Towards a Probabilistic Model of Syntactic Change

SHES9, Leiden

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Outline

- Introduction
  - What kind of a model?
- Variation as probability
  - Yang 2000 – summary
  - Example: headedness of IP
  - Proposed modifications
- Capturing context-dependency
  - Conditional functional constraints
  - Example: V→C movement, especially NegV1
  - Functional constraints as the endpoint of change
- Conclusion

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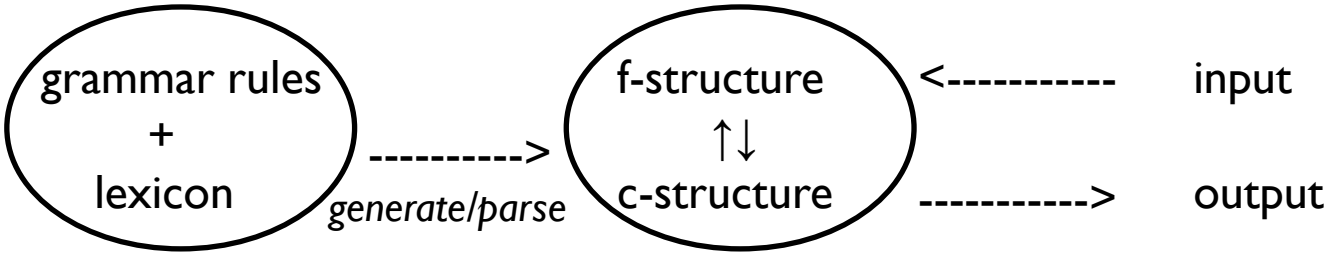

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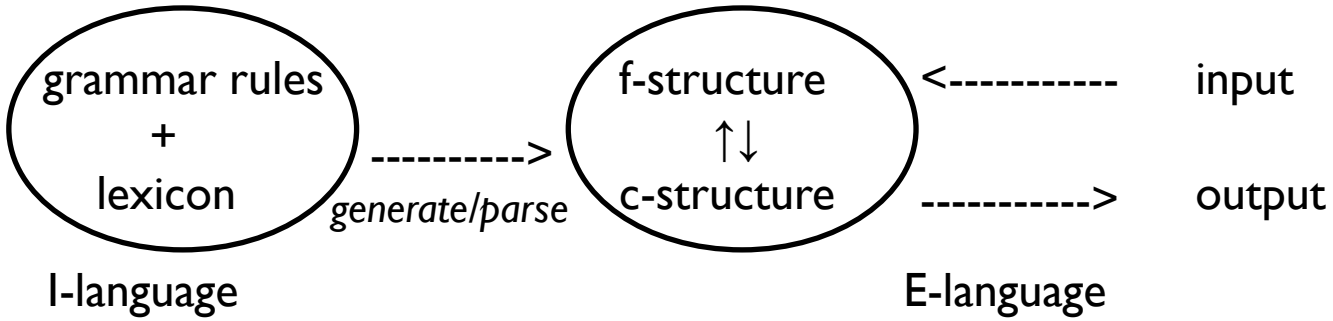

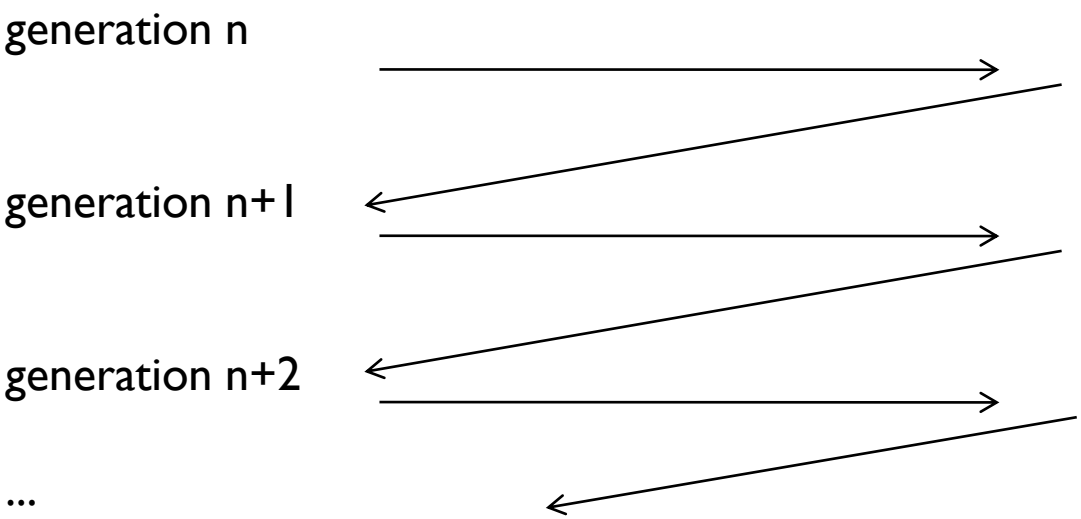

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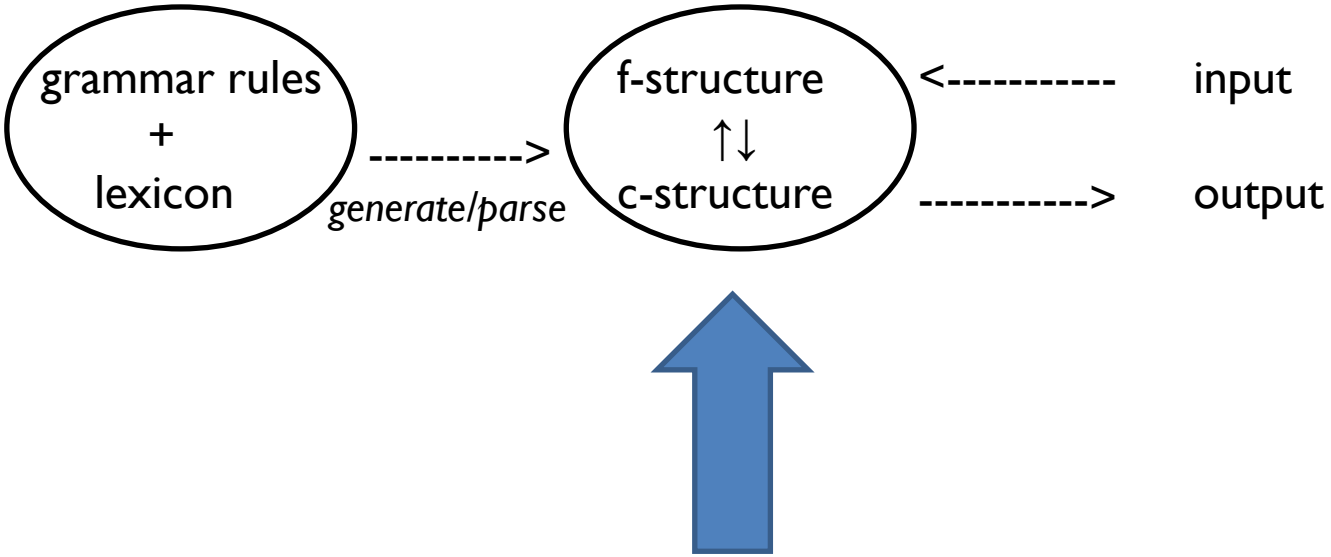

Some scholars encode source of syntactic change here
e.g. Vincent 2000 (OT-LFG for syntactic change)

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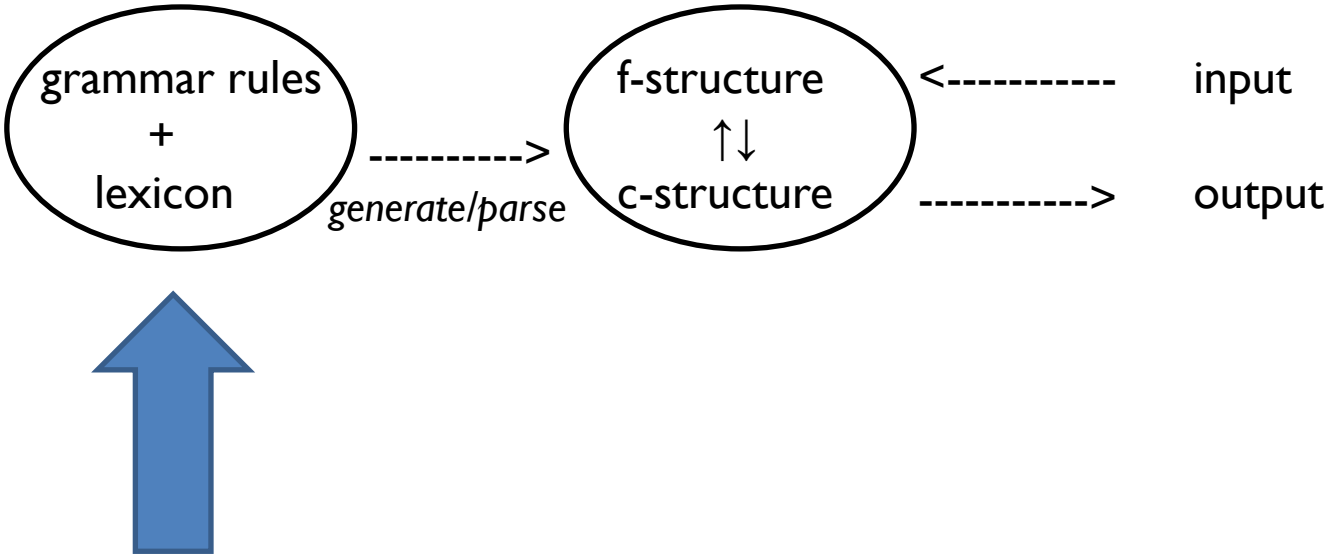

Speakers choose a grammar with a certain probability
(grammar competition)
approach that I will take here

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•Then: if Grammar_i analyses a sentences successfully, then:

$$\begin{cases} p_i` = p_i + \gamma(1 - p_i) \\ p_j` = (1 - \gamma)p_j \end{cases} \qquad i \neq j$$

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if $Grammar_i$ does not analyse a sentences successfully, then:

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reward all other grammars

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•Children can acquire multiple grammars with different probabilities (grammar competition)

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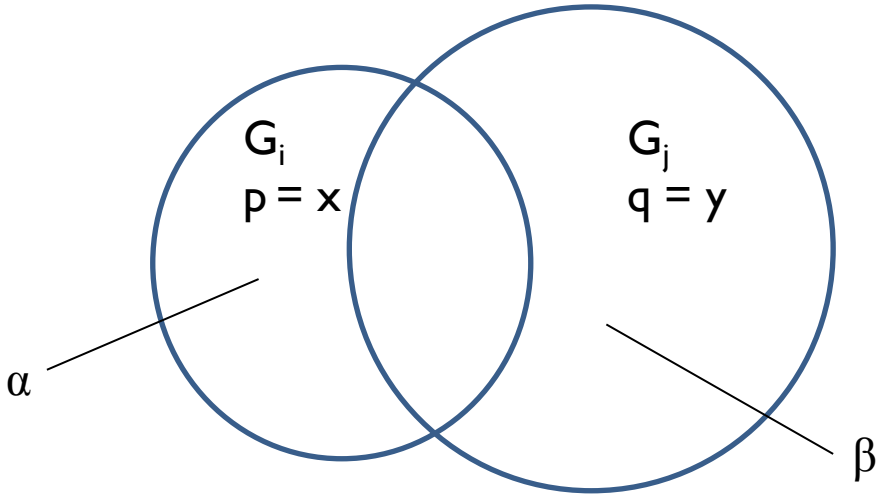

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calculation of grammar weights p' (q') of the next generation:

$$p' = \frac{\alpha p}{(\alpha p + \beta q)}$$

$$q' = \frac{\beta q}{(\beta q + \alpha p)}$$

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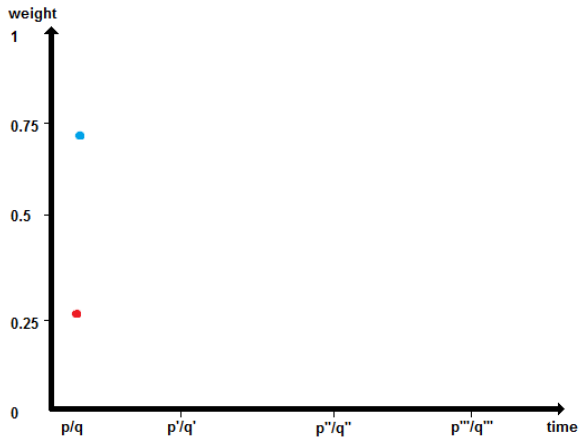

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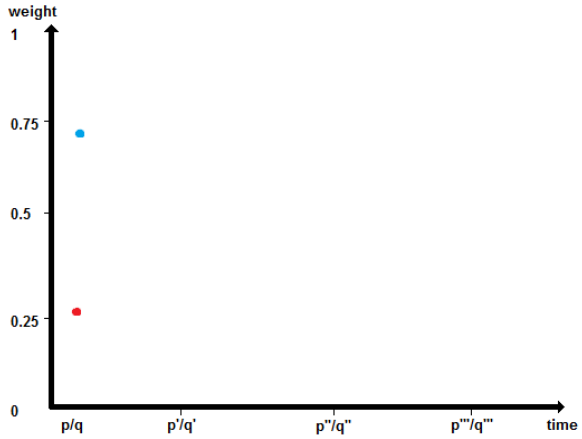

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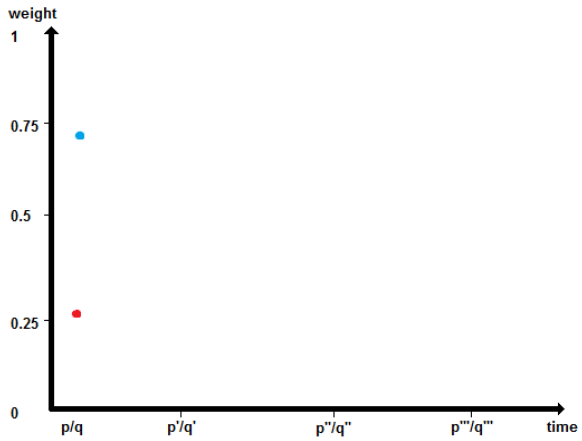

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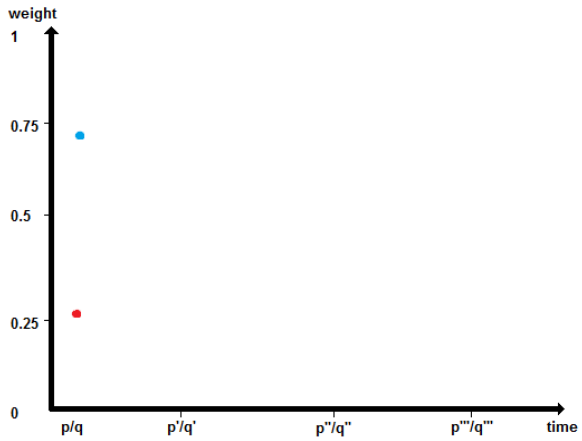

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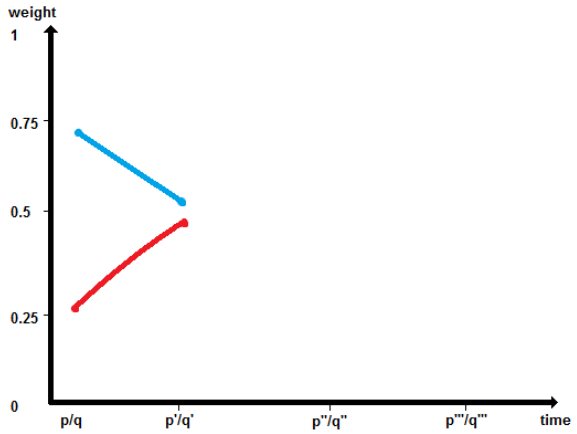

