Experimental Evidence for Diachronic Change

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Evidence for sound change

- The importance of synchronic patterns in informing reconstruction has a long history (e.g. Sweet 1974, Paul 1886), and is implicit in most historical linguistics, even if it is not made explicit
- Connections between synchronic and diachronic data can be attributed to shared biases in perception and production, which moreover can be tested experimentally
- I compared a sample typology of diachronic developments was with patterns of errors from experimentally elicited misperception and natural errors in perception and production

Variability

- Studies on production as a source of sound change generally look at existing gradient variability in production
- Natural patterns of variation in production can demonstrate biases resulting from motor planning, gestural mechanics, and aerodynamics (Garrett and Johnson 2013)
- Existing work has demonstrated parallels in production and sound changes, e.g. tonogenesis conditioned by voicing (Hombert et al. 1979)

Speech errors

- Categorical mispronunciations provide a different source of evidence for biases in production that may play a role in sound change
- Such errors have been interpreted as evidence for phonological categorization and motor planning (Garrett and Johnson 2013)
- The intended sound and produced sound are usually phonologically similar

Speech error collections

- Collections of such errors include e.g. Meringer and Mayer 1895, van den Broecke and Goldstein 1980
- Mowrey and MacKay (1990) elicited similar errors using tongue twisters

(Mis)perception as a source of change

- Acoustic similarity facilitates misperception and subsequently change, e.g. if listeners fail to account for contextual influences on phonetic realization (Ohala 1993, a.o.)
- Various works have demonstrated perceptual parallels of attested changes, e.g. palatalization (Chang et al. 2001)

Misperception in natural speech

- Perception errors in natural speech can also provide evidence for phonological processing, lexical retrieval, and salience of different acoustic cues (Browman 1980)
- While lexical influences often make these errors more complicated, Tang (2015) provides a tabulated collection of single-phoneme replacement errors

Misperception in experimental settings

- How close a parallel can misperception studies (e.g. Miller and Nicely 1955) provide for historical developments?
- They are usually unnatural in some ways: masking noise, limited phonological environments, constrained response set (structurally and/or segmentally), lack of semantic content

Diachronic typology

- There are few systematic typologies of sound changes; those which exist are limited to a few language families (e.g. Kümmel 2007)
- Moreover, a reliable typology might not even be possible for cross-linguistically uncommon sounds
- If a correlation between synchronic patterns and known sound changes can be established, similar synchronic patterns could be used as a line of evidence in evaluating less clear reconstructions

Data collection

To test the relationship between sound changes and synchronic patterns in perception and production, I made a collection of consonant developments (989 observations)

- From a range of unrelated but relatively well-described language families: Indo-European, Semitic, Sino-Tibetan, Uto-Aztecan, Uralic, Mayan, Austronesian, and Otomanguean
- Using inputs of segments that are present in most of these proto-languages (p t k b d g s z ʃ m n l r j w h); the outputs also include t͡ʃ d͡ʒ ʒ v f

The data

Table: Diachronic developments (as percents)

