Demography shapes grammar: a close-up view

Freek Van de Velde

University of Leuven

Quantitative Lexicology and Variational Linguistics – QLVL

Acknowledgements:

Isabeau De Smet

Dirk Pijpops

Katrien Beuls

Quantitative Lexicology and Variational Linguistics
KU Leuven

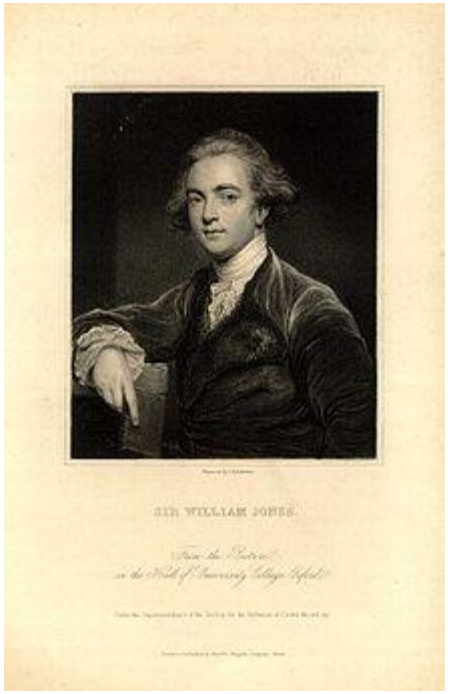
Main ideas of this talk

1. Language *structure* (synchrony) is co-determined by population structure
2. Language *change* (diachrony) is a function of population structure (historical demography)
3. The crucial factor in both structure and change is language contact

- This can be most clearly established by comparing different language families, and on the synchronic level
- But working with proxies and with simulations, we can make educated guesses about the past, within language families

William Jones (°1746, Londen - †1794, Calcutta)

“The Sanscrit language, whatever be its antiquity, is of a wonderful structure; more perfect than the Greek, more copious than the Latin, and more exquisitely refined than either, yet bearing to both of them a stronger affinity, both in the roots of verbs and the forms of grammar, than could possibly have been produced by accident; so strong indeed, that no philologer could examine them all three, without believing them to have sprung from some common source, which, perhaps, no longer exists; there is a similar reason, though not quite so forcible, for supposing that both the Gothic and the Celtic, though blended with a very different idiom, had the same origin with the Sanscrit; and the old Persian might be added to the same family.” (1786)



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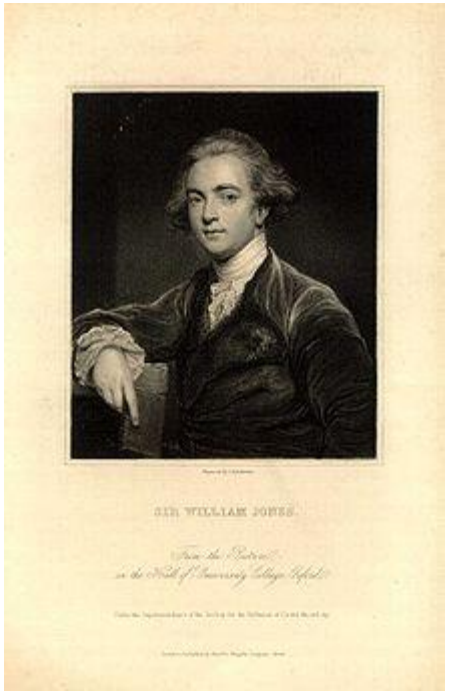
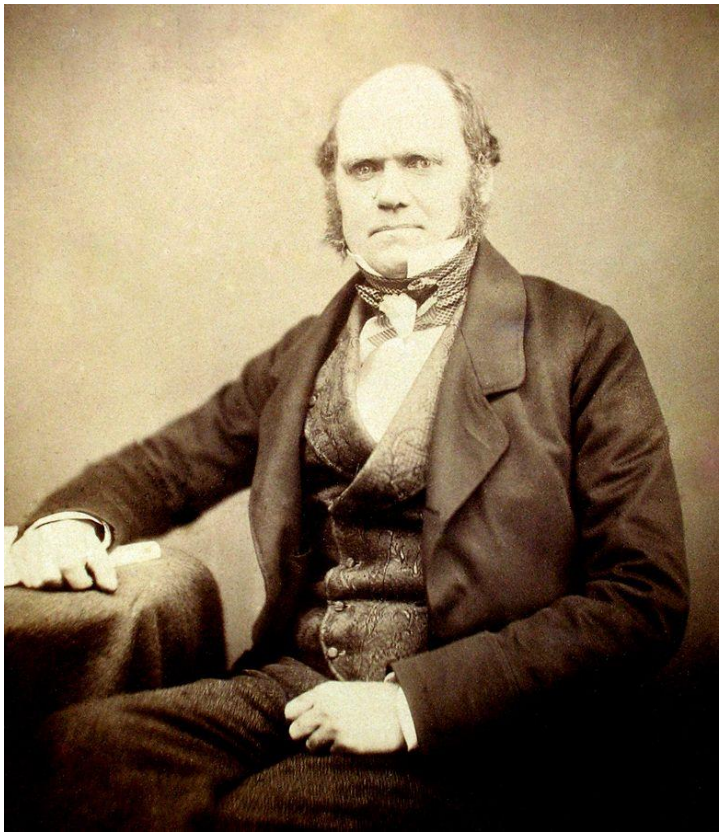
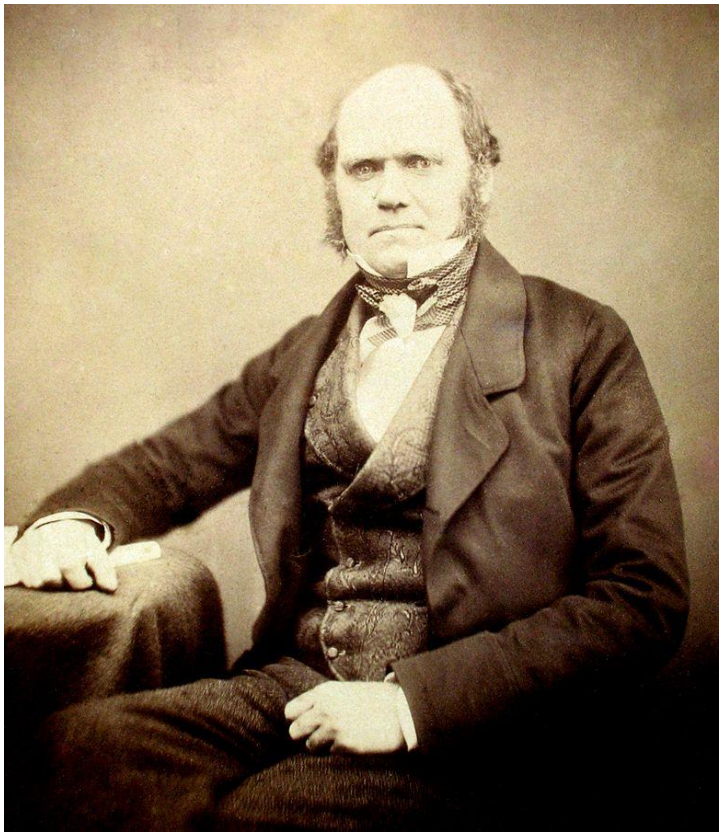




"[I]t might be that some very ancient language had altered little, and had given rise to few new languages, whilst others (owing to the spreading and subsequent isolation and states of civilisation of the several races, descended from a common race) had altered much, and had given rise to many new languages and dialects." (Darwin, C.R. 1859. *On the Origin of Species*, p.422)



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The structuralist era

- Ferdinand De Saussure: 'internal' vs. 'external' linguistics

- Many linguists are wary of digging into external explanations for language change (Lass, Kuryłowicz, Ohala ... see e.g. Woods 2001: 974-975)

  "In view of the confusion and controversies surrounding causes of language change, it is not surprising that some reputable linguists have regarded the whole field as a disaster area, and opted out altogether." (Aitchison 1991: 106)

Reasons for the wariness

- If morphosyntax is too responsive to demographic change, this potentially undermines universalism, which reeks of crypto-racism and discredited romantic ideas (Herder, Humboldt, Schiller ...) about the deep connection between language and people

- There is no shortage of crackpot theories
  - German tribes using fricatives instead of stops because of their impetous nature
  - German tribes using fricatives instead of stops because of the huffing and puffing in mountainous terrain
  - recently en vogue again: Dry climate doesn't sustain tonal languages

- General aversion to 'nomothetic' (as opposed to 'idiographic') approaches in linguistic (Roberts & Winters 2012)

Reasons for the wariness (continued)

- Results of research into the impact of demographic factors on language change are unclear:
  - Nettle (1999): smaller languages, faster change
  - Wichmann & Holman (2009): 1° No clear effects: "The test shows mainly negligible effects of population", 2° "... the exception being an apparently faster rate of change in the larger of two closely related variants."
  - Bromham et al. (2015): Higher lexical gain and lower lexical loss in large languages
  - Trudgill (2002: 725): Linguistic change tends to be relatively rapid in high-contact language communities where contact is short-term and/or involves imperfect language learning by adults.

Restoration

- Labovian sociolinguistics
- Contact linguistics

> "In a sense, most of what historical linguists study under the designation "language change" is due to contact." (Thomason 2003: 687)

> "[C]ontact has emerged in recent studies as a more essential element in triggering linguistic innovation than had previously been assumed."
> (Drinka 2010: 342)

- However: a lot of studies deal with **borrowing** (also Harris & Campbell 1995; Lucas 2015).
- Wat remains more controversial is **(de)complexification and analyticisation**

> "Language contact, especially when extensive L2 learning is involved, is a main source of complexity reduction (grammar simplification). By definition, such processes involve language change. But complexity reduction is actually at the heart of many type of language change, especially in morphology and syntax." (Karlsson et al. 2008: viii)

(de)complexification and analyticisation

- Two big, related themes with a time-honoured scholarly interest:
  1. Morphological types
  2. Demographic correlations

Types of languages

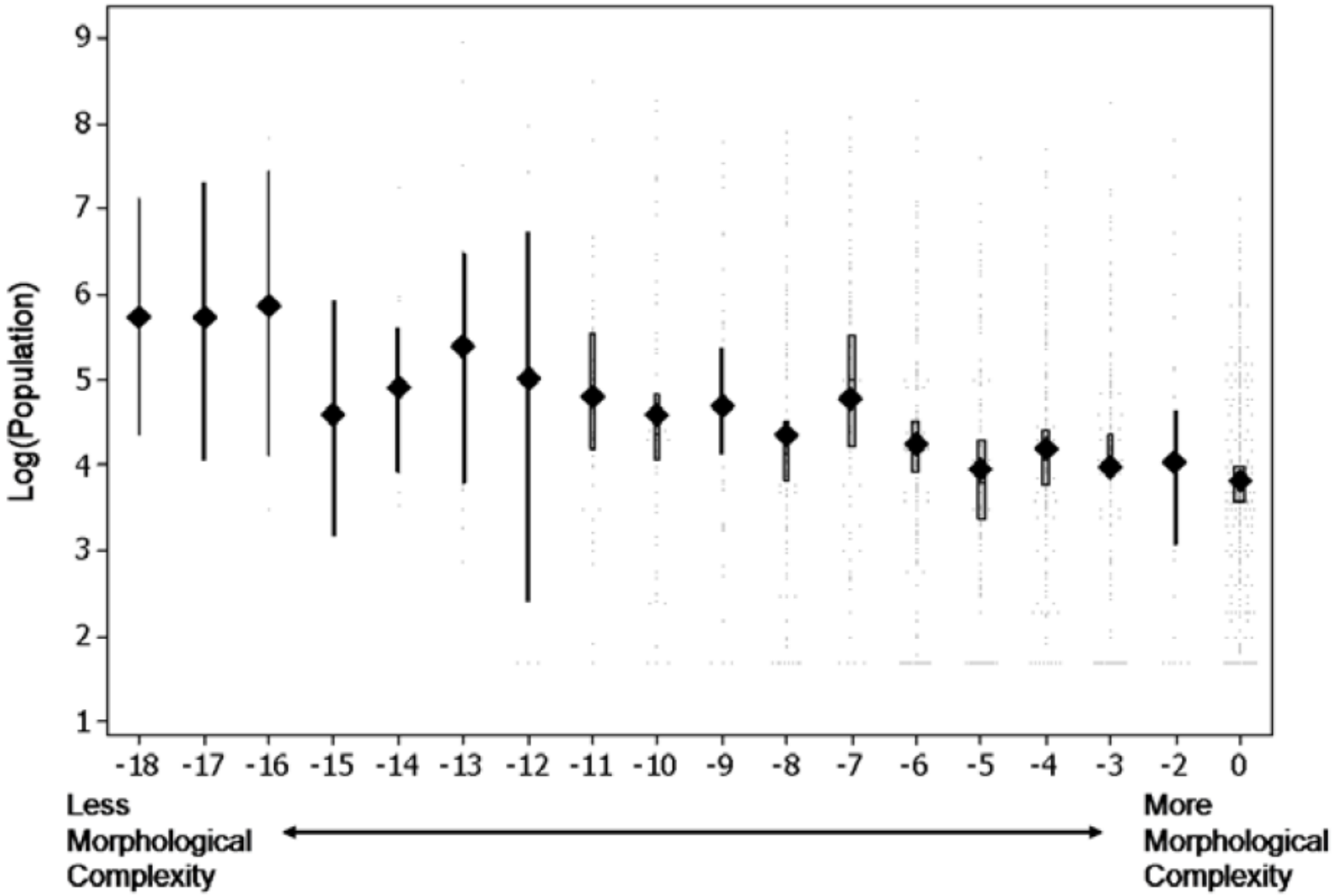
- Morphological types: isolating, agglutinative, fusional, polysynthetic, introflexive ... (disagreement and confusion, see Bickel & Nichols 2013)
- Analytic vs. synthetic:

> "En Europe les langues dérivées du latin, et l'anglais, ont une grammaire tout analytique (...) synthétiques dans leur origine (...) elles penchent fortement vers les formes analytiques" (Von Schlegel 1846: 161, cited in Szmrecsanyi 2012)

Demographic explanations for the analytic-synthetic difference

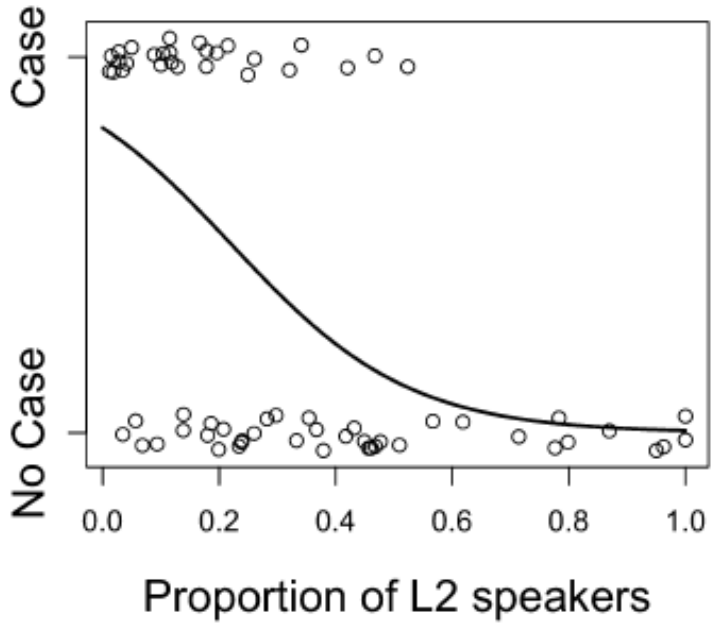
- Lupyan & Dale (2010)
  - Due to evolutionary pressures, languages adapt to their community (see also Christiansen and Chater 2008; Lupyan & Dale 2016)

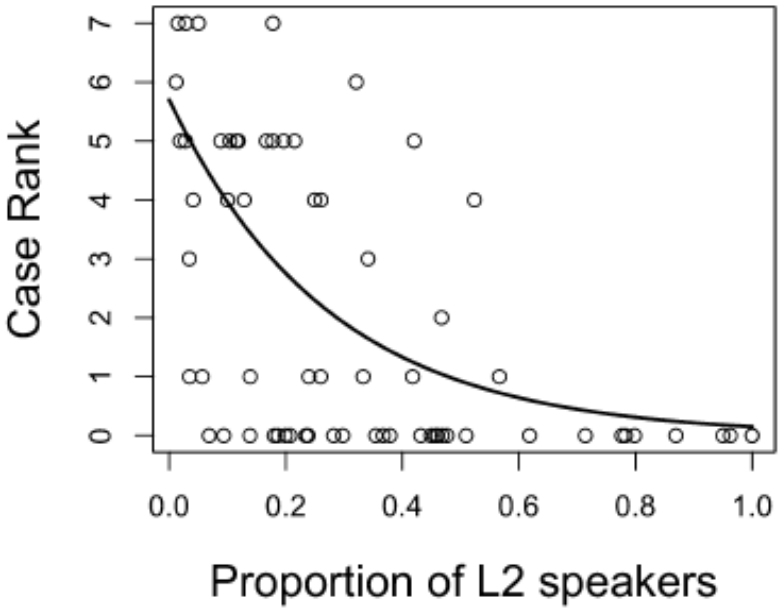
    ⇨ *Linguistic Niche Hypothesis*
  - **Esoteric languages**: morphologic complexity, redundancy, synthetic, favouring L1 acquisition ⇨ smaller languages
  - **Exoteric languages**: analytic-syntactic complexity, transparency, analytic, favouring L2 acquisition ⇨ patterns with bigger languages


Log(Population)
9
8
7
6
5
4
3
2
1
-18
-17
-16
-15
-14
-13
-12
-11
-10
-9
-8
-7
-6
-5
-4
-3
-2
0
Less
Morphological
Complexity
More
Morphological
Complexity

Demographic explanations for the analytic-synthetic difference

- Bentz & Winter (2013)
  - Data:
    - 226 languages using the *SIL Ethnologue*, the *Rosetta project website* and the *UCLA Language Materials Project*; area and family information from *AUTOTYP database,* case information from *WALS*
    - Overlap: 66 languages (26 language families, 16 areas)
  - Operationalisation:
    - L2 speakers: adult L2 speakers as opposed to early bilinguals
    - Case: productive morphological inflections of nouns (loose definition: possessive clitic *-s* in English is counted as case)
  - Method:
    - Generalized linear mixed effects models: logistic regression (case vs. no-case), and negative binomial regression (count of case). Response variable: case; explanatory variable: proportion of L2 speakers
    - Throw in population count in the regression models to see whether it is a predictor on top of the L2 proportion. ⇨ It isn't.


