

LSci 51/Psych 56L: Acquisition of Language

Lecture 9

Phonological development II

Announcements

Be working on the review questions for phonological development

Be working on HW3 (due 10/25/21)

Cross-linguistic variation in speech production



Interactive chart

of the

International Phonetic Alphabet

<http://www.ipachart.com/>

Click on a symbol to hear the sound it represents.

Pulmonic consonants

	Bi-labial	Labio-dental	Dental	Alveolar	Post-alveolar	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		ɳ̺	ɲ	ŋ	ɴ		
Trill				r					ʀ		
Tap or Flap				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		ɸ		ɹ		ɻ	j	ɰ			
Lateral Approximant				l		ɭ	ʎ	ʟ			

Where symbols appear in pairs, the one to the right represents a voiced consonant.
Areas shaded grey indicate articulations judged impossible.

Other symbols

ɱ	Voiceless labial-velar fricative
ɰ	Voiced labial-velar approximant
ɥ	Voiced labial-palatal approximant
ħ	Voiceless epiglottal fricative
ʕ	Voiced epiglottal fricative
ʡ	Epiglottal plosive
ɕ	Voiceless alveolo-palatal fricative
ʑ	Voiced alveolo-palatal fricative
ɺ	Alveolar lateral flap
ɺ͡ɰ	Simultaneous ɺ and ɰ

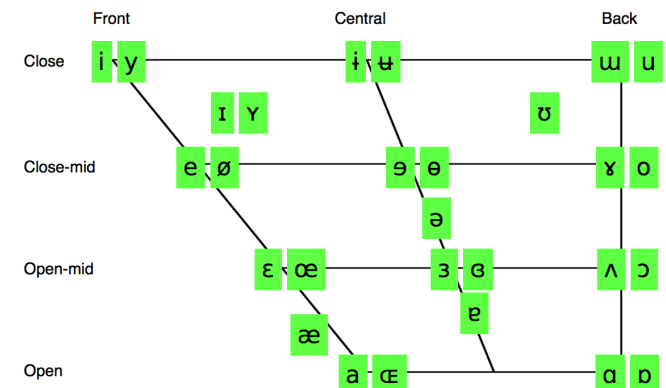
Affricates

ɬ͡ɳ	Voiceless alveolar affricate
ɬ͡ʃ	Voiceless palato-alveolar affricate
ɬ͡ɕ	Voiceless alveolo-palatal affricate
ɬ͡ʂ	Voiceless retroflex affricate
ɖ͡z	Voiced alveolar affricate
ɖ͡ʒ	Voiced post-alveolar affricate
ɖ͡ɕ	Voiced alveolo-palatal affricate
ɖ͡ʑ	Voiced retroflex affricate

Non-pulmonic consonants

Clicks	Voiced implosives	Ejectives
ɔ Bilabial	ɓ Bilabial	ɸ' Bilabial
ɮ Dental	ɗ Dental/alveolar	ɬ' Dental/alveolar
ɰ (Post)alveolar	ɠ Palatal	ɰ' Velar
ɰ̺ Palatoalveolar	ɠ Velar	ɰ' Alveolar fricative
ɰ̺̺̺ Alveolar lateral	ɠ Uvular	' etc...

Vowels



Where symbols appear in pairs, the one to the right represents a rounded vowel.

Describing speech sounds: Recap

Where is the air-flow blocked? (**place** of articulation)
labial, alveolar, palatal, velar etc.

Where/how is the air flowing? (**manner** of articulation)
nasal/oral, stop, fricative, liquid, tap/flap etc.

What are the vocal folds doing? (**voicing**)
voiced vs. *voiceless*

Features

Prediction: by combining a small number of atomic features, it should be possible to create a larger number of speech sounds

Goal: a set of universal features should make it possible to describe the speech sounds of all of the languages of the world

Different languages choose different feature combinations

	(bi)labial	labio-dental	inter-dental	al-veolar	post-alveolar	palatal	velar	glottal
(oral) stop	p b			t d			k g	
nasal (stop)	m			ŋ			ŋ	
fricative		f v	θ ð	s z	ʃ ʒ			h
affricate						tʃ dʒ		
liquid				l ɹ				
glide					j		w	
flap				ɾ				

	(bi)labial	labio-dental	inter-dental	al-veolar	post-alveolar	palatal	velar	glottal
(oral) stop	p b			t d			k g	
nasal (stop)	m			n		?	ŋ	
fricative	?	f v	θ ð	s z	ʃ ʒ		?	h
affricate						tʃ dʒ		
liquid				l ɹ		?		
glide					j		w	
flap				ɾ				

	(bi)labial	labio-dental	inter-dental	al-veolar	post-alveolar	palatal	velar	glottal
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fricative	ɸ β	f v	θ ð	s z	ʃ ʒ		?	h
affricate						tʃ dʒ		
liquid				l		?		
glide					j		w	
flap				ɾ				

“Fuji”
“Cuba”

	(bi)labial	labio-dental	inter-dental	al-veolar	post-alveolar	palatal	velar	glottal
(oral) stop	p b			t d			k g	
nasal (stop)	m			n		ɲ	ŋ	
fricative	ɸ β	f v	θ ð	s z	ʃ ʒ		? ?	h
affricate								
liquid				l ɭ		ʎ	?	
glide					j		w	
flap				r				

“año”

	(bi)labial	labio-dental	inter-dental	al-veolar	post-alveolar	palatal	velar	glottal
(oral) stop	p b			t d			k g	
nasal (stop)	m			n		ɲ	ŋ	
fricative	ɸ β	f v	θ ð	s z	ʃ ʒ		x ɣ	h
affricate								
liquid				l ɭ				
glide					j		w	
flap				ɾ				

“Bach”
“agua”

?

	(bi)labial	labio-dental	inter-dental	al-veolar	post-alveolar	palatal	velar	glottal
(oral) stop	p b			t d			k g	
nasal (stop)	m			n		ɲ	ŋ	
fricative	ɸ β	f v	θ ð	s z	ʃ ʒ		x ɣ	h
affricate						tʃ dʒ		
liquid				l ɭ		ʎ		
glide					j		w	
flap				ɾ				

“caballo”

