Do we need probabilistic grammars for language change?

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Outline

Grammatical variables

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Example of a grammatical variable

Verb clusters with three verbs in German: the variable 'verb position' has two variants: the finite verb can appear before or after the VP:

(1) a. ... dass er ein Buch lesen wollen wird
... that he a book read want will
'... that he will want to read a book'

b. ... dass er ein Buch wird lesen wollen

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Examples of hard and soft factors

The contextual factor 'phonological context' influences the grammatical variable 'occurence of consonants' in Dutch:

(2) *velar nasal before schwa and full vowel in Dutch*

a. ^{ok}[eŋəl] /before schwa

b. *[taŋo] /before full vowel

(3) *other consonants before schwa and full vowel in Dutch*

a. preferred: [kɛpə] /before schwa

b. dispreferred: [kɛpo] /before full vowel

(Oostdorp 2011)

Context dependency

Definition

By 'context dependency' I mean the observation that grammatical variation can be constrained by unrelated factors, irrespective of what such factors may be, and irrespective of whether these factors determine the grammatical variable categorically or influence them statistically.

Two general explanations for contextual factors

structural reasons:

↓

should be part of a model of linguistic knowledge

non-structural reasons:

- processing ease
- discourse optimization
- general cognitive principles
- third factors
- sociology

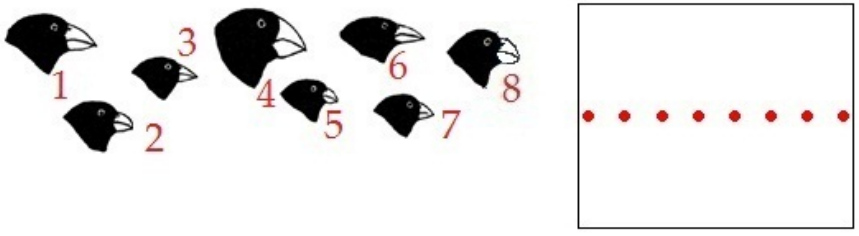
↓

should not be part of a model of linguistic knowledge

A biological metaphor...

- a population of birds; no two birds are identical

A biological metaphor...



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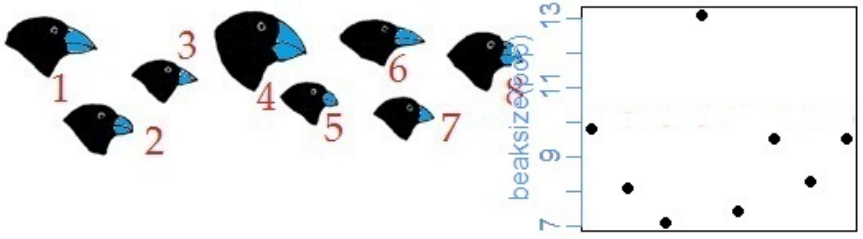

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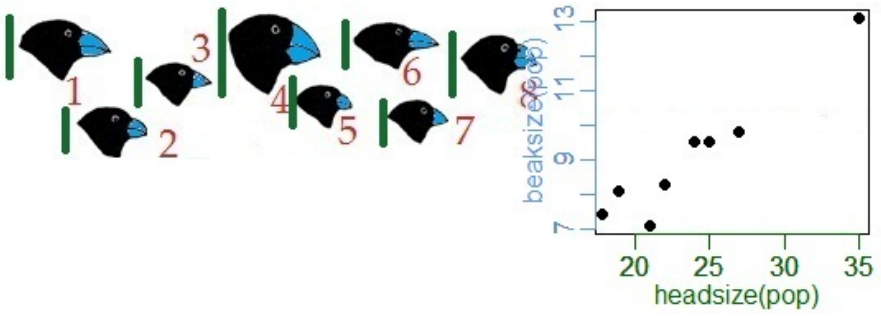

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- headsize(pop) = {27mm, 19mm, ..29mm}

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Example 1: German verb position by 'clause type'

- (4) a. ... dass Peter Maria ein Buch gibt.
  ... that P. M. a book gives
  '...that Peter gives Mary a book'

  b. *... dass Peter gibt Maria ein Buch.

  c. Peter gibt Maria ein Buch
  P. gives M. a book
  'Peter gives Mary a book'

  d. *Peter Maria ein Buch gibt.

- Speakers of German probably *know* that verb position is constrained by the contextual factor "clause type", [+/- main clause].

Example 2: French indirect pronouns by 'verb semantics'

- (5) a. je pense à lui
  I think of him
  'I think of him'
  b. *je lui pense.

  c. je lui parle
  I him talk
  'I talk to him'
  d. *je parle à lui.

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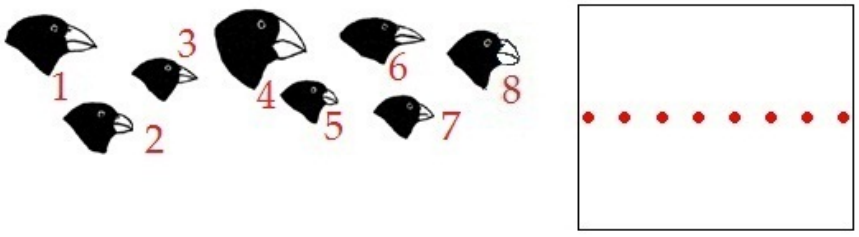

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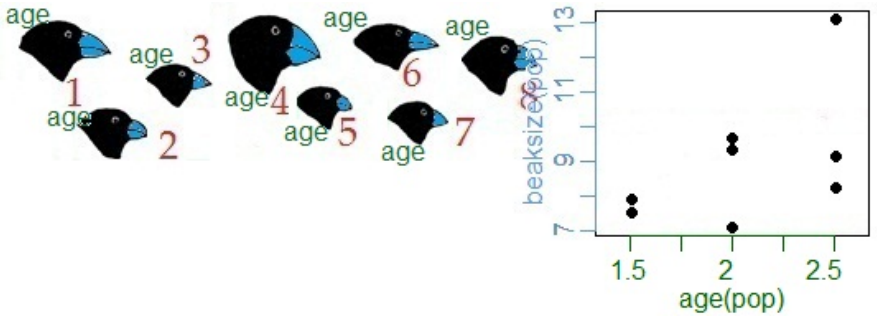

- a population of birds; no two birds are identical
- population = {1,2,... 8}
- beaksize(pop) = {9.8mm, 8.1mm, ... 8.7mm}
- independent variables like: nourishment, weather, habitat ...

  age(pop) = {2.5years, 1.5years, ..2years}

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Example 3: Topic-drop by 'register'

- (6) a. *_ Must try harder. (narrative, discourse)
  b. _ Must try harder. (school report)
  (Haegeman 1990)
- English speakers probably do not *know* that Topic-drop is constrained by the contextual factor "register", [+/- school report].

