Mathematical Models of Word Order Change in Middle English

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EXPLANATIONS OF SYNTACTIC CHANGE & REANALYSIS

• Three Hard Questions:
  – Description of language before
  – Description of ambiguous, unambiguous, reanalyzed forms
  – Description of language after

• Three Very Hard Questions:
  – Why did the change occur once feasible?
  – Why did it happen at the time it did?
  – Why didn’t some other potential change happen?
**Verb-second in northern Middle English**

(1) ‘[Oðir labur] *sal* they *do’

*(The Rule of St. Benet, Fischer et al. [2000, p. 131]*)

CP-type verb-second, pronouns are full words
Verb-second in southern Middle English

(2) ‘[alle ðese bebodes] ic habbe ihealde fram childhade’

(Vices & Virtues, Fischer et al. [2000, p. 130])

FP-type verb-second, pronouns are special
THREE HARD QUESTIONS

- Before: South SVO+FPv2+pronoun slot, North SVO+CPv2
- Northern, Southern, Modern: Subject Vf ...
  Northern, Southern: XP Vf Subject ...
  Southern: XP Pronoun Vf Subject ...
- After: Modern SVO
Cue sentences for NME

XP Vf Subject . . .

- Assume children determine quickly that NME has underlying SVO
- Cue sentences: Those which can only be parsed with SVO+CPv2
- Learning hypothesis: Northern children acquire a verb-second grammar only if they hear enough sentences of this form. Proposed by Lightfoot [1999].
- Contact with southern ME leads to fewer cue sentences
**First model: Grammar and learning**

- Two grammars, $G_1$ and $G_2$, but $G_1$ is marked (requires substantial evidence to acquire) and $G_2$ is the default

- People speak either $G_1$ or $G_2$, no diglossia
  (We’ll come back to this…)

- Learning: Children hear $n$ sentences total; choose $G_1$ if $m$ or more of them are cues, else choose $G_2$

- Speakers of $G_1$ produce cue sentences at rate $p_1 \approx 30\%$
  Speakers of $G_2$ produce cue sentences at rate $p_2 < 5\%$
FIRST MODEL: POPULATION STRUCTURE

- Two regions, North and South; children learn only from neighbors
- $x_N = \text{fraction of northerners speaking } G_1$
- $x_S = \text{fraction of southerners speaking } G_1$
- Mixing parameters $\alpha$ and $\beta$: Measure rate at which people move from one region to the other
Mathematical notation

\[ q(x) = \mathbb{P}\{\text{child picks } G_1\} \]

\[ = \sum_{j=m}^{n} \binom{n}{j} \gamma^j \gamma^{n-j} \]

\[ \gamma = p_1 x + p_2 (1 - x) \]
\[ x = \text{fraction speaking } G_1 \]
\[ n = \# \text{ sample sentences} = 100 \]
\[ m = \text{min } \# \text{ cue} = 20 \]
\[ p_1 = \text{cue freq for } G_1 = 0.3 \]
\[ p_2 = \text{cue freq for } G_2 = 0.05 \]

\[ \dot{x}_N = q(x_N) - x_N + \alpha(x_S - x_N) \]
\[ \dot{x}_S = q(x_S) - x_S + \beta(x_N - x_S) \]
Phase portrait for isolated regions

\[ \alpha = \beta = 0 \]
Phase portrait: small mixing

$$\alpha = \beta = 0.03$$
Phase portrait: more and more mixing

\[ \alpha = \beta = 0.03 \]

\[ \alpha = \beta = 0.1 \]

\[ \alpha = \beta = 0.15 \]

\[ \alpha = \beta = 0.152985 \ldots \]
Phase portrait: bifurcation

Before

After
**Time traces**

Horizontal axis: Time (rescaled units, not years)
Vertical axis: Fraction of population speaking $G_1$
Using $\alpha = \beta$, both increasing linearly in time
The goal

The model so far
**Needed Improvements**

- Allow diglossia
- Allow more grammars (SVO+v2, SVO+v2+pronoun slot, vanilla SVO, various kinds of v2, etc.)
- Connect to manuscript data
SECOND MODEL: A SIMULATION

In collaboration with Anthony Kroch

- Agent based, not a continuous approximation
- Minimalist grammar [Adger, 2003]
- Detailed learning algorithm [Yang, 2002]
- Literacy
References