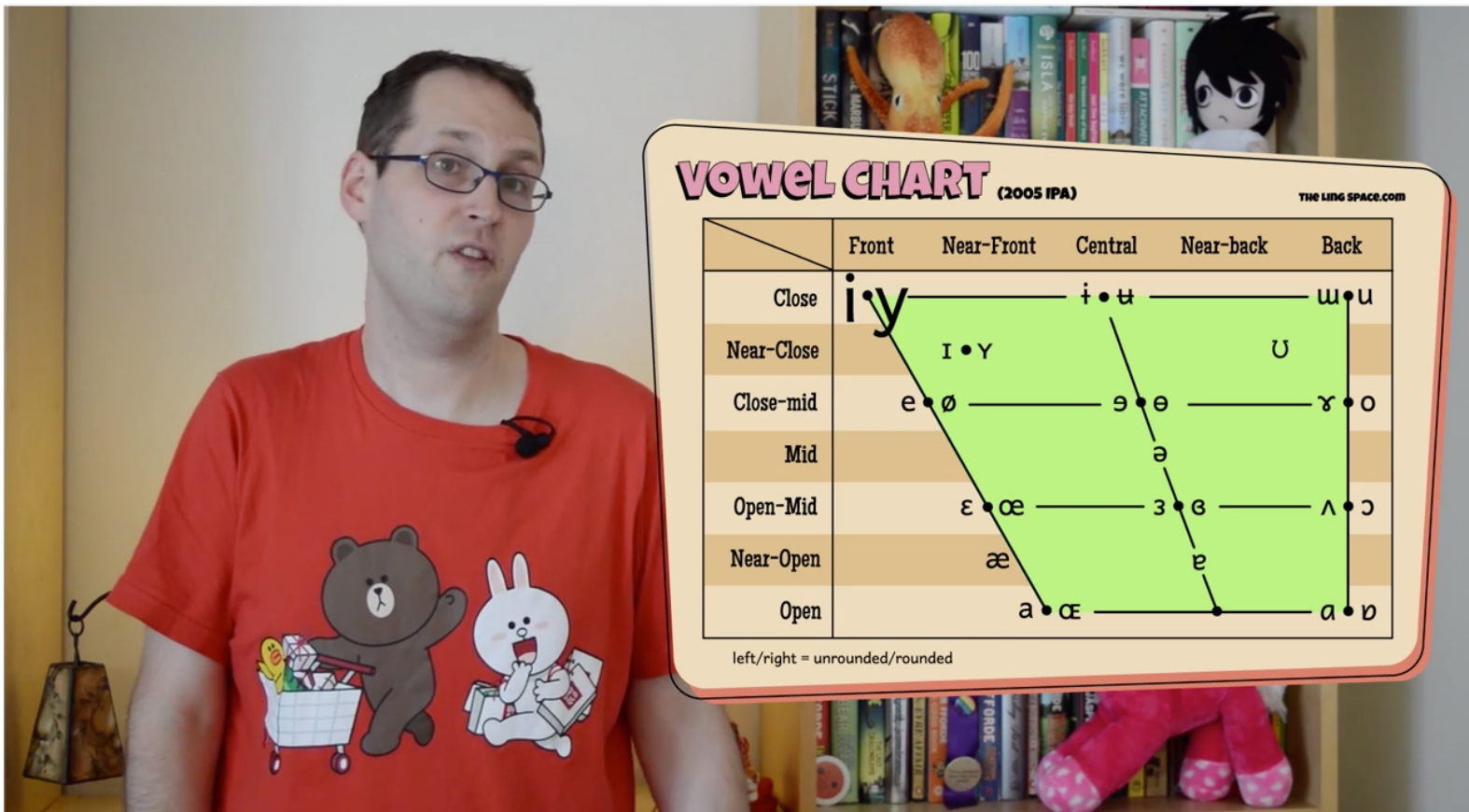
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affricate						tʃ dʒ		
liquid				l ɭ		ʎ		
glide					j		w	
flap				ɾ				

Cross-language differences

<https://www.youtube.com/watch?v=arMntA15A0s>

<http://www.thelingspace.com/episode-27>

4:10 through 5:08



VOWEL CHART (2005 IPA) THE LING SPACE.COM

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

left/right = unrounded/rounded

[Extra]

Cross-language differences

Feature Combinations

English: back vowels are rounded, others are not

German/French has high, front, rounded vowel [y]

Russian has high back unrounded vowel [ɯ]

Many languages don't make the tense/lax distinction found in English (ex: Spanish [i], rather than [i] and [ɪ])

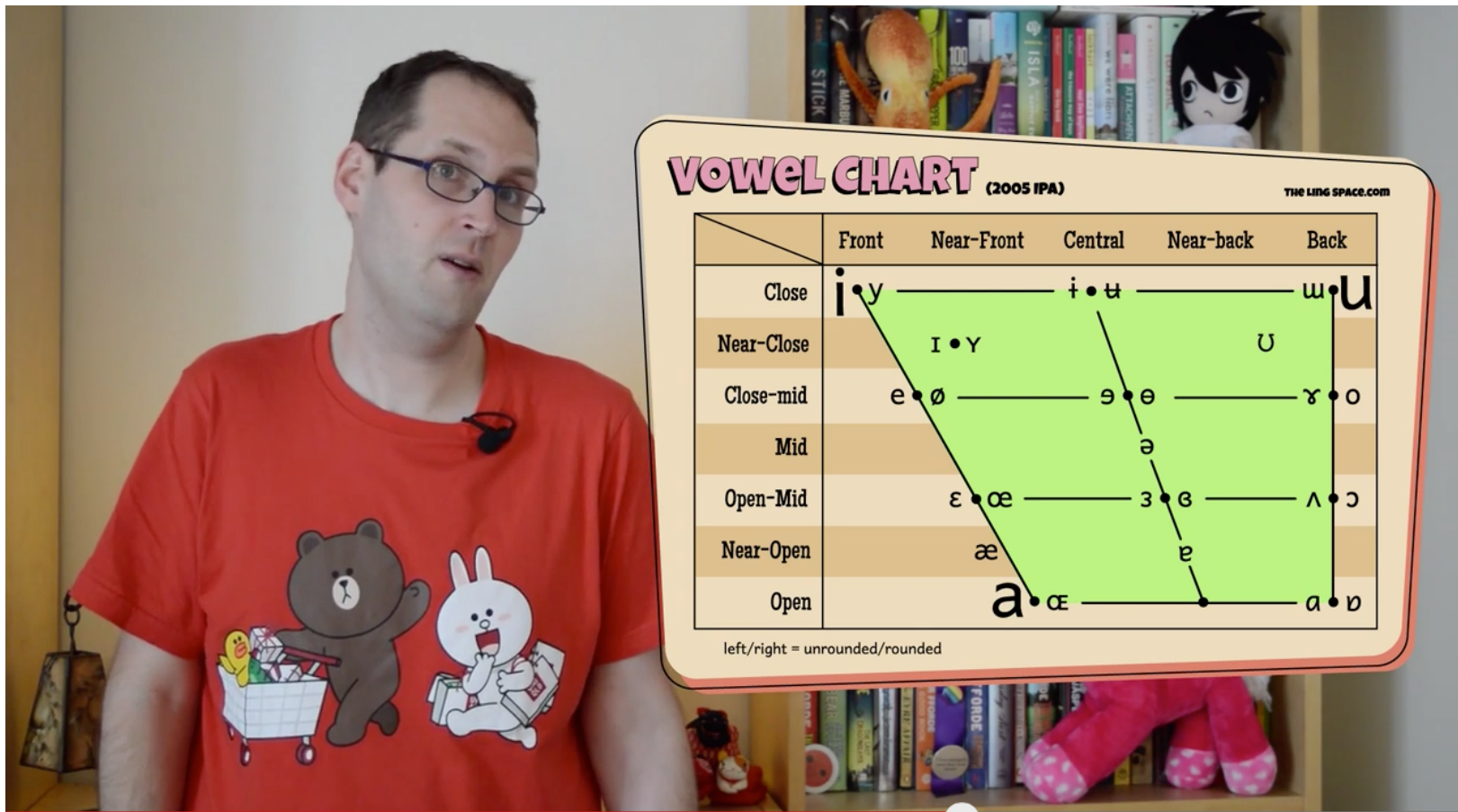
Many languages distinguish short and long vowels (unlike English), ex: Japanese [i] vs. [i:]