Case
No Case
0.0
0.2
0.4
0.6
0.8
1.0
Proportion of L2 speakers


Case Rank
0
1
2
3
4
5
6
7
0.0
0.2
0.4
0.6
0.8
1.0
Proportion of L2 speakers

Demographic explanations for the analytic-synthetic difference

- Lupyan & Dale (2010), Bentz & Winter (2013): synchronic quantitative evidence for Schlegel's diachronic claim

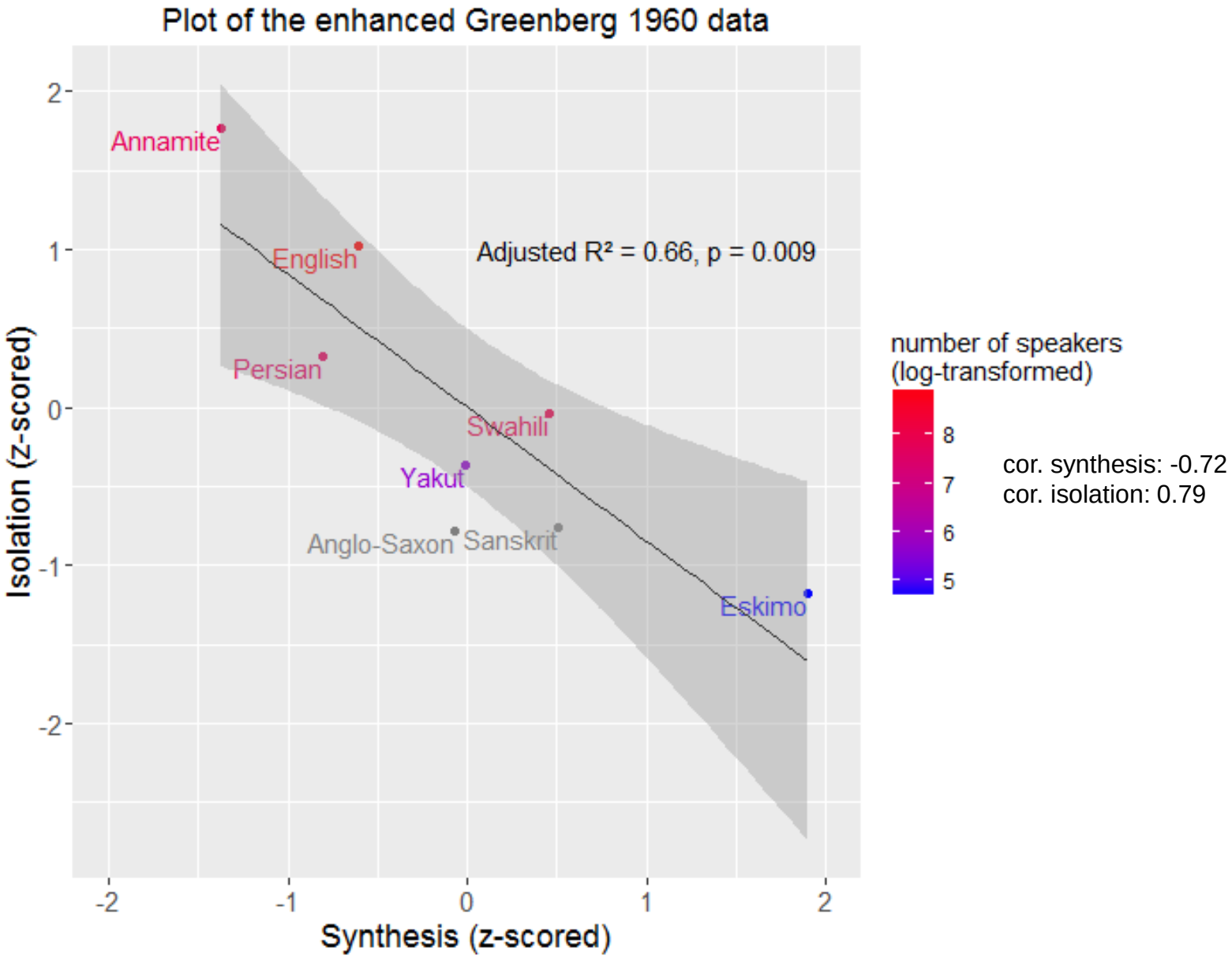
- What about diachronic quantitative evidence? (see Kusters 2003; Szmrecsanyi 2012; Carlier et al. 2012; Haspelmath, forthc.; Haspelmath & Michaelis, forthc.)

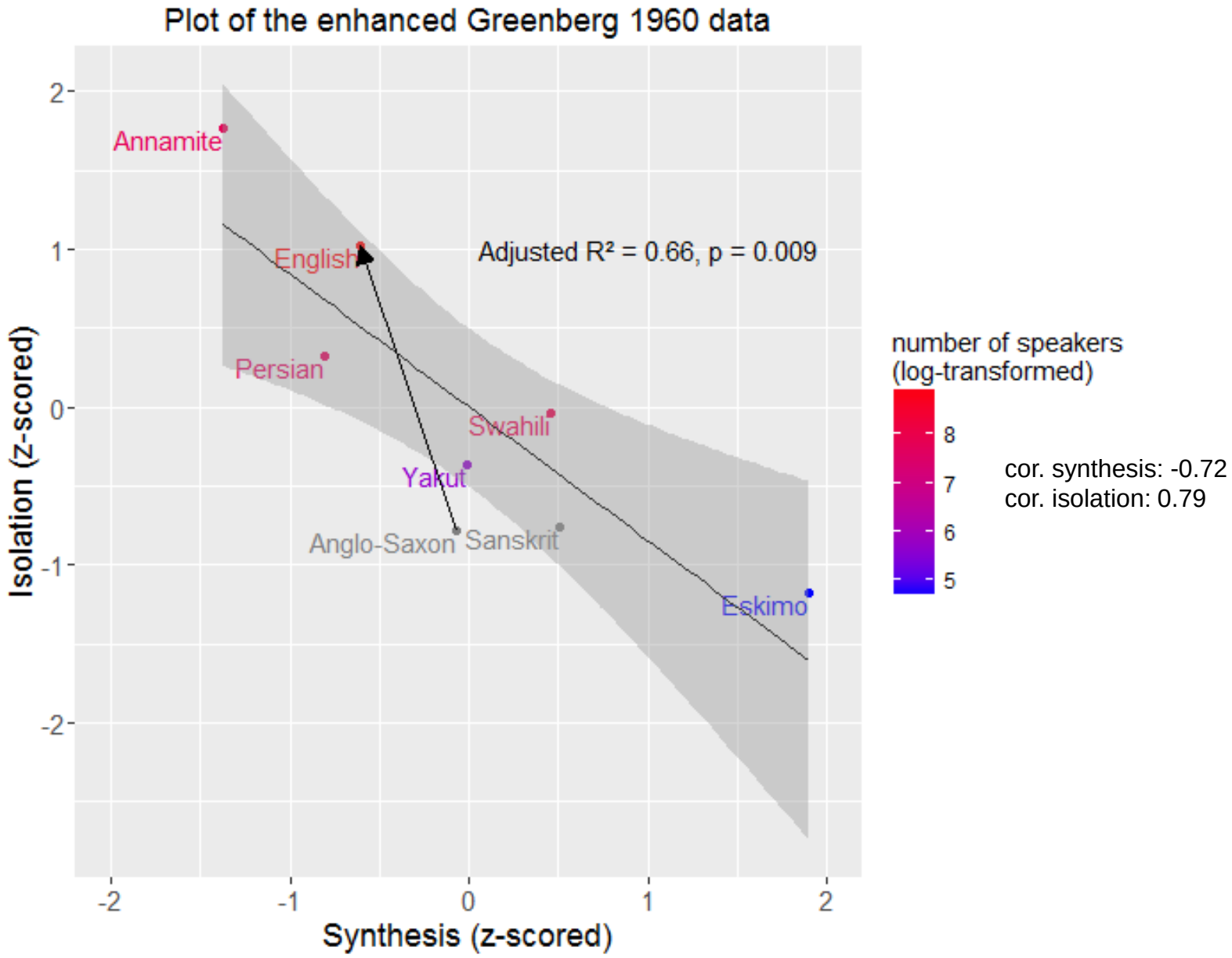
From synchrony to diachrony

Greenberg (1960)

- Index of synthesis (proportion of morphemes to words)
- Index of isolation (proportion of word order as a grammatical marker to the total number of nexus)
- Along with a number of other indices (Index of agglutination, Index of compounding, Index of inflection, Index of prefixation ...).
- Calculated on 100 word stretches of different languages (labour-intensive):

	Sanskrit	Anglo-Saxon	Persian	English	Yakut	Swahili	Annamite	Eskimo
Synthesis	2.59	2.12	1.52	1.68	2.17	2.55	1.06	3.72
Isolation	.16	.15	.52	.75	.29	.40	1.00	.02


Plot of the enhanced Greenberg 1960 data
Annamite
English
Persian
Swahili
Yakut
Anglo-Saxon
Sanskrit
Eskimo
Adjusted R² = 0.66, p = 0.009
Isolation (z-scored)
Synthesis (z-scored)
2
1
0
-1
-2
-2
-1
0
1
2
number of speakers
(log-transformed)
8
7
6
5
cor. synthesis: -0.72
cor. isolation: 0.79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From synchrony to diachrony

Haspelmath & Michaelis (forthc.), Haspelmath (forthc.):

- 'word' is a problematic concept
- new operational definition:

> "Analytic pattern: a morphosyntactic pattern that was created from lexical or other concrete material and that is in functional competition with (and tends to replace) an older (synthetic) pattern"
>
> "Thus, the term *analytic* should be understood as roughly meaning "freshly regrammaticalized". This definition works, because all patterns that have traditionally been called "analytic" are known to have been created from lexical or other concrete material; there does not seem to be any other way in which such patterns can come about. This definition is somewhat broader than the traditional purely synchronic definition, in that it also includes cases like the English past-tense marker *-ed* as in *play-ed*, which is generally thought to be a much newer pattern than the old pattern represented by ablauting verbs such as *sing/sang, write/wrote* (...) because it is based on a refunctionalization."

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Case study: weak preterites

- Germanic languages have two morphological strategies for building preterites (not counting analytic perfects, *he has written a book*):

1. Strong inflection:
   - English *sing – sang*
   - Ablaut, based on Indo-European aspectual system (perfect > preterite)

PIE root *b^h_id^h-	e-grade (present)	o-grade (perfect)
Greek	*peíth-omai*	*$_2$pé-poith-a*
Gothic	*beid-an*	**baid-* (PGm ă < PIE ŏ)

2. Weak inflection
   - English *work – worked*
   - Dental suffix, based on a analytic formation [VERB + *d^heh_1-, *d^hoh_1- ('did')]

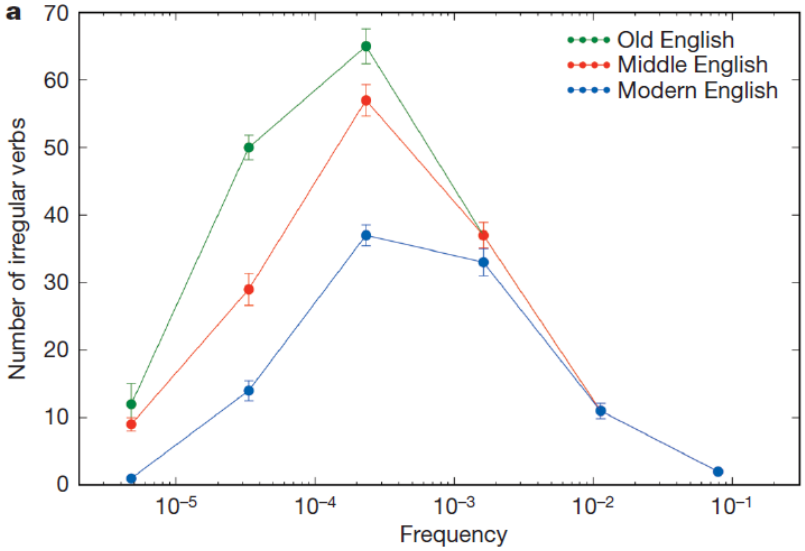
Gothic	*beid-an*	**baid-*
Dutch	*beid-en (~ †bijden)*	*beid-de*

Case study: weak preterites

- Various changes occur:
  - irregularisation (Eng. *buy* – *bought*)
  - one strong ablaut class to another (Du. *heffen* – *hief* < *hoef* (Germ. *hob*, *hub*))
  - weak to strong (Du. *vragen* – *vroeg* (vs. Germ. *fragte*))
  - strong to weak (Eng. *carve* – *carved* < *cearf* (Du. *kerfde* < *karf*))

⇨ Long-term drift, over many centuries

ENGLISH: Lieberman et al. 2007



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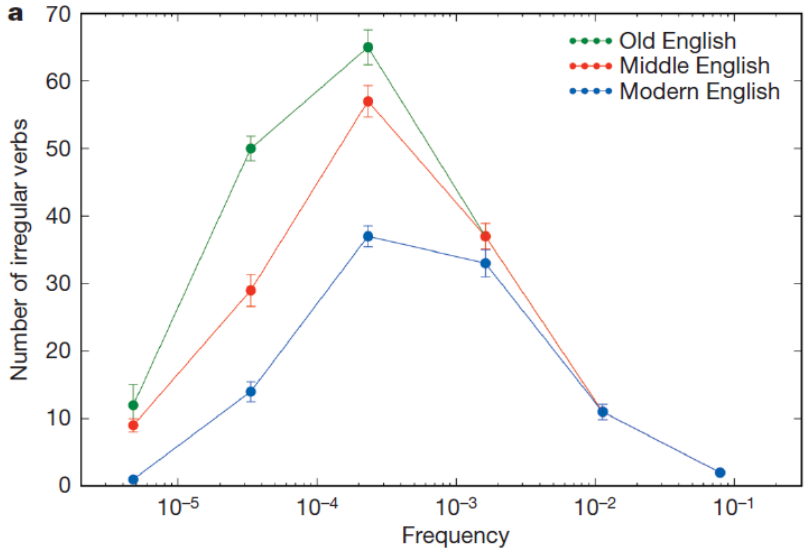

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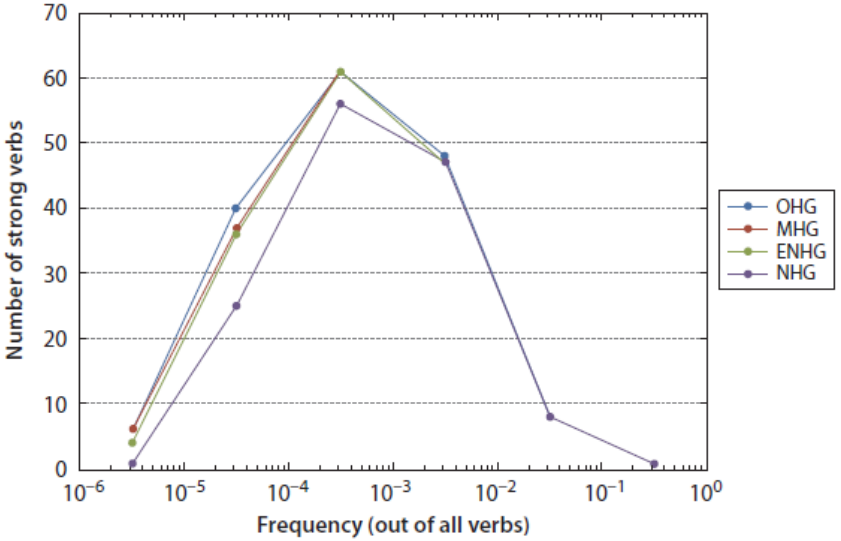