Example 4: Postposition by 'phonological weight'

- (7) a. The astronomer [gazed [into the dark sky] [through his effective but unwieldy telescope]]
  (27 examples in Hawkins' sample of 117 clauses with instrument and direction PP)

  b. ?The astronomer [gazed [through his effective but unwieldy telescope] [into the dark sky]]
  (2 examples in Hawkin's sample of 117 clauses with instrument and direction PP)

  (Hawkins 2000)
- English speakers probably do not *know* that postposition is constrained by the contextual factor "phonological weight", [+/- heavy].

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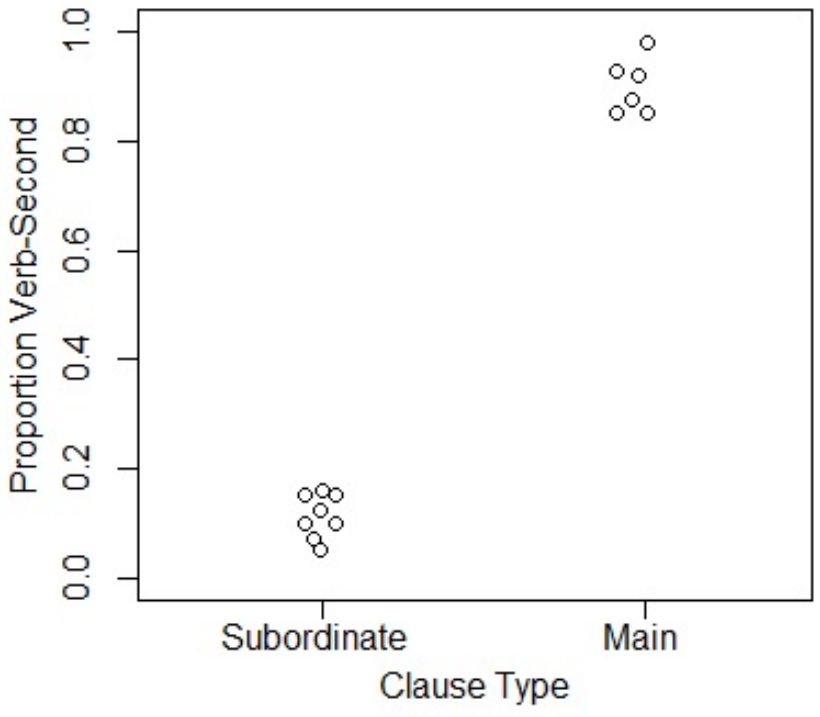
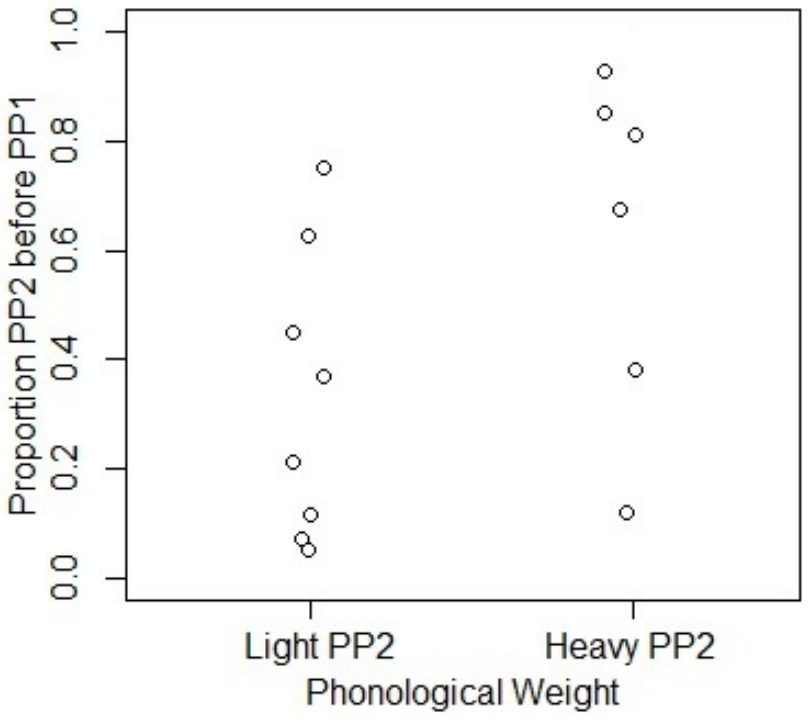
Hard vs. soft factors





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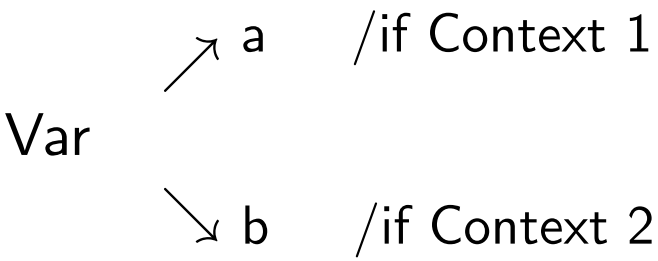
A though nut...

- Hard contextual factors are often encoded in a formal model of competence, i.e. they are seen as structural.

Hard contextual factor - general description



Hard contextual factor - example

subject - auxiliary inversion

↗ SAI /if question

↘ no SAI /if not a question

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- researcher decides that the difference between question and non-question is structural / part of language knowledge / should be encoded in the formal model of competence