Cross-language differences

<https://www.youtube.com/watch?v=arMntA15A0s>

<http://www.thelingspace.com/episode-27>

5:08 through 7:02



VOWEL CHART (2005 IPA) THE LING SPACE.COM

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

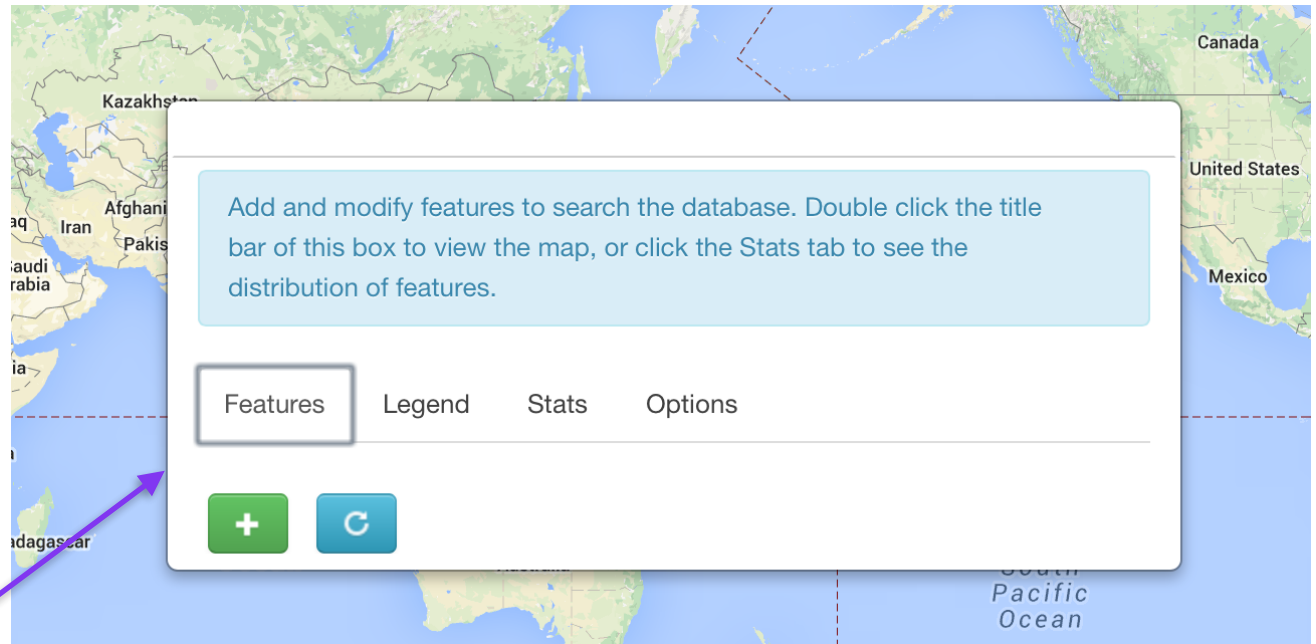
left/right = unrounded/rounded

Cross-linguistic variation in sounds (called segments)

<http://phonotactics.anu.edu.au/index.php>

[In-class demo if the site is working]

WORLD PHONOTACTICS DATABASE
Home
Introduction to phonotactics
How to use this site
Features
Sample
Contributing
Citing
Downloads
Contact
Launch database

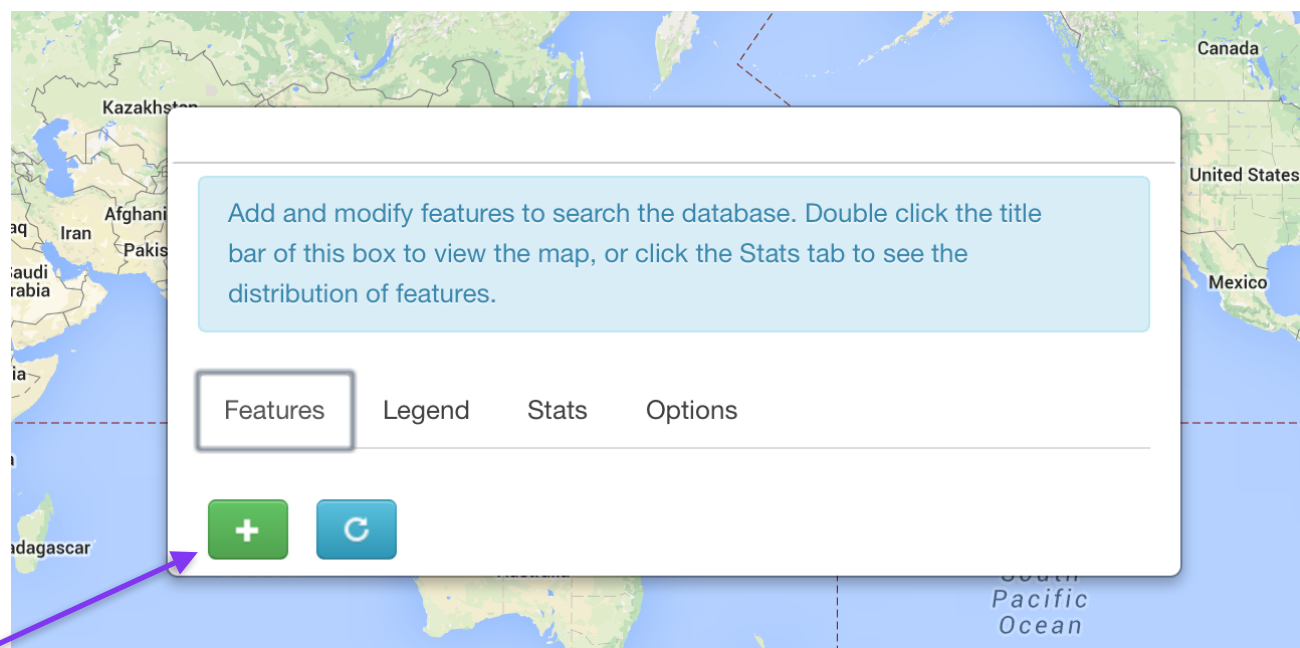


Click on this to get this

Cross-linguistic variation in sounds (called segments)

<http://phonotactics.anu.edu.au/index.php>

[Extra]



Then look through the features

Cross-linguistic variation in sounds (called segments)

<http://phonotactics.anu.edu.au/index.php>

[Extra]

The screenshot shows the Phonotactics database interface. At the top, there is a map of the world with a white overlay box containing the text: "Add and modify features to search the database. Double click the title bar of this box to view the map, or click the Stats tab to see the distribution of features." Below the map, there is a navigation bar with four tabs: "Features", "Legend", "Stats", and "Options". The "Features" tab is currently selected. Below the navigation bar, there are two buttons: a green "+" button and a blue circular refresh button. A purple arrow points from the text "Then look through the features till you find segments" to the "+" button. To the right of the buttons, there is a list of linguistic features under the heading "Segments: consonants". The list includes: "Total obstruents", "Total sonorants", "Total egressive consonants", "Segments: consonants: plosives", "Total plosives", "Supralaryngeal Plosive places", "Supralaryngeal Plosive series", "Plosive manners", "Voiceless plosives?", "Voiced plosives?", "Aspirated plosives?", "Ejective plosives?", "Imploded/glottalised plosives?", and "Prenasalised plosives?".

