Sound Change

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Languages are always changing. Ancestral forms of languages change and diverge to become "daughter languages," which have daughters of their own. Languages change in a variety of dimensions:

- Lexicon—words are born and die [1]
- Lexical Semantics—words change in meaning
- Morphology—the structure of words changes
- Syntax—the structure of phrases and sentences change
- Sentence Semantics—the way in which sentence structure maps onto meaning changes
- Pragmatics—the way language is used to do social work changes
- **Phonology—the sounds in words change**

[1] Maria Ryskina, Ella Rabinovich, Taylor Berg-Kirkpatrick, David R. Mortensen, and Yulia Tsvetkov. Where new words are born: Distributional semantic analysis of neologisms and their semantic neighborhoods. In *Proceedings of the Society for Computation in Linguistics*, volume 3, 2020. URL `https://arxiv.org/abs/2001.07740`; and David Francis, Ella Rabinovich, Farhan Samir, David Mortensen, and Suzanne Stevenson. Quantifying cognitive factors in lexical decline. *Transactions of the Association for Computational Linguistics*, 9:1529–1545, 2021. URL `https://aclanthology.org/2021.tacl-1.91`

The focus of this lecture will be on phonological change—specifically, SOUND CHANGE.

A sound change is a systematic change in the pronunciation of words. For example, a sound change happened in the history of Pittsburghese (a dialect of English spoken by working-class Pittsburghers). In Pittsburghese, the vowel /i/ as in *Steelers* /ʃtilɹz/ becomes /ɪ/ (as in *still*) when it is followed by /l/. Consider the following examples: It is as if someone went through the phonology of Pittsburghese and replaced all instances of /il/ with /ɪl/, erasing the distictions between *peel* and *pill*, *feel* and *fill*, and *steal* and *still*. We could view this change as the replacement of /i/ with /ɪ/ before /l/:

Othography	Earlier English	Pittsburghese
peel	pil	pɪl
peeler	pilɹ	pɪlɹ
eel	il	ɪl
deal	dil	dɪl
dealer	dilɹ	dɪlɹ
realistic	rilɪstɪk	rɪlɪstɪk

Table 1: Examples of words affected by laxing before /l/ in Pittsburghese.

(1) i > ɪ / __ l

Note that the > in this rule indicates that the change took place as a historical event, not as a pattern in the grammar at a particular stage of a language's development.

This change in Pittsburghese described above occurred very recently, but we can study sound changes that occurred long ago. For example, a change occurred in High German that converted earlier (Proto-West Germanic) *t[2], which is unchanged in English, to /t͡s/, which is written as ⟨z⟩ in the German orthography: However, we can easily see that the Proto-West Germanic *t

[2] We write phonemes with asterisks to indicate that they are inferred based on attested data rather than being observed directly.

English	German	German Gloss
tooth	Zahn	'tooth'
ten	zehn	'ten'
toe	Zeh	'toe'
tide	Zeit	'time'
too	zu	'too'

Table 2: Affrication in High German

came from yet another sound. Consider *ten* and *tooth*: The other languages

Language	'ten'	'tooth'
English	tɛn	tuθ
Sanskrit	dáśa	dán
Persian	dah	—
Latin	decem	dēns
Greek	déka	dónti
Irish	deich	déad
Russian	désjat′	—
Lithuanian	dẽšimt	dantìs

Table 3: Illustration of d > t in Germanic

in the vast Indo-European family usually have /d/ in these words. For this reason, we typically reconstruct these words as having *d and say that there was a sound change in Pre-Germanic that changes all instances of *d to *t (and all instances of *b to *p and all instances of *g to *k)[3] In High German, *t then became *t͡s.

[3] In fact, the truth is a bit more complicated that this. If you are interested, consider taking up historical linguistics as a hobby.

The former shifts (those in Pre-Germanic) are part of what is probably the most famous set of sound changes in the word and were formulated as "sound laws" by Jakob Grimm (one of the Brothers Grimm). After him, they are called Grimms Law. It was made up of a series of smaller changes:

(2) Grimm's Law

a. *p *t *k *kʷ > f θ x xʷ

b. *b *d *g *gʷ > p t k kʷ

c. *b^h *d^h g^h g^{wh} > b d g g^w

This law explains why we have English *father* as a cognate to Sanskrit *pitṛ́* and English *brother* as a cognate to Sanskrit *bhrā́tṛ*.

It is worth noting that Grimm's Law is UNCONDITIONED—it affected all instances of the relevant sounds regardless of the contexts in which they occurred. This contrasts with the laxing before /l/ change in Pittsburghese, which is CONDITIONED (it affects only instances of /i/ that are before /l/). Both types of sound change are very common.