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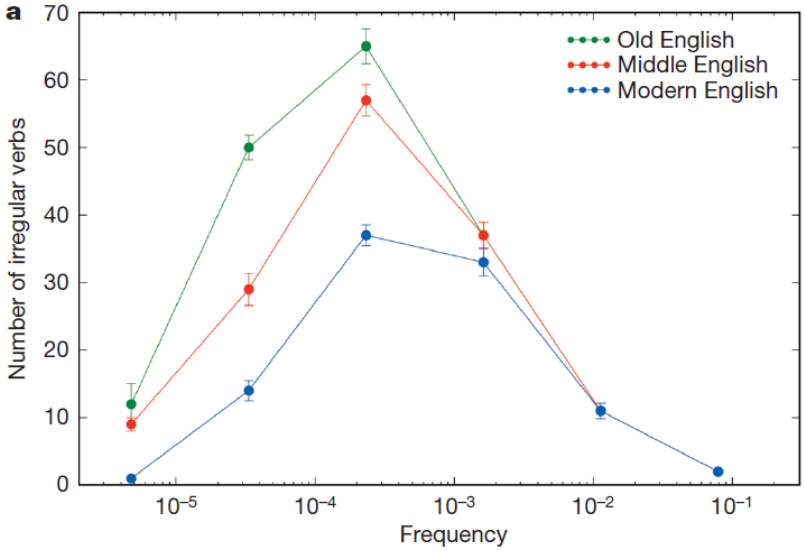

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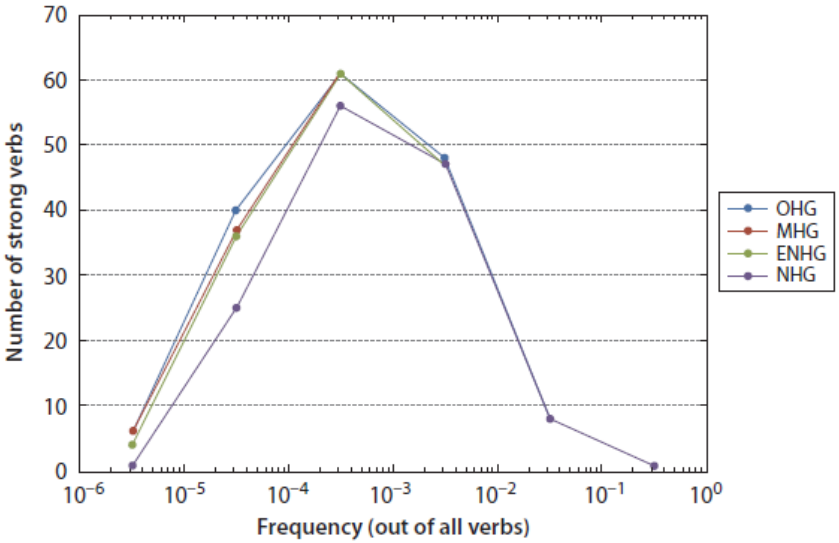
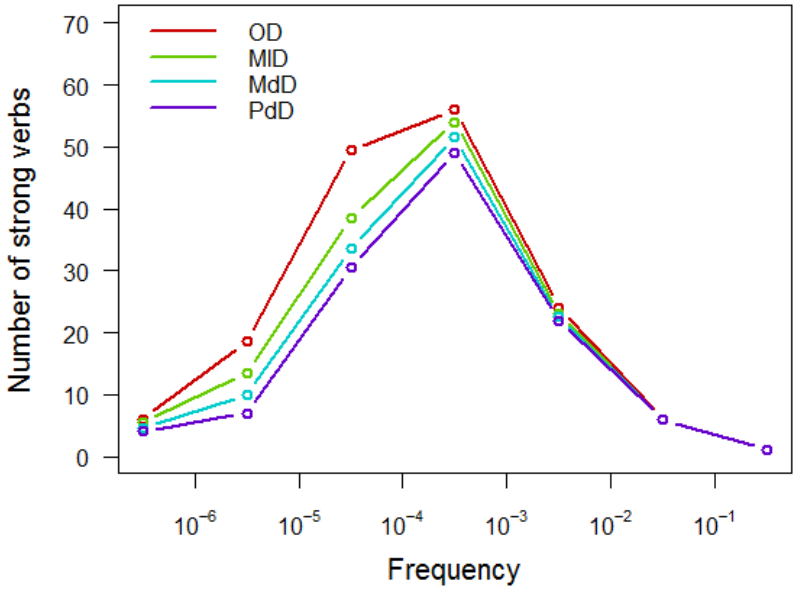


DUTCH



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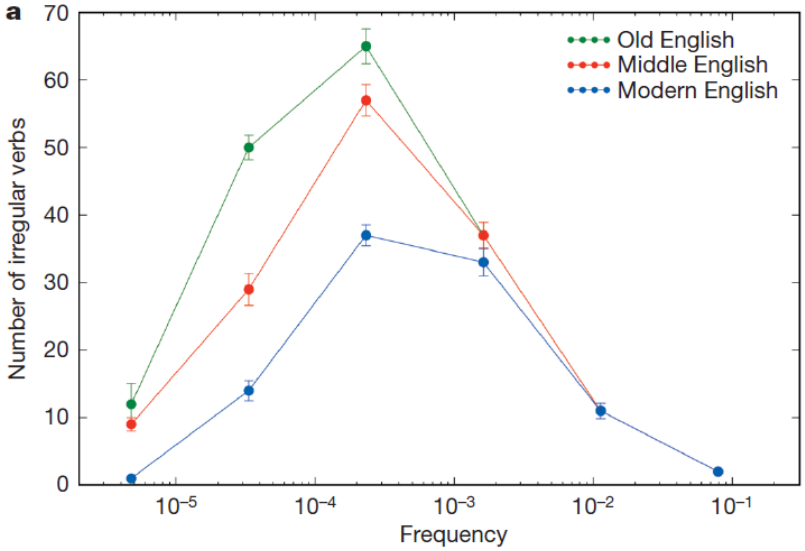

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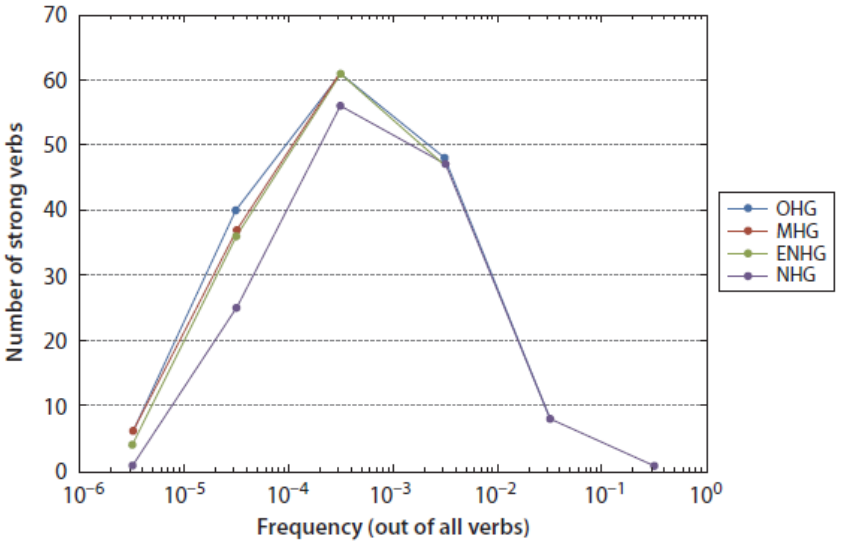

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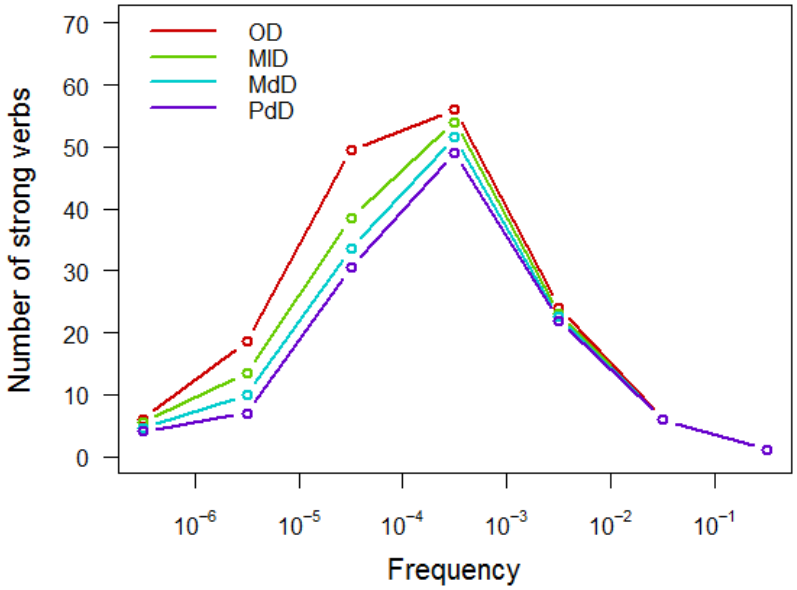
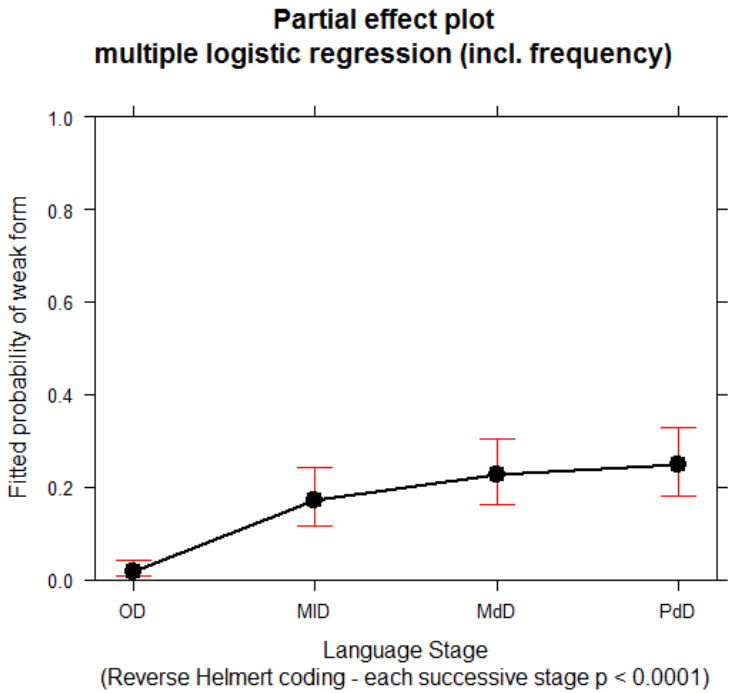
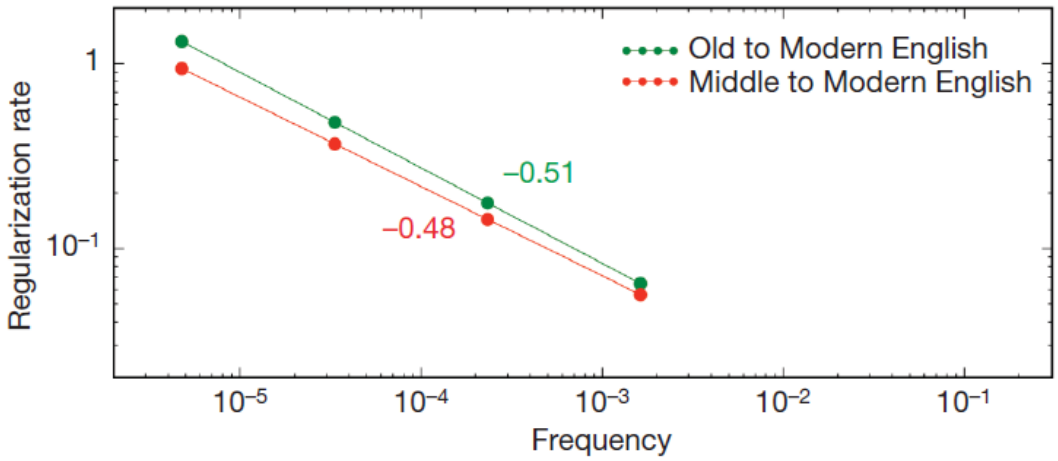




Lieberman et al. 2007: Constant rate of regularisation through time, only dependent on frequency



⇨ lines follow the same power law curve (linear on log-log plot) and overlap

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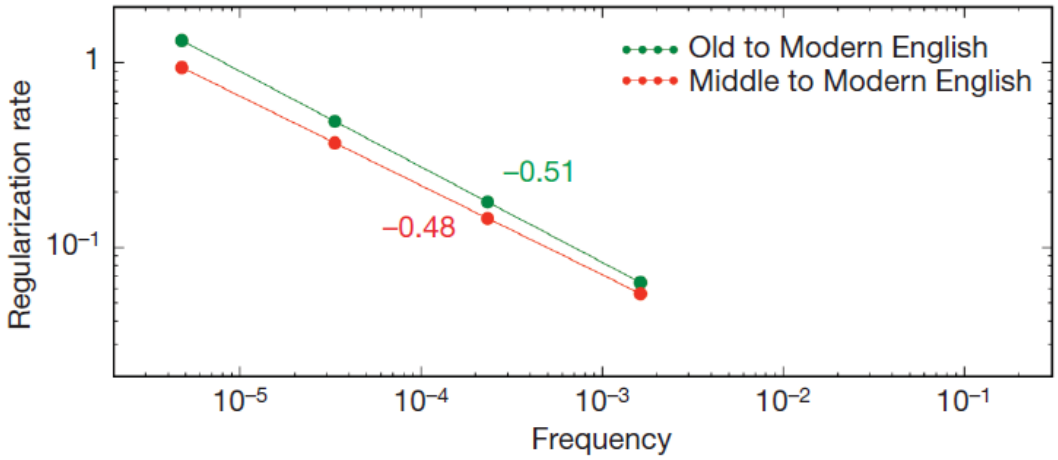
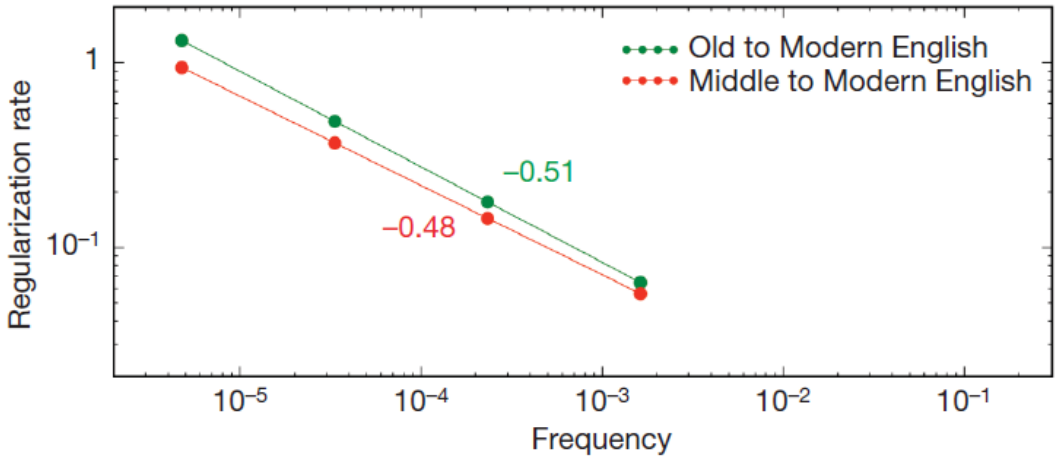