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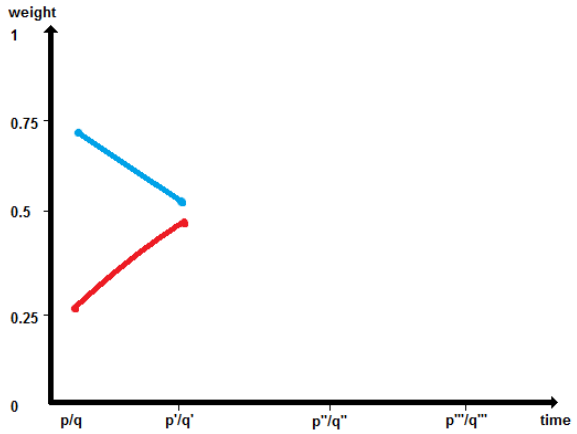

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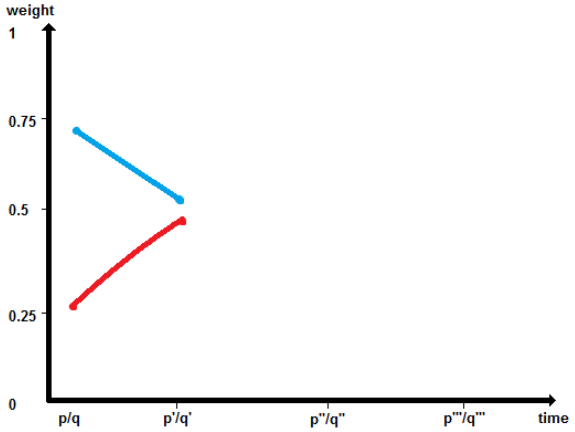

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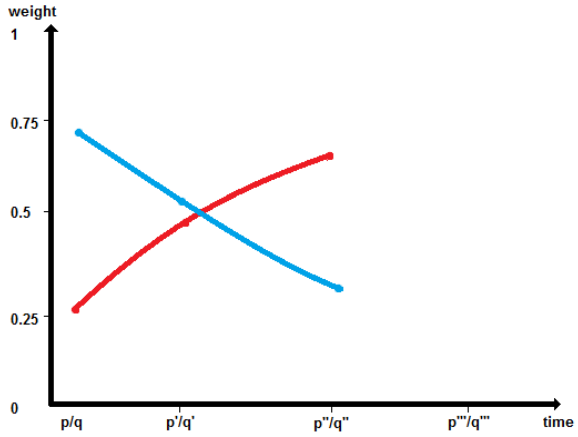

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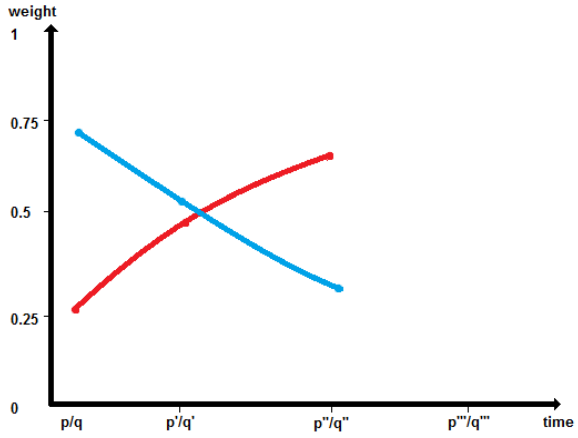

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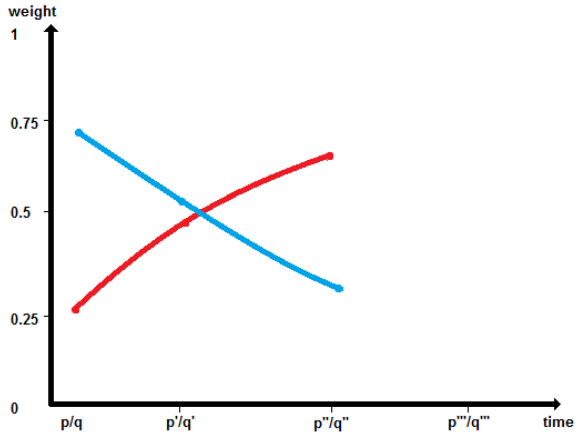

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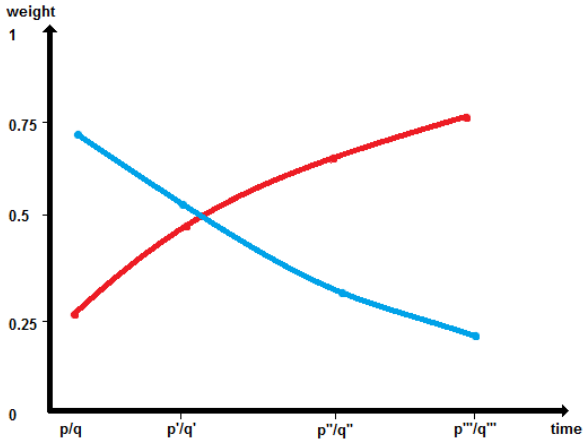

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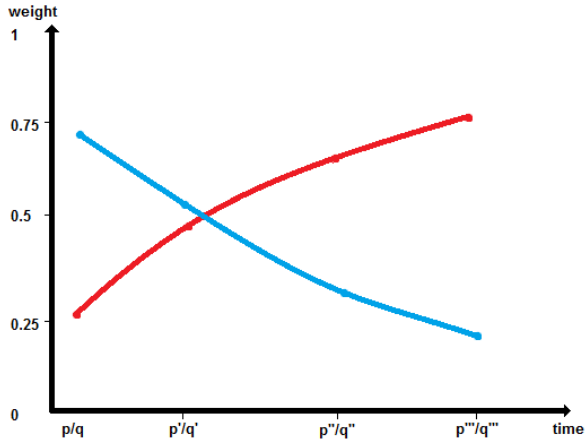

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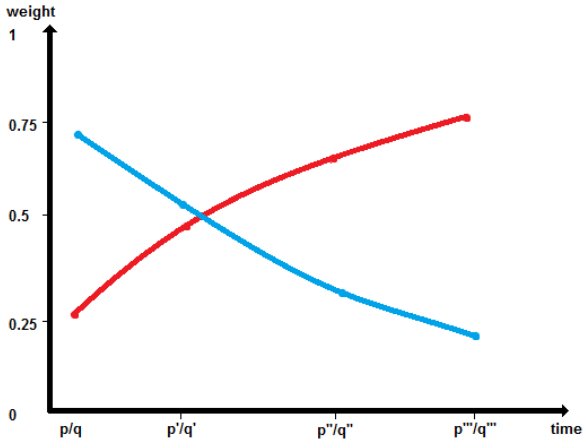
→ yields familiar S-shaped curves observed in language change (Kroch 1989)



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The fundamental theorem of language change

G_2 overtakes G_1 if $\beta > \alpha$

(Yang 2000: 239)

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Change in headedness of IP: (e.g. Pintzuk 1999)

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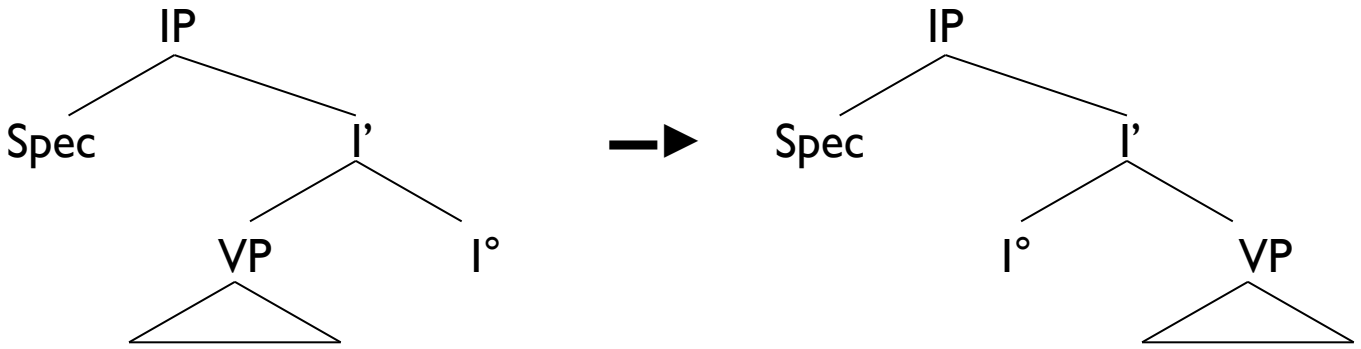

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Innovative G_2: head-initial IP

Conservative G1: $I' \rightarrow VP \quad I^\circ$
$IP \rightarrow IP \quad VP$
$IP \rightarrow IP \quad DP|PP|AP...$

Innovative G2: $I' \rightarrow I^\circ \; VP$

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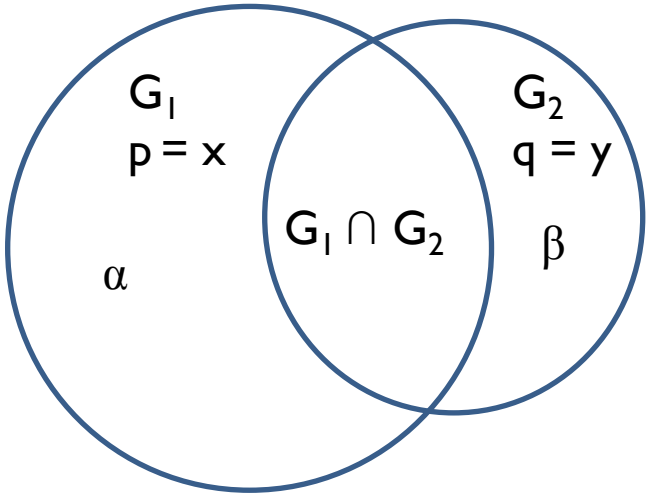

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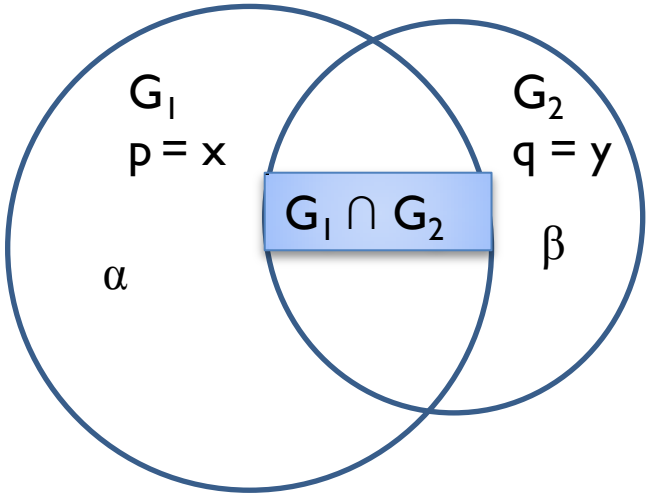

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lest of.you some complain in mind
'lest some of you should complain'
(coaelhom, ÆHom_6:367.1053)

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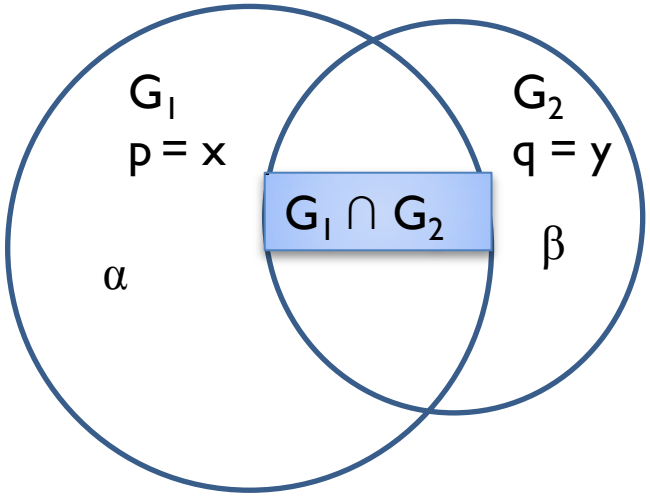

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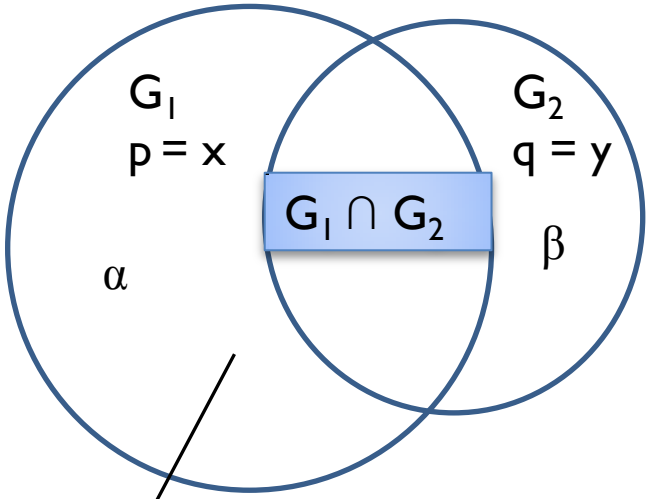

(1) þe læs þe eower sum ceorige on mode
lest of.you some complain in mind
'lest some of you should complain'
(coaelhom, ÆHom_6:367.1053)

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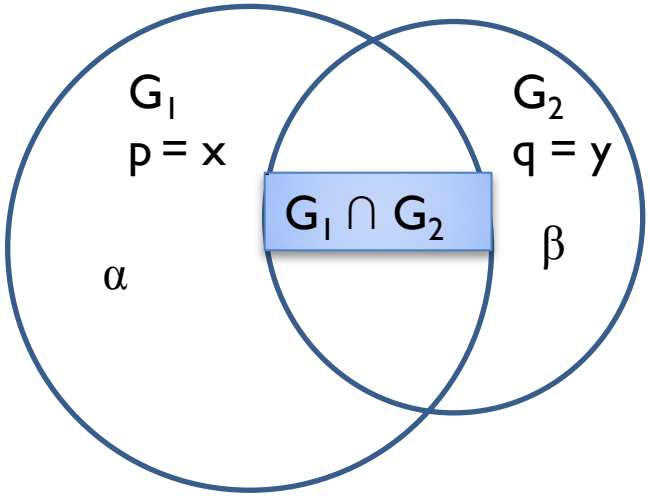
IP → IP PP (extraposition of the PP)

Example: headedness of IP



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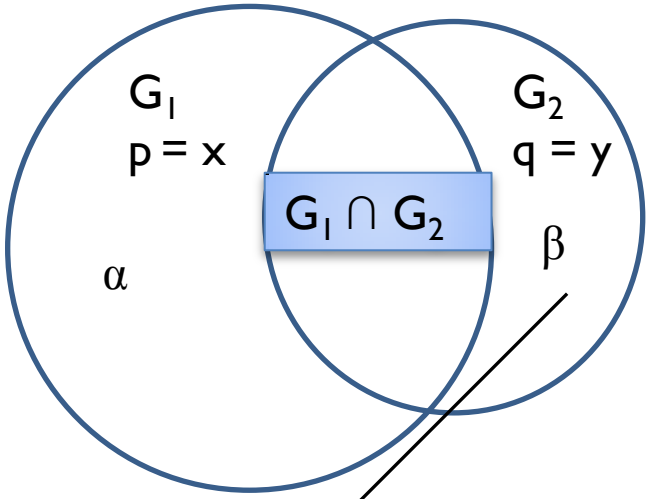