Then look through the features till you find segments

Cross-linguistic variation in sounds (called segments)

<http://phonotactics.anu.edu.au/index.php>

[Extra]

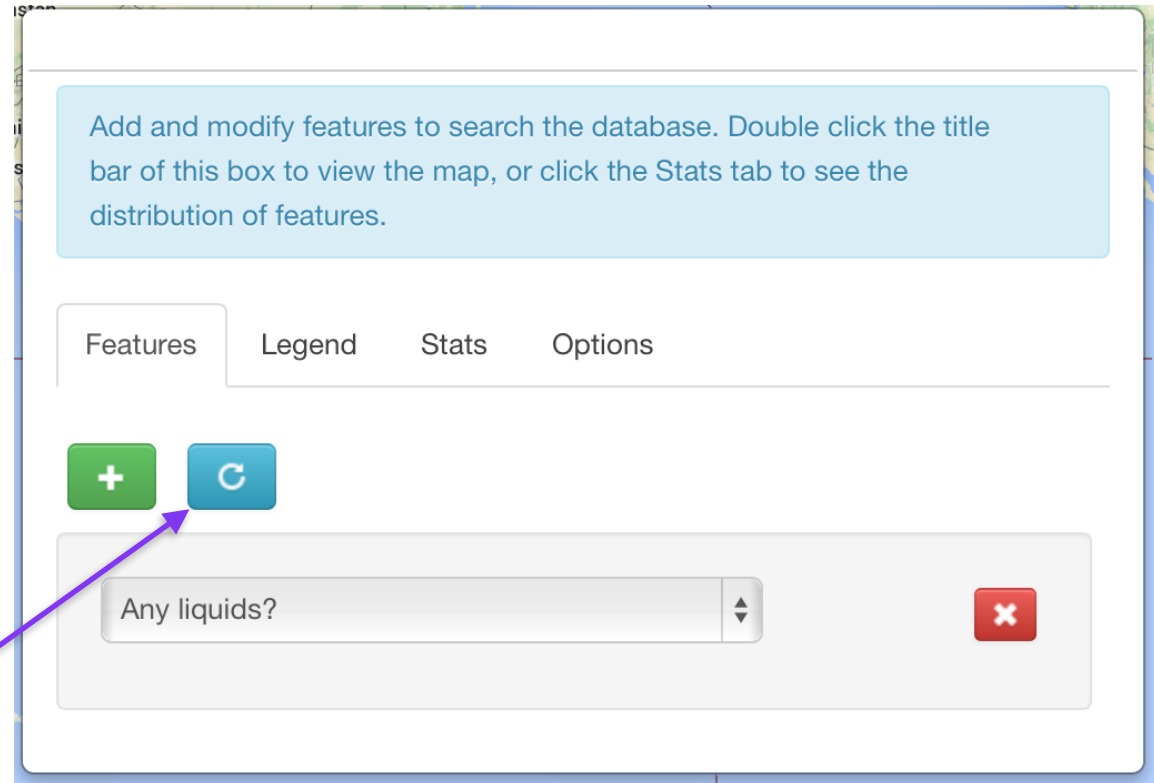
The screenshot displays the Phonotactics database interface. A map of the world is visible in the background, with a white overlay box containing a light blue instruction: "Add and modify features to search the database. Double click the title bar of this box to view the map, or click the Stats tab to see the distribution of features." Below the map, there is a "Features" section with a green "+" button and a blue circular refresh button. A purple arrow points from the text "Select something of interest" to the "+" button. To the right, a dropdown menu is open, listing various phonological features such as "Pharyngeal fricatives", "Any liquids?", "Total liquids", "Any rhotics?", "Any laterals?", "Bilabial trills?", "Total rhotics", "Total lateral", "Lateral places", "Liquid manners", "Voiceless liquids?", "Glottalised liquids?", and "Breathy liquids?".

Select something of interest

Cross-linguistic variation in sounds (called segments)

<http://phonotactics.anu.edu.au/index.php>

[Extra]

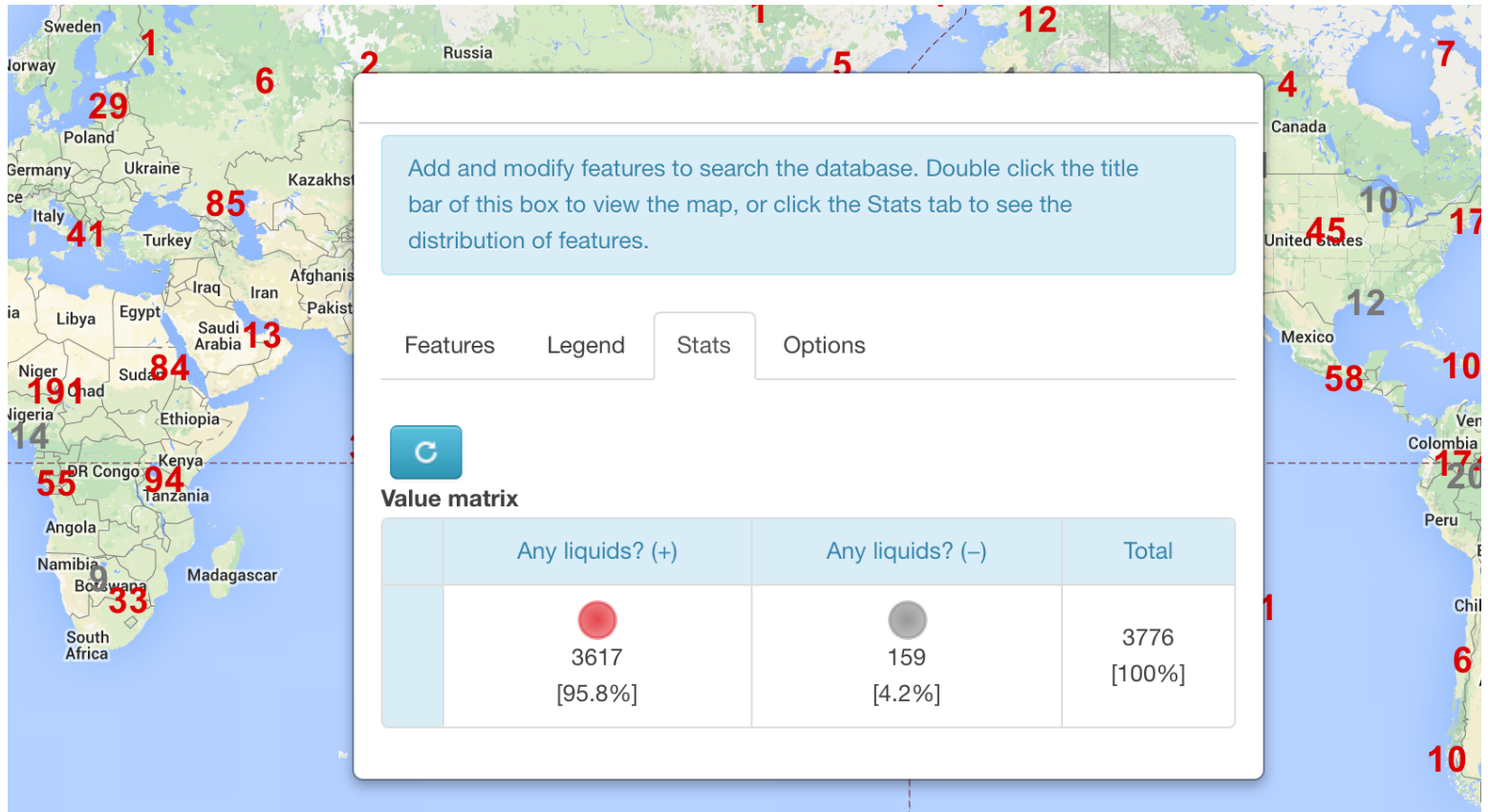


And see how the languages of the world look

Cross-linguistic variation in sounds (called segments)

[Extra]

<http://phonotactics.anu.edu.au/index.php>



The world's languages are full of lots of fun variation when it comes to the sounds they use.