⇨ lines follow the same power law curve (linear on log-log plot) and overlap

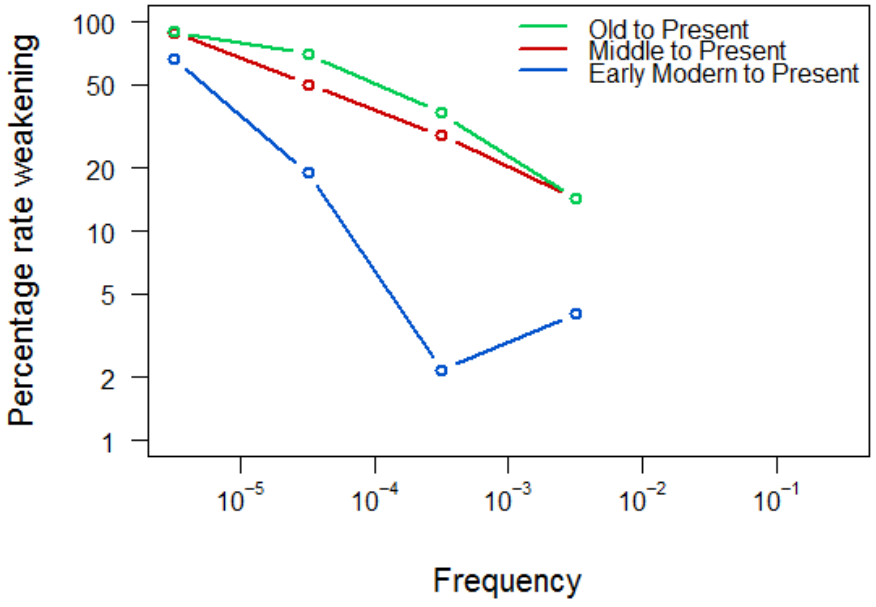
Lieberman et al. 2007: three measurement points:

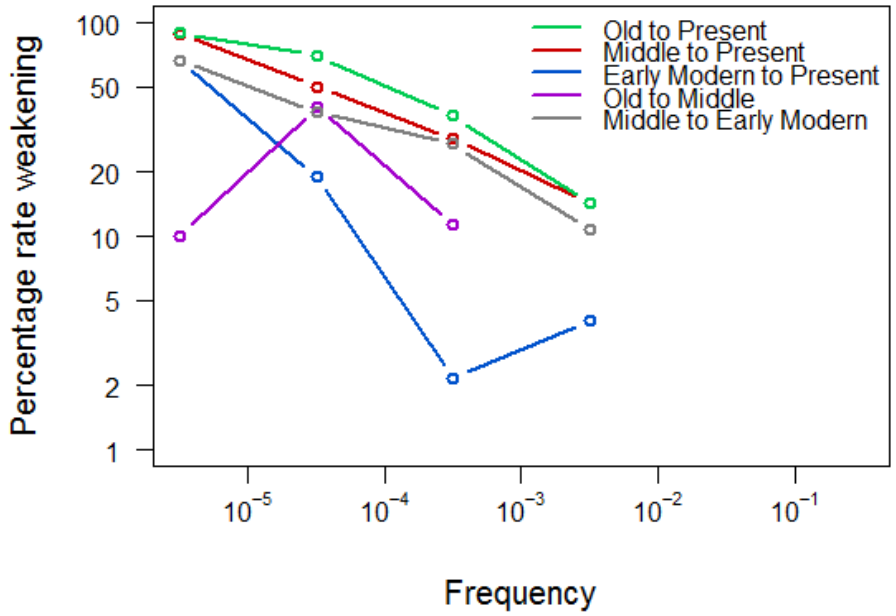
Replication with fourth measurement point:

Lieberman et al. 2007: Constant rate of regularisation through time, only dependent on frequency



But the constant rate breaks down when we add an extra measurement point for E. Mod. Eng.:





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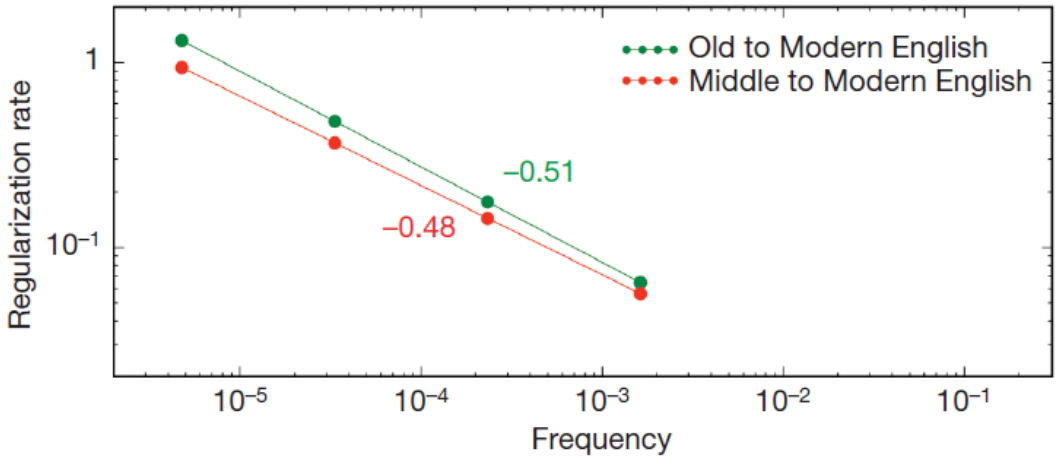
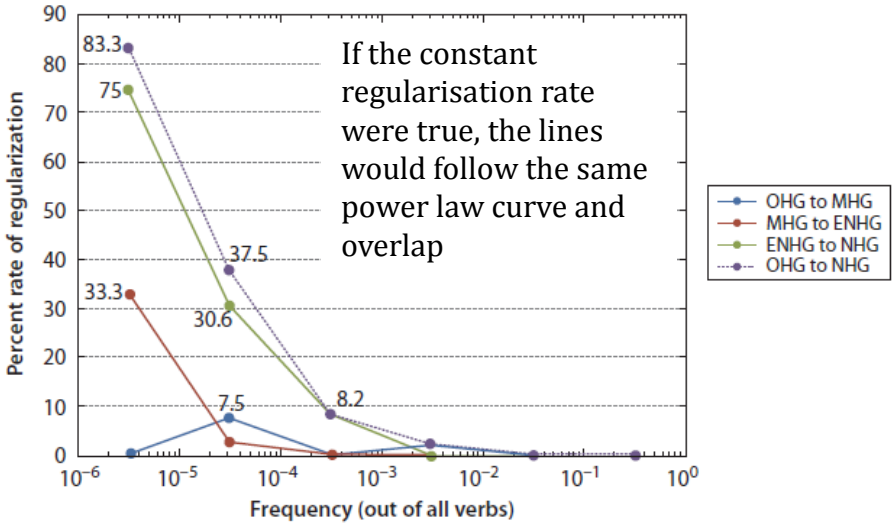
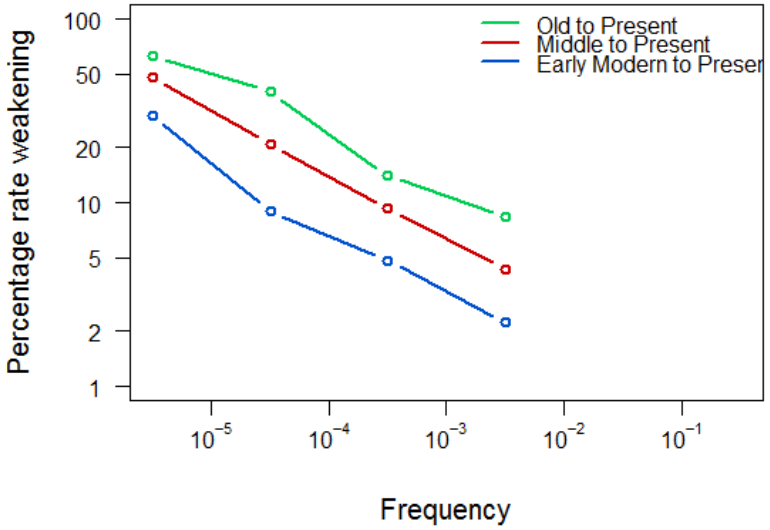


Carroll et al. 2012: Constant rate does not work for German

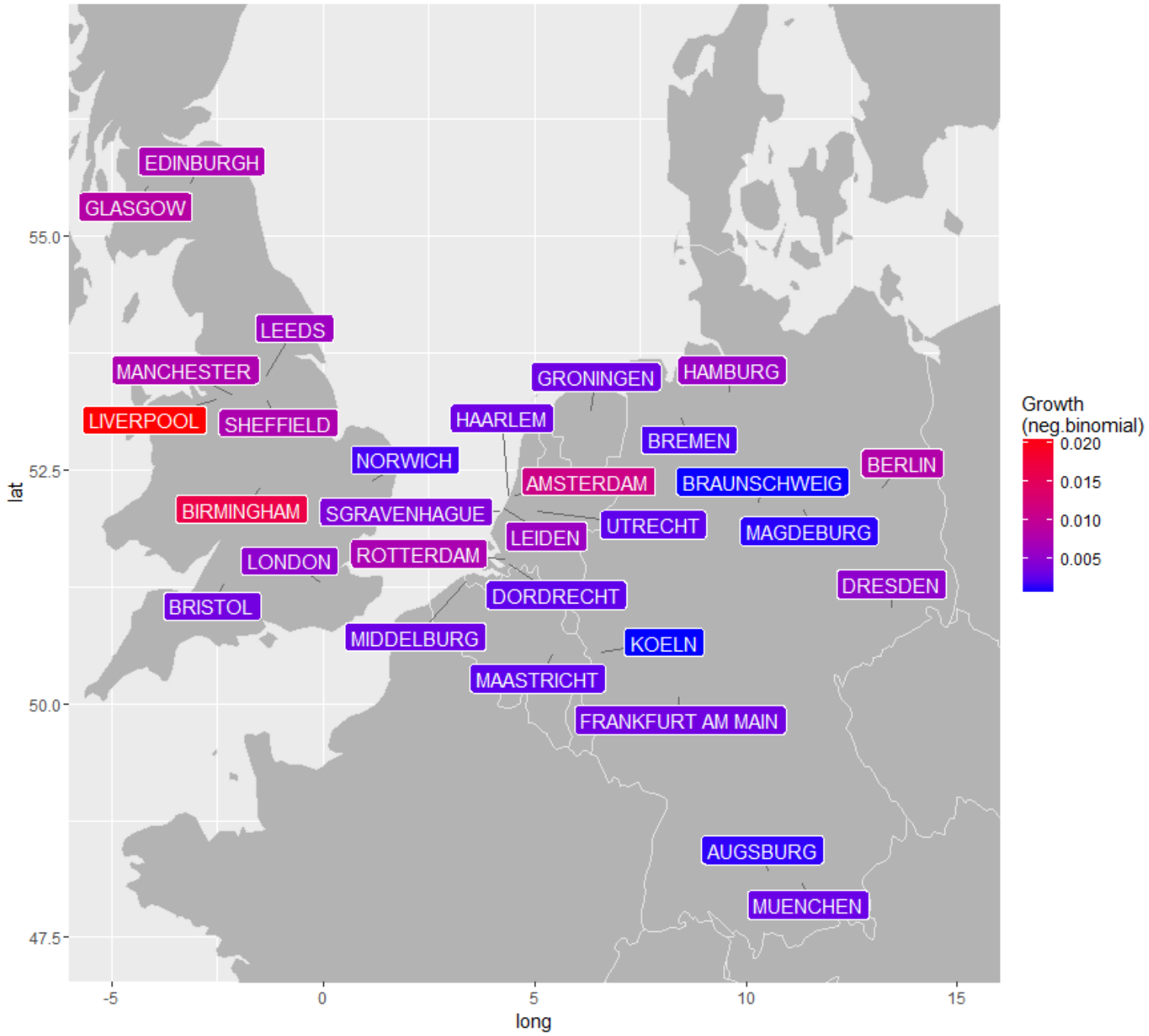


... neither for Dutch



Historical demographic data

- The change in the preterite does not an follow iron law
- Can the analyticisation of the preterite be attributed to language contact?
- Through dialect leveling, koineisation, as suggested by Carroll et al. (2012)
- Problem: no direct quantitative data on migration
- Urbanisation is a workable proxy, as the growth in cities is too large to have come about through natural births, and suggests immigration (Howell 2006: 208), and language change propagates in major urban centres.