reconstructed sound ↓ \ outcome →	p	b	t	d	k	g	s	z	ʃ	m	n	l	r	h	j	w	f	v	ʒ	t͡ʃ	d͡ʒ	∅
p	54	8.5	0	0	0	0	0	0	0	0	0	0	0	4.3	0	2.1	12	6.4	0	0	0	6.4
b	15	52	0	0	0	0	0	0	0	0	0	0	0	1.9	0	7.7	7.7	14	0	0	0	1.9
t	0	0	62	9.2	0.9	0	3.7	0.9	0	0	0	1.8	2.8	0.9	0	0	0	0	0	4.6	0	2.8
d	0	0	13.3	53	0	0	3.3	0	0	0	1.7	10	10	0	0	0	0	0	1.7	0	1.7	3.3
k	0	0	0.9	0	57	9.5	1.7	0	0	0	0	0	0	4.3	0	0	0	0.9	0	4.3	0.9	4.3
g	0	1.8	1.8	1.8	33	47	0	1.8	0	0	0	1.8	0	1.8	0	0	0	0	0	0	3.5	3.5
s	0	0	2	0	0	0	53	8.1	8.1	0	0	0	1	7.1	1	0	0	0	1	2	0	12
z	0	0	0	2.9	0	0	18	59	2.9	0	0	0	2.9	0	2.9	0	2.9	0	5.9	2.9	0	0
ʃ	0	0	0	0	0	0	19.4	0	56	0	0	0	0	5.6	0	0	0	0	5.6	2.8	0	8.3
m	0	0	0	0	0	0	0	0	0	90	2.9	0	0	0	0	1.4	0	1.4	0	0	0	4.3
n	0	0	0	0	0	0	1.5	0	0	0	90	0	0	0	0	0	0	0	0	0	0	5.9
l	0	0	0	3.2	0	0	0	0	0	0	14	67	9.5	1.6	0	0	0	0	0	0	0	3.2
r	0	0	1.9	1.9	0	0	0	0	0	0	0	7.5	81	0	3.8	0	0	0	0	1.9	0	1.9
h	0	0	0	0	0	0	0	0	0	0	0	0	0	44	1.9	1.9	0	0	0	0	0	37
j	0	0	0	1.3	0	0	0	2.6	1.3	0	0	1.3	0	1.3	66	0	0	0	1.3	5.2	3.9	14
w	1.2	2.4	0	0	1.2	3.5	0	0	0	0	0	1.2	0	2.4	3.5	45	4.7	17	0	0	0	15

Correlations with misperception (laboratory)

- This collection of diachronic developments is correlated with the perceptual confusions from Miller and Nicely 1955 (English nonce words in white noise and with filters)
- The correlation is highly significant: $r(174) = 0.93$, $p < 0.001$, though largely due to cells for unchanged segments and accurately identified segments
- Including *only* unchanged and accurately identified segments, reflecting the relative stability of segments, $r(9) = 0.69$, $p = 0.0033$

Correlations with misperception (laboratory)