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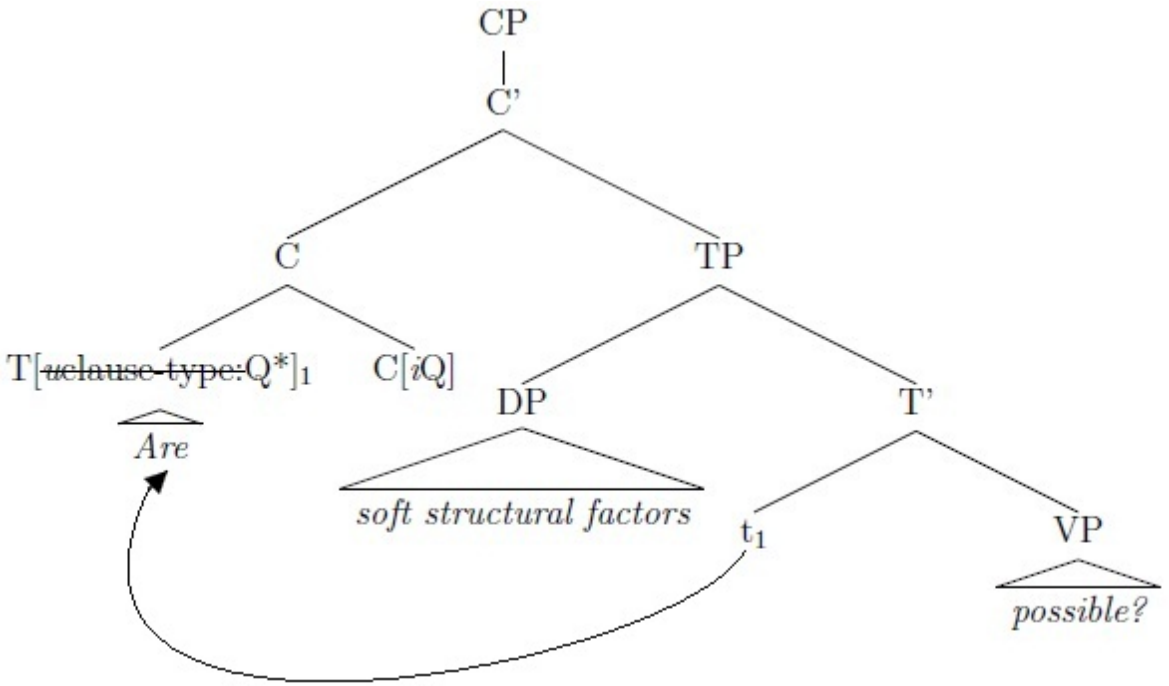
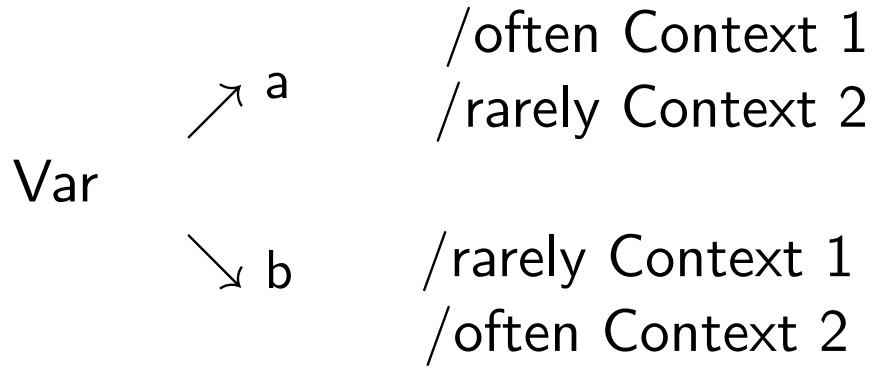
- one possible implementation:



Soft contextual factor - general description



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- Lots of different formulations of this idea (e.g., Roeper 1999)
- Alternative: leakage - one and the same representation can somehow belong to two different categories at the same time (Denison 2004)

Where do soft contextual factors come from?

Hypothesis 1:

- Statistical distribution of variants always arises for reasons outside of competence
- variation + non-structural (grammar-external) cause
- There are no soft structural factors.

Hypothesis 2:

- Statistical distribution of variants may arise for reasons within competence
- variation + structural (grammar-internal) cause
- Soft structural factors are possible.

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- A functional constraint (e.g. Hawkin's Minimize Domain Principle) or other non-structural reasons cause the statistical tendencies observed in large scale corpora.
- Hence, *all* soft constraints are "accidental". They "emerge" as grammatical knowledge is used.

Hypothesis 1 example one

"Let me give an example. Abney 1996 suggests that grammars have weighted probabilities for different parses of the same string. So take the phrase (39):

(39) the shooting of the hunters

[...] the NP is [overwhelmingly] interpreted as the object of the gerund, not as the subject. That is a raw fact about frequency of interpretation. [...] It seems to me that the most natural treatment is to say that the phrase is grammatically ambiguous and that extragrammatical factors determine which reading is both statistically preferred and likely to be preferred in a given instance." (Newmeyer 2003)

Hypothesis 1 example two

"Whether a speaker says *You will stay here*, *or You won't go anywhere*, or *You won't go nowhere*, will depend, apart from the meaning he intends to express, on his choice of interactional and social register (assuming he has sufficient command of the registers concerned), whereby frequency considerations may play a limited role. Other than that, frequency plays no role in linguistic competence. In particular, once the speaker has set his sociolinguistic register, the rule systems he employs do not contain a frequency parameter."
(Pieter Seuren's Blog, April 6, 2013)

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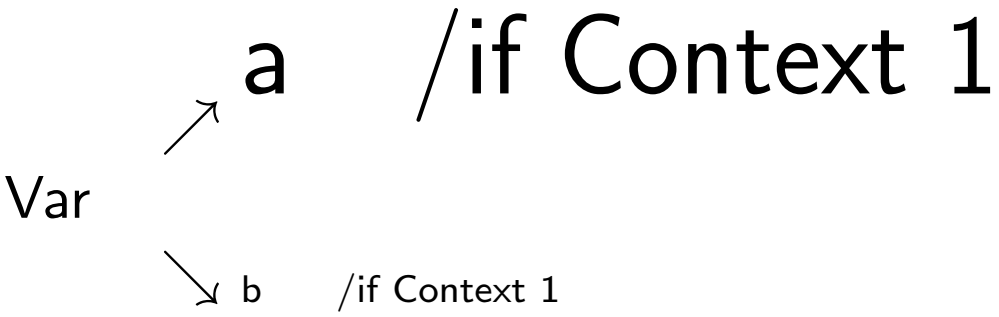
- The most common way to represent this idea is with *probabilistic grammars*; they include a frequency parameter for each dually represented variant.
- Note: This only concerns structural factors. Contextual factors like sociology, genres, registers, phonological weight, information structure etc. need not be encoded in our model of competence but can still be due to functional constraints.

Hypothesis 2 illustration



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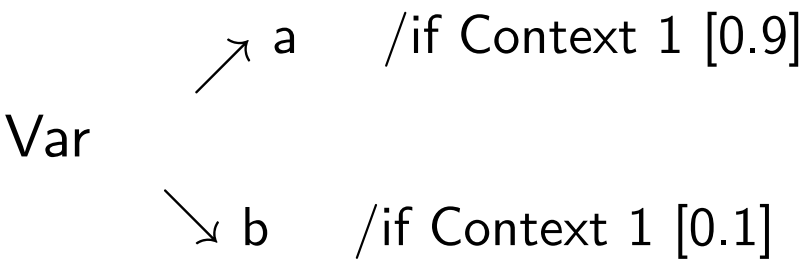

