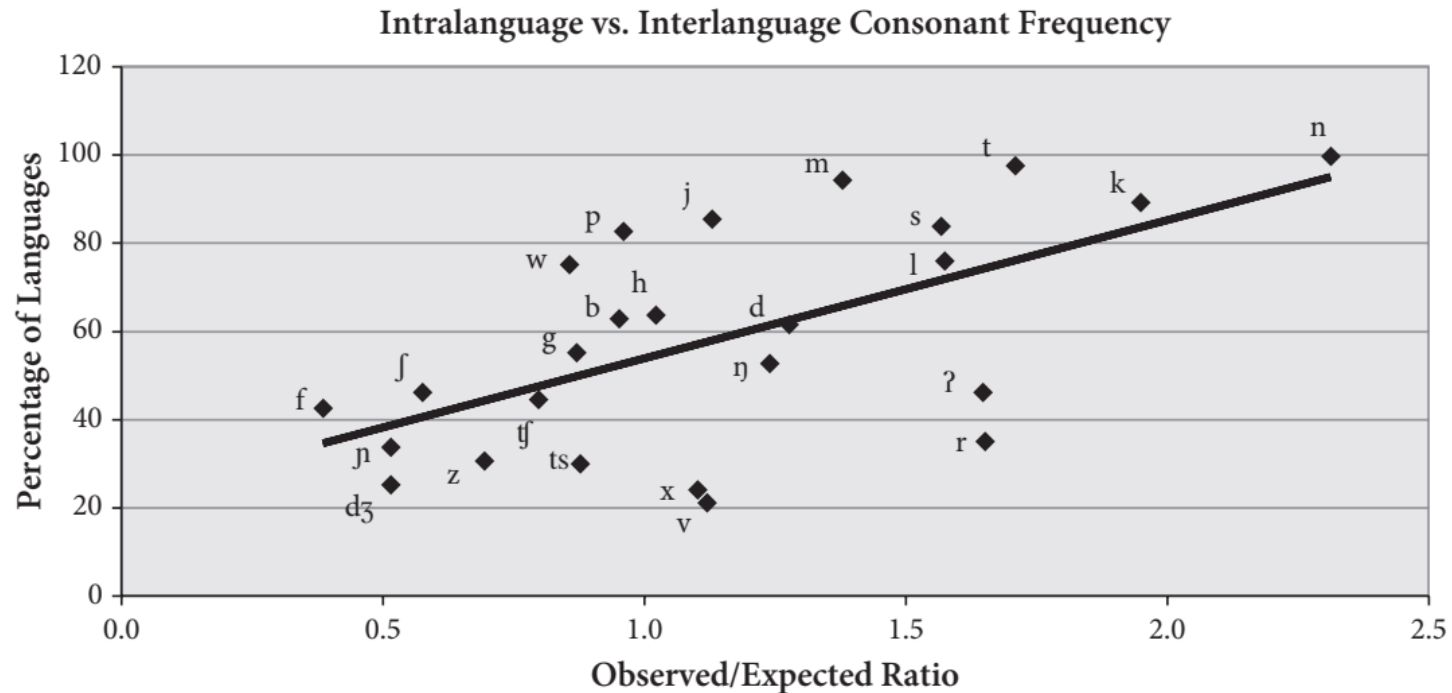
# Frequency Distributions Within Languages: Vowels

- Schwa [Ə] occurs with greater frequency within languages than three of the cardinal vowels /e, o, u/, even though schwa is considerably less common across languages.