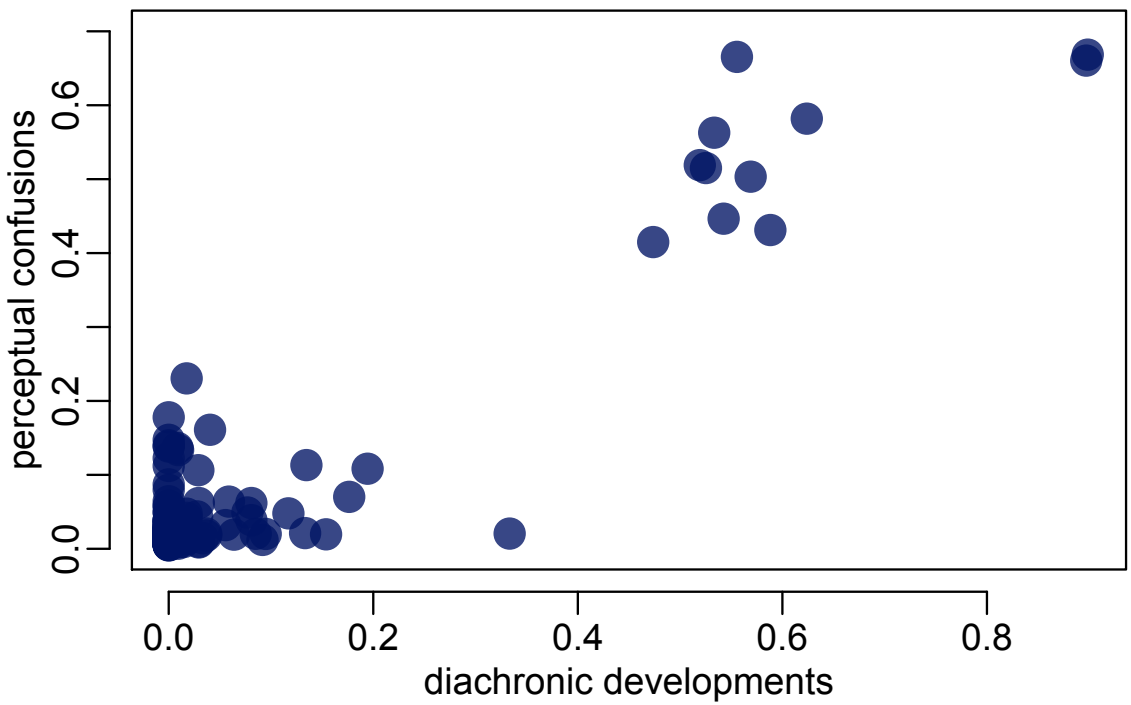

Figure: Diachronic Developments by Perceptual Confusions

Correlations with misperception (laboratory)

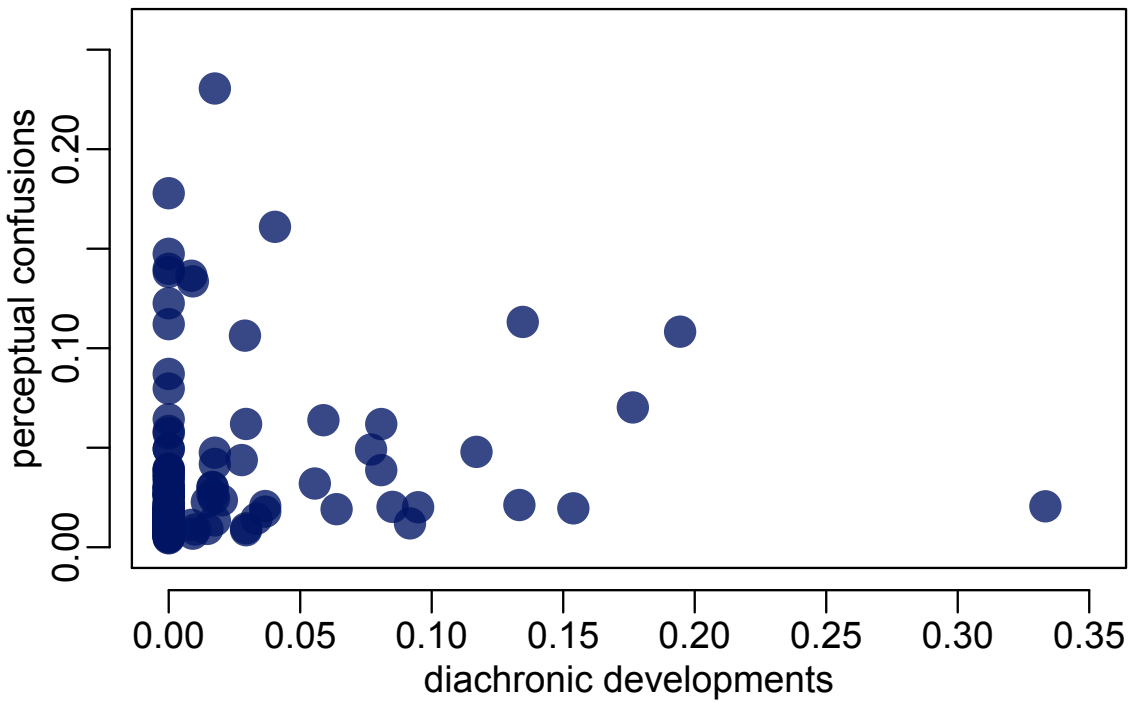

Figure: Diachronic Developments by Perceptual Confusions

- Omitting unchanged and accurately identified segments, the correlation is still significant: $r(163) = 0.17$, $p = 0.027$

Correlations with misperception (laboratory)

Correlations with confusions from other misperception experiments with different adverse listening conditions are similar or even higher. Omitting unchanged and accurately identified segments:

- Identifications in speech shaped noise in Broersma and Scharenborg 2010, $r(334) = 0.35$, $p < 0.001$
- Identifications including stimuli in unfamiliar languages in Singh and Black 1966, $r(278) = 0.37$, $p < 0.001$