Graphical summary

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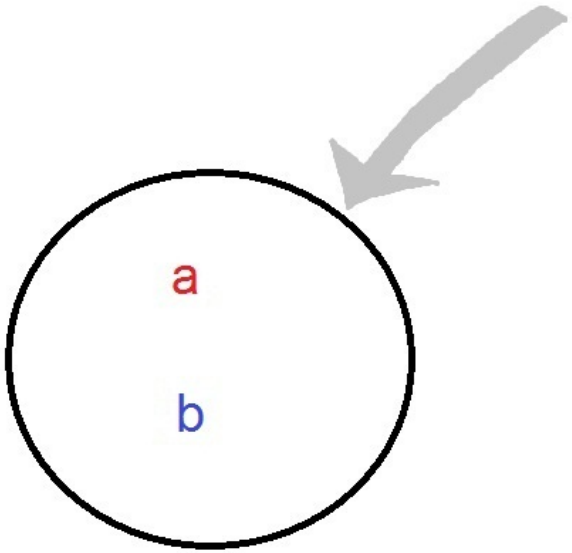

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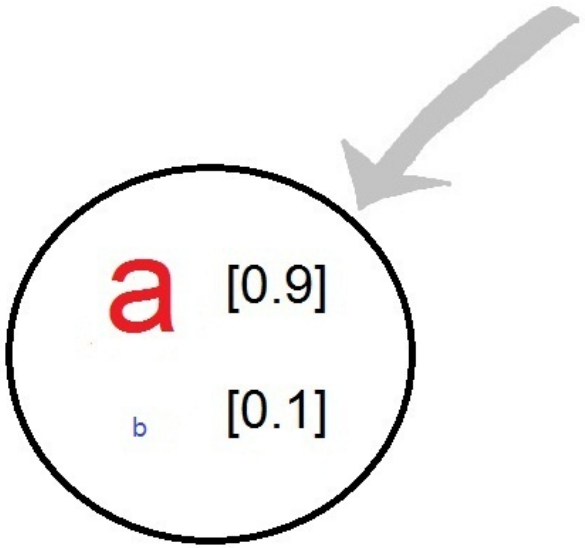

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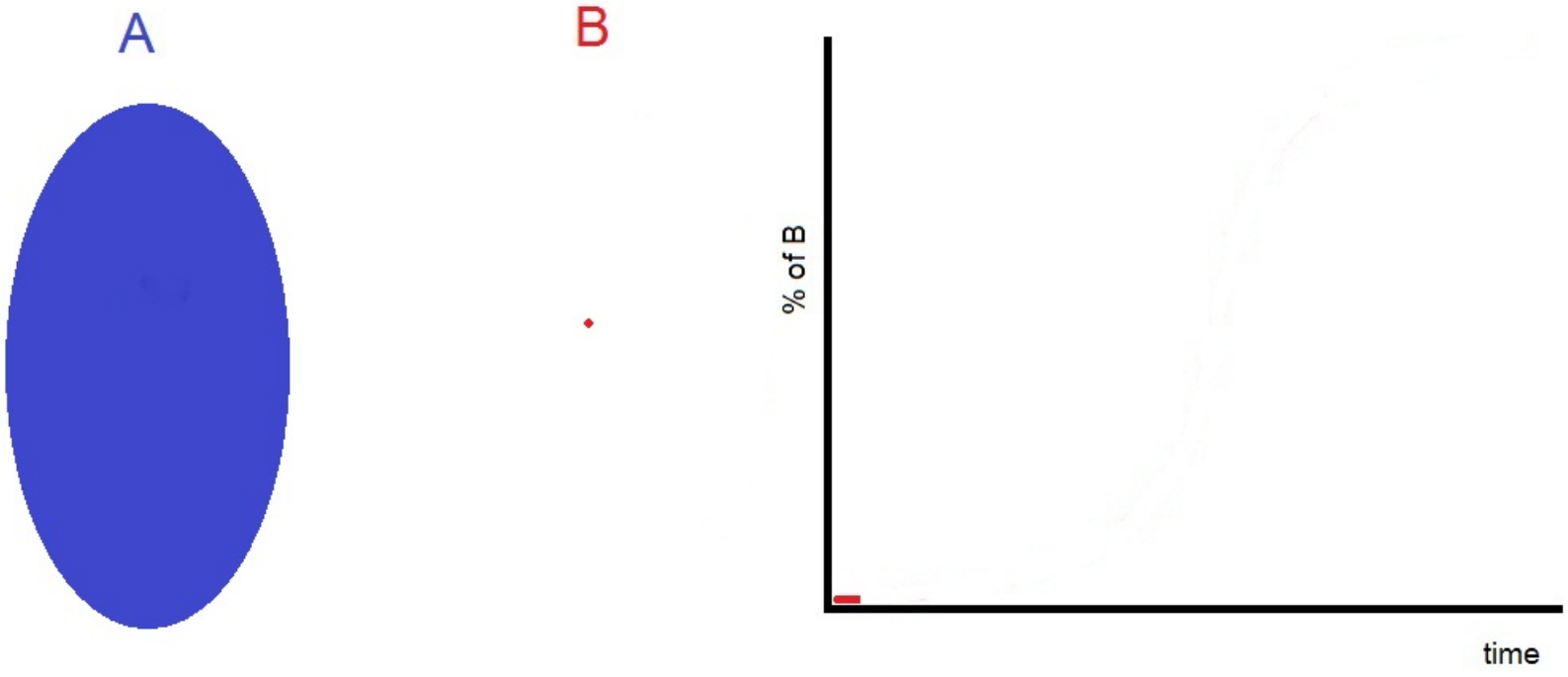
  3. methodology, how to use historical corpora