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I' → I° VP

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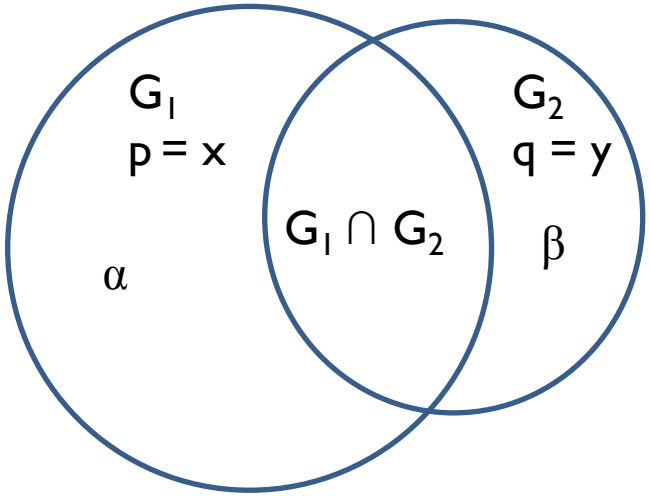

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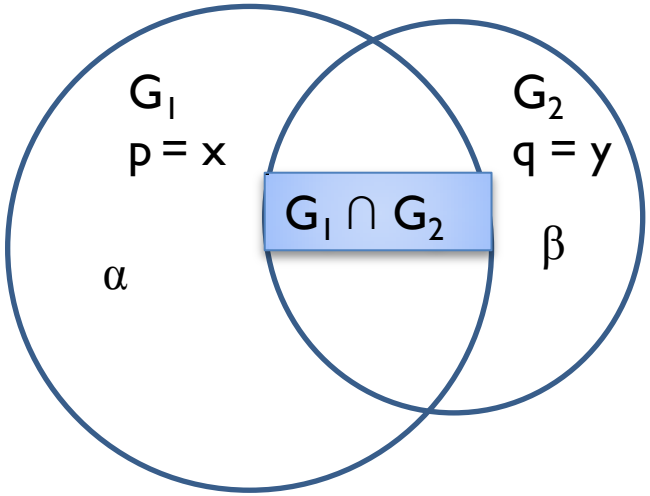

(2) þæt ge ne beon geæswicode.
that you not be offended
'so that you may not be offended.'
(coaelhom,ÆHom_9:12.1307)

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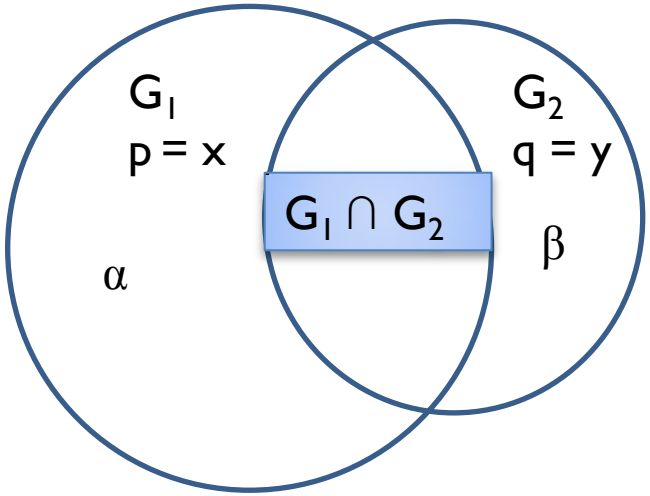

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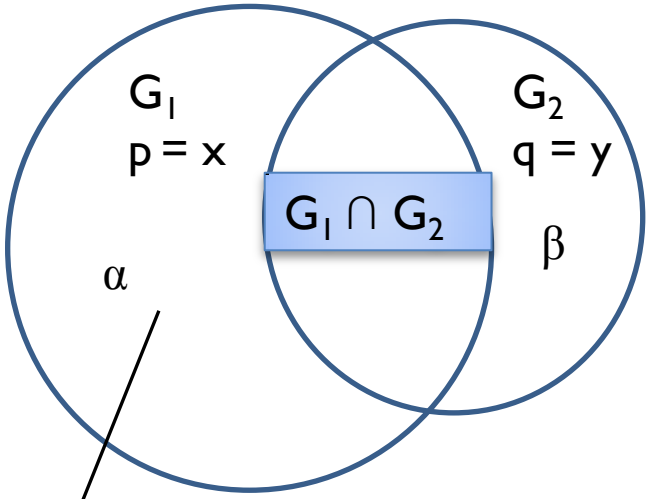

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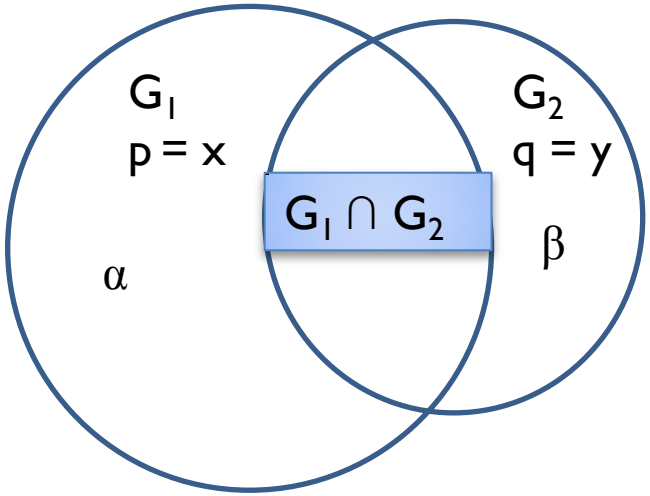
IP → IP VP (verb (projection) raising)

Example: headedness of IP



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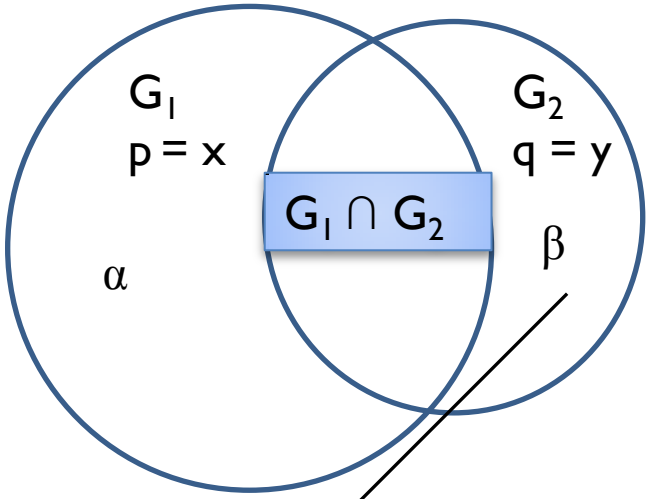

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$I' \rightarrow I° \ VP$

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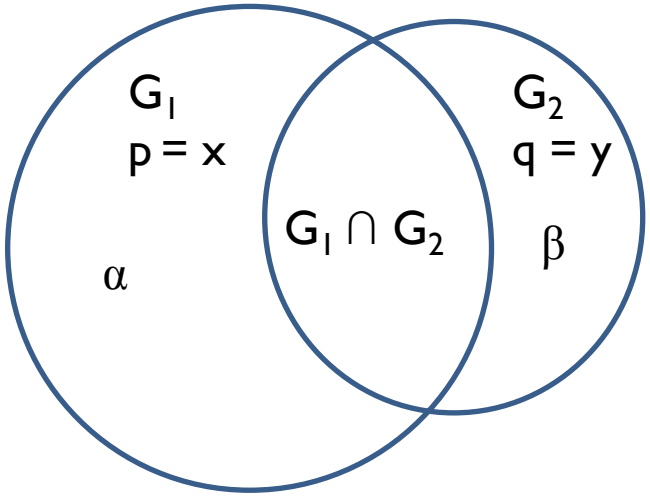

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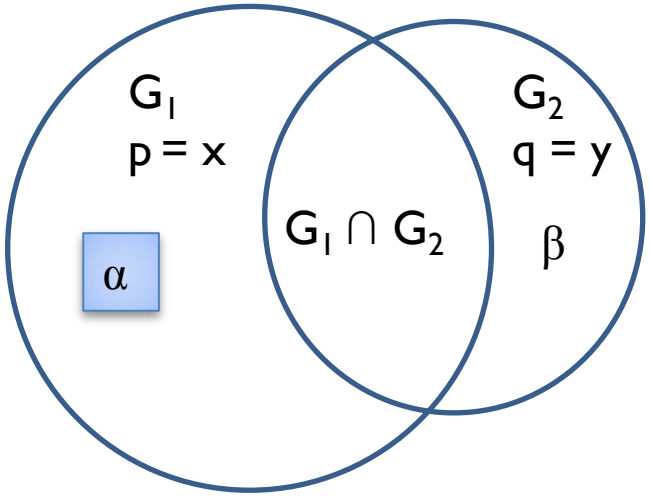

(3) þæt we for earfoðnysse ure anginn ne forlæton
that we for hardship our origin not give-up
'that we will not give up our origins because of hardship'
(coaelhom, ÆHom_9:145.1365)

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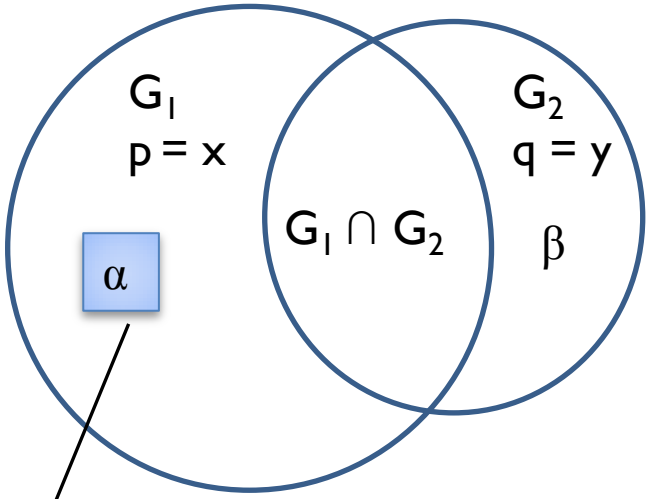

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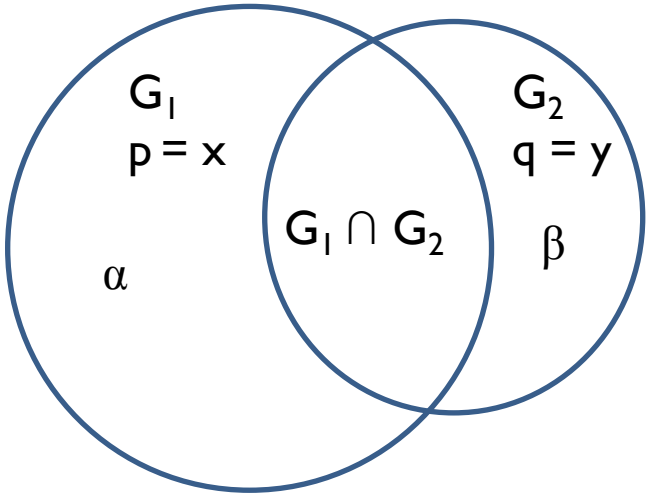

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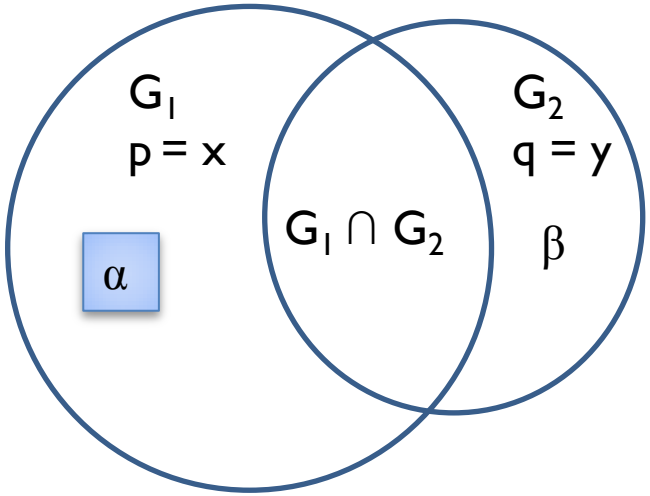

(4) ða ða he acenned wæs
then when he born was
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(cocathom1, ÆCHom_I,_15:305.172.2898)

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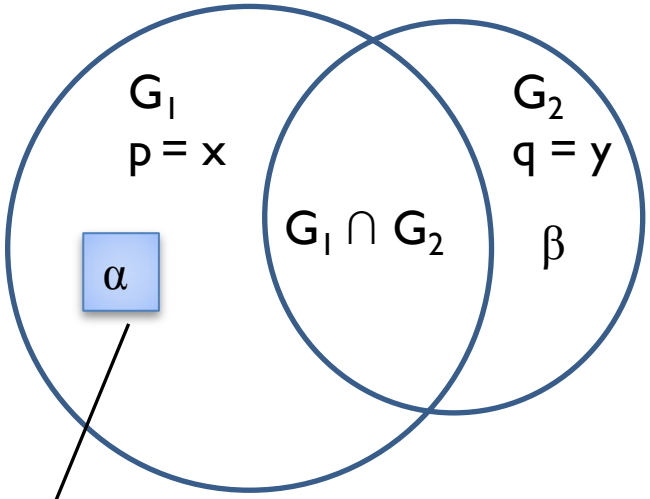

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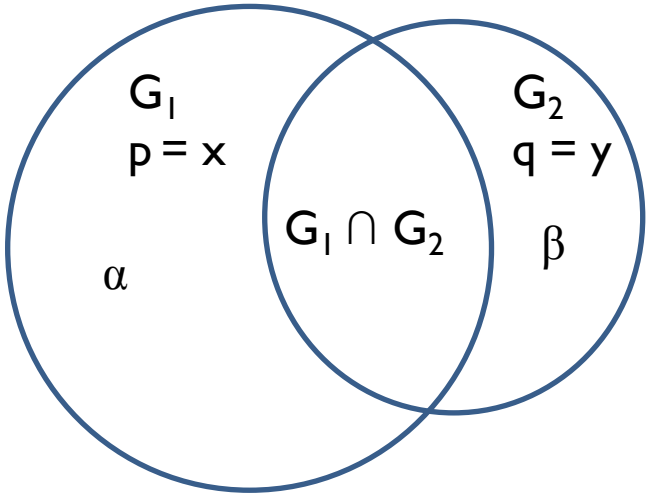

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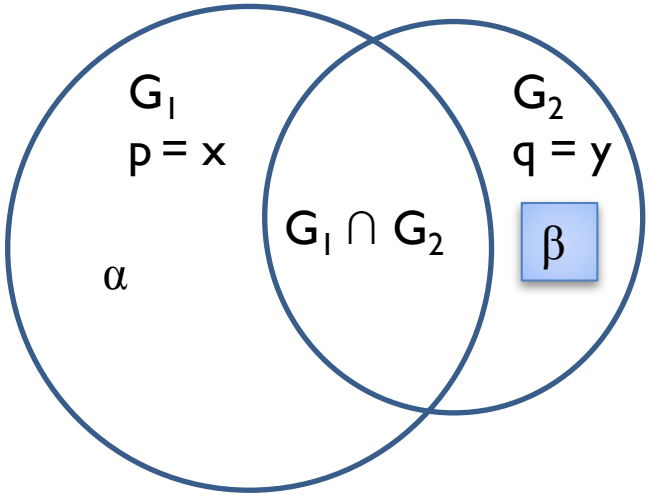
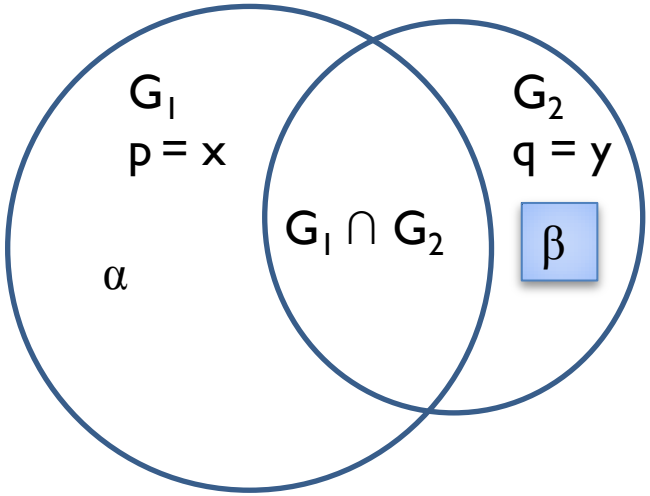


(5) butan hi sungon þone lofsang forð on
but they sang the praise-song forth on
'but that they continued to sing the praise'
(coaelive, ÆLS_[Swithun]:230.4371)

Example: headedness of IP



particles
pronouns
negative objects
negative adverbs
stranded preps.