Correlations with misperception (natural)

- Perception errors in natural speech from Tang's (2015) compilation across English dialects
- The correlation with the collection of diachronic developments is highly significant: $r(382) = 0.94$, $p < 0.001$

Correlations with misperception (natural)

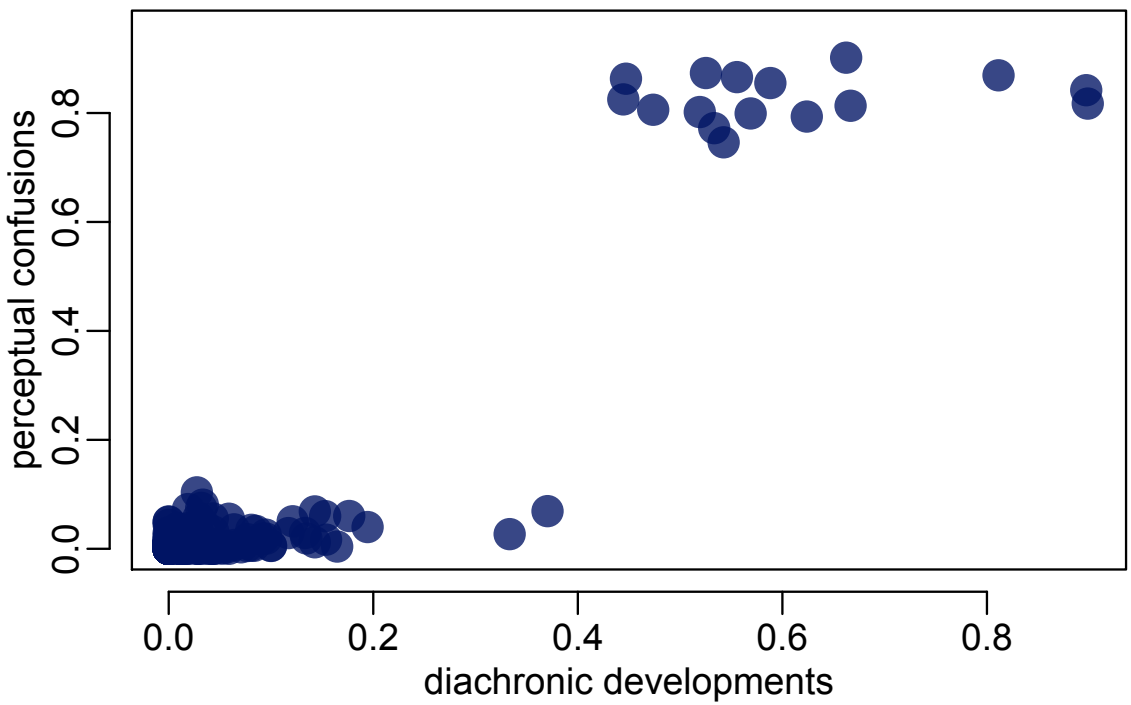

Figure: Diachronic Developments by Perceptual Confusions

Correlations with misperception (natural)