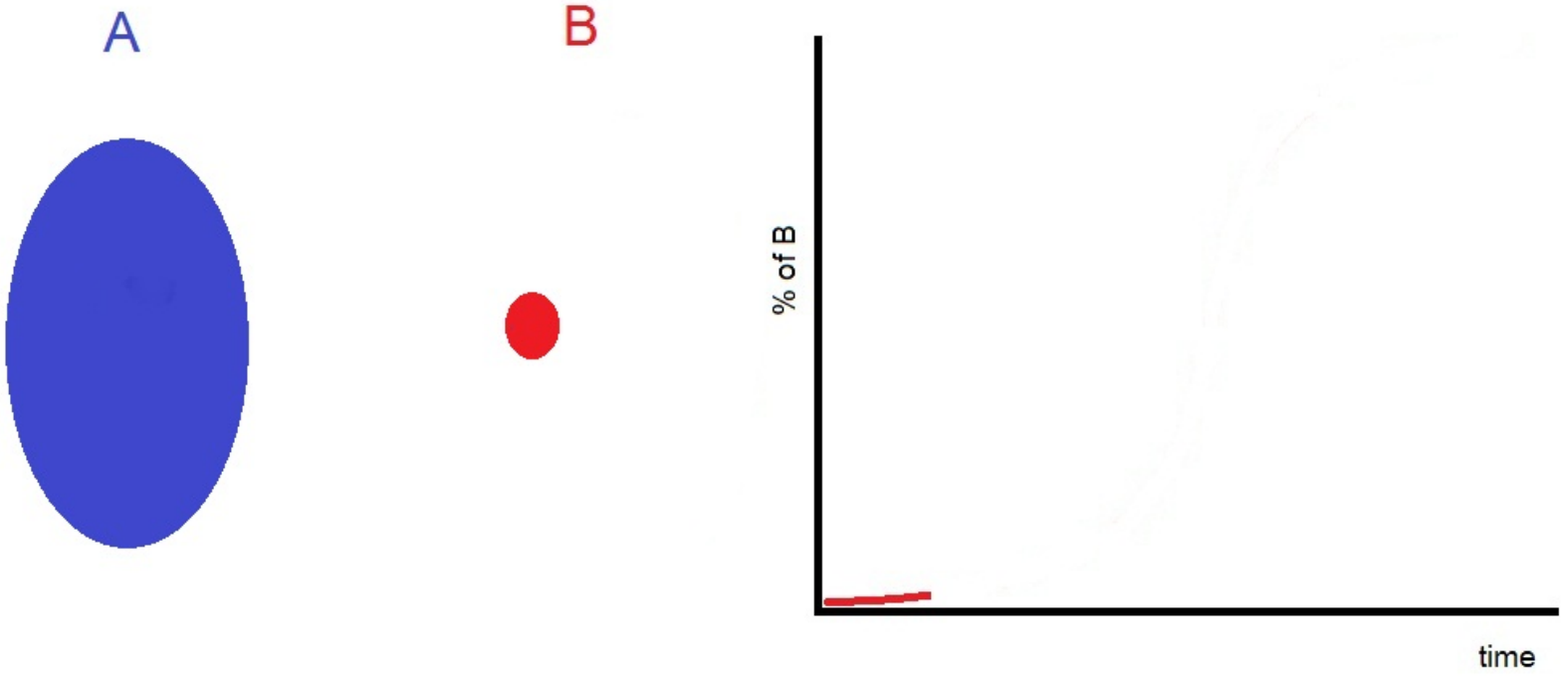
Descriptive facts of language change

- New variant B arises. Actuation.



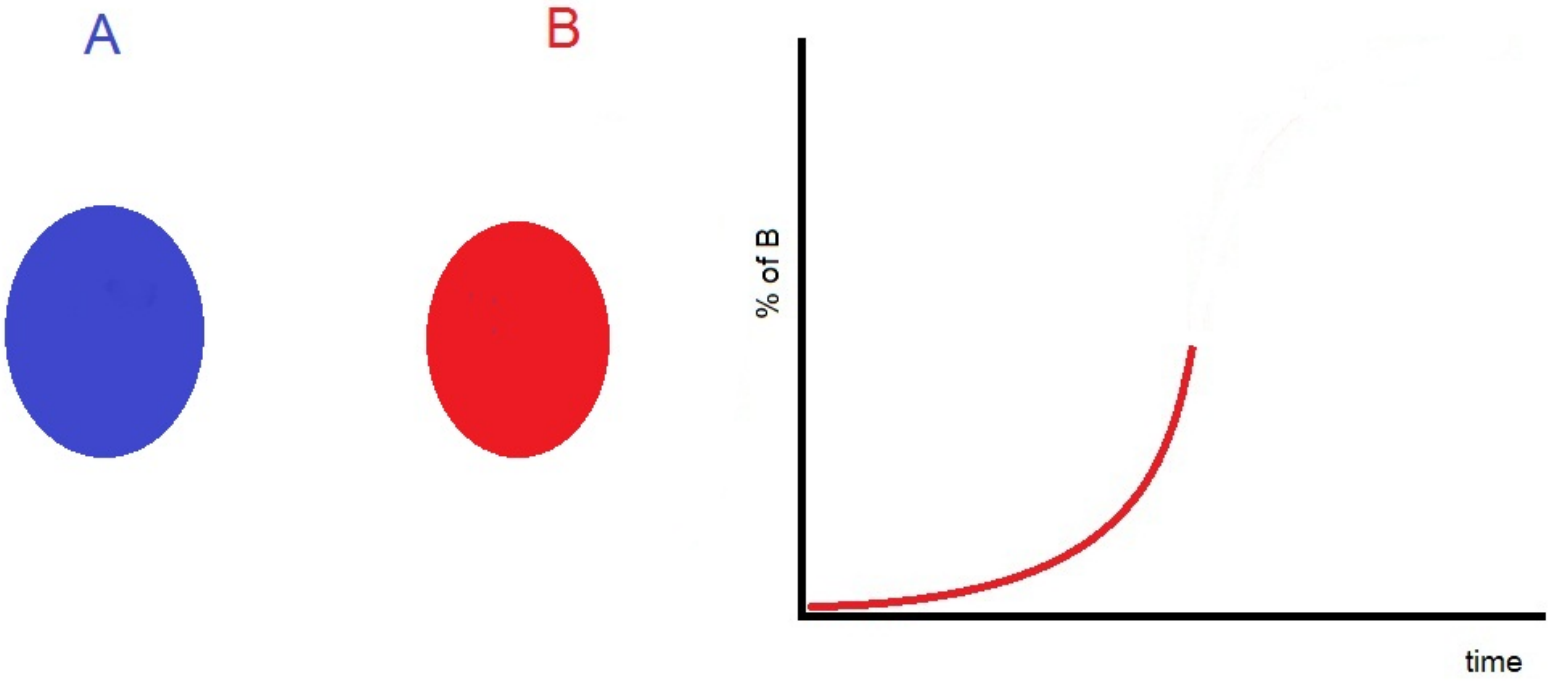
Descriptive facts of language change

- The new form can be found only rarely. Initially slow spread.



Descriptive facts of language change

- The implementation then accelerates. B overtakes A.