[Extra]

Pronunciations of different languages

https://richardbeare.github.io/marijatabain/ipa_illustrations_all.html



[Extra]

More details of American English pronunciation

http://en.wikipedia.org/wiki/General_American

Monophthongs	Front	Central		Back
		plain	rhotacized	
Close	i			u
Near-close	ɪ			ʊ
Close-mid	e ^[4]			o ^[4]
Mid		ə	ɚ	
Open-mid	ɛ		ɜ˞	ʌ • ɔ
Near Open	æ			ɑ

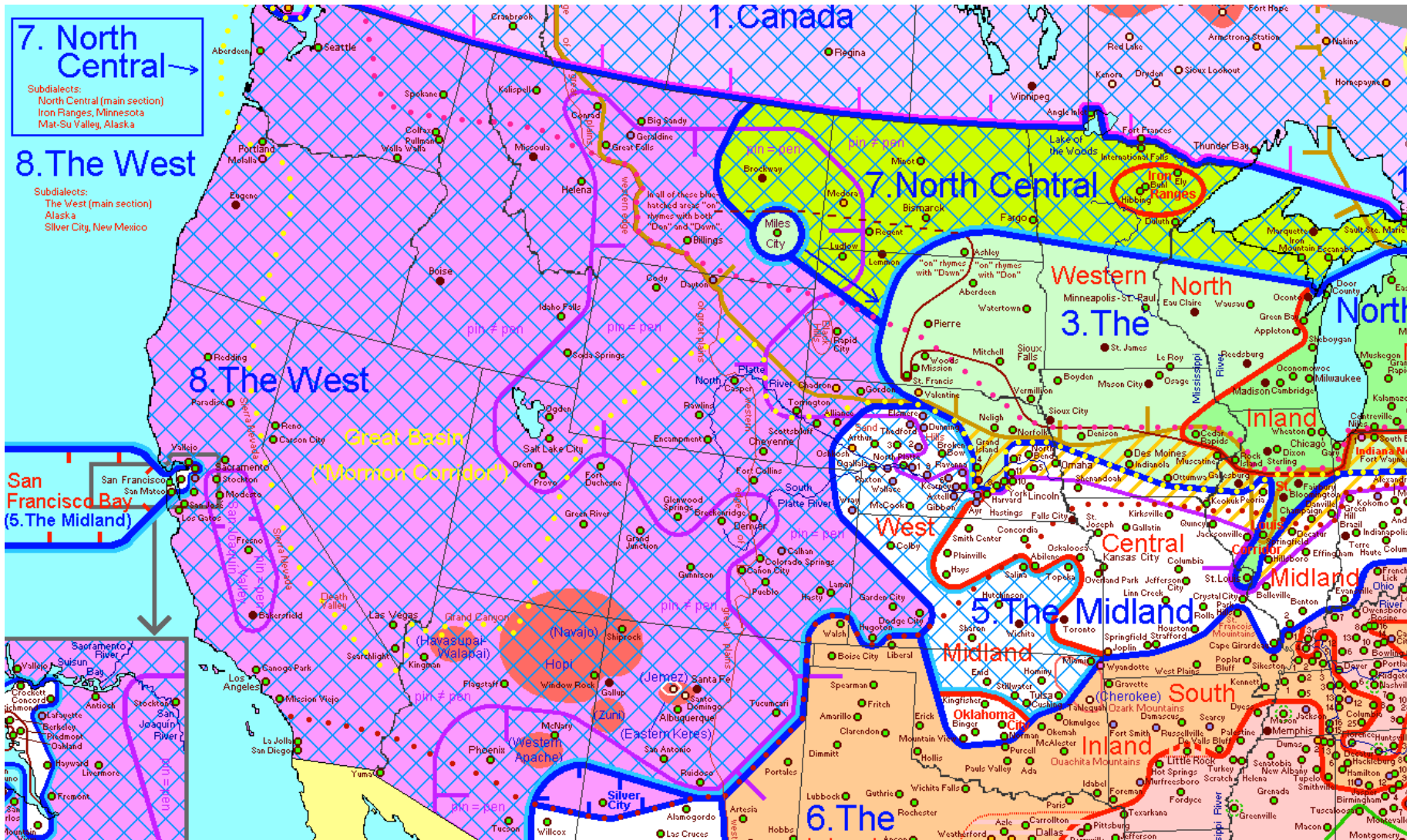
Depending on one's analysis, people who *merge the vowels of *cot* and *caught** to /ɑ/ either have /noʊθ/ and /hoʊs/, but since all accents with *cot* and *caught* merged to /kɑt/ have also undergone these changes, the [ɔ] before /ɑ/ can be analyzed as an allophone of /ɑ/. [ɜ˞] and [ə] are often unstressed syllables. Since the occurrence of [ə] is mostly predictable, it need not be considered. Among speakers who distinguish between /ɑ/ and /ɔ/, the vowel of *cot* (usually transcribed /ɔ/ closer to [ɔ]).^[6] Among *cot-caught* merged speakers, /ɑ/ usually remains a back vowel, [ɑ], or /ɔ/, their retracted allophones for /ɑ/ may be identical to the lowered allophones of /ɔ/ among. The *diphthongs* of General American are shown in the next table:

Diphthongs	Offglide is a front vowel	Offglide is a back vowel
Opener component is unrounded	aɪ eɪ ^[4]	aʊ
Opener component is rounded	ɔɪ	oʊ ^[4]

[Extra]

Dialect variation in North American English

<http://aschmann.net/AmEng/>



Prelinguistic “speech” production



Stages of prespeech vocal development

Newborns make biologically-related sounds: reflexive crying, burping, breathing, sucking

Helpful: infants' **vocal cords vibrate** & **airflow through the vocal apparatus** is stopped and started



Stages of prespeech vocal development

Around 6-8 weeks: infants start **cooing**
(sounds that result from being happy).

First coos sound like one long vowel - but
over many months, babies acquire a
variety of different vowel sounds.



Stages of prespeech vocal development

Around 16-30 weeks: **vocal play**. Infants use a variety of different consonant-like and vowel-like sounds. At the end of this stage, infants form long combinations of the sounds (**marginal babbling**).

Recognizable vowel sounds heard at the beginning, while recognizable consonant sounds (usually **velars like k/g**) are usually heard around 2-3 months. Recognizable consonant sounds occurring near the **front of the mouth (n/m/p/b/d)** come in around 6 months of age.