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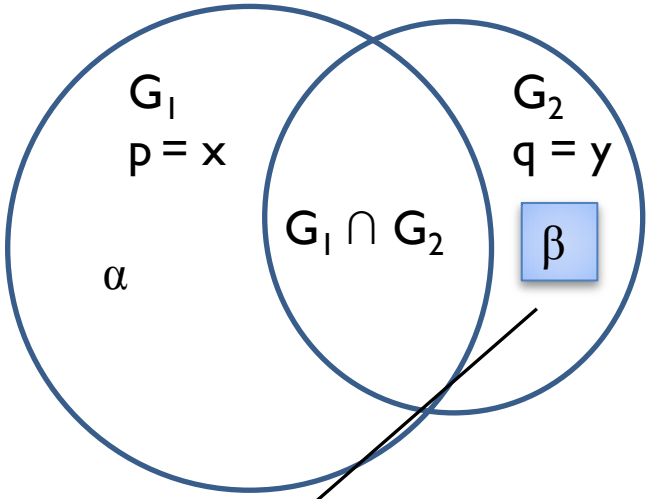

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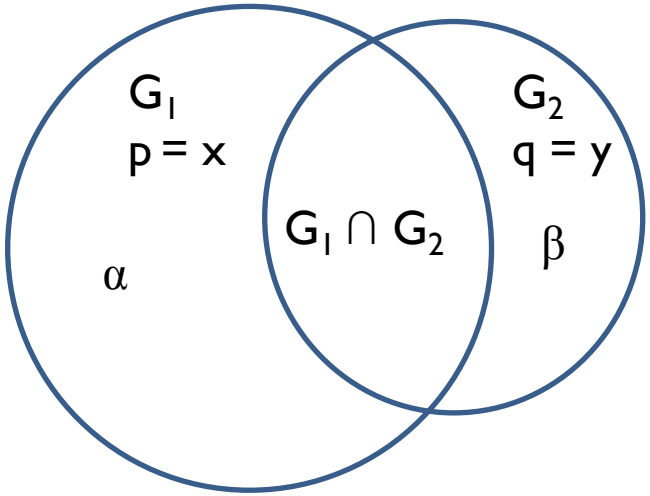

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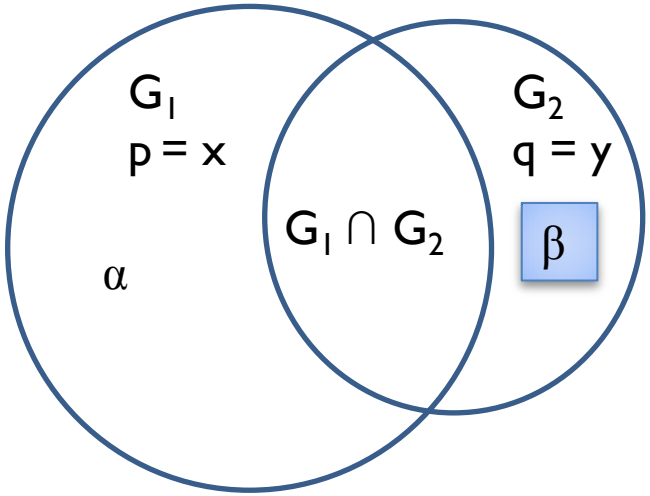
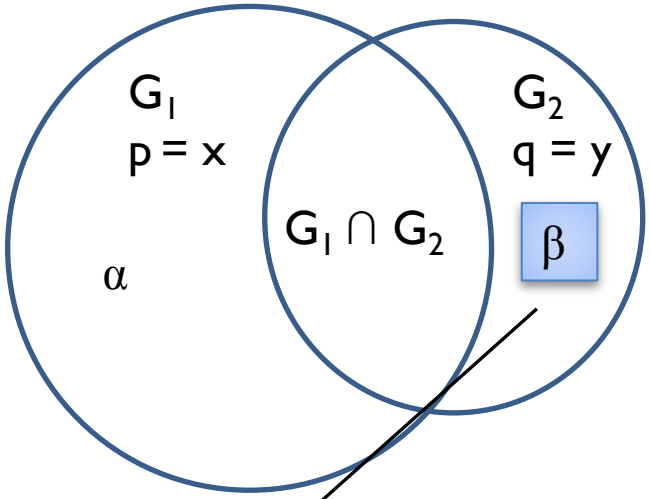


(6) for ðan ðe hit ne stod na ær þurh hit sylf.
for that that it not stood not-at-all earlier by itself
because it didn't stand by itself earlier at all.
(cocathom1, ÆCHom_I,_10:262.123.1914)

Example: headedness of IP



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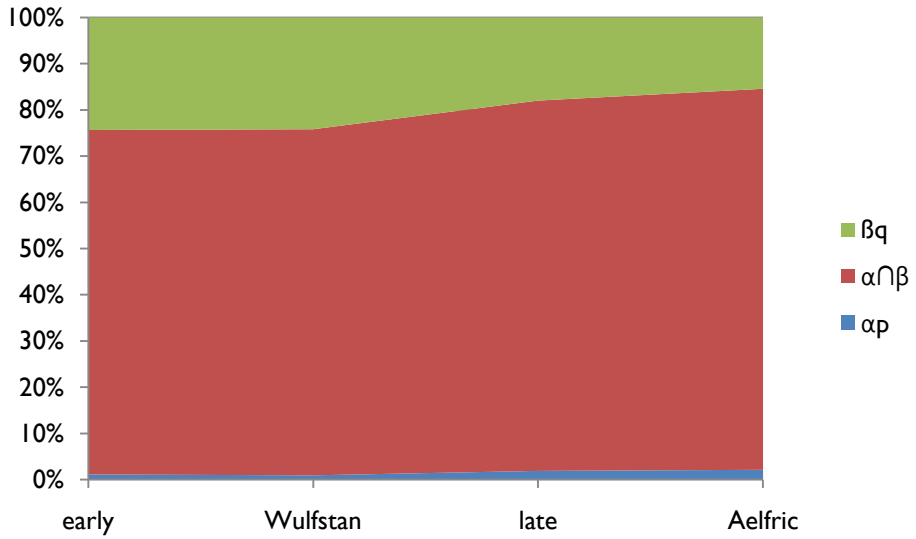
Example: headedness of IP

Results:

Example: headedness of IP

Results:

	ßq	G1∩G2	αp
early	1.12%	74.53%	24.35%
Wulfstan	0.93%	74.88%	24.18%
late	1.89%	80.13%	17.98%
Aelfric	2.13%	82.45%	15.43%



Example: headedness of IP

The fundamental theorem of language change
G_2 overtakes G_1 if $\beta > \alpha$

Example: headedness of IP

•Calculation of maximum weights of the two grammars from observed penalty probabilites:

early OE:	$\beta q = 1.12\%$	$\alpha p = 24.35\%$
	$q < 4\%$	$p > 96\%$
	$\beta \approx 0.3$	$\alpha \approx 0.25$
	$0.04 \times 0.3 = 0.012$	$0.96 \times 0.25 = 0.24$
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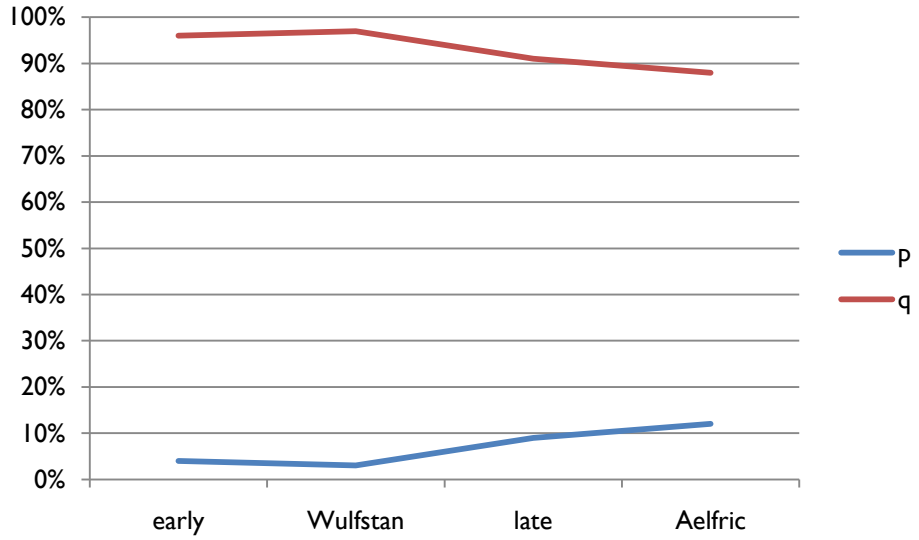
	$\beta > \alpha$	
Ælfric:	$\beta q = 2.13\%$	$\alpha p = 15.43\%$
	$q < 12\%$	$p > 88\%$
	$\beta \approx 0.177$	$\alpha \approx 0.175$
	$0.12 \times 0.177 = 0.021$	$0.88 \times 0.175 = 0.154$
	$\beta > \alpha$	

Example: headedness of IP

•Calculation of maximum weights of the two grammars from observed penalty probabilites:



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  - are there unambigously I-intial clauses not identified yet?
  - are we in fact observing the early stages of a change in this context?
- Yang's theory allows for empirical testing and makes mathematically rigid predictions for grammars of future generations
- May shed some light on the emergence of new syntactic rules

Proposed Modifications

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- concept of "target grammar" can be ignored for language change
- Yang views alpha and beta as constants
  - idiosyncratic features of some authors
  - limited corpus size
- It is not different grammars that are in competition but individual rules of the same grammar

Proposed Modifications

From Grammars in competition to rules in competition:
Instead of G1 and G2:

Conservative G1: $I' \rightarrow VP \quad I^{\circ}$
$IP \rightarrow IP \quad VP$
$IP \rightarrow IP \quad DP|PP|AP...$

Innovative G2: $I' \rightarrow I^{\circ} \; VP$

Proposed Modifications

From Grammars in competition to rules in competition:
Set of grammatical rules in competition Rc:

Old English G: $Rc=\{I' \rightarrow VP\ \ I^{\circ},\quad I' \rightarrow I^{\circ}\ VP\}$
$IP \rightarrow IP\quad VP$
$IP \rightarrow IP\quad DP|PP|AP...$

Proposed Modifications

From Grammars in competition to rules in competition:

Advantages:

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weight: probability that speaker uses rule to analyze a sentence
or
speaker's level of confidence that a rule is part of his/her grammar

Proposed Modifications

From Grammars in competition to rules in competition:

Advantages:
•Yang's mechanism of change can be directly retained.
•Simplicity

Proposed Modifications

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- Simplicity

Yang's example: 4 grammars which are defined by 2 binary parameters, wh-Movement and generalized V2

(1) [+wh] [+V2]
(2) [-wh] [+V2]
(3) [+vh] [-V2]
(4) [-wh] [-V2]

alternative: 4 grammar rules in pairs of two in competition

Rc1={+wh, -wh}
Rc2={+V2, -V2}

Proposed Modifications

From Grammars in competition to rules in competition:

Advantages:

- Yang's mechanism of change can be directly retained.
- Simplicity

Yang : 8 grammars which are defined by 3 binary parameters, wh-Movement, generalized V2, and a third parameter X

(1) [+wh] [+V2] [+X]	(5) [+wh] [+V2] [-X]
(2) [-wh] [+V2] [+X]	(6) [-wh] [+V2] [-X]
(3) [+vh] [-V2] [+X]	(7) [+vh] [-V2] [-X]
(4) [-wh] [-V2] [+X]	(8) [-wh] [-V2] [-X]

alternative: 6 grammar rules in pairs of two in competition

Rc1={+wh, -wh}
Rc2={+V2, -V2}
Rc3={+X, -X}

Proposed Modifications

From Grammars in competition to rules in competition:

Advantages:
- Yang's mechanism of change can be directly retained.
- Simplicity

Yang : number of grammars = $2^{\text{number of binary parameters}}$
Alternative: number of rules = Σ values of parameters
(can also handle non-binary parameters)

e.g. 5 binary parameters
Yang: $2^5 = 32$ grammars
Alternative: 2+2+2+2+2 = 10 rules

Proposed Modifications

From Grammars in competition to rules in competition:

Advantages:
- Yang's mechanism of change can be directly retained.
- Simplicity
- Modelling interaction

Proposed Modifications

From Grammars in competition to rules in competition:

Advantages:
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- Simplicity
- Modelling interaction
- Capturing context dependency

Conditional Functional Descriptions

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Format of Phrase Structure Rules in LFG:

Conditional Functional Descriptions

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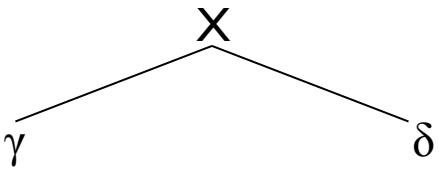
$X \quad \rightarrow \quad \gamma \quad \delta$