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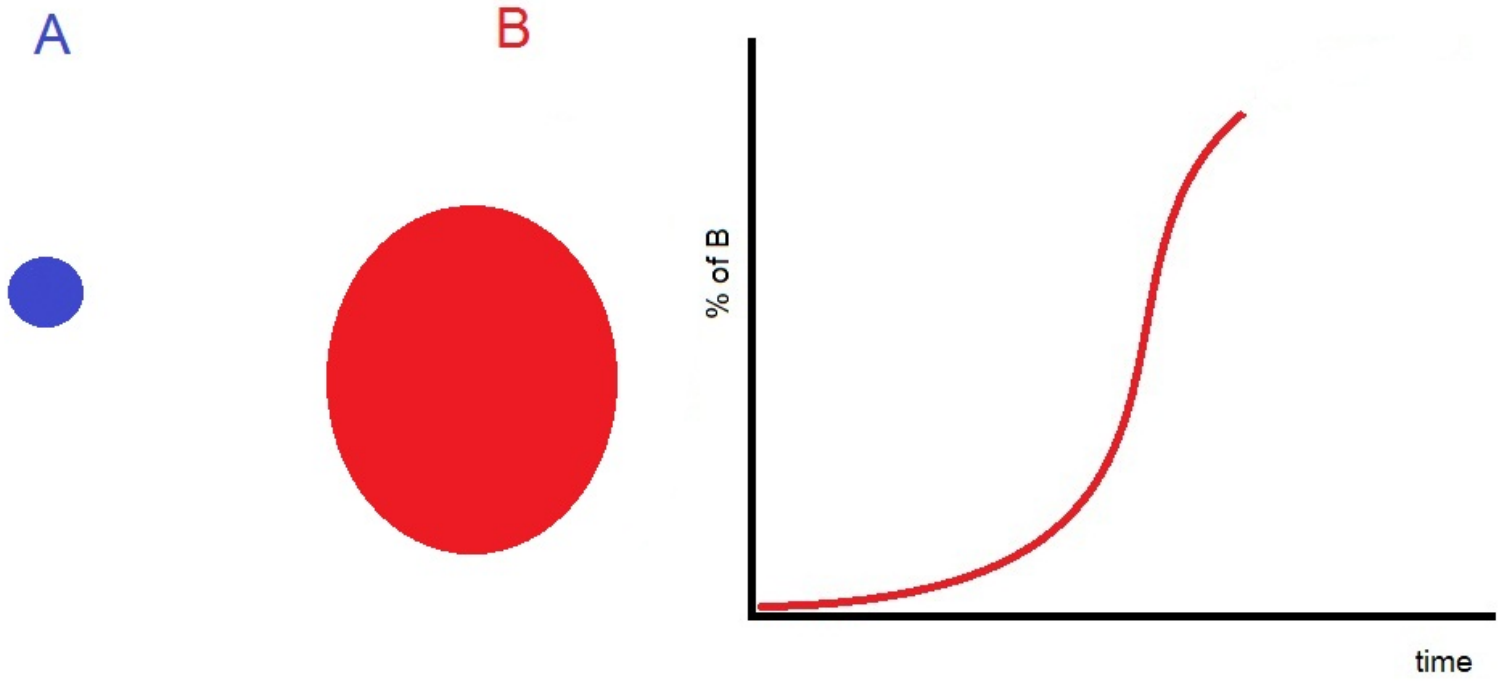
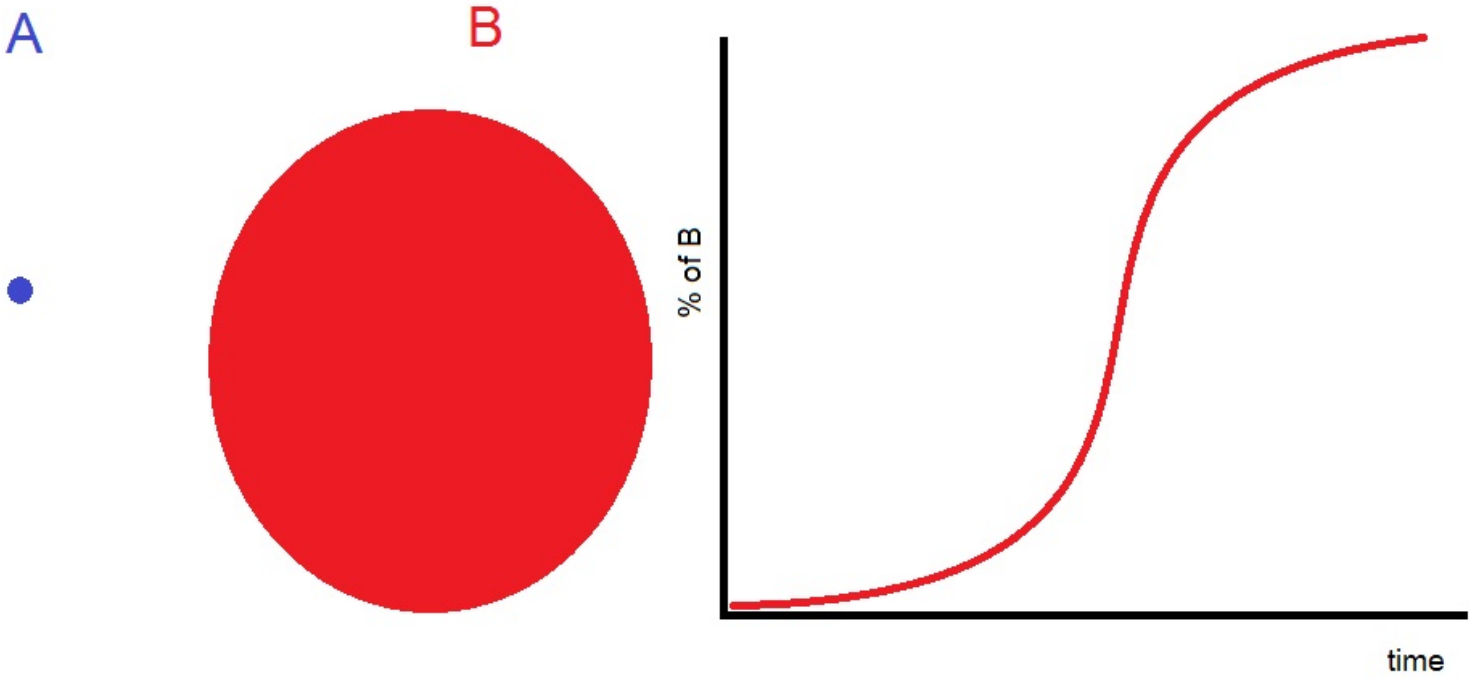
- The new variant drives out the old one. A change occurred.



Descriptive facts of language change

- S-shaped curves (e.g., Weinreich et al. 1968; Kroch 1989)



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- Example: *do*-support with possessive have in American English

Do-support in the history of English

- From early Modern English on, main verbs started requiring *do* for question formation and negation:

  (8) a. Why puttyn men her sonys rair to laue ciuile?
  R. Wimbledon, Serm. (c. 1450)

  b. Why doe men put their sons to the Civill Law?
  R. Wimbledon, Serm. (c. 1635)

  (from Denison 1993)

Do-support with possessive *have*

- For AmE possessive *have*, the development is recent, and is in fact only now coming to completion.