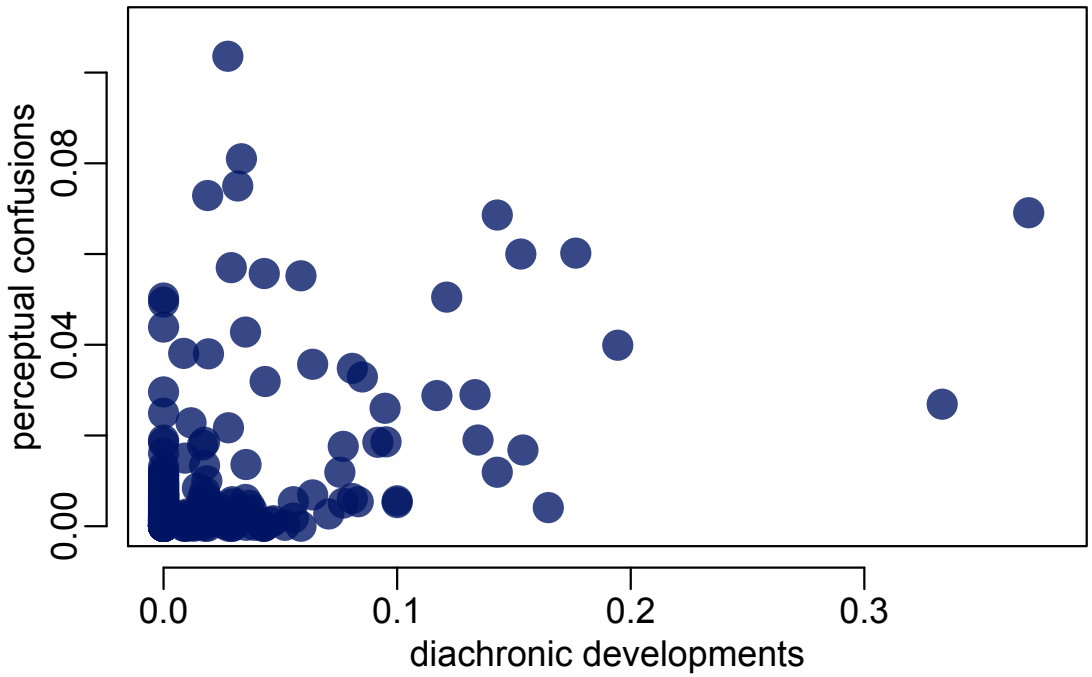

Figure: Diachronic Developments by Perceptual Confusions

- Omitting cells of unchanged and correctly identified segments, $r(366) = 0.49$, $p < 0.001$
- This is the only comparison made with misperception data from natural speech, which is likely why it provides the best parallel

Correlations with speech errors (natural)

- Diachronic developments were also correlated with production errors from van den Broecke and Goldstein 1980 (collections from English, German, and Dutch)
- This collection doesn't provide comparisons with the number of correctly produced segments
- The correlation is highly significant: $r(270) = 0.33$, $p < 0.001$

Correlations with speech errors (natural)