EDINBURGH
GLASGOW
LEEDS
MANCHESTER
LIVERPOOL
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NORWICH
BIRMINGHAM
LONDON
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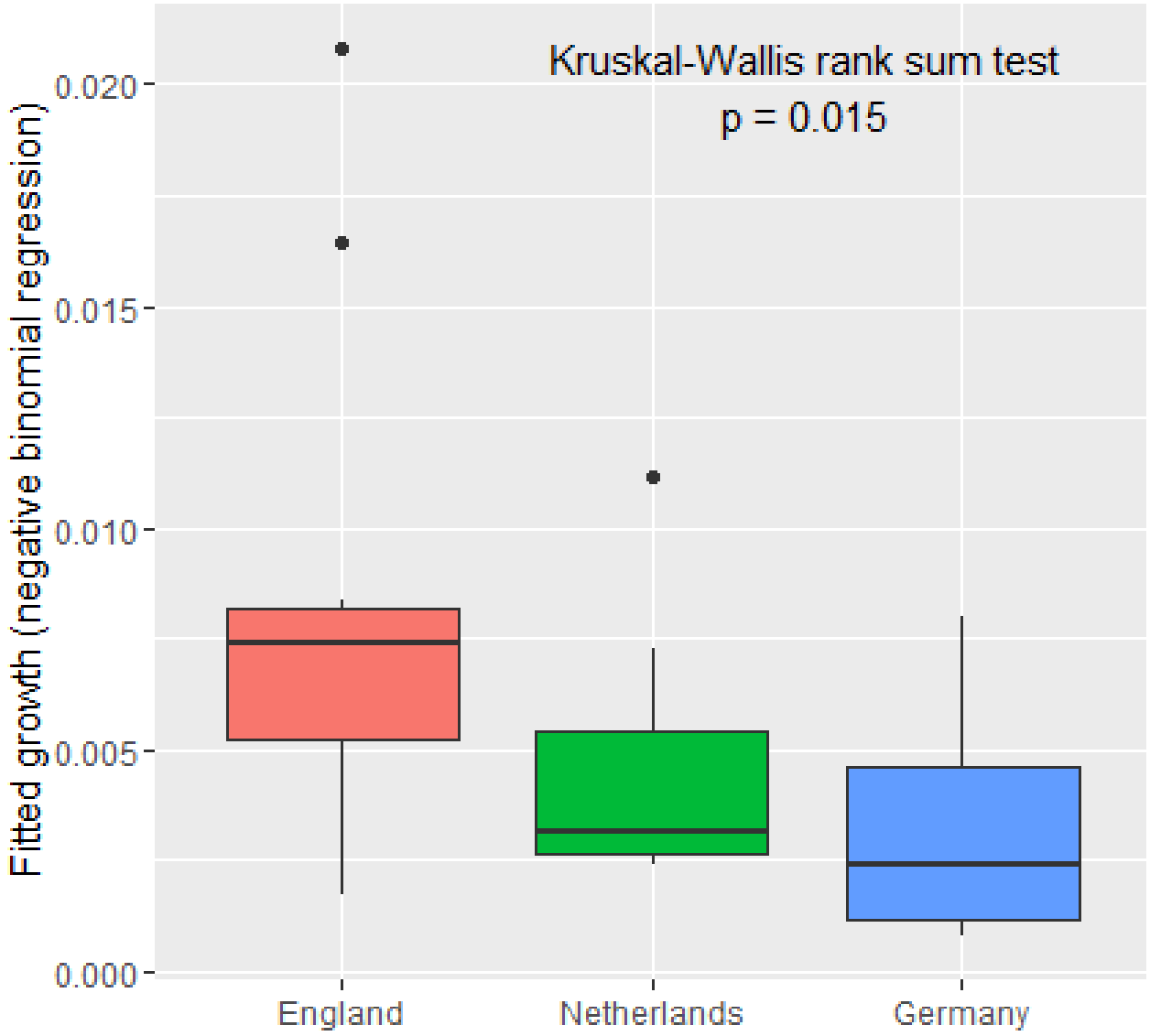
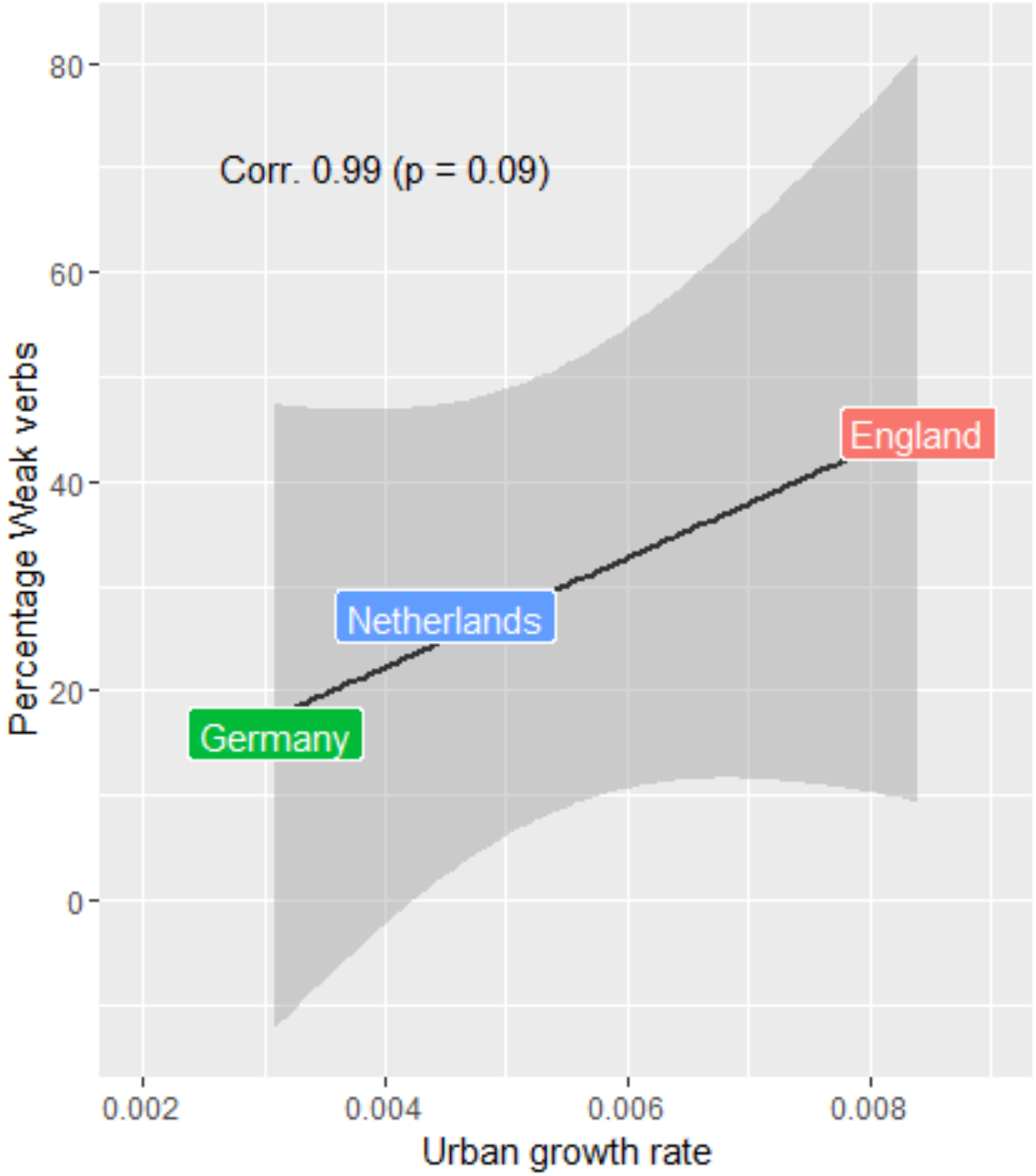
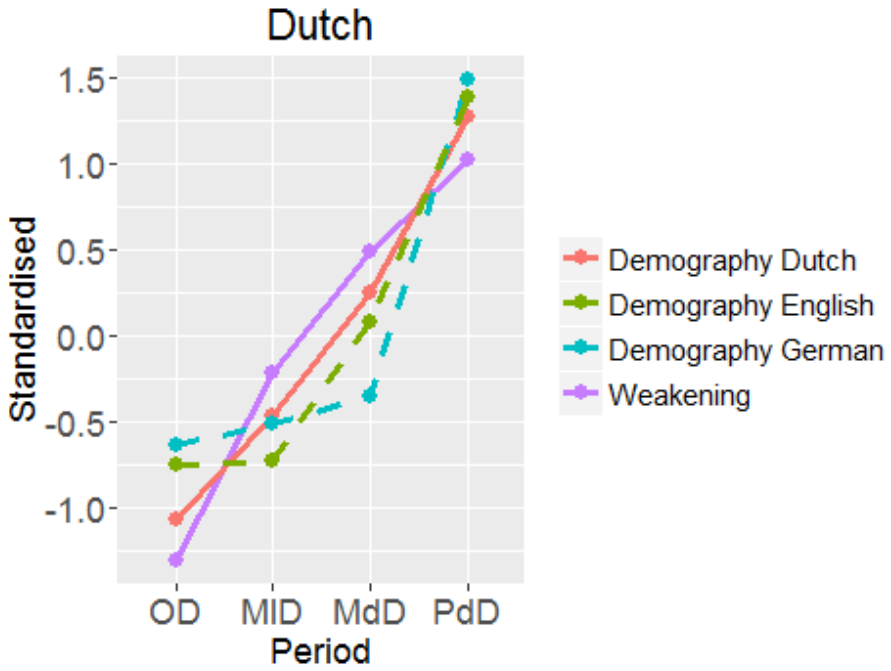
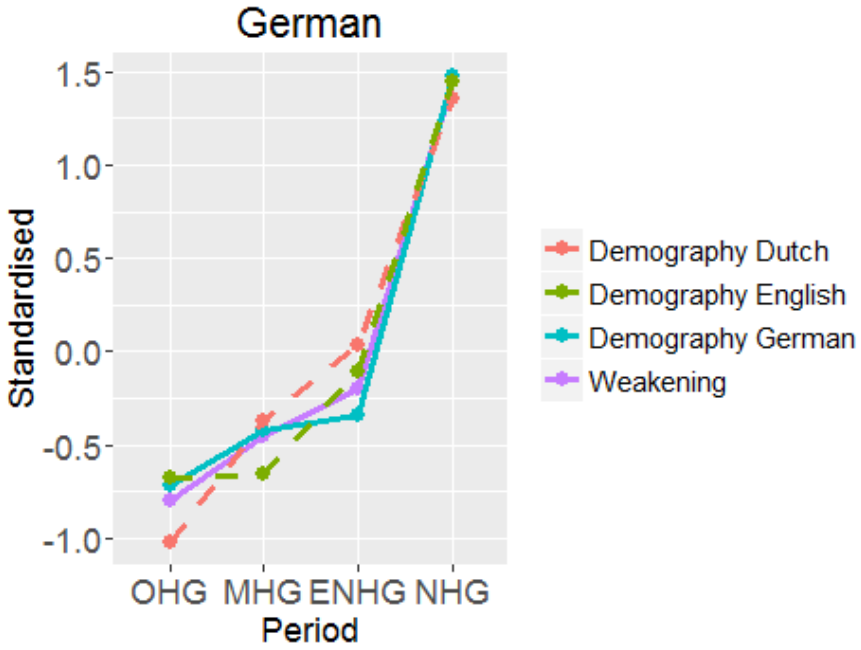
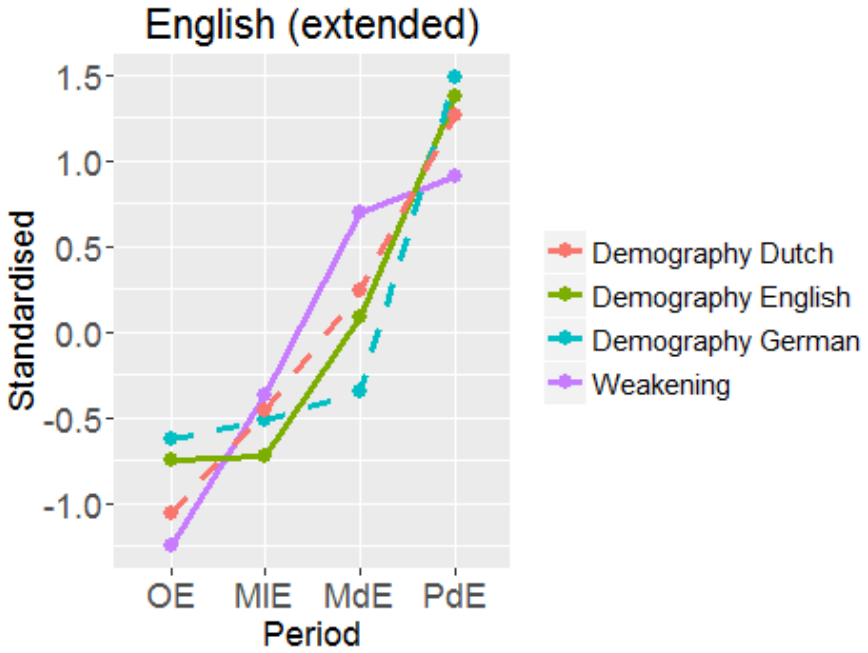
SGRAVENHAGUE
ROTTERDAM
LEIDEN
DORDRECHT
MIDDELBURG
MAASTRICHT
HAARLEM
AMSTERDAM
UTRECHT
GRONINGEN
HAMBURG
BREMEN
BRAUNSCHWEIG
MAGDEBURG
BERLIN
DRESDEN
KOELN
FRANKFURT AM MAIN
AUGSBURG
MUENCHEN
55.0
52.5
50.0
47.5
lat
-5
0
5
10
15
long
Growth
(neg.binomial)
0.020
0.015
0.010
0.005


Kruskal-Wallis rank sum test
p = 0.015
Fitted growth (negative binomial regression)
0.020
0.015
0.010
0.005
0.000
England
Netherlands
Germany


Corr. 0.99 (p = 0.09)
England
Netherlands
Germany
Percentage Weak verbs
80
60
40
20
0
0.002
0.004
0.006
0.008
Urban growth rate



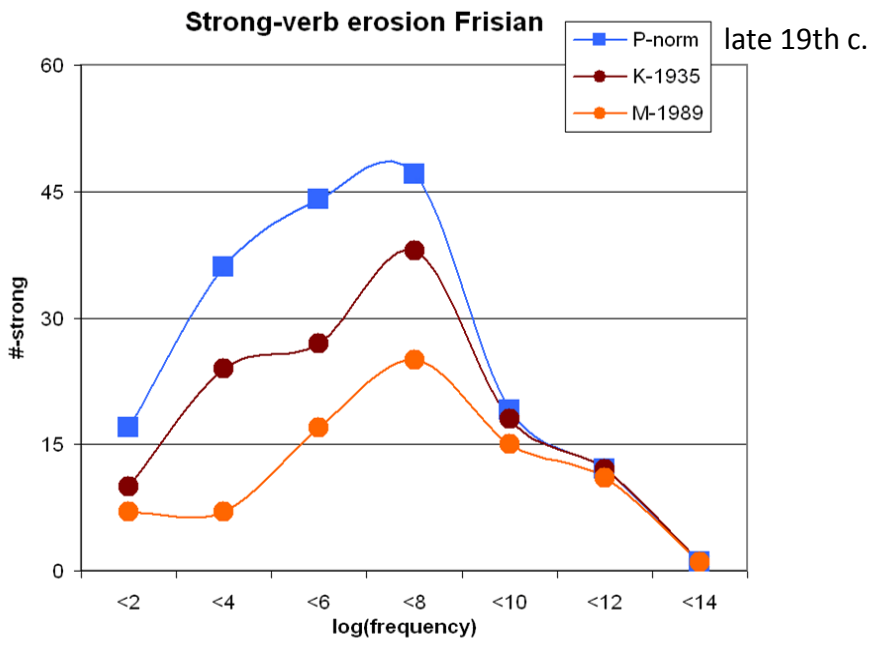




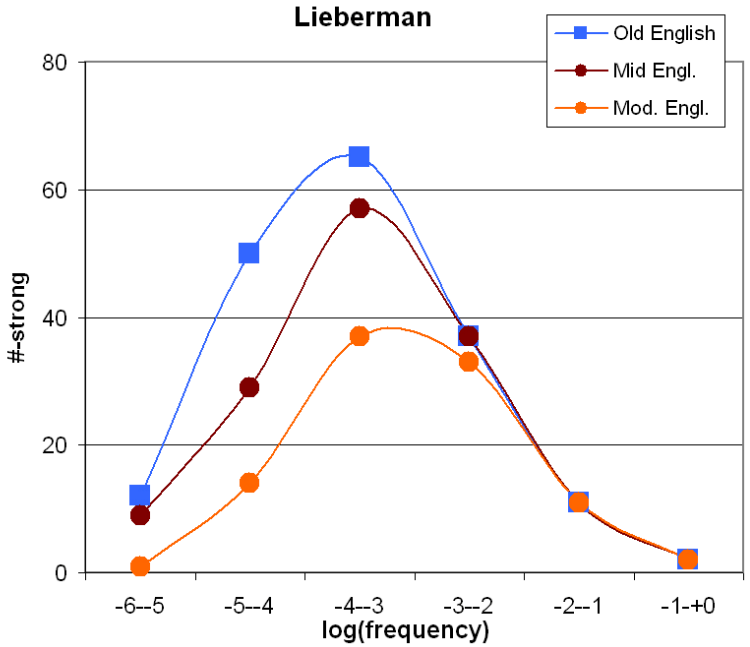
Average of largest city in each century covering the linguistic periods in each area

log(inh) ⇨ Weakening ⇩	English	Dutch	German
English	0.96*	0.97*	0.77 (n.s.)
Dutch	0.94 (n.s.)	0.99**	0.82 (n.s.)
German	0.90 (n.s.)	0.81 (n.s.)	0.99*

Time scales can be radically different



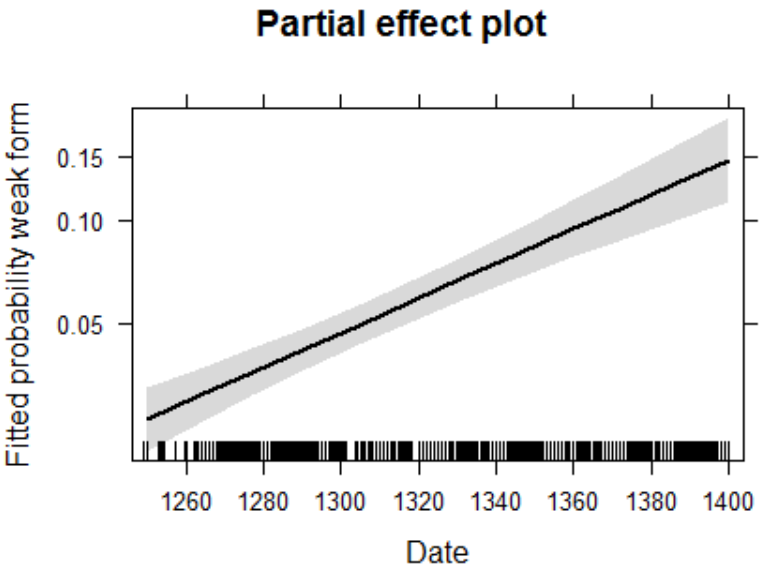
late 19th c.

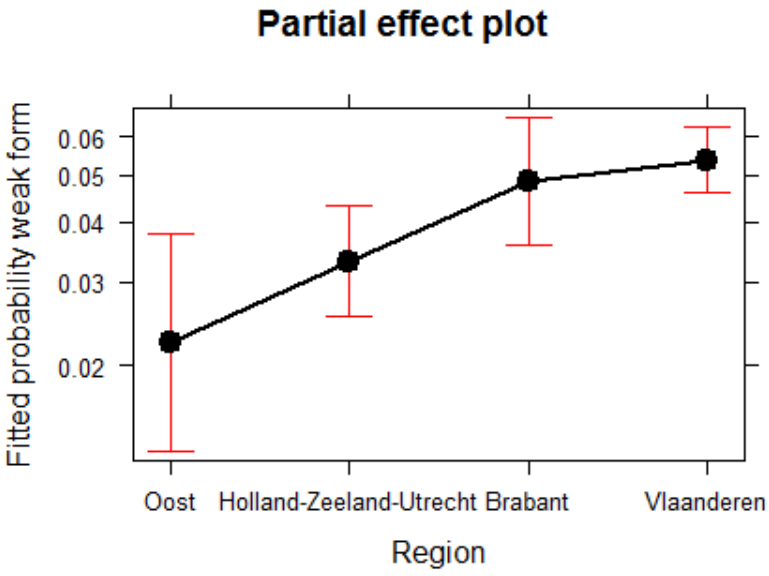


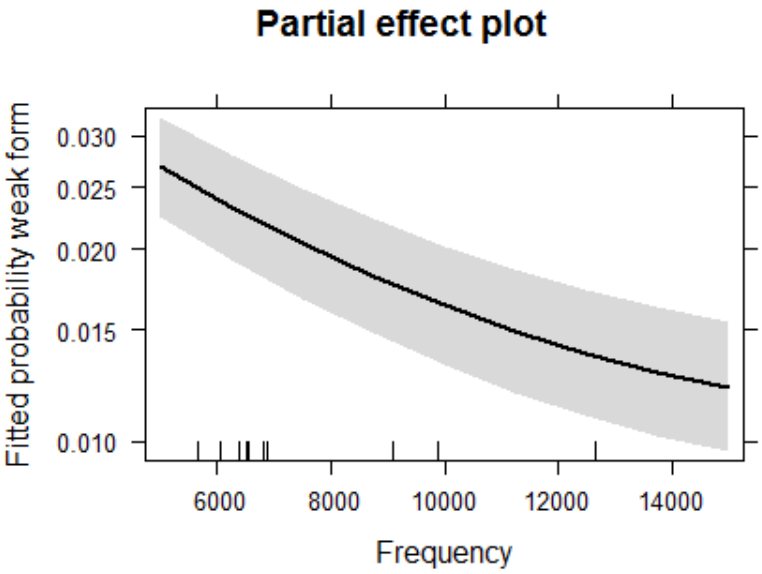
Graphs from: Versloot, Arjen (p.c.)