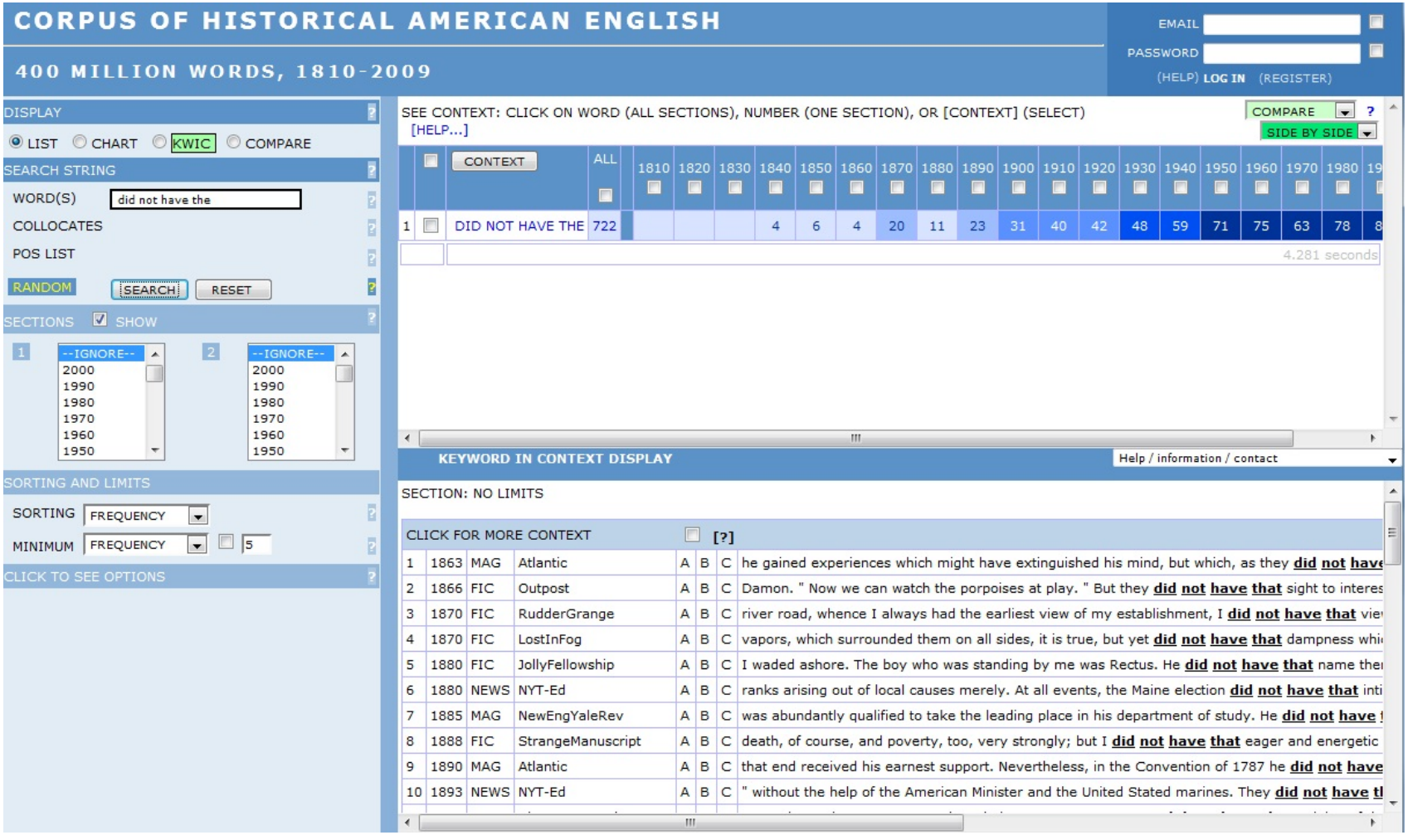
(9) a. I may add that it is a matter in which I have not the slightest interest.
ViolaGwyn (1922)

b. I do not have the slightest intention of even mentioning the word " Bermuda"
Play:CatsPaw (1998)

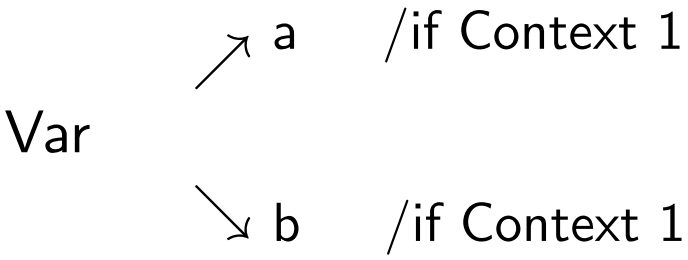
Data collection

- 400m word Corpus of Historical American English (Davies 2010)
- collection of all sentences with negation and possessive *have*
  1. 120 queries like "have not the", "hasn't any", "don't have a", "did not have his" etc.
  2. manual clean-up (still in progress)

Data collection - COHA



Variants and contextual factor



Variants and contextual factor

Negation ↗ *do*-support /if possessive *have*

Negation ↘ no *do*-support /if possessive *have*

Variants and contextual factor

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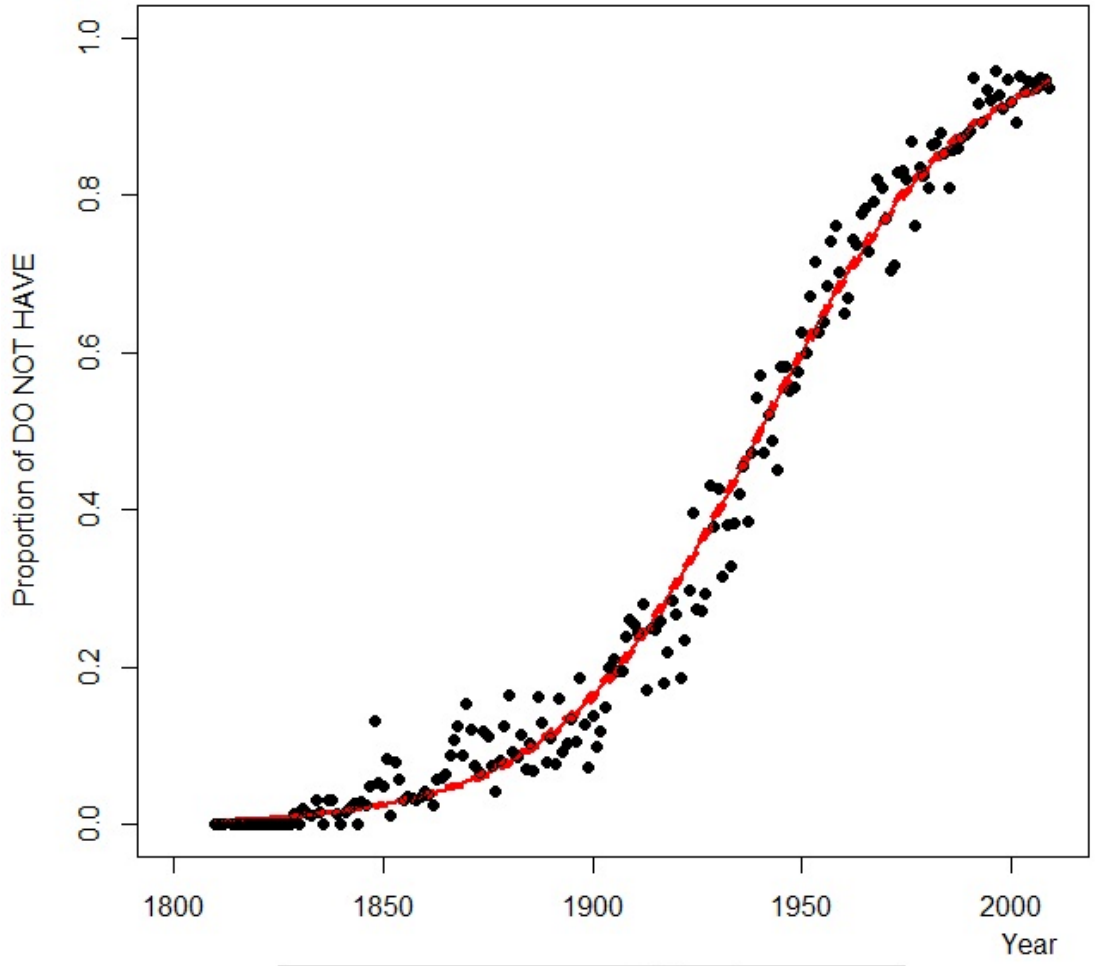
- The contextual factor (possessive *have* vs. other kinds of verbs) is plausibly structural.