Intralanguage vs. Interlanguage vowel frequency
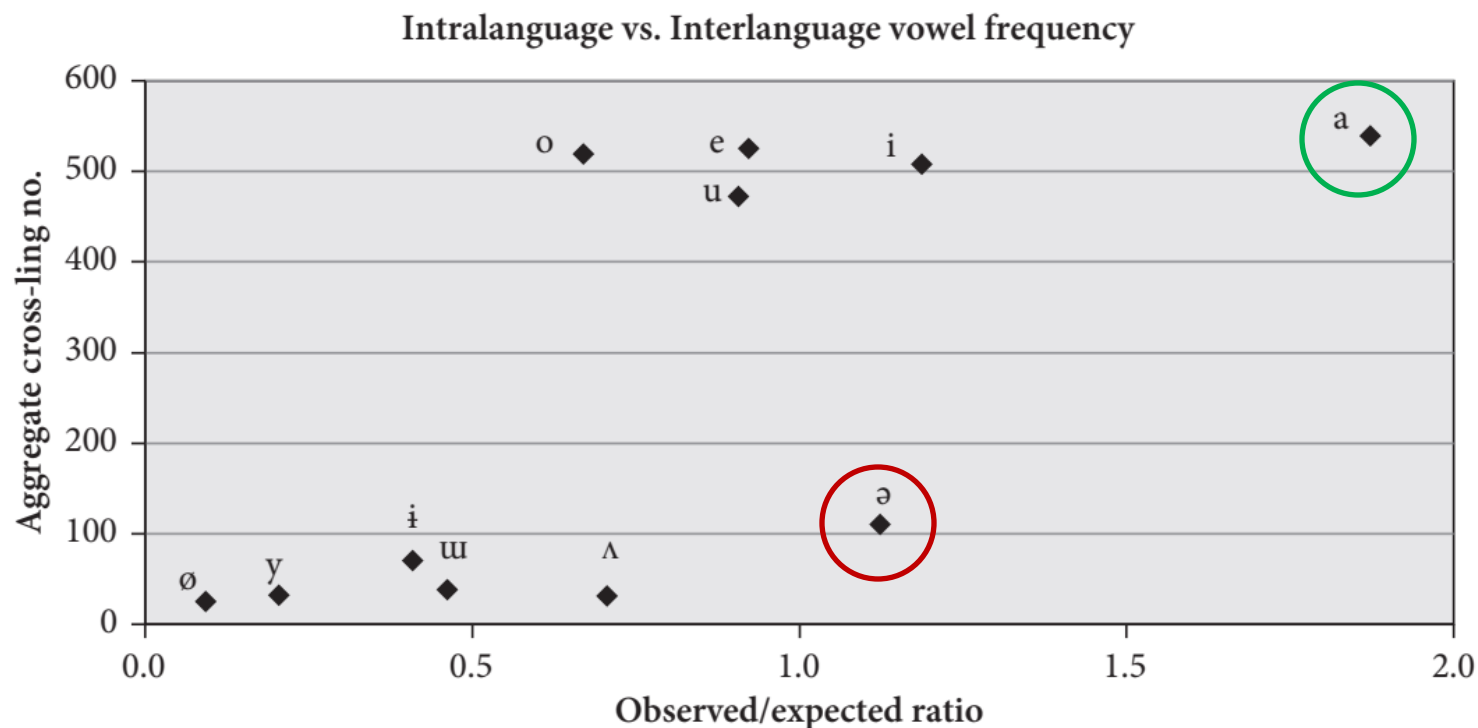
# Phoneme Inventories: Summary

- Although there is a large number of sounds attested in languages of the world, most languages only employ a relatively small subset of them to make contrasts.

- There are certain consonants and vowels that are much more common than others both cross-linguistically and within languages.

  - There is an extensive literature about the phonetic and phonological motivations for phoneme inventories.

- Changes: Constantly evolving nature of the lexicon leads to changes in intra-language frequency distribution of phonemes.

# Phonological Rule Typology: Segmental Processes

|  | Nom. sg. | Dim. (nom.sg.) | Loc.sg. |  |
|---|---|---|---|---|
|  | stol | stol$^j$ik | stol$^j$e | 'table' |

- Assimilation   (*bags* [bæ**gz**])
- Long-distance assimilation (e.g. harmony)
- Dissimilation (*pilgrim* ← lat. *peregrinus*)
- Fortition, Lenition, Deletion and compensatory lengthening (*p[ə]ˈtato, p[Ø]ˈtato*)
- Epenthesis (e.g. *oputimisuto* in Japanese as syllable repair, etc.)
- Metathesis (more sporadic, more diachronic)

VC metathesis in Late Common Slavic (Townsend and Janda 1996: 60–1)

| Late Common Slavic | Gloss | Polish | Bulgarian |
|---|---|---|---|
| gôrdŭ | 'enclosure' | grod | grad |
| golvá | 'head' | gwowa | glavá |
| sólma | 'straw' | wwoma | sláma |
| melkó | 'milk' | mleko | ml$^j$áko |

# Example of Assimilation: Vowel Harmony

- A type of long-distance assimilatory phonological process involving vowels,

- A vowel or vowels in a word are changed to sound similarly (thus "in harmony").

- In languages with vowel harmony, there are constraints on which vowels may be found near each other.

- Many agglutinative languages have vowel harmony.