Conditional Functional Descriptions

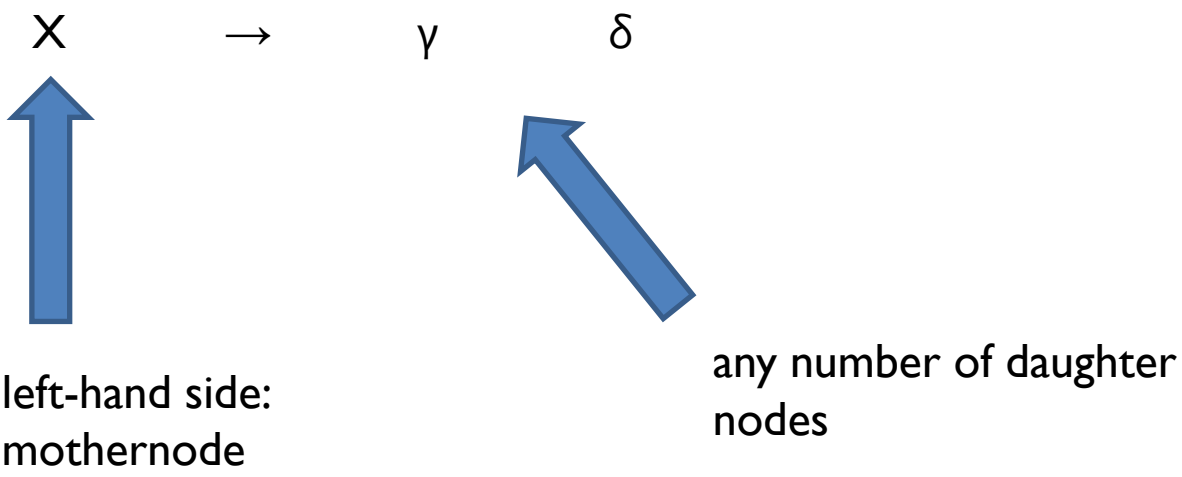
Format of Phrase Structure Rules in LFG:

X → γ δ



Conditional Functional Descriptions

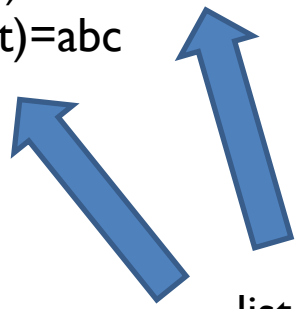
Format of Phrase Structure Rules in LFG:



Conditional Functional Constraints

Format of Phrase Structure Rules in LFG:

X → γ δ
(↑ GF)=↓ ↑=↓
(↑ Feat)=+
(↓ Feat)=abc



list of functional constraints, daughter nodes and in the lexicon, 0 (↑=↓) or more, introduce information on mother (↑) or daughter node (↓)

Conditional Functional Constraints

Examples:

IP	→	DP	I’
		(↑ SUBJ)=↓	↑=↓

Conditional Functional Constraints

Examples:

CP → AdvP C'
(↑ADJUNCT) ∋↓ ↑=↓
(↓ TYPE)=$_c$ op

Conditional Functional Constraints

Examples:

IP	→	IP	DP
		↑=↓	(↑OBJ)=↓
			(↑ OBJ (PHON.WEIGHT))=$_c$ heavy

Conditional Functional Constraints

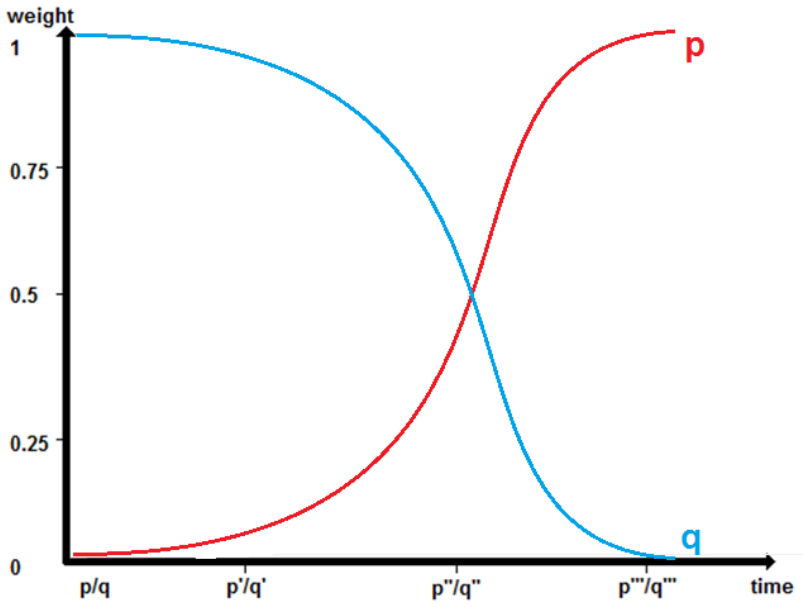
Conditional Functional Constraints

Functional constrains have "a 'make it so' character: whatever f-structure elements are identified by an equation are made to exist in the f-structure model. The equations of the functional description define the model and so are called **defining [functional] constraints**."

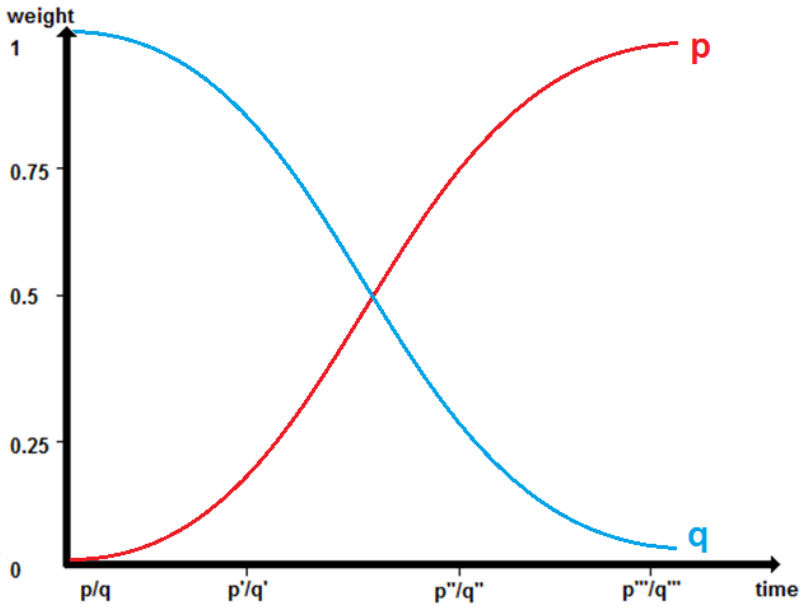
(Bresnan 2001: 60)

Conditional Functional Constraints

context 1:



context 2:



Conditional Functional Constraints

Defining functional constraint:

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$$X \rightarrow \gamma \quad (\downarrow a)=v \qquad p=1.0$$

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"Whenever I need to re-write X as γ I also make sure that (γ a) = v. If I re-write X as γ, but (γ a) ≠ v, I judge the expression as ungrammatical"
"I'm 100% certain that this rule, including the functional constraint, is part of my grammar"

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A functional constraint *(f a)* = *v* holds iff f is a function from attributes to values, a is an attribute symbol, and the pair <*a, v*> is an element of *f*. (Bresnan 2001: 49, 64)

Conditional Functional Constraints

Defining functional constraint:

$$X \quad \rightarrow \quad \begin{matrix} \gamma \\ (\downarrow a)=v \end{matrix} \qquad p=1.0$$

Conditional functional constraint (for rules in competition):

Conditional Functional Constraints

Defining functional constraint:

$$X \rightarrow \gamma \quad (\downarrow a)=v \qquad p=1.0$$

Conditional functional constraint (for rules in competition):

$$Rc = \left\{ \begin{array}{llll} X \rightarrow \gamma & (\uparrow=\downarrow) & \text{if: } (\downarrow a)=v, & p=x \\ & & & p=p+p_c \\ Y \rightarrow \delta & (\uparrow=\downarrow) & \text{if: } (\downarrow a)=v, & p=1-x \\ & & & p=p-p_c \end{array} \right\} \quad (x<1.0)$$

Conditional Functional Constraints

Defining functional constraint:

$$X \rightarrow \underset{(\downarrow a)=v}{\gamma} \qquad p=1.0$$

Conditional functional constraint (for rules in competition):

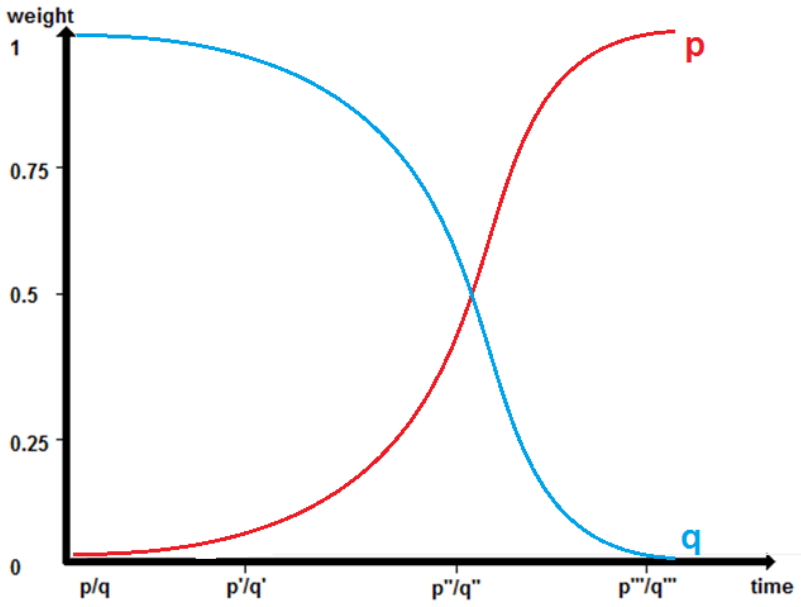
$$Rc = \left\{ \begin{array}{llll} X \rightarrow \underset{\substack{(\uparrow=\downarrow) \\ \text{if: } (\downarrow a)=v,}}{\gamma} & & p=x & \\ & & p=p+p_c & \end{array} \right\} \quad (x<1.0)$$

$$\left\{ \begin{array}{llll} Y \rightarrow \underset{\substack{(\uparrow=\downarrow) \\ \text{if: } (\downarrow a)=v,}}{\delta} & & p=1-x & \\ & & p=p-p_c & \end{array} \right\}$$

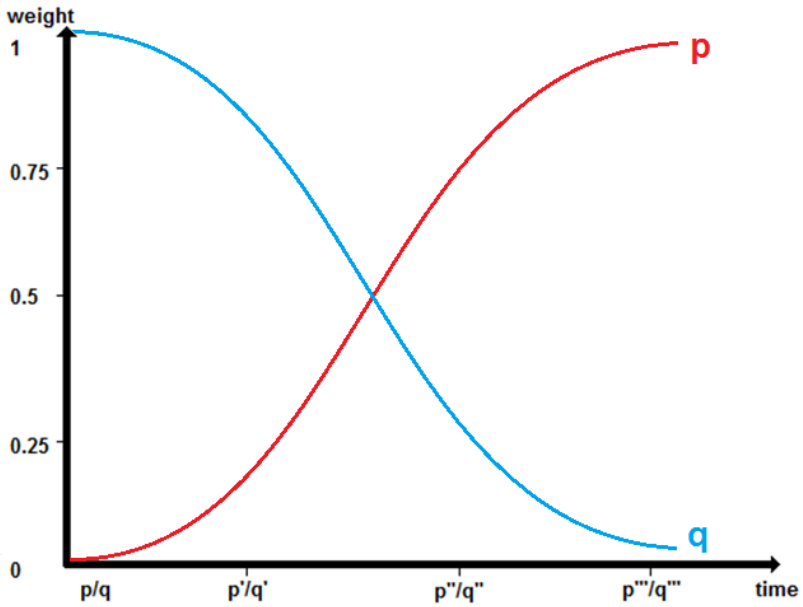
"In x% of all cases when I access Rc, I re-write X as γ. However, I re-write X as γ p_f% more/less frequently if (γ a) = v."
"I'm x% certain that this rule is part of my grammar. But if a certain feature v=a is present, I'm p_f% more/less certain that it is."

Conditional Functional Constraints

context 1:
if: (↓ a)=v TRUE



context 2:
if: (↓ a)=v FALSE



Conditional Functional Constraints

Conditional functional constraint (for rules in competition):

$$R_C = \left\{ \begin{array}{lcll} X & \rightarrow & \gamma & p=x \\ & & (\uparrow=\downarrow) & \\ & & \text{if: } (\downarrow a)=v, & p=p+p_c \\ Y & \rightarrow & \delta & p=1-x \\ & & (\uparrow=\downarrow) & \\ & & \text{if: } (\downarrow a)=v, & p=p-p_c \end{array} \right\} \quad (x<1.0)$$

Example: V → C / NegV1

Example: V → C / NegV1

Toy Grammar of the left periphery of Old English, G1:

CP → "wh-element"		C'	
CP → "operator adverb"		C'	(e.g. *þa, þonne, nu*)
CP → "topic"		C'	(Topic= {DP, AP, AdvP, PP, VP,...})
CP →	C'		(for V1 declaratives, yes/no questions)
C' →	C°	IP	
C' →	IP		
IP → "pronominal subject"		I'	
I' →	I°	VP	
I' →	VP		
VP → ...			
C° → VHEAD			(to model head adjunction of negation, particles)
I° → VHEAD			
VHEAD → (NEG) VFIN			

Example: V → C / NegV1

Toy Grammar of the left periphery of Old English, G1:

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CP → C' (for V1 declaratives, yes/no questions)

C' → C° IP
C' → IP

IP → "pronominal subject" I'
I' → I° VP
I' → VP

two rules in competition

VP → ...

C° → VHEAD (to model head adjunction of negation, particles)
I° → VHEAD

VHEAD → (NEG) VFIN

Example: V → C / NegV1

Conditional functional constraint (for rules in competition):

$$R_C = \left\{ \begin{array}{llll} C^\circ & \rightarrow & \text{VHEAD} \; (\uparrow = \downarrow) & p = x \\ I^\circ & \rightarrow & \text{VHEAD} \; (\uparrow = \downarrow) & p = 1 - x \end{array} \right\} \quad (x < 1.0)$$

Example: V → C / NegV1

Conditional functional constraint (for rules in competition):

$$R_C = \left\{ \begin{array}{llll} C^\circ & \rightarrow & \text{VHEAD} & p = x \\ & & (\uparrow = \downarrow) & \\ 1^\circ & \rightarrow & \text{VHEAD} & p = 1 - x \\ & & (\uparrow = \downarrow) & \end{array} \right. \quad (x < 1.0)$$

Estimation of the weight of the two rules (p, q, where p+q=1):

Example: V → C / NegV1

Conditional functional constraint (for rules in competition):

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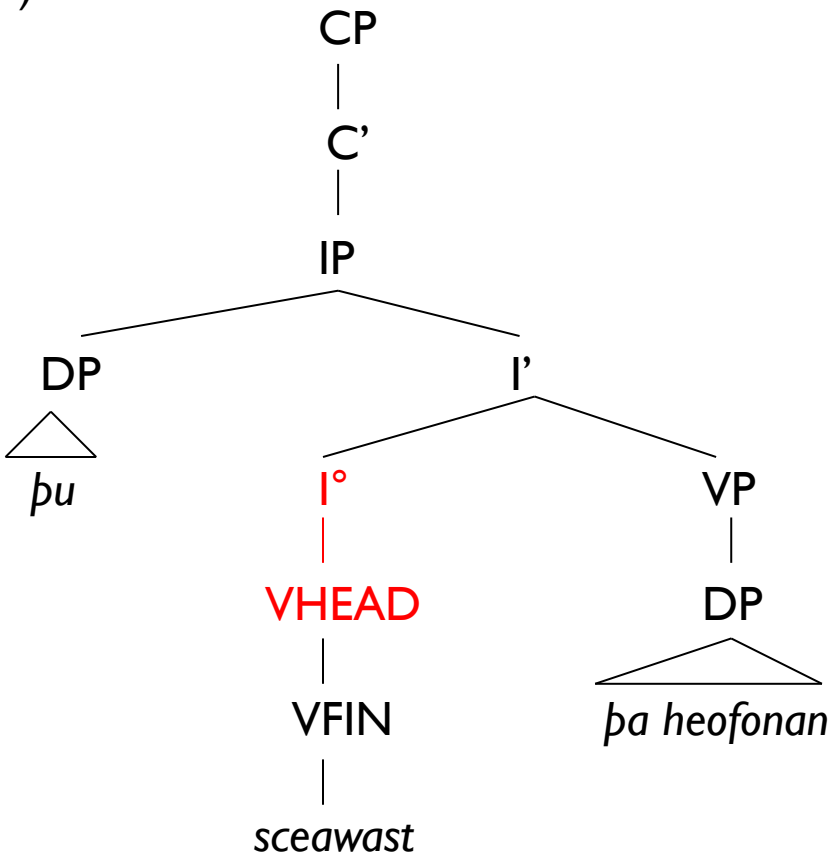
Estimation of the weight of the two rules (p, q, where p+q=1):