Stages of prespeech vocal development

Around 6-9 months: **canonical/reduplicated babbling**, with actual syllables in the sounds produced (ex: [dadada]). These syllables are often repeated in a row.

Social aspect: **babies don't give any indication that they're initially babbling to communicate (no intentionality at this point) even though sometimes it may look like it.** They babble in the car and their crib, showing no sign that they expect any reply.

Note: **even deaf infants babble**, but they tend to produce marginal babbling instead of canonical babbling.



Stages of prespeech vocal development

After canonical babbling: **nonreduplicated/variegated babbling**, with non-repetitive syllables and more variety in consonant and vowel sounds. Infants also incorporate **prosody** (the rhythm of the language) into their babbling, which makes it sound much more like they're trying to talk. However, the “words” in this kind of babbling are usually only 1 or 2 syllables.

http://www.youtube.com/watch?v=_JmA2CIUvUY



Developmental links of babbling

nonreduplicated babbling



Farquharson, Hogan, Hoffman, Wang, Green, & Green 2018. Children with **more complex babbling** between 9 and 30 months do **better at core skills needed for literacy** at age 6.

<https://www.sciencedaily.com/releases/2018/10/181010141736.htm>



Stages of prespeech vocal development



0 weeks

reflexive crying, biological-based sounds

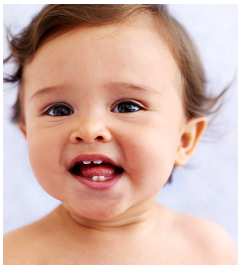
6-8 weeks

cooing



16 weeks

vocal play begins



36 weeks

reduplicated/canonical babbling



48 weeks

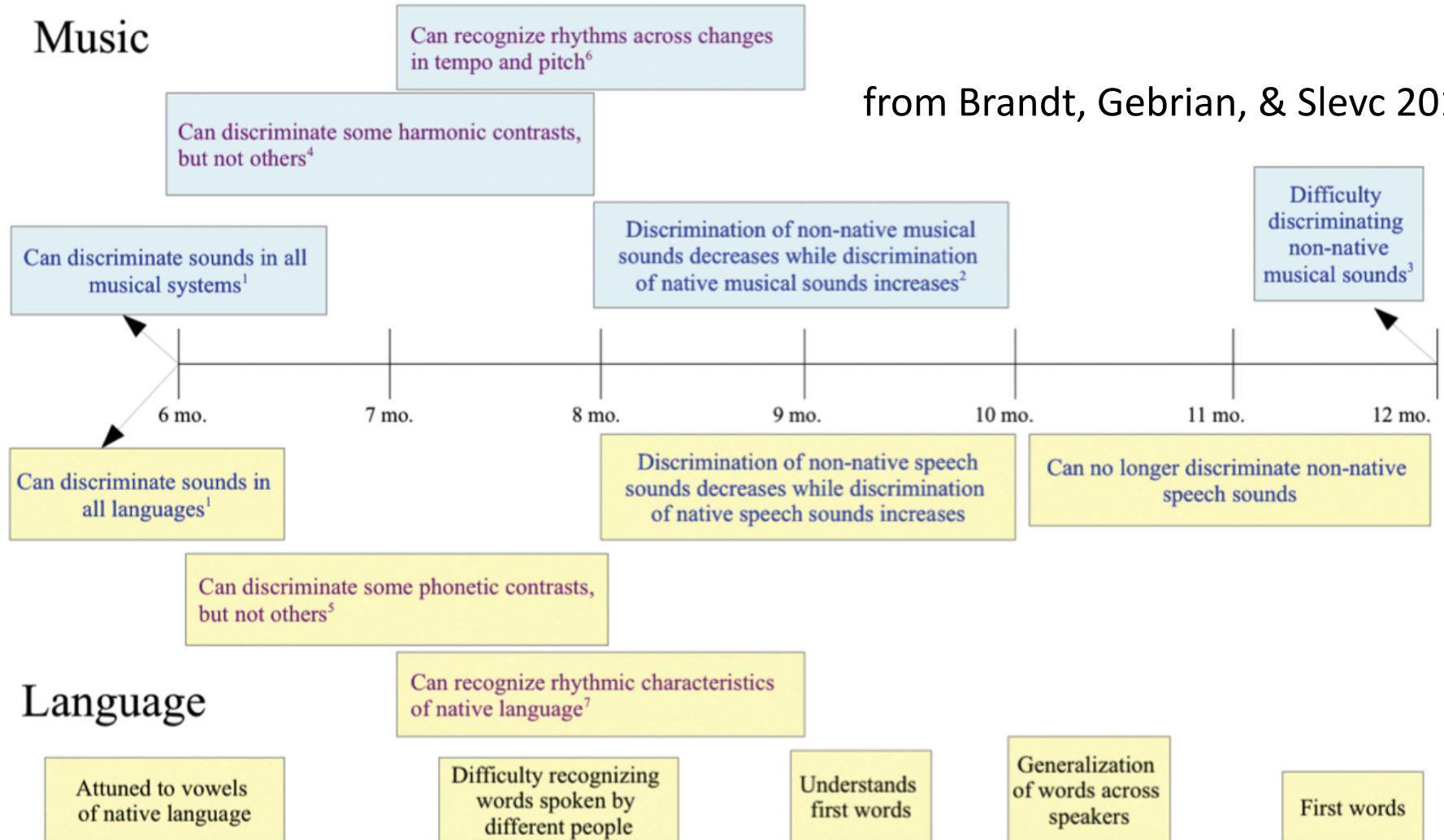
nonreduplicated babbling

First Word

Language- and culture-specific effects: Language and music

[Extra]

from Brandt, Gebrian, & Slevc 2012



Language and music

Similarity in inner ear processing of speech sounds & music sounds + different from other auditory processing

On Warren, Ramamoorthy, Ciganovic, Zhang, Wilson, Petrie, Wang, Jacques, Reichenbach, Nuttall & Fridberger 2016:

“...the parts of the inner ear that process sounds such as speech and music seem to work differently than other parts of the inner ear. ”



<https://www.sciencedaily.com/releases/2016/07/160711092510.htm>

Language and music

But there are neural specializations for language vs music

On Albouy, Benjamin, Morillon, & Zatorre
2020:

“...the **two hemispheres respond to speech and music differently**...we show that this hemispheric specialization is linked to basic acoustical features that are relevant for speech and music. ”



<https://www.sciencedaily.com/releases/2020/02/200227144317.htm>

Language and music: Developmental linking

On Gordon et al. 2014:

“Though the grammatical and musical tests were quite different, Gordon found that children who did well on one kind tended to do well on the other, regardless of IQ, music experience and socioeconomic status...Perhaps children who are better at detecting variations in music timing are also better at detecting variations in speech and therefore have an advantage in learning language...”

<http://www.sciencedaily.com/releases/2014/11/141105101238.htm>



Language and music: From music to language

On Zhao & Kuhl 2016:

“Babies in the music group had **stronger brain responses** to the disruption in **both music and speech rhythm** in both the auditory and the prefrontal **cortex**, compared with babies in the control group. This suggests that participation in the **play sessions with music** improved the infants' ability to **detect patterns in sounds**.”