Frisian has recently been heavily influenced by Dutch

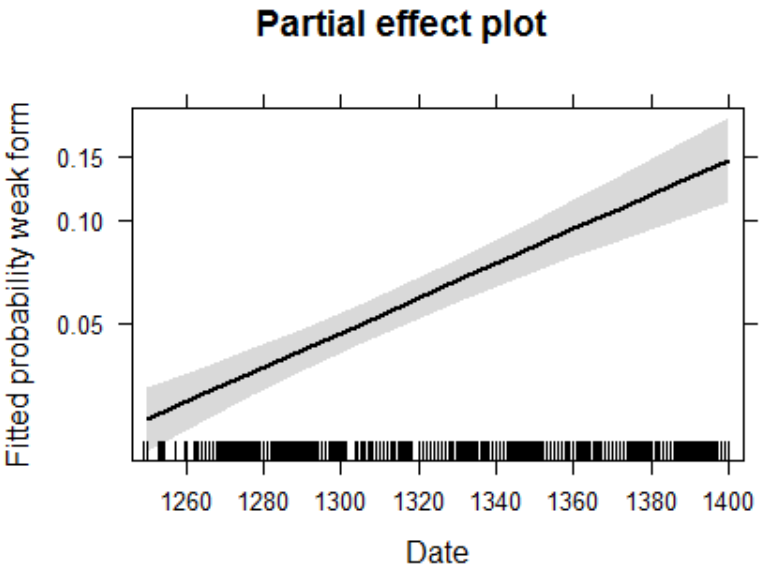
From grammars to corpora: 13th and 14th century Dutch

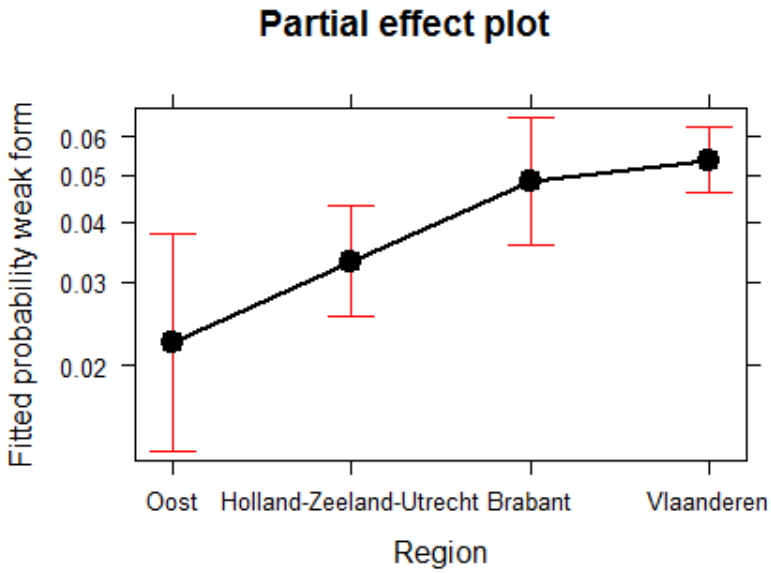


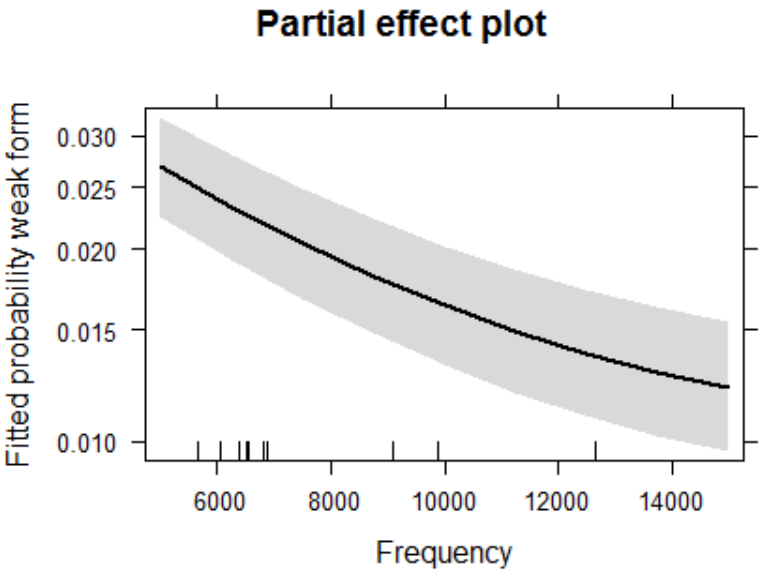


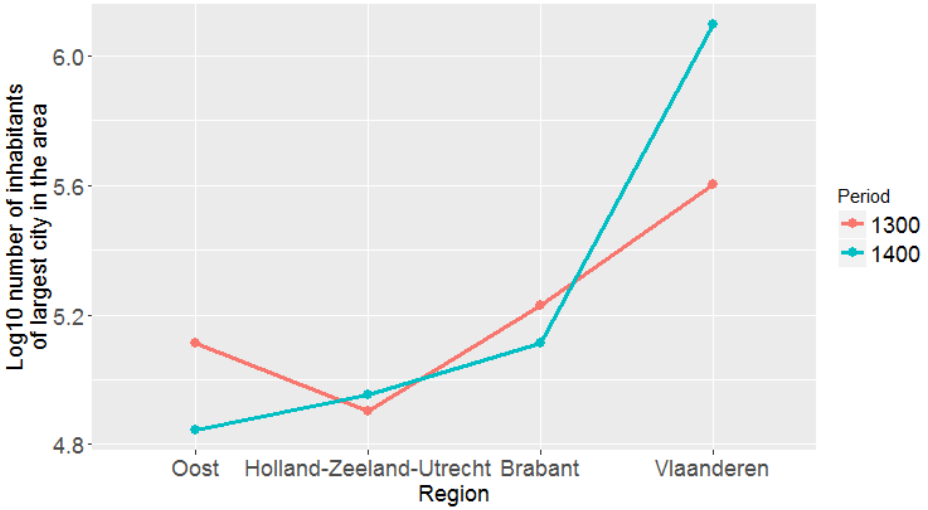


From grammars to corpora: 13th and 14th century Dutch









In silico simulation: agent-based model

(Pijpops, Beuls & Van de Velde 2015)

- Standard method in evolutionary biology, economics etc.
- Recently also applied in linguistics (see Steels 2016)
- Interactions between software agents, equipped with grammar and lexicon
- To see emergence of trends

In silico simulation: agent-based model

- What do we put in?
  - Single, generally applicable weak suffix vs. multiple strong classes
  - Weak suffix has lower type and token frequency to any individual ablaut class (super-conservative)
  - Verbs have a realistic (Zipfian) frequency distribution
  - Agents are gradually replaced (birth & death)
  - Lexical replacement (work in progress)

In silico simulation: agent-based model

- What do we NOT put in?
  - Any restrictions on the strong system: each verb can be conjugated strongly
  - Any irregular-only verbs, or ways to become irregular
  - Any other possible advantage to the weak inflection that its mere general applicability
  - Agents will never forget strong verb forms (↔ Taatgen and Anderson 2002: 124)
  - No advantage of linear segmentability: Hearers recognize equally easy
    - sing-ed 'sing + PAST'
    - s-ou-ng 'sing + PAST'
  - No social structure or social preference
  - New agents start with an empty grammar

Keep It Simple Stupid

(Landsbergen 2009: 18-19)

- Only finite past tenses
- No influence of phonetic resemblance

Evaluation criteria

1. Rise of the Weak Inflection (Carroll et al. 2012; Cuskley et al. 2014)
2. Gradual Rise (Cuskley et al. 2014)
3. Conserving Effect (Bybee 2006: 715; Lieberman et al. 2007)
4. Class Resilience (Mailhammer 2007; Carroll et al. 2012: 163-164)

⇨ Emergence should not be dependent on specific parameter settings

implementational level

Strong vowel alternations: extracted from Corpus of Spoken Dutch

1	I	ij → ee	krijg → kreeg
2	II-a	ie → oo	vlieg → vloog
3	II-b	ui → oo	kruip → kroop
4	III-a	i → o	vind → vond
5	III-b	e → o	trek → trok
6	III-c	e → ie	sterf → stierf
7	IV/V-a	ee → a	geef → gaf
8	V-b	i → a	zit → zat
9	VI	aa → oe	draag → droeg
10	VII-a	aa → ie	laat → liet
11	VII-b	a → i	hang → hing

Verbs: extracted from Corpus of Spoken Dutch

(all can be conjugated strongly, no irregulars, realistic frequency distribution)

- vinden 1518
- zitten 1157
- krijgen 359
- liggen 208
- …
- stinken 11
- dragen 11
- eten 10
- …
- bidden 1

World

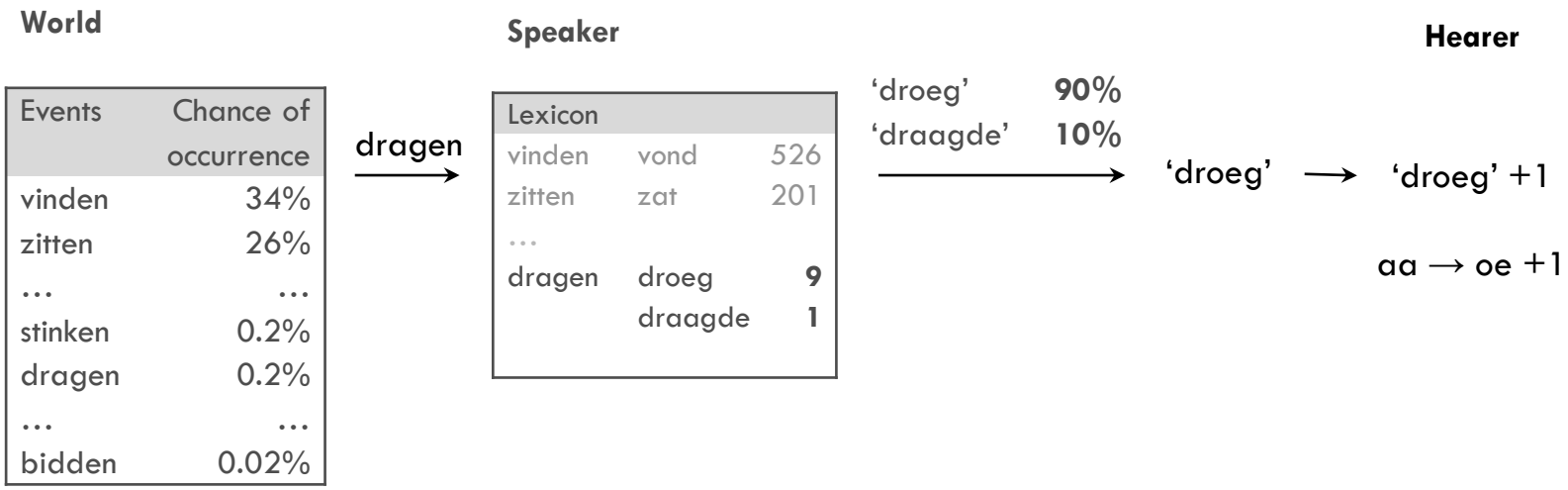
Events	Chance of occurrence
vinden	34%
zitten	26%
…	…
stinken	0.2%
dragen	0.2%
…	…
bidden	0.02%

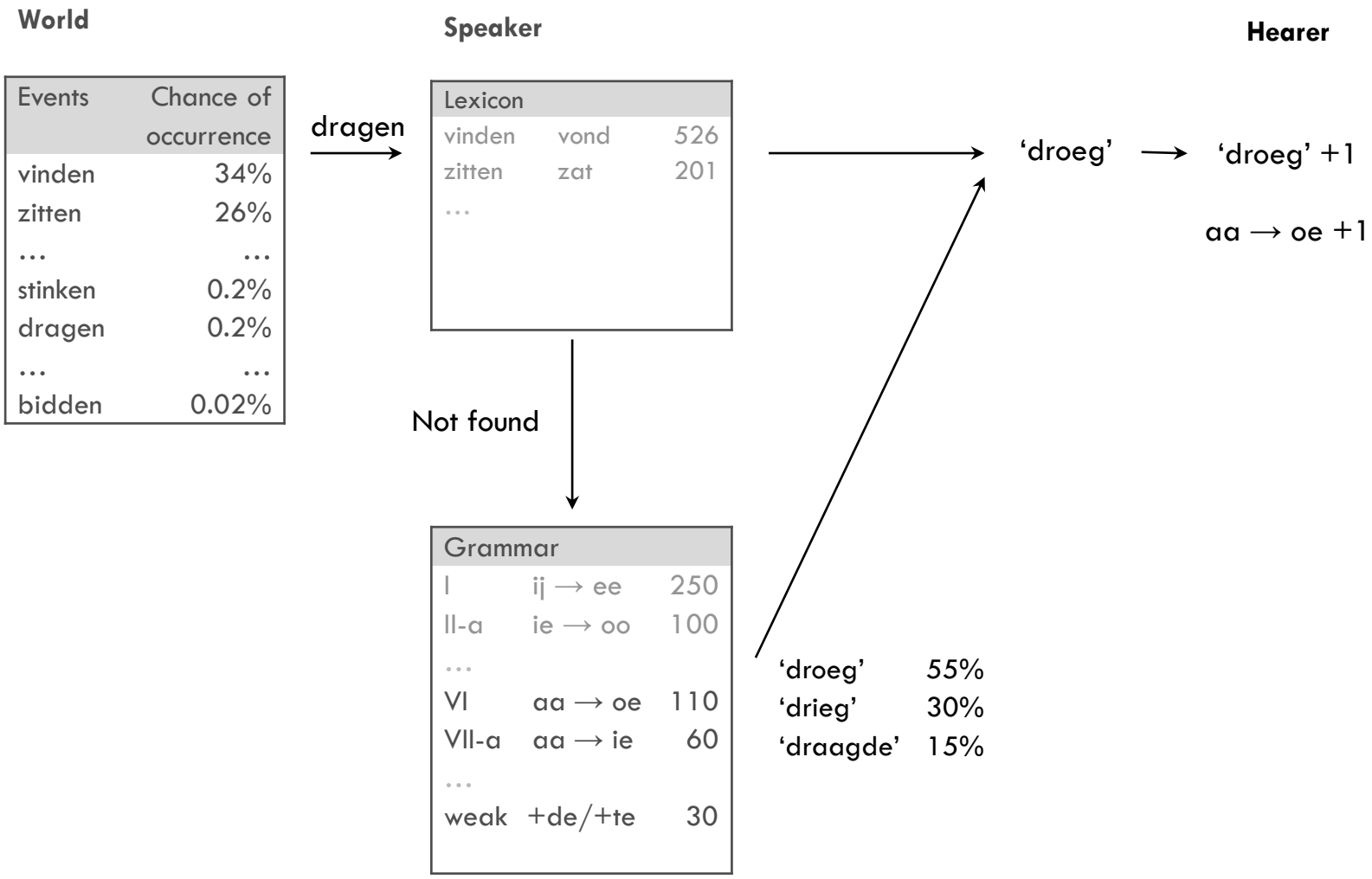
dragen →

Speaker

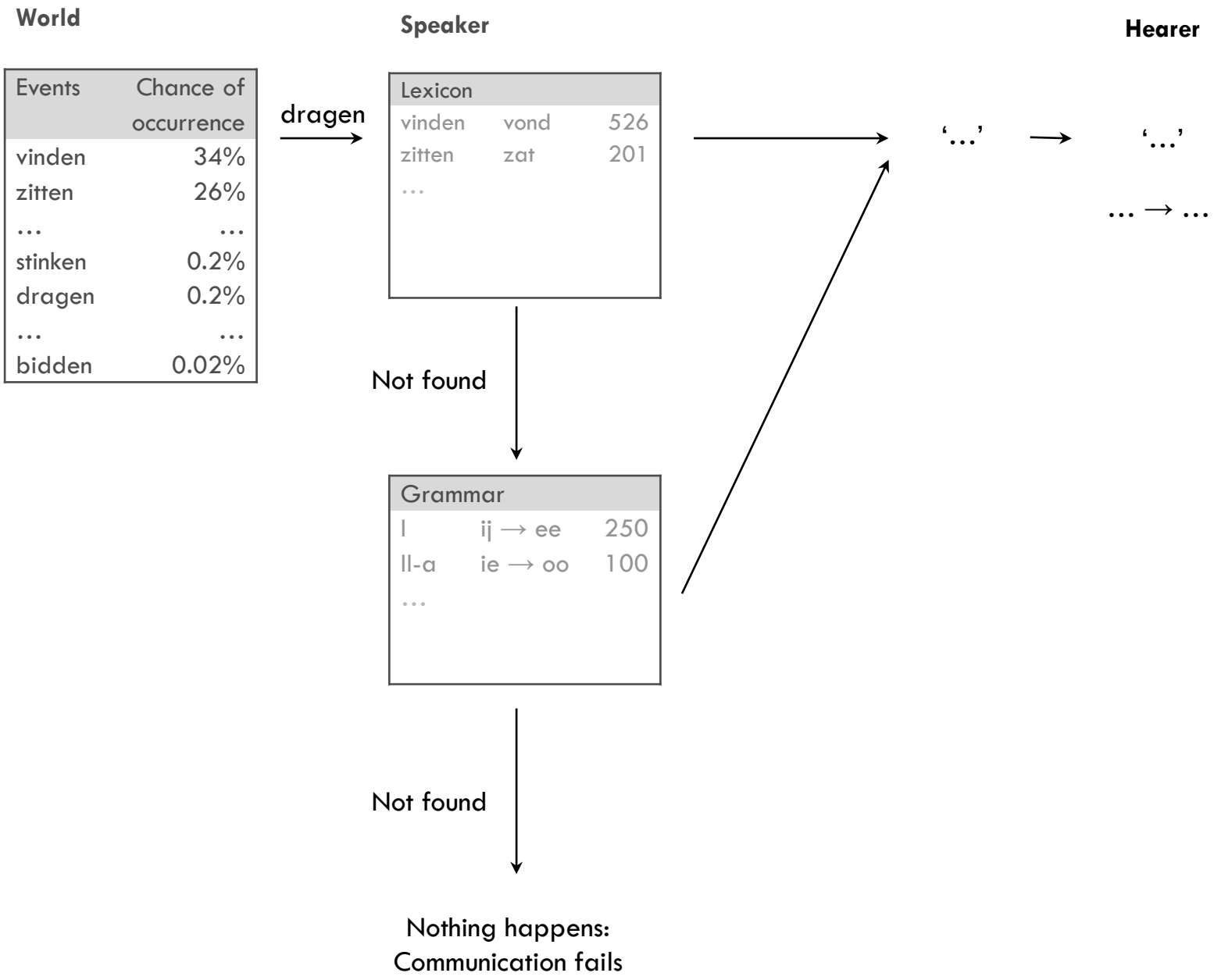
Lexicon		
vinden	vond	526
zitten	zat	201
…		
dragen	droeg	9
	draagde	1