- V*fin* – spro vs. spro – V*fin*
- no initial constituent in Spec,CP(adverb, wh-item, topic)
- (preceding subordinate clauses, vocatives, interjections etc.)
- only main clauses, not conjoined main clauses
- no negation

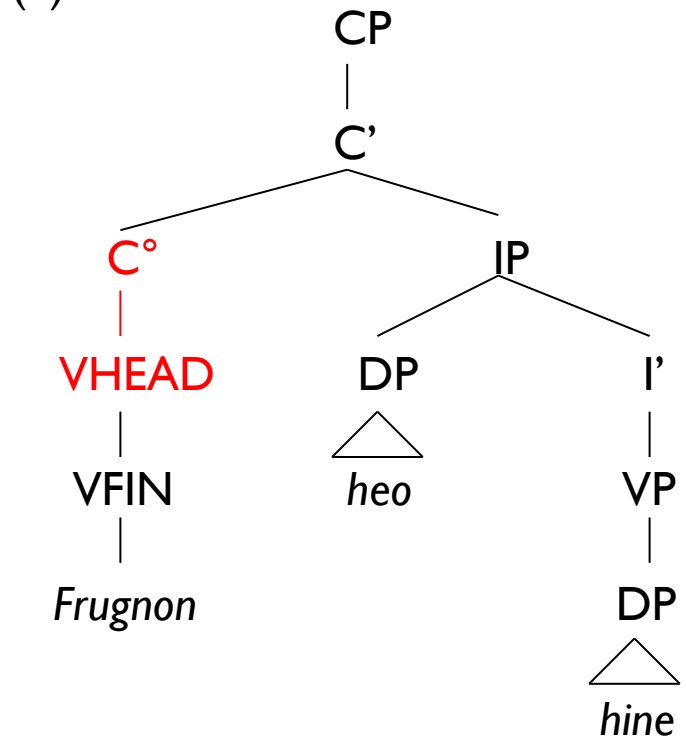
Example:V → C / NegV1

(7)



(coaelhom,ÆHom_1:280.145)
'You look at the heavens'

(8)



(cobede,Bede_2:2.100.21.942)
'They asked him'

Example: V → C / NegV1

Conditional functional constraint (for rules in competition):

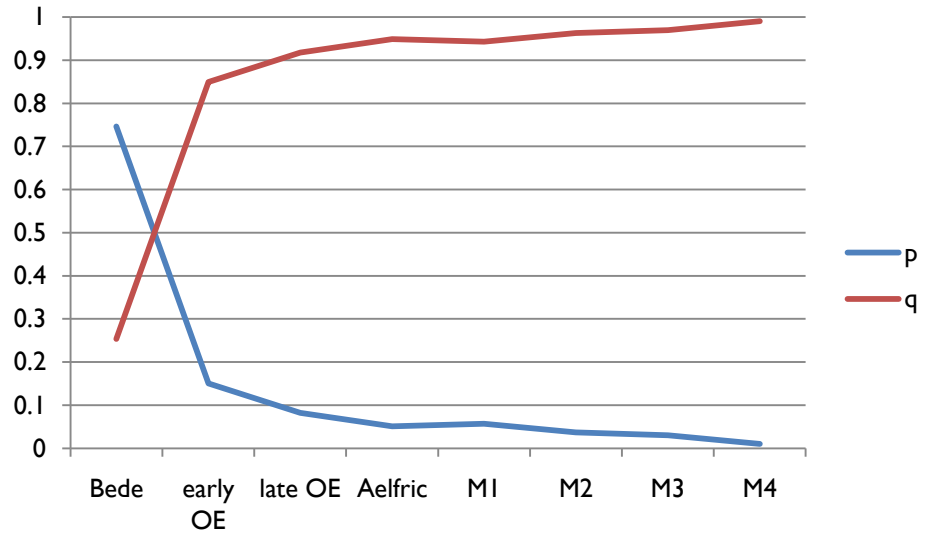
$$R_C = \left\{ \begin{array}{llll} C^\circ & \rightarrow & \text{VHEAD} & p=x \\ & & (\uparrow = \downarrow) & \\ I^\circ & \rightarrow & \text{VHEAD} & q=1-p \\ & & (\uparrow = \downarrow) & \end{array} \right\} \quad (x<1.0)$$

Example: V → C / NegV1

Conditional functional constraint (for rules in competition):

$$R_C = \begin{cases} C^\circ \rightarrow \text{VHEAD } (\uparrow = \downarrow) & p = x \\ I^\circ \rightarrow \text{VHEAD } (\uparrow = \downarrow) & q = 1 - p \end{cases} \quad (x < 1.0)$$

	p	q=1-p
Bede	0.74603175	0.25396825
early OE	0.15071556	0.84928444
late OE	0.0821281	0.9178719
Aelfric	0.05106728	0.94893272
M1	0.05671642	0.94328358
M2	0.03684662	0.96315338
M3	0.03018576	0.96981424
M4	0.00988003	0.99011997



Conditional Functional Constraints

Conditional functional constraint (for rules in competition):

$$R_C = \left\{ \begin{array}{llll} X & \rightarrow & \gamma & p = x \\ & & (\uparrow = \downarrow) & \\ & & \text{if: } (\downarrow a) = v, & p = p + p_c \\ Y & \rightarrow & \delta & p = 1 - x \\ & & (\uparrow = \downarrow) & \\ & & \text{if: } (\downarrow a) = v, & p = p - p_c \end{array} \right. \quad (x < 1.0)$$

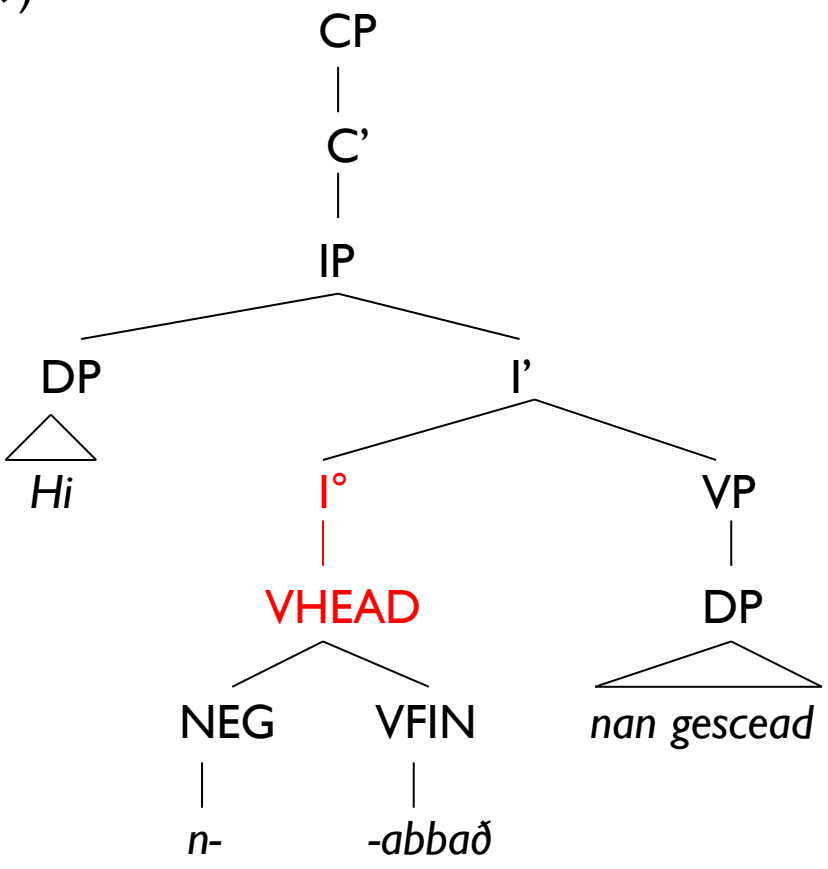
Conditional Functional Constraints

Conditional functional constraint (for rules in competition):
probabilites for Ælfric texts:

$$R_C = \left\{ \begin{array}{llll} C^\circ & \rightarrow & \text{VHEAD} & p = 0.051 \\ & & (\uparrow = \downarrow) & \\ & & \text{if: } (\downarrow \text{NEG}) = + & p = 0.051 + p_c \\ I^\circ & \rightarrow & \text{VHEAD} & q = 0.948 \\ & & (\uparrow = \downarrow) & \\ & & \text{if: } (\downarrow \text{NEG}) = + & q = 0.948 - p_c \end{array} \right\} \quad (p<1.0)$$

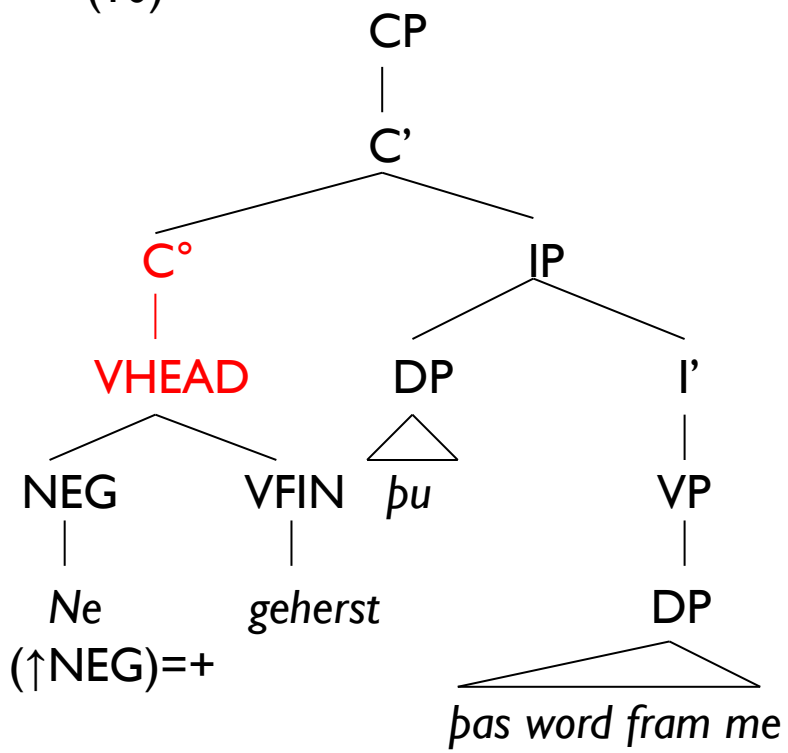
Example: V → C / NegV1

(9)



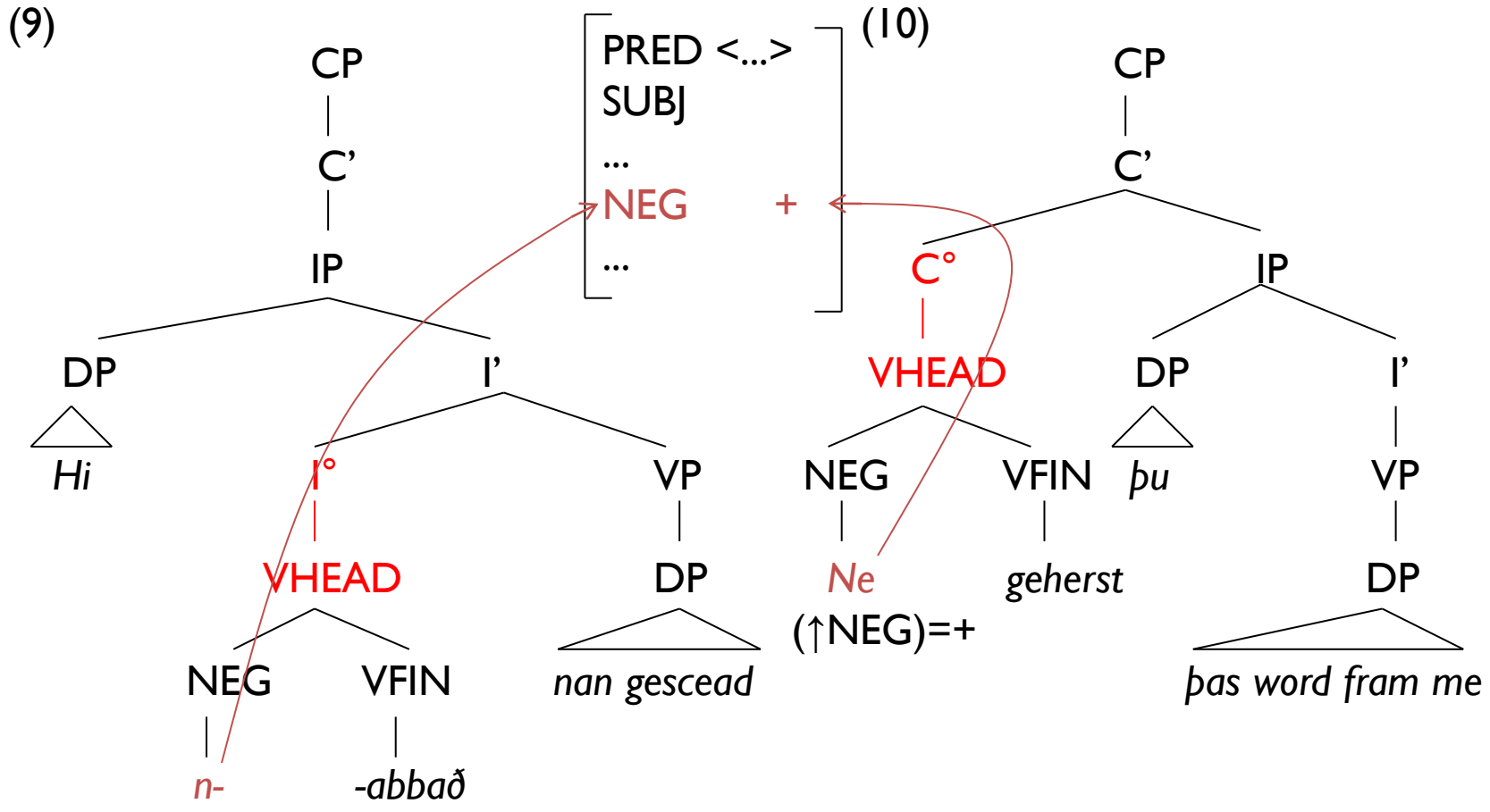
(cocathom1, ÆCHom_I,_21:349.126.4210)
'They don't have any difference'

(10)



(coalcuin,Alc_[Warn_35]:435.331)
'You don't hear that word from me'

Example: V → C / NegV1



(cocathom1, ÆCHom_I,_21:349.126.4210)
'They don't have any difference'

(coalcuin,Alc_[Warn_35]:435.331)
'You don't hear that word from me'