<https://www.sciencedaily.com/releases/2016/04/160425161148.htm>

<https://www.youtube.com/watch?v=whzxMNvHBD4&feature=youtu.be>
Musical stimuli example: 0:09-0:26



Language and music: From music to language

4- to 5-yr-old Mandarin-speaking children receiving piano lessons for 6 months vs. extra reading lessons for 6 months:

“Children who had piano lessons showed a significant advantage over children in the extra reading group in **discriminating between words that differ by one consonant.**”

<https://www.sciencedaily.com/releases/2018/06/180625192827.htm>



Language and music: From music to language

For hearing-impaired children with cochlear implants (Torppa & Huotilainen 2019):

“...musical activities [especially singing] develop children's perception of prosody, such as rhythm and pitch variation, and spoken language.”

<https://www.sciencedaily.com/releases/2019/06/190627114029.htm>



Language and music: Not from language to music

On Langus et al. 2016:

“Several clues, like the fact that many of the cortical auditory regions responsible for linguistic and musical processing are the same and the existence of auditory illusions dependent on the mother tongue or dialect, have led investigators to **hypothesize that native listening transfers also to non-linguistic sound stimuli such as music**. [However,] Alan Langus...and other colleagues demonstrat[ed] that there is **no transfer to the non-linguistic domain**.”

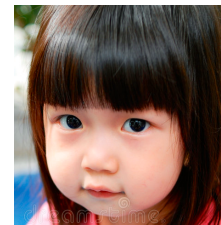
<https://www.sciencedaily.com/releases/2016/02/160224070645.htm>



Language and music:

Yes from language to music

Creel, Weng, Fu, Heyman, & Lee 2018 — pitch perception in 3- to 5-yr-olds: “...we compared the pitch perception of Chinese children who spoke a tone language (i.e., Mandarin) with English-speaking American children. We found that **Mandarin-speaking children were more advanced at pitch processing** than English-speaking children but both groups performed similarly on a control music task (timbre discrimination). The findings support...that tone languages drive attention to pitch in nonlinguistic contexts, and suggest that **language learning benefits aspects of music perception in early development.**”



Language-specific effects

“From the moment of birth, babies cry in the accent of their mother's native language...” – Annie Murphy Paul, 2011 *Ted Talk: What We Learn Before We're Born*



“...the foundation for the richness of variants of later intonation patterns in speech is already laid during crying.” (Wermke, Robb, & Schluter 2021)

<https://www.sciencedaily.com/releases/2021/02/210224100904.htm>



Is all babbling the same?

Besides the differences between the vocal babbling of deaf children and non-deaf children, **babies' babbling is also influenced by the language they hear.**

How do we know?

(1) Test competent native speakers.

Record the babbling of babies who are learning to speak different languages (ex: French, Arabic, Chinese, English). See if native speakers can identify which baby's babble is from their language (ex: asking French mothers to choose between Arabic babble and French babble as French.)



De Boysson-Bardies, Sagart, and Durand (1984): **recordings of 8-month-old babblings can be recognized by language.**

Is all babbling the same?

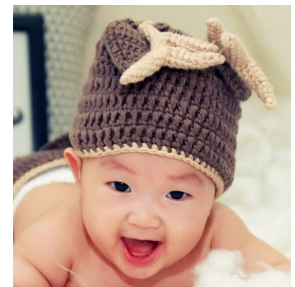
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Lee, Jhang, Chen, Reylea & Kimbrough Oller 2016: **recordings of 8-month-olds, 10-month-olds, and 12-month-olds can be recognized by language** (English vs. Chinese), though only when the babblings are word-like.



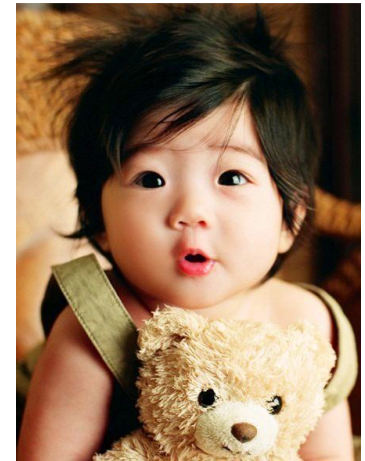
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Besides the differences between the vocal babbling of deaf children and non-deaf children, **babies' babbling is also influenced by the language they hear.**

How do we know?

(2) See if babbling features accord with language features

Determine which vowels and consonants (and other features) appear in babbling, and how frequently they appear. Compare to target language's features.



Ex: Japanese & French words contain more nasal sounds than Swedish & English words; Japanese & French babbles contain more nasal sounds than Swedish & English babbles.

NASAL Vowels

Is all babbling the same?

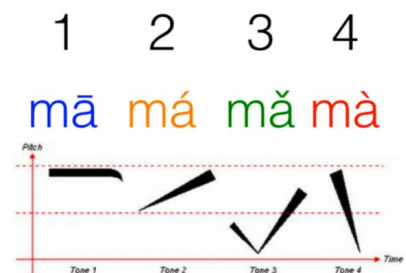
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How do we know?

(2) See if babbling features accord with language features

Determine which vowels and consonants (and other features) appear in babbling, and how frequently they appear. Compare to target language's features.

Ex: Mandarin Chinese uses tone-like pitches to distinguish meaning, and **Mandarin babbles also use these tone-like pitches while English babbles do not** (Meltzoff et al. 2009).



Is all babbling the same?

Besides the differences between the vocal babbling of deaf children and non-deaf children, **babies' babbling is also influenced by the language they hear.**

How do we know?

(2) See if babbling features accord with language features

Determine which vowels and consonants (and other features) appear in babbling, and how frequently they appear. Compare to target language's features.

Even **Mandarin Chinese newborn cries carry the tonal contours of Mandarin** (Wermke, Teiser, Yovsi, Joscha Kohlenberg, Wermke, Robb, Keller, & Lamm 2016).



Processes underlying speech sound development

Three main factors

Physical growth & development of the vocal tract

Development of brain & other neurological structures responsible for vocalization

Experience

Processes underlying speech sound development

Physical growth & development of the vocal tract

A newborn's vocal tract is smaller & shaped differently from an adult's. (Ex: The tongue fills the entire mouth, limiting range of motion.)

“A newborn has a vocal tract like a nonhuman mammal. The larynx comes up like a periscope and engages the nasal passage, forcing the infant to breathe through the nose and making it anatomically possible to drink and breathe at the same time.” – Steven Pinker, *The Language Instinct*



Processes underlying speech sound development

Physical growth & development of the vocal tract

“By three months the larynx has descended deep into the throat, opening up the cavity behind the tongue (the pharynx) that allows the tongue to move forwards and backwards and produce the variety of vowel sounds used by adults.”

– Steven Pinker, *The Language Instinct*

As the facial skeleton grows, the tongue gets more room. This happens during the vocal play stage, and the exploration of this new vocal freedom may be the cause of the vocal play itself.



Processes underlying speech sound development

Development of brain & other neurological structures responsible for vocalization

Later neurological developments in higher brain structures correlate with developments in vocalization.

Ex: Onset of **cooing** at 6-8 weeks coincides with development of **limbic** system (associated with expression of emotion in both humans and other animals).