**gün**
'day'

**günler**
'days'

**ay**
'month'

**aylar**
'months'

**L A R**

| FRONT | | BACK | |
|-------|---|------|---|
| e | ö | a | o |
| i | ü | ı | u |

**Turkish**

# Vowel Harmony



- Vowel harmony
  - Front-back (Turkish, Hungarian)
  - Height (N. Salentino)
  - Rounding (Turkish)
- Variations in Rounding Harmony
  - Kirghiz – all vowels assimilate in rounding to preceding vowels except that [a] does not assimilate to [u]
  - Turkish – only high vowels undergo, all round vowels trigger
  - Sakha (Yakut) – high vowels undergo, round vowels trigger; nonhigh vowels undergo if same height as trigger
  - Mongolian – only nonhigh vowels undergo, only nonhigh vowels trigger
  - Yawelmani – vowels undergo if same height as trigger
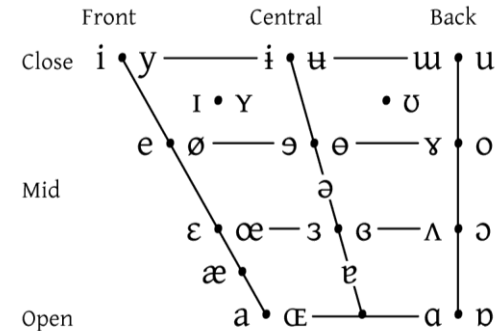
# Phonological Rule Typology: Segmental Processes

- A more complex problem than segment inventory typology, requires more language-particular commentary and analysis.

- All spoken languages have phonological rules, but not all rules are found in every language.

  - may be in certain language families but not in the others, e.g. rounding harmony common in Turkic languages

- Most phenomena affecting segments may be explained by minimizing articulating effort and enhancing perceptual salience.

# Vowel Harmony in Hungarian

| | | | | |
|---|---|---|---|---|
| háború | 'war' | | körút | 'ring way' |
| háborúról | 'about war' | | körről | 'about ring' |
| bűn | 'guilt' | | bátor | 'brave' |
| bűntelen | 'guiltless' | | bátorságról | 'about braveness' |
| bűnről | 'about guilt' | | bátortalan | 'not brave' |
| út | 'way' | | föld | 'field' |
| útról | 'about way' | | földtelen | 'fieldless' |
| keserű | 'bitter' | | burgonya | 'potato' |
| keserűség | 'bitterness' | | burgonyaföld | 'potato field' |
| keserűsó | 'bitter salt' | | sötét | 'dark' |
| kör | 'ring' | | sötétség | 'darkness' |

1. Which words are compounds and why?
2. Which of the following words can be divided into parts?

földtan, földnek, háborúellenes, Budapest, burgonyalevés, óraütés, hőálló, bűnöző.

3. Translate into Hungarian:
*guiltlessness, about field, about potato, wayless*

Joan Bybee. *Phonology and Language Use*. Cambridge University Press, 2003

Matthew K. Gordon. *Phonological Typology*. Oxford University Press, 2016

Dryer, Matthew S. & Haspelmath, Martin (eds.) 2013.
*The World Atlas of Language Structures Online*. Leipzig: Max Planck Institute for Evolutionary Anthropology.

David Odden. *Introducing Phonology*. Cambridge University Press, 2013

Paul de Lacy (eds.). *The Cambridge Handbook of Phonology*. Cambridge University Press, 2007

Ian Maddieson. *Typology of Phonological Systems*. In: Jae Jung Song (ed.) The *Oxford Handbook of Linguistic Typology*, Oxford University Press, 2010. Moran, Steven, McCloy, Daniel, and Wright, Richard (eds) (2014). PHOIBLE Online. Leipzig: Max Planck Institute for Evolutionary Anthropology. (Available online at <http://phoible.org>)

Liljencrants, Johan and Lindblom, Bjorn (1972). Numerical simulation of vowel quality systems: the role of perceptual contrast. Language 48: 839–62.

Schwartz, Jean-Luc, Boë, Louis-Jean, Valle´e, Nathalie, and Abry, Christian (1997). The Dispersion-Focalization Theory of vowel systems. Journal of Phonetics 25: 255–86

Lindblom, Björn and Maddieson, Ian (1988). Phonetic universals in consonant systems, in Larry Hyman and Charles N. Li, Language, Speech and Mind: Studies in Honour of Victoria A. Fromkin. New York: Routledge, 62–78.

Firchow, Irwin and Jacqueline, and David Akoitai, compiler. 1973. Vocabulary of Rotokas-Pidgin-English. Ukarumpa, P. N. G.: Summer Institute of Linguistics

Firchow, I. and Firchow, J. 1969. An abbreviated phoneme inventory. Anthropological Linguistics 11. 271-276

Lindblom, Björn and Maddieson, Ian. 1988. Phonetic Universals in Consonant Systems. In Li, C. and Hyman, L. M. (eds.), Language, Speech and Mind, 62-78. London: Routledge.

Maddieson, Ian (1984). Patterns of Sounds. Cambridge: Cambridge University Press.

Handbook of phonological data from a sample of the world's languages : a report of the Stanford Phonology Archive / compiled and edited by John H. Crothers ... [et al.]

Marilyn M. Vihman. *Phonology Archive Coding Manual*. Stanford University, 1974