Example: V → C / Neg V I

Conditional functional constraint (for rules in competition):
probabilites for Ælfric texts:

R_C =

C°	→	VHEAD (↑=↓) if: (↓NEG)=+	p= 0.051 p= 0.051 $+p_c$	(p<1.0)
I°	→	VHEAD (↑=↓) if: (↓NEG)=+	q= 0.948 q= 0.948 $-p_c$	

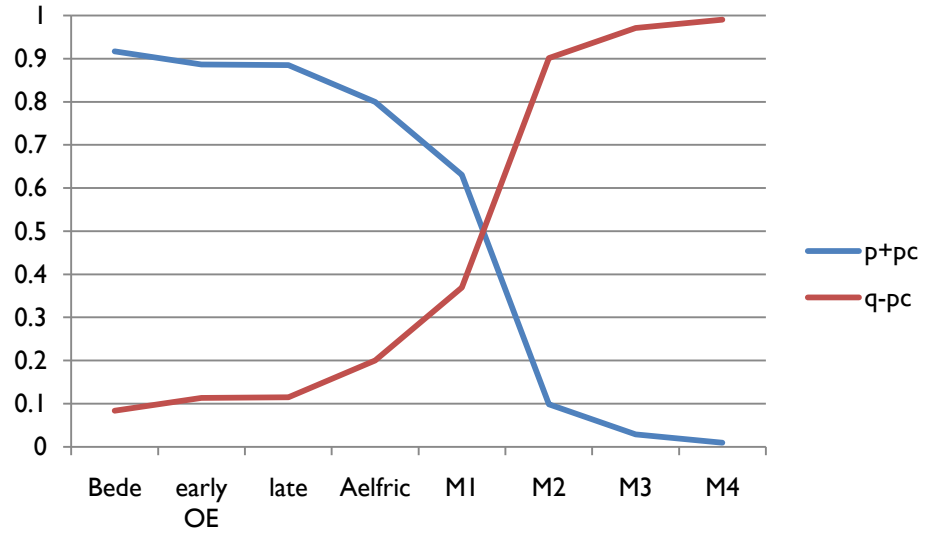
Example: V → C / NegV I

Conditional functional constraint (for rules in competition):
probabilites for Ælfric texts:

R_C =

C°	→	VHEAD (↑=↓) if: (↓NEG)=+	p= 0.051 p= 0.051 $+p_c$	(p<1.0)
I°	→	VHEAD (↑=↓) if: (↓NEG)=+	q= 0.948 q= 0.948 $-p_c$	

	$p+p_c$	$q-p_c$
Bede	0.91666667	0.08333333
early OE	0.88648649	0.11351351
late	0.88518519	0.11481481
Aelfric	0.79961832	0.20038168
M1	0.6302521	0.3697479
M2	0.09859155	0.90140845
M3	0.02877698	0.97122302
M4	0.00970874	0.99029126



Example: V → C / NegV I

Conditional functional constraint (for rules in competition):
probabilites for Ælfric texts:

R_C =

C°	→	VHEAD (↑=↓) if: (↓NEG)=+	p= 0.051 p= 0.051 $+p_c$	(p<1.0)
I°	→	VHEAD (↑=↓) if: (↓NEG)=+	q= 0.948 q= 0.948 $-p_c$	

$$p_c = (p+p_c) - p$$

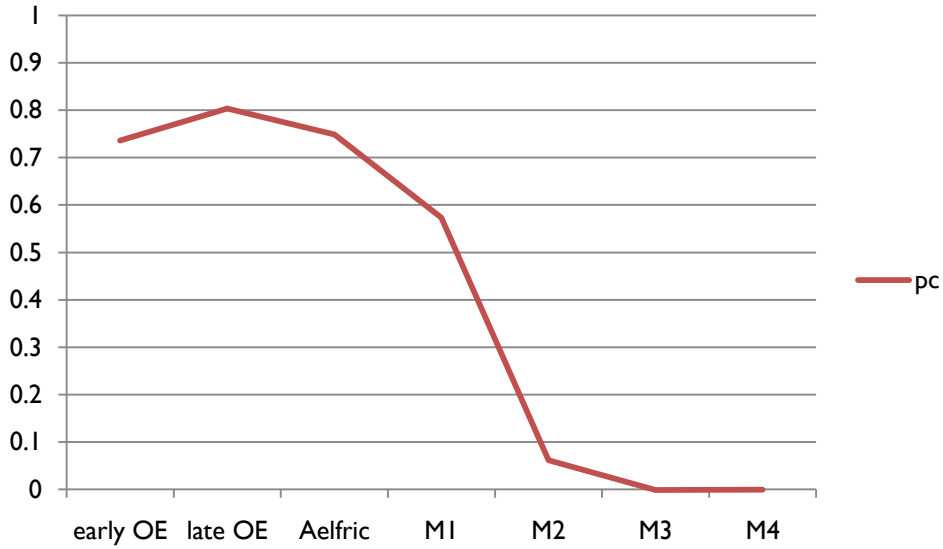
Example: V → C / NegV I

Conditional functional constraint (for rules in competition):
probabilites for Ælfric texts:

R_C =

C°	→	VHEAD (↑=↓) if: (↓NEG)=+	p= 0.051 p= 0.051 +p_c	(p<1.0)
I°	→	VHEAD (↑=↓) if: (↓NEG)=+	q= 0.948 q= 0.948 -p_c	

	p_c
early OE	0.73577092
late OE	0.80305709
Aelfric	0.74855104
M1	0.57353568
M2	0.06174493
M3	-0.00140878
M4	-0.00017129



Example: V → C / NegV I

Conditional functional constraint (for rules in competition):
probabilites for Ælfric texts:

R_C =

C°	→	VHEAD (↑=↓) if: (↓NEG)=+	p= 0.051 p= 0.051 +p_c	(p<1.0)
I°	→	VHEAD (↑=↓) if: (↓NEG)=+	q= 0.948 q= 0.948 -p_c	

	p_c
early OE	0.73577092
late OE	0.80305709
Aelfric	**0.74855104**
M1	0.57353568
M2	0.06174493
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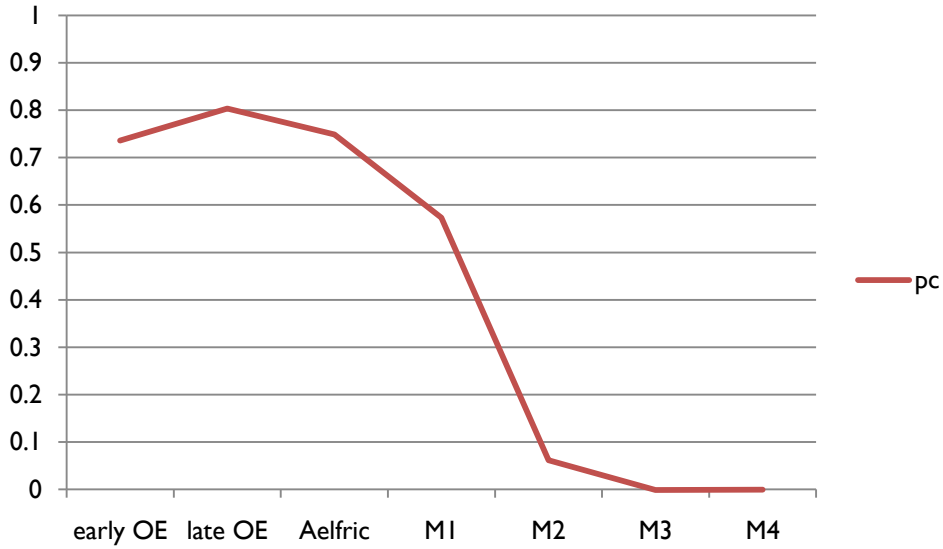
M4	-0.00017129



Example: V → C / NegV I

Conditional functional constraint (for rules in competition): probabilites for Ælfric texts:

R_C =

C°	→	VHEAD (↑=↓)	p= 0.051	(p<1.0)
		if: (↓NEG)=+	p= 0.051 + 0.748	
I°	→	VHEAD (↑=↓)	q= 0.948	
		if: (↓NEG)=+	q= 0.948 - 0.748	

Example: V → C / NegV I

Conditional functional constraint (for rules in competition): probabilites for Ælfric texts:

R_C =

C°	→	VHEAD (↑=↓)	p= 0.051	(p<1.0)
		if: (↓NEG)=+	p= 0.799	
I°	→	VHEAD (↑=↓)	q= 0.948	
		if: (↓NEG)=+	q= 0.201	

Example: V → C / NegV I

Conditional functional constraint (for rules in competition): probabilites for Ælfric texts:

R_C =	C°	→	VHEAD (↑=↓)	p= 0.051	(p<1.0)
			if: (↓NEG)=+	p= 0.799	
	I°	→	VHEAD (↑=↓)	q= 0.948	
			if: (↓NEG)=+	q= 0.201	

→ loss of head-adjoined negation ne

Example: V → C / NegV I

Conditional functional constraint (for rules in competition): probabilites for Ælfric texts:

R_C =	C°	→	VHEAD (↑=↓)	p= 0.051	(p<1.0)
			if: (↓NEG)=+	p= 0.799	
	I°	→	VHEAD (↑=↓)	q= 0.948	
			if: (↓NEG)=+	q= 0.201	

→ loss of head-adjoined negation ne
→ if-function will never be true

Example: V → C / NegV1

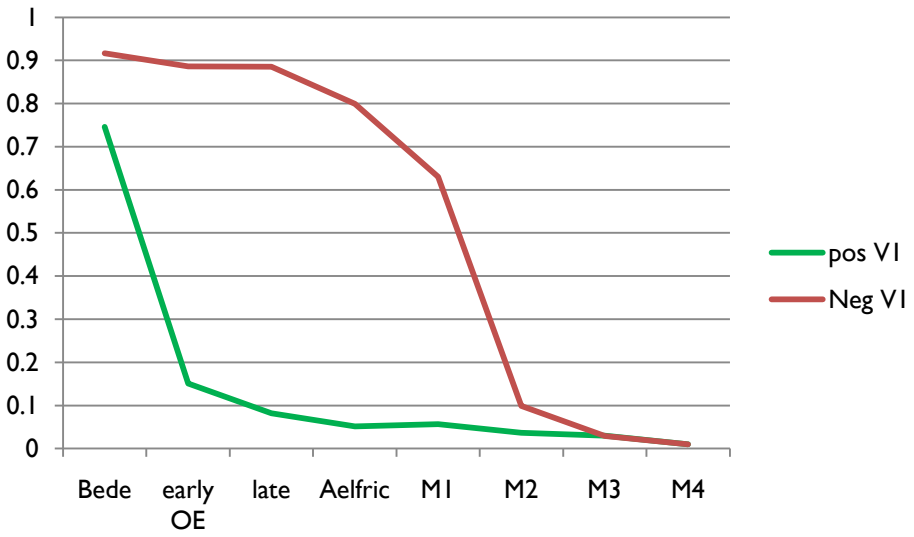
Conditional functional constraint (for rules in competition): probabilites for Ælfric texts:

$$R_C = \left\{ \begin{array}{llll} C^\circ & \rightarrow & \text{VHEAD} & p = 0.051 \\ & & (\uparrow = \downarrow) & \\ & & \text{if: } (\downarrow \text{NEG}) = + & p = 0.799 \\ I^\circ & \rightarrow & \text{VHEAD} & q = 0.948 \\ & & (\uparrow = \downarrow) & \\ & & \text{if: } (\downarrow \text{NEG}) = + & q = 0.201 \end{array} \right\} \quad (p<1.0)$$

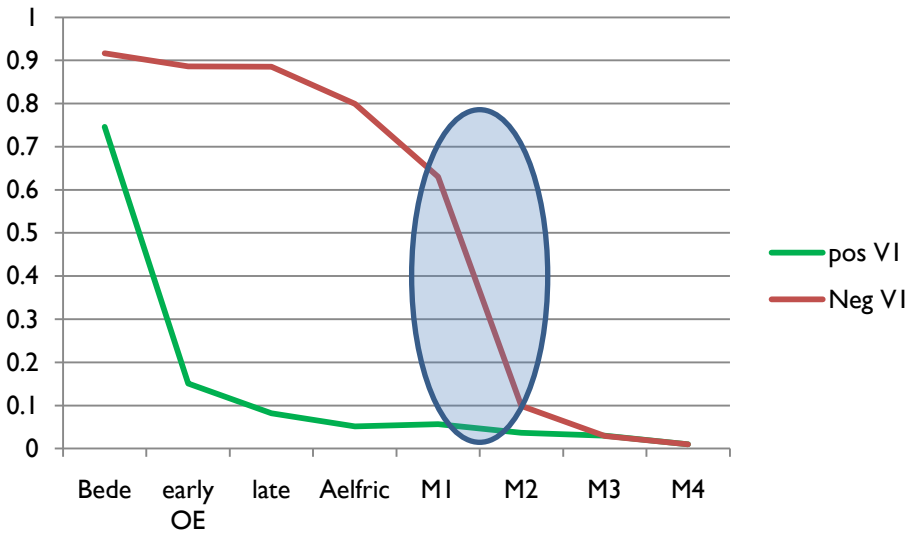
→ loss of head-adjoined negation ne
→ if-function will never be true
→ high frequency of NegV1 reduced to base probability of C°→V

Example: V → C / Neg V I

Example: V → C / Neg V1



Example: V → C / Neg V1



Example: V → C / Neg V1

ME verse, from:
Ingham (2005)

Example: V → C / NegV1

(11) oc Crist it ne uuolde.
but Christ it not wanted
'but Christ wouldn't allow it'
(CMPETERB,54.374)

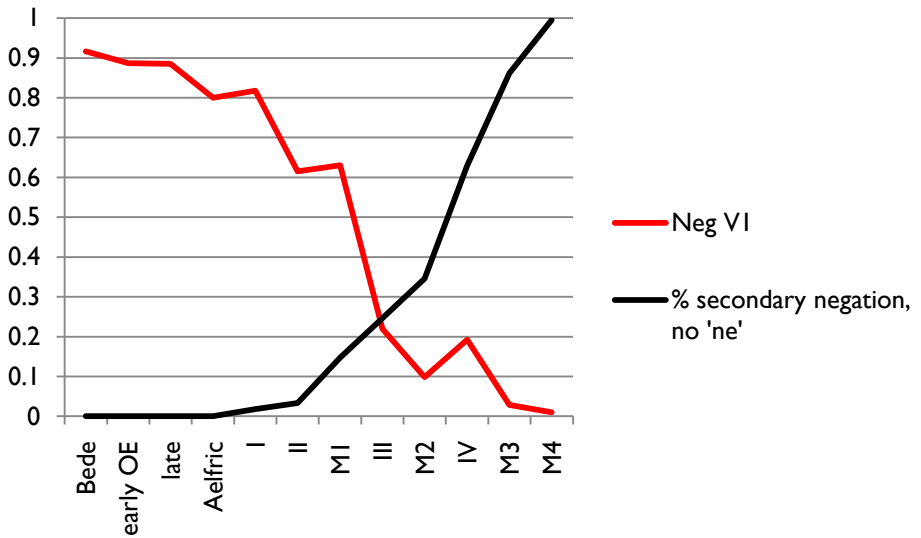
(12) & swa ne don nohht alle þa þatt follȝhenn rihhtwisnesse,
and so not do not all those who follow righteousness
'and those who follow righeousness don't do so'
(CMORM,1,10.207)

vs.