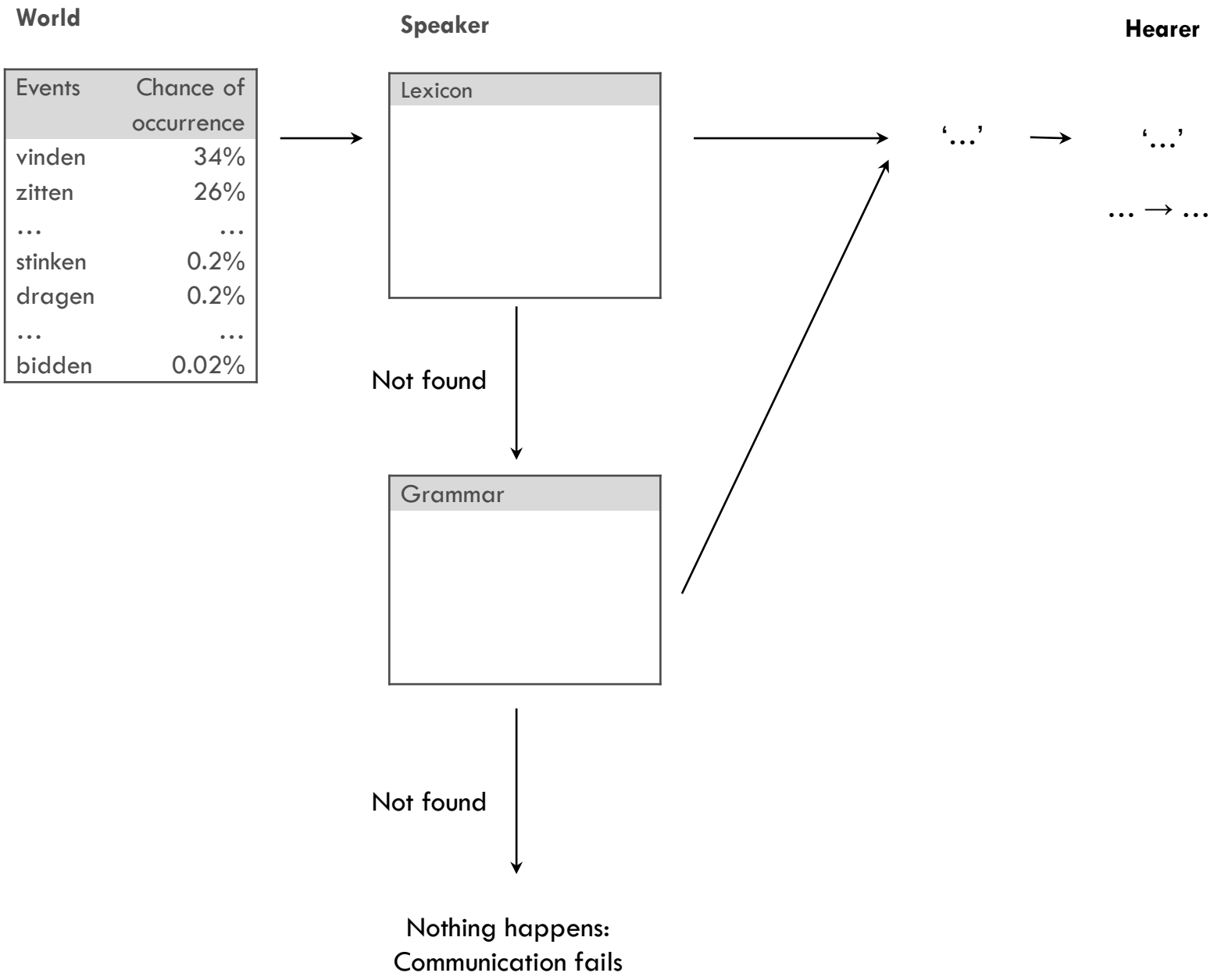
‘droeg’ 90%
‘draagde’ 10%
→


World
Events
Chance of occurrence
vinden 34%
zitten 26%
… …
stinken 0.2%
dragen 0.2%
… …
bidden 0.02%
dragen
Speaker
Lexicon
vinden vond 526
zitten zat 201
…
dragen droeg 9
draagde 1
‘droeg’ 90%
‘draagde’ 10%
‘droeg’
Hearer
‘droeg’ +1
aa → oe +1



Grammar implemented using Fluid Construction Grammar, see Steels (2011) and van Trijp et al. (2012)


World
Speaker
Hearer
Events
Chance of occurrence
vinden 34%
zitten 26%
… …
stinken 0.2%
dragen 0.2%
… …
bidden 0.02%
dragen
Lexicon
vinden vond 526
zitten zat 201
…
Not found
Grammar
l ij → ee 250
ll-a ie → oo 100
…
Not found
Nothing happens:
Communication fails
'…'
'…'
… → …


World
Speaker
Hearer
Events
Chance of occurrence
vinden 34%
zitten 26%
… …
stinken 0.2%
dragen 0.2%
… …
bidden 0.02%
Lexicon
Not found
Grammar
Not found
Nothing happens:
Communication fails
'…'
'…'
… → …

LET'S RUN A SIMULATION!

Starting situation: only strong classes

- All starting agents know perfectly how to conjugate each verb
- Have access to all strong classes

Lexicon		
vinden	vond	1518
zitten	zat	1157
…		
dragen	droeg	11
…		
bidden	bad	1

Grammar		
I	ij → ee	879
II-a	ie → oo	43
II-b	ui → oo	32
III-a	i → o	1633
III-b	e → o	33
III-c	e → ie	10
VI/V-a	ee → a	239
Vb	i → a	1366
VI	aa → oe	185
VII-a	aa → ie	65
VII-b	a → i	34

A PRELIMINARY SIMULATION

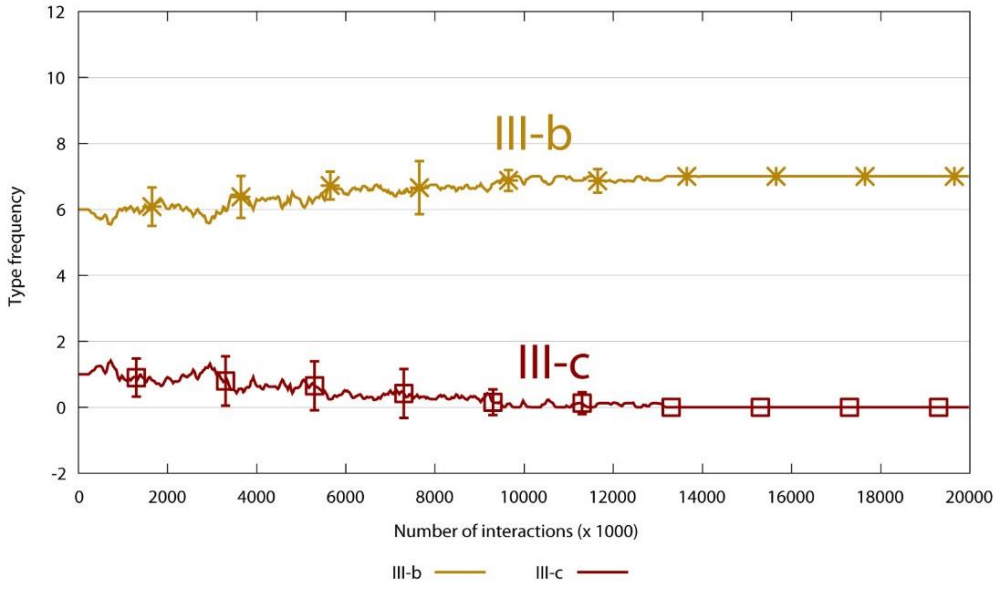
Starting situation: only strong classes

- All starting agents know perfectly how to conjugate each verb
- Have access to all strong classes

Lexicon		
vinden	vond	1518
zitten	zat	1157
…		
dragen	droeg	11
…		
bidden	bad	1

Grammar		
I	ij → ee	879
II-a	ie → oo	43
II-b	ui → oo	32
III-a	i → o	1633
III-b	e → o	33
III-c	e → ie	10
VI/V-a	ee → a	239
Vb	i → a	1366
VI	aa → oe	185
VII-a	aa → ie	65
VII-b	a → i	34

RESULTS: COMPETING STRONG CLASSES

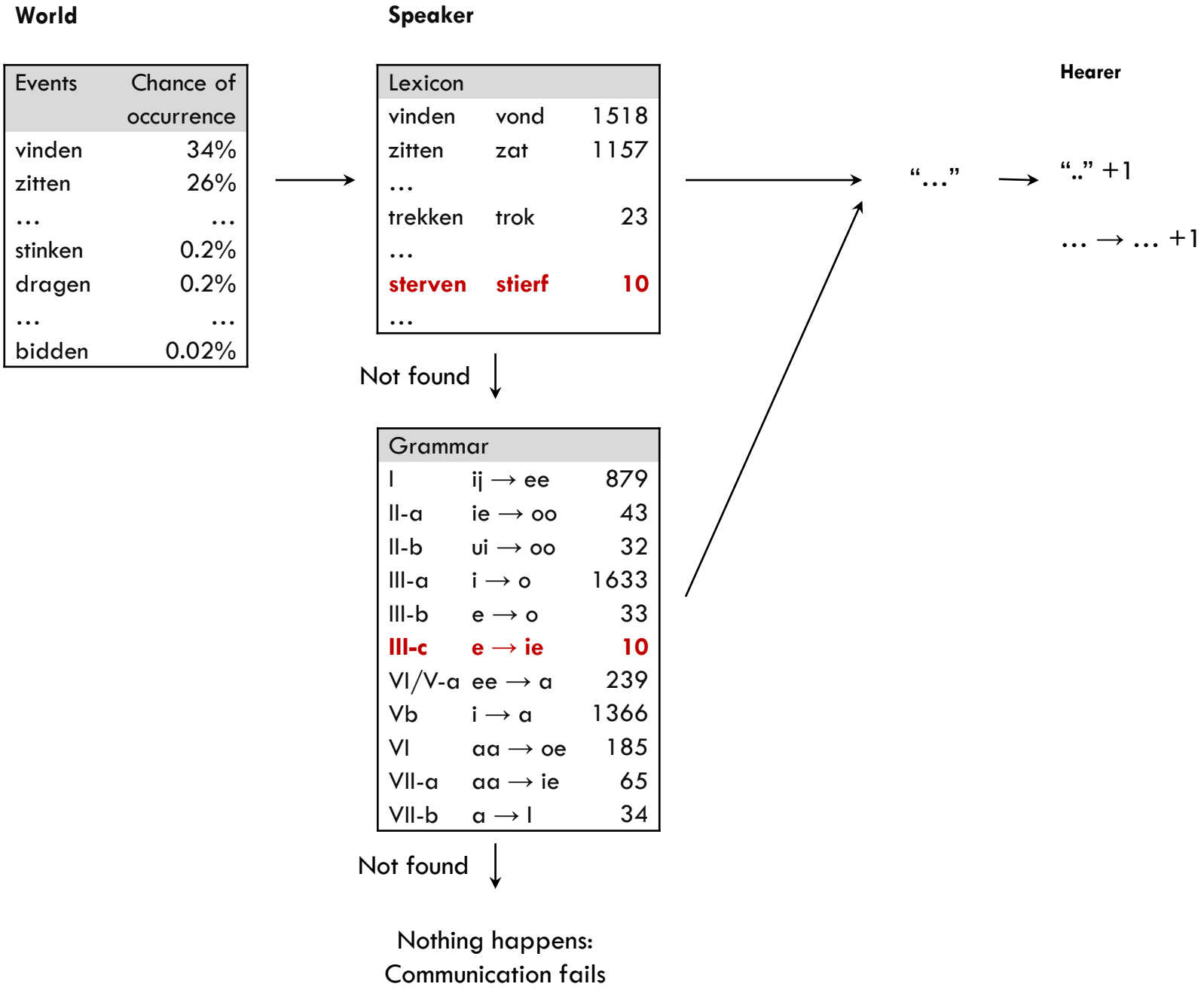


- Either both competing classes hold each other in balance
- Or the initially most frequent one prevails

RESULTS: BRING IN THE WEAK INFLECTION

Starting position of the weak inflection

- Take the starting position of the feeblest strong class, i.e. III-c (e ⟶ *ie*)
  - Inferior in type & token frequency to any other class
  - Direct competition with more frequent III-b class (e ⟶ o)
  - Went extinct in the previous simulation


World
Speaker
Hearer
Events
Chance of occurrence
vinden 34%
zitten 26%
… …
stinken 0.2%
dragen 0.2%
… …
bidden 0.02%
Lexicon
vinden vond 1518
zitten zat 1157
…
trekken trok 23
…
sterven stierf 10
…
Not found
Grammar
I ij → ee 879
II-a ie → oo 43
II-b ui → oo 32
III-a i → o 1633
III-b e → o 33
III-c e → ie 10
VI/V-a ee → a 239
Vb i → a 1366
VI aa → oe 185
VII-a aa → ie 65
VII-b a → I 34
Not found
Nothing happens:
Communication fails
“…”
“..” +1
… → … +1

World

Events	Chance of occurrence
vinden	34%
zitten	26%
…	…
stinken	0.2%
dragen	0.2%
…	…
bidden	0.02%

Speaker

Lexicon		
vinden	vond	1518
zitten	zat	1157
…		
trekken	trok	23
…		
sterven	**sterfde**	**10**
…		

Not found

Grammar		
I	ij → ee	879
II-a	ie → oo	43
II-b	ui → oo	32
III-a	i → o	1633
III-b	e → o	33
weak	**+de/te**	**10**
VI/V-a	ee → a	239
Vb	i → a	1366
VI	aa → oe	185
VII-a	aa → ie	65
VII-b	a → I	34