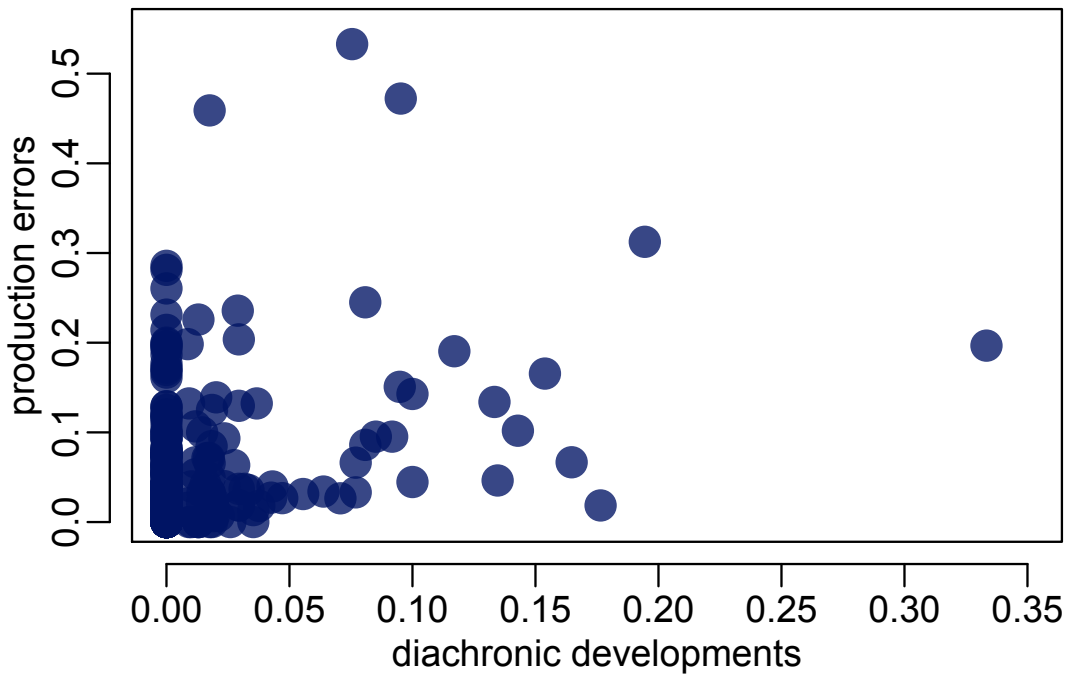

Figure: Diachronic Developments by Production Errors

Summary

Patterns of diachronic developments are strongly correlated with synchronic patterns of perception and production

- In perceptual confusions observed in natural speech
- In the perceptual confusion patterns in highly constrained experimental settings
- In categorical production errors observed in natural speech

Applications

- The correlations demonstrate that synchronic data can be used as a line of evidence in reconstructing sound changes
- Experimental methods can complement traditional comparative reconstruction, particularly for developments without established diachronic parallels
- Due to methods of elicitation and reporting, they provide the strongest parallel for diachronic mergers or shifts within an inventory

Explanatory value

- These connections shed some light on possible factors facilitating sound change
- Differences in correlations under different conditions and for different segments may further help identify the mechanisms of particular diachronic changes

Selected References

Broersma, M. & O. Scharenborg. 2010. Native and non-native listeners? Perception of English consonants in different types of noise. *Speech Communication* 52: 980–995.

Browman, C. 1980. Perceptual processing: Evidence from slips of the ear. In V. Fromkin (ed.), *Errors in linguistic performance: Slips of the tongue, ear, pen, and hand*, 213–230. New York: Academic Press.

Chang, S., M. Plauché, & J. Ohala. 2001. Markedness and consonant confusion asymmetries. In E. Hume & K. Johnson (eds.), *The Role of speech perception in phonology*, 79–101. San Diego: Academic Press.

Garrett, A., & K. Johnson. 2013. Phonetic bias in sound change. In A. Yu (ed.), *Origins of sound change: Approaches to phonologization*, 51–97. Oxford: OUP.

Hombert, J.-M., J. Ohala, & W. Ewan. 1979. Phonetic explanations for the development of tones. *Linguistic Society of America* 55(1): 37–58.

Kümmel, M. 2007. *Konsonantenwandel: Bausteine zu einer Typologie des Lautwandels und ihre Konsequenzen für die vergleichende Rekonstruktion*. Wiesbaden: Reichert Verlag.

Meringer, R., & K. Mayer. 1895. *Versprechen und Verlesen: Eine Psychologische-Linguistische Studie*. Stuttgart: Göschen'sche Verlagsbuchhandlung.

Miller, G., & P. Nicely. 1955. An analysis of perceptual confusions among some English consonants. *JASA* 27(2): 338–352.

Mowrey, R., & I. MacKay. 1990. Phonological primitives: Electromyographic speech error evidence. *JASA* 88(3):1299–1312.

Ohala, J. 1993. The phonetics of sound change. In C. Jones (ed.), *Historical linguistics: Problems and perspectives*, 237–278. New York: Longman Publishing.

Paul, Hermann. 1886. *Prinzipien der Sprachgeschichte*. 2nd edn. Halle: Niemeyer.

Singh, S. & J. Black. 1966. Study of twenty-six intervocalic consonants as spoken and recognized by four language groups. *JASA* 39(2): 372–387.

Sweet, Henry. 1874. The history of English sounds. London: Trübner.

Tang, K. 2015. *Naturalistic Speech Perception*. London: University College London dissertation.

van den Broecke, M., & L. Goldstein. 1980. Consonant features in speech errors. In V. Fromkin (ed.), *Errors in linguistic performance: Slips of the tongue, ear, pen, and hand*, 47–65. New York: Academic Press.