Results



Factor	Estimate	Wald (z^2)	df	p
(Intercept)	-79.04	9846.6	1	<0.001***
Year	0.04	9868.4	1	<0.001***

Evaluation

- one of the most extensive studies of a syntactic change, N=33,456 examples
- sufficient material to have a data point for every single year!
- clear support of the hypothesis that syntactic changes proceed in s-shaped curves

Hypothesis 1

- If speakers cannot represent near-synonymous variants with different strengths, non-structural explanations for a change must be sought, i.e. something outside of competence must change as the cause of competence.
  1. Functional constraints (e.g. Hawkins Minimize Domains principle) should be a relatively universal aspect of the human processor. How can that change?
  2. Sociological factors are not really plausible. *Do*-support with possessive *have* is not an identity marker. The American speech community did not experience any major disruptions (e.g. no invasion, no substratum effects). Americans learned English continuously from one generation to the next.
- The s-shaped curve is unexpected. Change should be more chaotic, like a drift, or catastrophic.

Hypothesis 2

- If speakers can represent near-synonymous variants with different strengths, those variants can emerge, grow and die out.
- With any kind of replicator-dynamics, the s-shaped curve follows mathematically.

  E.g. Variational learning:

$$p_{t+1} = \frac{\alpha p_t}{\alpha p_t + \beta q_t}$$

Conclusion

Conclusion

$\rightarrow$ the facts of language change seem to me to support the hypothesis that variants can be represented more or less strongly, i.e. of probabilistic grammars.

A Counterargument

- The development found in corpus studies are irrelevant. They can never reveal anything about the competence of an individual.

Some quotes

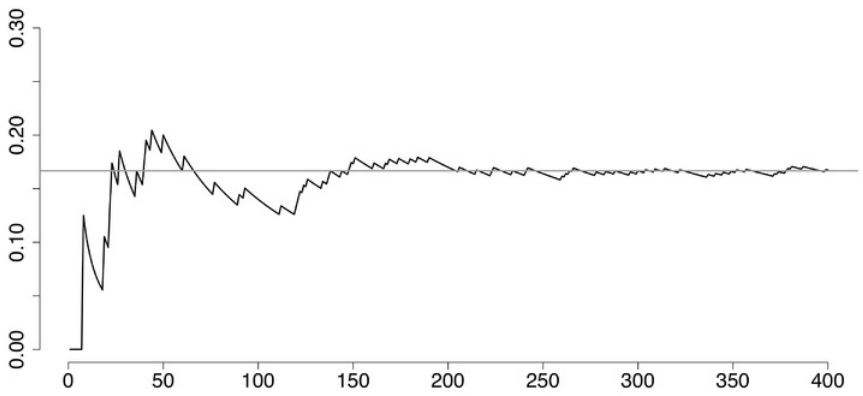
"corpus-derived statistical information is [hardly] relevant to the nature of the grammar of an individual speaker."
"There is no way that one can draw conclusions about the grammar of an individual from usage facts about communities"
"we do not have group minds"
"the corpora upon which stochastic grammars of American English are based do not [...] explicitly exclude spoken language samples from AAVE. And why stop at the American border? If corpora contain utterances from diverse dialects of American English, then why not from British, Australian, and Indian English as well?"
(Newmeyer 2003, 2005)

Shared linguistic knowledge

- It is not quite correct to say that we do not have "group minds" in this context. A relatively large proportion of competence must be communal , i.e. shared by speakers of a speech community.
  1. Communication would be impossible; all speech would be mutually unintelligble.
  2. Abstractions like "English", "French" would not make sense.

Law of large numbers

- If a trial is repeated many times, the average of the results will approach the expected value.



As a trial is repeated many times (x-axis), the expected value (y-axis) is approached

- Similarly, if examples in a corpus are numerous enough, the "true average" in the population will be approached.
- If absolutely nothing was known about an individual, the expected value would be predicted for that individual. Most people are close to the average.

Controlled variables

- Corpora control for variables that would introduce a lot of noise, i.e. corpora of particular modes (spoken or written), genres, dialects. This is standard practice in corpus construction.

Predictions

- If corpus information controls for individual variables and there are enough examples, predictions will be very accurate.
- Example: if theme / recipient pronominality, theme:recipient length ratio, animacy, spoken vs. written mode, age and gender of speaker are known, 94% of individual utterances of dative alternation are correctly predicted based on training data from corpora (Bresnan et al. 2007)

S-shaped curve again

- If the corpus data were completely divorced from individual competences, we could not expect a regular pattern, but chaos.
- The noise in the data may easily come from individual differences, functional constraints and measuring errors but the regularity in the data cannot be explained with such factors.
- Put differently, the large number of observation smoothes out individual preferences to the population average. It is therefore likely that the *regular* patterns cannot be explained away with *heterogenity* in the data.

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Conclusion

- It is much too simplistic to assert that corpus information cannot in principle reveal anything about he competence of individuals.
  1. There is shared linguistic knowledge.
  2. Large numbers of examples approach population average.
  3. Important variables can be controlled for.
  4. Consequence: individual predictions based on corpus data are accurate.
  5. S-shaped curves are explainable only if there is some correlation between group averages and individual preferences.

Thank you for your attention!

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