Why do Sound Changes Occur

When asked why sound changes occur, many people—including many linguists—with say that sound change occurs to make words easier to pronounce:

(3) **Hypothesis 1**: Sound change occurs to reduce articulatory complexity

However, articulation is only one half of phonetic reality. Sounds must also be perceived, and some have argued that sound changes eliminate hard-to-perceive distinctions:

(4) **Hypothesis 2**; Sound change occurs to reduce perceptual complexity

Note that these two hypotheses are not mutually exclusive:

(5) a. Some sound changes could reduce articulatory complexity (e.g., *b^h > b in Germanic)
b. Some sound changes could reduce perceptual complexity (e.g., *t > t͡s in High German)
c. Some sound changes could reduce both (e.g., *m̥ > m in Mong Leng)

I will try to persuade you that neither of these hypotheses are correct:

(6) a. Many sound changes increase articulatory complexity
b. Many sound changes increase perceptual complexity
c. Some sound changes increase both articulatory and perceptual complexity
d. There is a better explanation

First, an observation phrased as a question:

(7) If sound change reduces complexity (and always has) are languages perpetually decreasing in complexity and, if so, how did they become complex in the first place?

You could view sound change as the rope in a tug-o-war between articulatory ease and perceptual distinctiveness: some changes make words easier to

Ukhrul	Huishu	Gloss
ʃi	sik	'blood'
ri	lik	'blow'
si	sik	'comb'
tʰi	tik	'die'
ci	tsik	'fear'
ti	kik	'four'
ri	rik	'medicine'
ni	nik	'mother-in-law'
ni	nik	'two'
tsu	tsuk	'touch'
ru	ruk	'chop'
fu	huk	'dog'
ru	ruk	'water, egg'
nu	nuk	'laugh'
ru	ruk	'bone'
nu	nuk	'breast'
vu	vuk	'carry'
ru	ruk	'grandchild'
ku	kʰuk	'insect'
su	suk	'tie'
pu	huk	'elephant'
su	suk	'wash'
ʃu	t͡suk	'dove'

Table 4: Huishu /k/ epenthesis. The first group ended in *i in Proto-Tangkhulic. The second group ended in *ɨ. The third group ended in *u.

say and countervailing changes make words easier to perceive. However, consider the insert of /k/ after high vowels in Huishu: This sound change is not optimizing:

(8) a. It makes words harder to pronounce by adding a coda /k/
b. It increases articulatory complexity by adding a sound in a difficult-to-perceive position
c. It does not enhance the distinction between these words and other words. While it makes these words less like those ending in *e and *o (was epenthesis after *ɨ a bonus?) it makes *i and *u more like *iʔ and *uʔ, which already existed in the language.

Why do sound changes occur, then?

(9) a. Sound changes arise out of speakers' drive to sound like those with whom they identify.
b. They perceive unintentional variation in the speech of their peers as intentional (and imitate it)
c. This variation arises from articulation and perception

For example, in the Huishu case, there was final devoicing in high vowels that occurred for aerodynamic reasons. This variability in articulation was misperceived by young listeners as the release of an attempted final plosive. They noticed (subconsciously) that these "plosive releases" in the speech of their peers occurred where their parents' generation used final high vowels. Young people then extended this pattern to all of the words that their parents' generation produced with final high vowels.

What Kinds of Sound Changes are There?

Assimilation

ASSIMILATION is when one phoneme is changed to become more like a neighboring phoneme.

(10) a. Latin octo > Italian otto 'eight'
b. Latin noctem > Italian notte 'night'
c. Latin factum > Italian fatto 'done'

(11) Proto-North Germanic *drinka > Swedish drikka 'drink'

(12) walkəd > walkd > Mod English walkt

Dissimilation

DISSIMILATION is when a phoneme changes in a way that makes it **less** like a nearby phoneme. A famous example of dissimilation is Grassmann's Law (in Sanskrit and Greek). In Grassmann's Law, the first of two aspirated phonemes nearby in a word is deaspirated:

(13) a. Sanskrit bʰabʰuːva > babʰuːva 'become'
b. Greek pʰépʰuːka > pépʰuːka 'converted'

Hermann Grassmann (1809–1877) has the distinction of having invented linear algebra and then, when is mathematical contributions were not appreciated, switching fields to linguistics and philology and discovering the law that bears his name

Deletions

Many sound changes delete sounds from words. For example, in many varieties of English, unstressed mid central vowels are deleted in certain contexts:

(14) a. memory > mem'ry
b. family > fam'ly

Many words have gone through multiple sound changes involving deletion, including Spanish *hablar* 'to speak'

(15) fābulare > fablare > fablar > hablar > /ablar/

Insertions (Epenthesis)

EPENTHESIS is the technical term for the insertion of a phoneme into a string in a particular context. For example,

(16) Latin scola 'school' > **i**skola > escole > Spanish escuela [ɛskuelɛ].