Ex: Maturation of areas in the **motor cortex** may be required for the onset of **canonical babbling**.



Processes underlying speech sound development

Experience

Experience 1: Hearing the **speech adults produce** (this influences the sounds children choose to babble and the prosodic character of later babbling)

Choi, Cutler, & Boersma 2017:

Speech heard before six months impacts a child's ability to produce those sounds later, even if the child switches to a completely different language environment afterwards: "The subconscious knowledge can then be tapped to speed up learning of the pronunciation of sounds of the lost tongue."



<https://www.sciencedaily.com/releases/2017/01/170118082828.htm>

Processes underlying speech sound development

[Extra]

Experience

Experience 1: Hearing the **speech adults produce** (this influences the sounds children choose to babble and the prosodic character of later babbling)

From Curtin & Zamuner 2014 (Box 1):

The amount of time 12-month-olds spend listening to speech is related to vocabulary size at 18 months (Newman et al. 2006).



Processes underlying speech sound development

[Extra]

Experience

Experience 1: Hearing the **speech adults produce** (this influences the sounds children choose to babble and the prosodic character of later babbling)

<https://www.sciencedaily.com/releases/2016/05/160523141552.htm>

Value for learning words later on:

“...we show that experience is essential in guiding infants, with increasing precision, to single out **which signals from the initially privileged set they will continue to link to meaning and which they will tune out.**” — Sandra Waxman



“...merely exposing 6-month-old infants to nonhuman primate vocalizations permits them to preserve, rather than sever, their early link between these signals and categorization.”

Processes underlying speech sound development

[Extra]

Experience

Experience 1: Hearing the **speech adults produce** (this influences the sounds children choose to babble and the prosodic character of later babbling)

<https://www.sciencedaily.com/releases/2021/03/210311142203.htm>

Value for learning words later on:

...but zebra finch vocalizations don't do this (Woodruff Carr, Perszyk, & Waxman 2021).

“...We now know that infants' earliest link, which is sufficiently broad to include non-human primate calls, does not include zebra finch song.”



Processes underlying speech sound development

[Extra]

Experience

Experience 1: Hearing the **speech adults produce** (this influences the sounds children choose to babble and the prosodic character of later babbling)

<https://www.sciencedaily.com/releases/2016/10/161005105845.htm>

<https://www.sciencedaily.com/releases/2016/08/160810113842.htm>

Value for learning words later on:

“...infants also pay attention to language cues in deciding where to place their attention...
infants **focused on the object that had first been presented by the native speaker** for a longer period of time....”



Marno, Guellai, Vidal, Franzoi, Nespor, & Mehler 2016

Processes underlying speech sound development

Experience

Experience 1: Hearing the **speech adults produce** (this influences the sounds children choose to babble and the prosodic character of later babbling)

Important: There appears to be a social component involved.

(1) Infants increase the complexity of their vocal output **when their mother provides immediate social feedback** (Goldstein, King, & West 2003).



Processes underlying speech sound development

Experience

Experience 1: Hearing the **speech adults produce** (this influences the sounds children choose to babble and the prosodic character of later babbling)

Important: There appears to be a social component involved.

(1) ...and mothers respond more often when babbling is perceived as more mature.

"The increased rate of response meant more language-learning opportunities for the baby. The mothers' speech was also more likely to contain simplified, learnable information about linguistic structure and the objects around the baby. Thus, by varying the form and context of their vocalizations, **infants influence maternal behavior and create social interactions that facilitate learning.**"



<https://www.sciencedaily.com/releases/2018/01/180118142545.htm>

Albert, Schwade, & Goldstein 2016

Processes underlying speech sound development

Experience

Experience 1: Hearing the **speech adults produce** (this influences the sounds children choose to babble and the prosodic character of later babbling)

Important: There appears to be a social component involved.

(1) ...and mothers also modify their speech to be an even better language learning signal when responding to their infants' babbling.

"...adults unconsciously modify their speech to include fewer unique words, shorter sentences, and more one-word replies **when they are responding to a baby's babbling**, but not when they are simply speaking to a baby."



<https://www.sciencedaily.com/releases/2019/08/190821125522.htm>

Elmlinger, Schwade, & Goldstein 2019

Processes underlying speech sound development

Experience

Experience 1: Hearing the **speech adults produce** (this influences the sounds children choose to babble and the prosodic character of later babbling)

Important: There appears to be a social component involved.

(2) 8-month-old infants increase their consonant-vowel vocalizations (canonical & non-canonical babbling) **when their mother responds to what she thinks they're saying**. The babies also learn to direct more of their babbling to their mothers (Gros-Louis, West, & King 2014) and have larger vocabularies later on (Lopez, Walle, Pretzer, & Warlaumont 2020.).



<http://www.sciencedaily.com/releases/2014/08/140827122632.htm>

<https://www.sciencedaily.com/releases/2020/11/201125154815.htm>

Processes underlying speech sound development

Experience

Experience 1: Hearing the **speech adults produce** (this influences the sounds children choose to babble and the prosodic character of later babbling)

Important: There appears to be a social component involved.

(3) Infants learn foreign sounds (ex: American infants learning Mandarin phonemes) **only when the input comes from a live speaker interacting with them** (and not from a television broadcast of that same speaker, for example). (Kuhl, Tsao, & Liu 2003)



Processes underlying speech sound development

[Extra]

Experience

Experience 1: Hearing the **speech adults produce** (this influences the sounds children choose to babble and the prosodic character of later babbling)

Important: There appears to be a social component involved.

(4) Adults also seem to pick up sounds more easily **when they're engaged socially with the input source.**



<http://www.sciencedaily.com/releases/2013/09/130910121523.htm>

(Stuart-Smith, Timmins, & Gunter 2013)

Processes underlying speech sound development

Experience

Experience 2: **Hearing their own vocal output** motivates infant vocalizations (also allows for calibration - matching what they produce to what they hear).

(Fagan 2014, 2015)

Links to early word forms:

Infants tend to **use the sounds that they've babbled in their first words** rather than the sounds that are most common in the speech that adults use with them.



Processes underlying speech sound development

Experience

Experience 2: **Hearing their own vocal output** motivates infant vocalizations (also allows for calibration - matching what they produce to what they hear).

(Fagan 2014, 2015)

Absence of auditory feedback may explain why deaf infants produce less elaborate vocal play than hearing infants, and reach the canonical babbling stage later.



Processes underlying speech sound development

Experience

Fagan (2014, 2015): Infants with profound hearing loss who received cochlear implants to help correct their hearing soon reached the vocalization levels of their hearing peers. Among other things, the infants with cochlear implants are able to reach the canonical babbling stage with reduplicated sounds (like “baba”).

<http://www.sciencedaily.com/releases/2014/09/140923182138.htm>

<https://www.sciencedaily.com/releases/2015/10/151022125740.htm>



Recap: Speech sound development

Sounds can be represented as a collection of features reflecting place of articulation, manner of articulation, and voicing (among others). Different languages select different combinations of these features for the sounds used in the language.

Infants go through different stages of pre-speech production, which allow them to develop the motor skills to produce the speech sounds in their native language.

Physical growth, neural growth, and experience all impact children's early speech-like productions.

Questions?



You should be able to do up through question 4 on HW3, and up through question 12 on the phonological review questions.