Not found

Nothing happens:
Communication fails

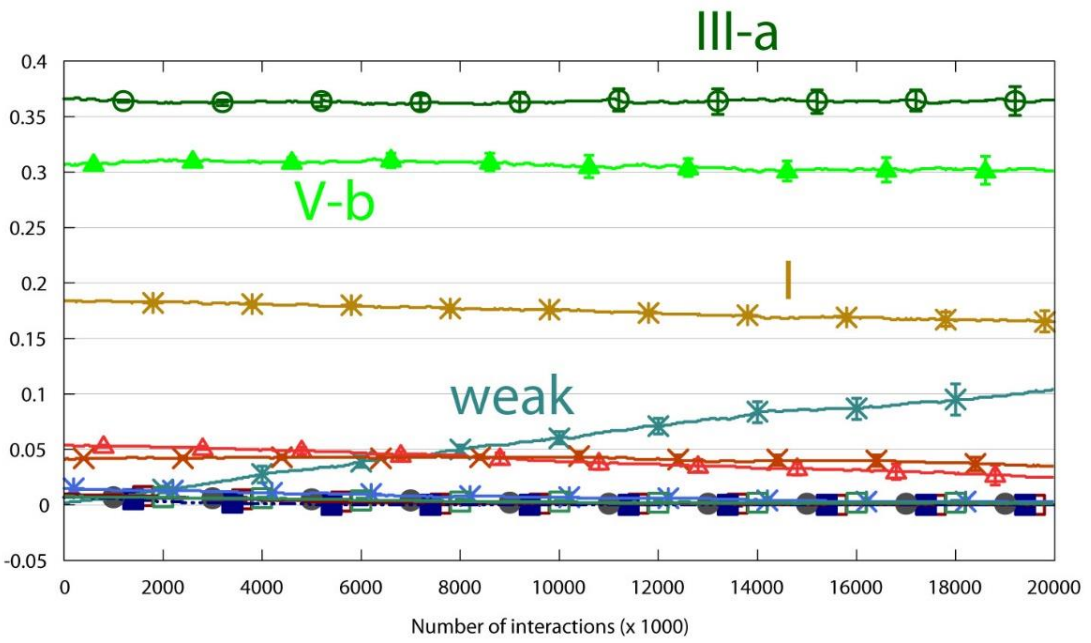
Hearer

"…" → ".." +1

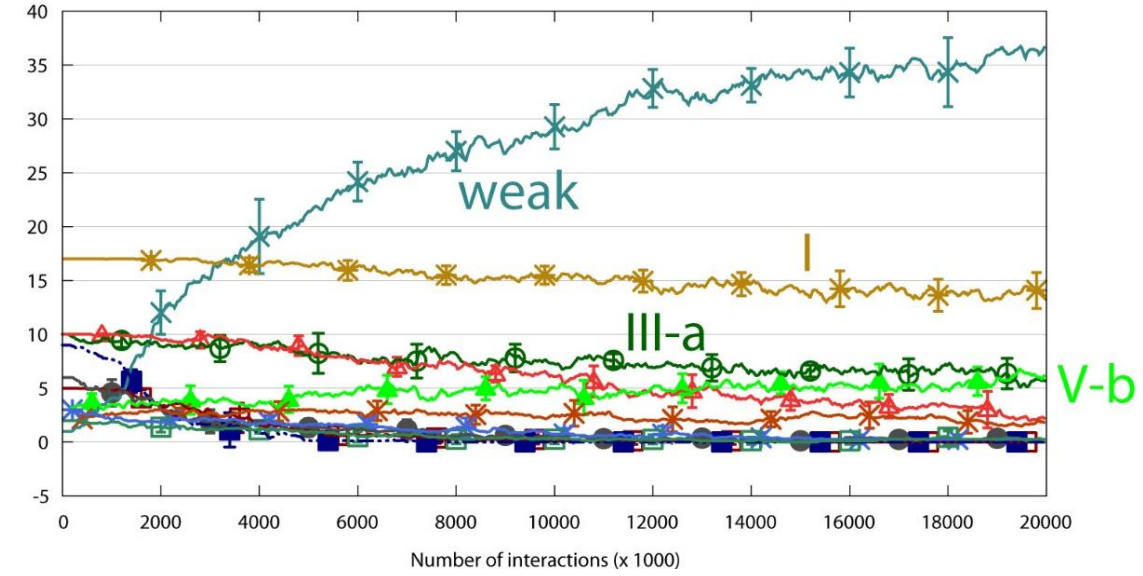
… → … +1

Only difference with the III-c class is that the weak suffix can in principle be applied to all verbs

Token frequency

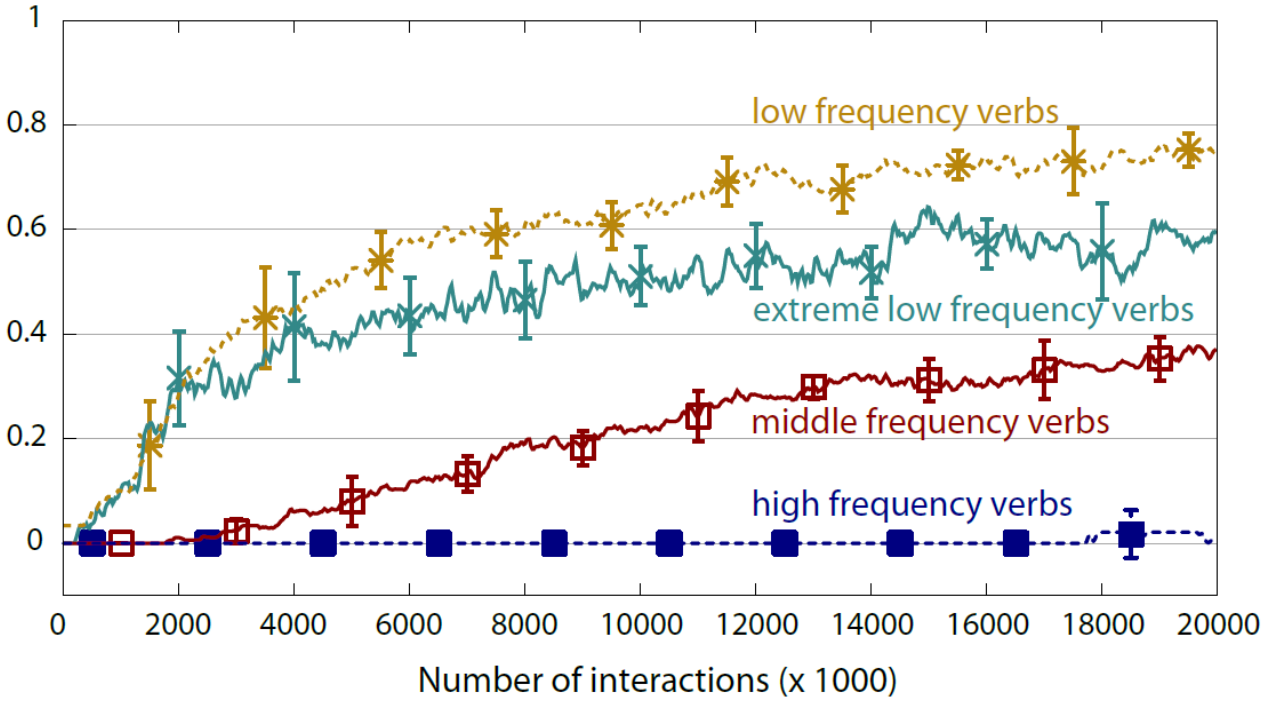


Type frequency

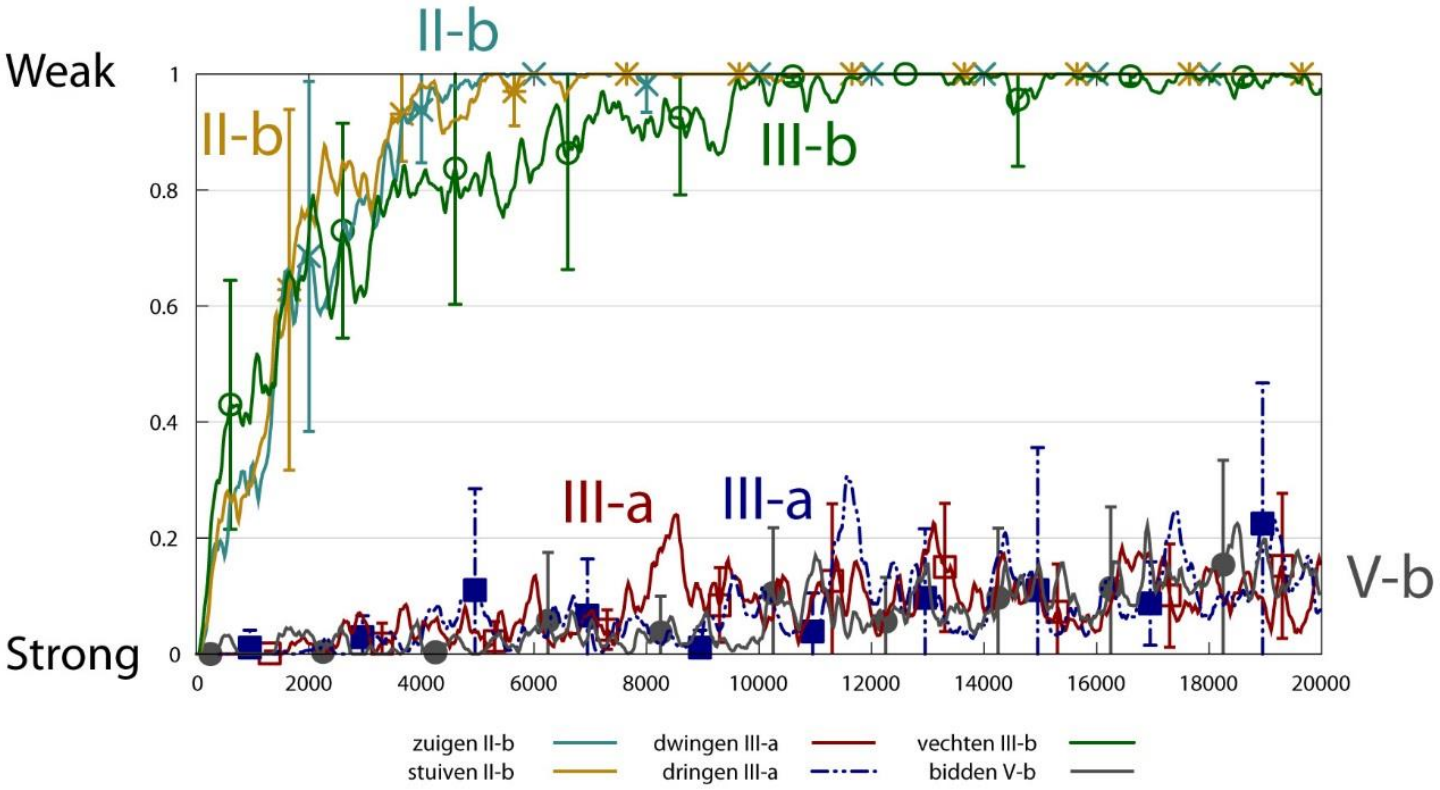


1. Rise of the Weak Inflection
2. Gradual Rise

Weak type frequency

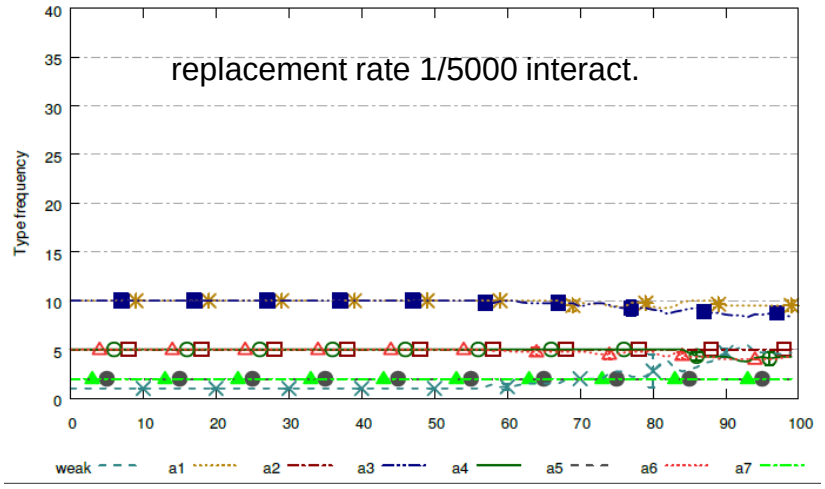


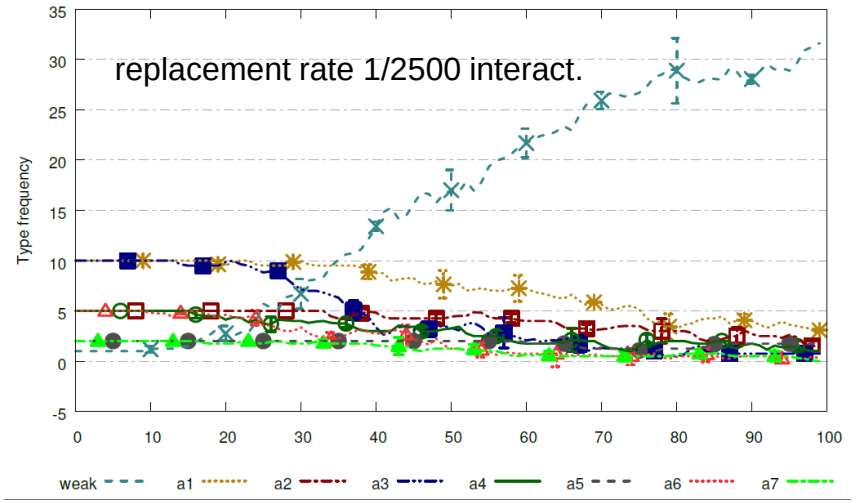
3. Conserving Effect

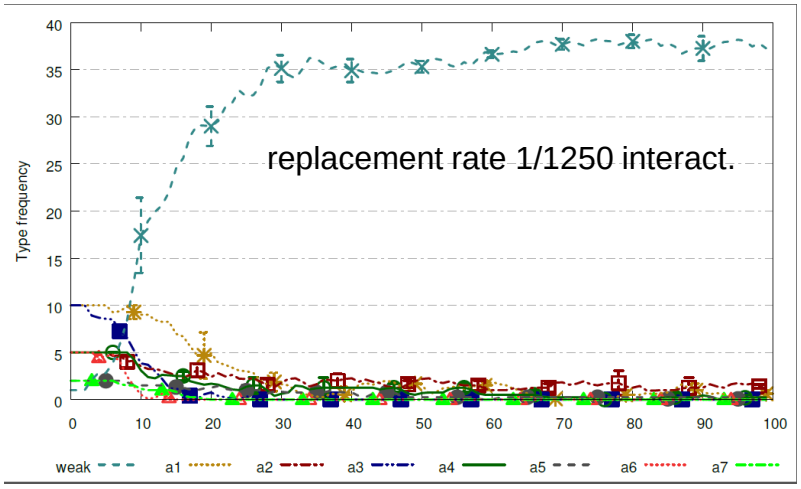


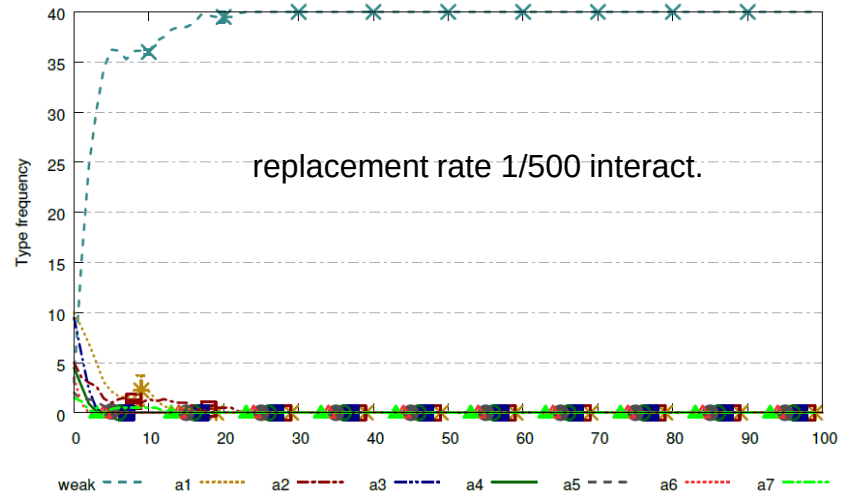
4. Class Resilience

Effect of parameter setting of agent replacement:









Other parameter settings (work in progress)

- More precipitous rise of weak inflection with
  - Higher agent replacement rate (see previous slide)
  - Bigger population
  - Sudden shifts instead of gradual replacement rate (1/10,000 vs. 2/20,000 or 4/40,000 interactions)

What kind of acquisition?

- Remember that we are (also) dealing with L2 acquisition here:
  - There is no one-to-one vertical transmission from old to new agents, but also horizontal transmission
  - All newly introduced agents have equal speech rights, and have the same influence in accommodation
  - Newly introduced agents are not initially confined to rote learning, but can extract rule-like patterns right away (see Beuls et al. 2010 for a stepwise learning model).
  - Agents have an adult 'world of events' that they want to speak about. They do not start out with simpler verbs like 'drink'. They follow the adult Zipfian distribution of verbs.
- Note that we cannot allow newly introduced agents to fall back on the analytic strategy (weak inflection), as that would give an unduly advantage to the weak inflection

Conclusions

- Language change is a function of historical demography
- between languages of different families
- between languages of the same family (English-Dutch-German)
- within a language (Dutch)

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