In Somali, a copy of the preceding vowel is inserted to break up consonant clusters like CC#:

(17) a. nirg > nirig 'baby camel'
b. gabɖ > gaβaɖ 'girl'[4]
c. gaʕam > gaʕan 'hand'

[4] Note that this example demonstrates another change in which plosives like /b/ become fricatives like /β/ between vowels.

Compensatory Lengthening

In COMPENSATORY LENGTHENING, one phoneme is deleted and a neighboring segment is lengthened in order to "compensate."

(18) a. Proto-Germanic *tɑnθs > **tonθ > Old English to:θ (nasal deleted before *θ and *ɑ lengthened to compensate) > Modern English tuθ (long /o:/ was raised to /u/)
b. Proto-Celtic *magl > Old Irish ma:l

Lenition

The Somali pattern noted above is a kind of LENITION or weakening. This is a hugely subjective term and one that I would avoid using were it not entrenched in the literature. Consider the following additional examples from Somali:

(19) a. lugo > luɣo 'leg.PL'
b. bado > baðo 'sea.PL'

Here, voiced plosives between vowels become voiced fricatives.

Fortition (Including Final Devoicing)

It is common for consonants in prominent positions to be FORTIFIED or strengthened. One common example is final consonant devoicing, as seen in Catalan:

(20) a. /kandid/ > /kandit/ 'candid'
b. /seg/ > /sek/ 'blind'
c. /grog/ > /grok/ 'yellow'

Diphthongization

Some confusing aspects of English spelling resulted from what is called the Great Vowel Shift. In this change, long high vowels became diphthongs. For example, /i/ became /aj/ (or /aɪ/). This is why *ride* is pronounced as /ɹajd/ rather than /ɹid/ (as you might expect if you are familiar with another language using the Roman alphabet).

Note that the English digraph ⟨ou⟩ (similarly to French) used to represent /uː/. Thus *pout* was once pronounced as /puːt/. As a result of the GVS, it is now pronounced /pawt/ in many conservative varieties of English.

Note that Scots, a close relative of English spoken in Scotland, did not undergo the full GVS, so the Scots pronunciation of this words differs.

Vowel Raising

Another part of the GVS was vowel raising. After the long high vowels diphthongized, the mid vowels rose to take their place. This is why *seed* is pronounced /sid/ and not /seːd/ and why *food* in pronounced /fud/ and not /foːd/.

Vowel Lowering

Vowels may also be lowered. This often happens around uvular consonants. For example, in Mong Leng, the high vowel *i was lowered to /e/ after uvular plosives.

(21) a. qiˈɬ > qeˈɬ ‘garlic’
b. qiɬ > qeɬ ‘close eyes’
c. qʰiˈ > qʰeˈ ‘open’

Vowels may be lowered without any conditioning, however. Take the following examples from Kavineño:

(22) a. *matusa > mat**o**ha ‘alligator’
b. *manu > man**o** ‘witch’
c. *maru > mar**o** ‘die’
d. *kunu > k**o**n**o** ‘vine’
e. *yuka > y**o**ka ‘head’

Nasalization

Nasalization is when oral segments become nasal under influence from a neighboring sounds. For example, in some varieties of English, nasal vowels developed from /n/ deleted before glottal stop.

(23) pænt > pæ̃nt > pæ̃ʔt > pæ̃ʔ ‘pant’

How Can Sound Change be Modeled Computationally

Overwhelmingly, sound changes can be represented as sound laws substituting a substring in the context of two sets of substrings (to the left and the right). To wit:

(24) A > B / L__R

These rules are equivalent to regular expression substitutions and the relation that maps between the inputs and outputs of such a sound law is a REGULAR RELATION. This means that all (or almost all?) sound laws can be represented by FINITE-STATE TRANSDUCERS (FSTs). FSTs are simple and computationally efficient. They are also highly interpretable. They have been used to encode sound laws in a variety of studies[5].

However, FSTs have one problem: it is comparatively difficult to learn them from data. As a result, their utility in approaches that seek to discover sound changes from primary data is limited.

Here is one idea on which we are working: **Represent sequences of sound laws using python programs.** Use LLMs to generate these programs based on sets of examples (e.g., protoform–reflex). This actually works very well with GPT-3.5 and GPT-4 and we have promising initial results with open code language models.

[5] Tomotheus A. Bodt and Johann-Mattis List. Reflex prediction: A case study of Western Kho-Bwa. *Diachronica*, 2022. ISSN 0176-4225. DOI: 10.1075/dia.20009.bod

References

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