(13) Tou schalt not tempte God, þy Lorde.
you shall not tempt God your Lord
'You shall not tempt God, your Lord'
(CMMIRK,83.2232)

Example: V → C / NegV1

	Neg V1	% secondary negation, no 'ne'
Bede	0.91666667	0
early OE	0.88648649	0
late	0.88518519	0
Aelfric	0.79961832	0
I	0.818	0.018
II	0.615	0.033
M1	0.6302521	0.14727085
III	0.22	0.246
M2	0.09859155	0.3459596
IV	0.192	0.63
M3	0.02877698	0.86206897
M4	0.00970874	0.9954955



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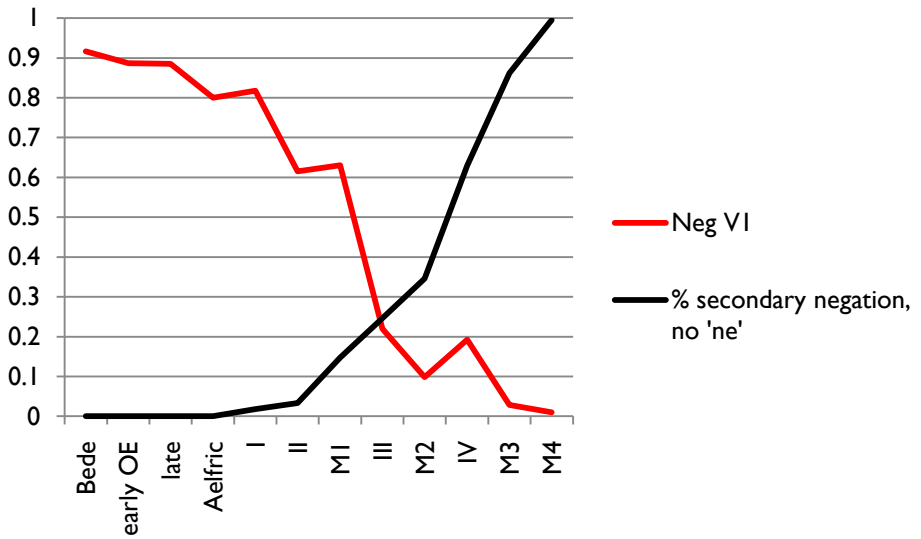

"The increase in secondary negation appears to have precedes the decline in NegV1" (Ingham 2005: 195)

Example: V → C / NegV1

	Neg V1	% secondary negation, no 'ne'
Bede	0.91666667	0
early OE	0.88648649	0
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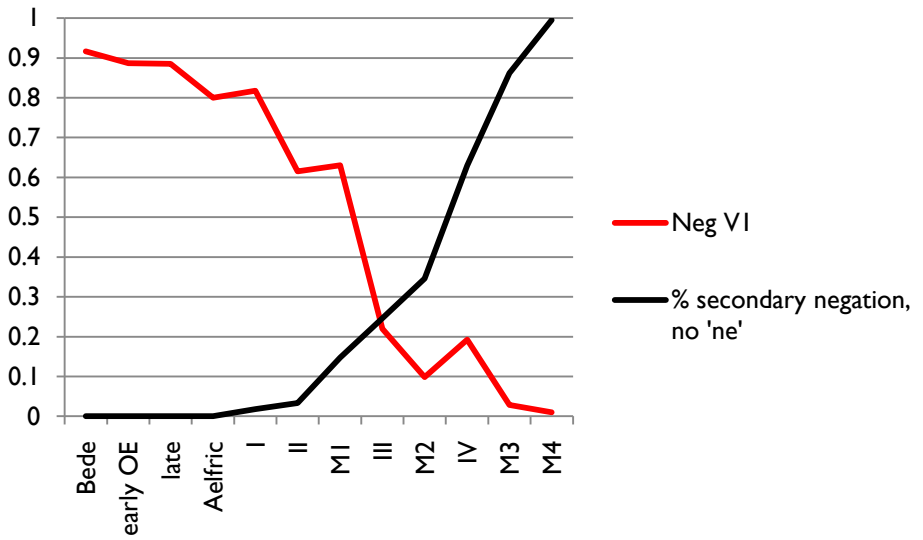


The rise of secondary negation and loss of NegV1 are roughly inversely proportional, as predicted by the probabilistic model.

Example: V → C / Neg V I

Example: V → C / NegV1

Open Questions:

(a) Learnability of conditional functional constraints

Example: V → C / NegV1

Open Questions:

(a) Learnability of conditional functional constraints
(b) more complex interaction

p(V→ C) by negation ~ initial constituent

	neg	pos
wh	1.00	0.992
opadv	0.895	0.887
null	0.799	0.050
TOP	0.045	0.020

Example: V → C / NegV I

Open Questions:

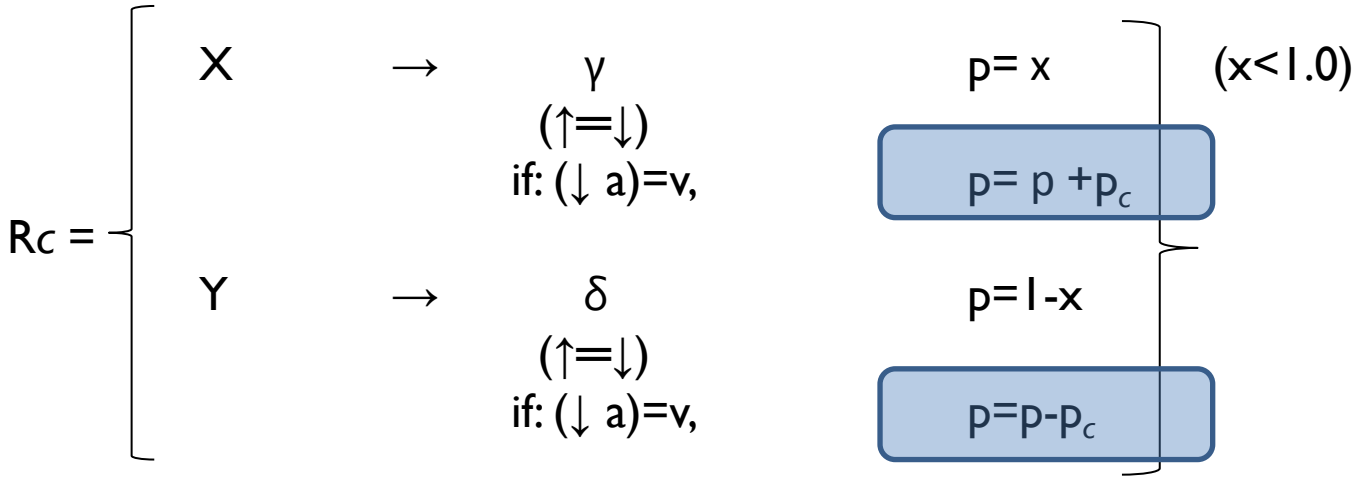
(a) Learnability of conditional functional constraints
(b) more complex interaction

p(V→ C) by negation ~ mood

	indicative	subjunctive
neg	0.62711864	0.88235294
pos	0.13072543	0.58823529

Conditional Functional Constraints

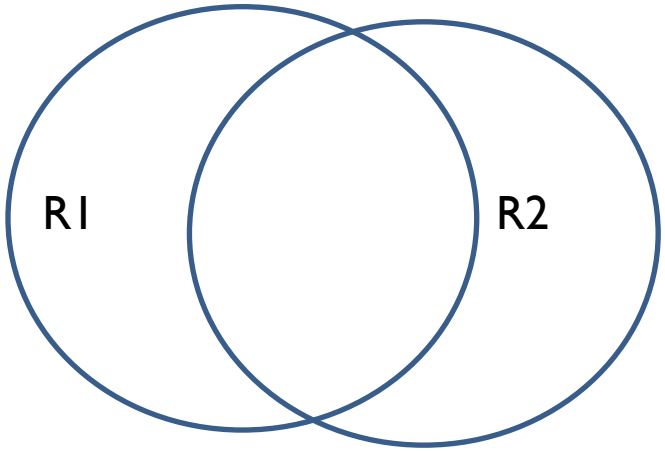
Conditional functional constraint (for rules in competition):



Defining functional constraints: The endpoint of syntactic changes

Defining functional constraints: The endpoint of syntactic changes

Rc=

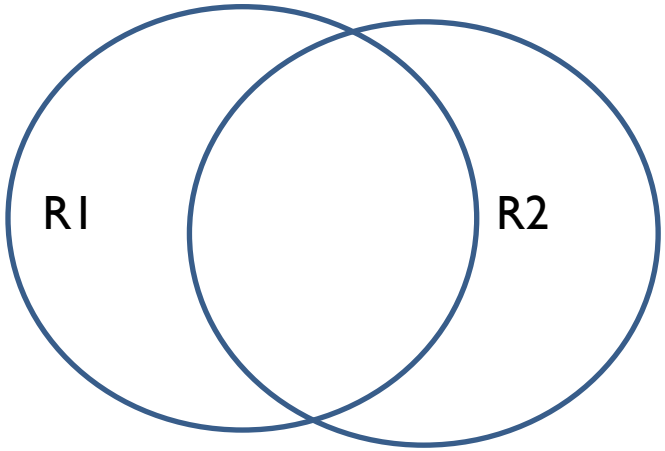


R1 = A → β
[p=…]

R2 = B → γ
[q=…]

Defining functional constraints: The endpoint of syntactic changes

Rc=

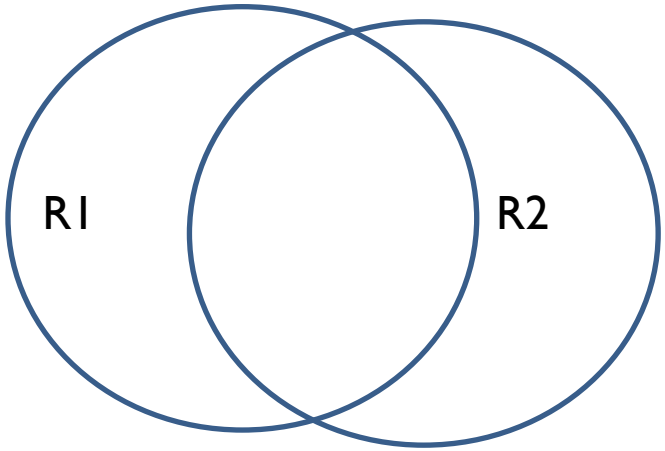


R1 = A → β [p=…]
if: (↑a)=v [p=p+p_c]

R2 = B → γ [q=…]
if: (↑a)=v [q=q-p_c]

Defining functional constraints: The endpoint of syntactic changes

Rc=

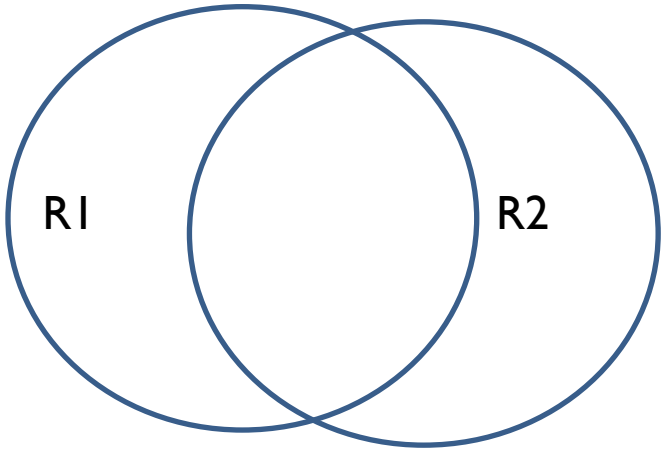


R1 = A → β [p=0.5]
if: (↑a)=v [p=0.5]

R2 = B → γ [q=0.5]
if: (↑a)=v [q=0.5]

Defining functional constraints: The endpoint of syntactic changes

Rc=

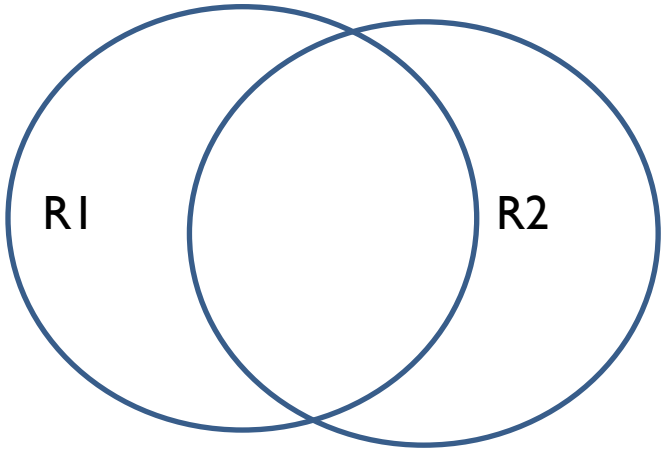


R1 = A → β [p=0.7]
if: (↑a)=v [p=0.3]

R2 = B → γ [q=0.3]
if: (↑a)=v [q=0.7]

Defining functional constraints: The endpoint of syntactic changes

Rc=

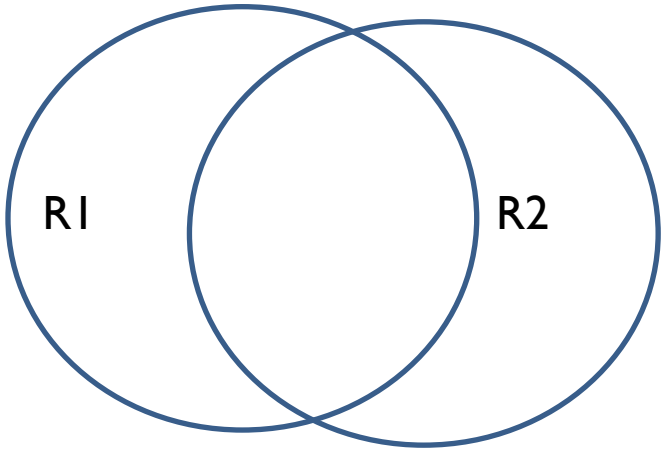


R1 = A → β [p=0.1]
if: (↑a)=v [p=0.9]

R2 = B → γ [q=0.9]
if: (↑a)=v [q=0.1]

Defining functional constraints: The endpoint of syntactic changes

Rc=

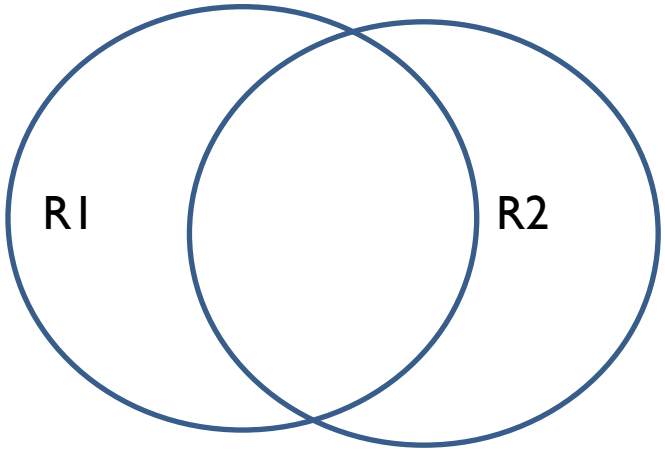


R1 = A → β [p=1.0]
if: (↑a)=v [p=0.0]

R2 = B → γ [q=0.0]
if: (↑a)=v [q=1.0]

Defining functional constraints: The endpoint of syntactic changes

Rc=



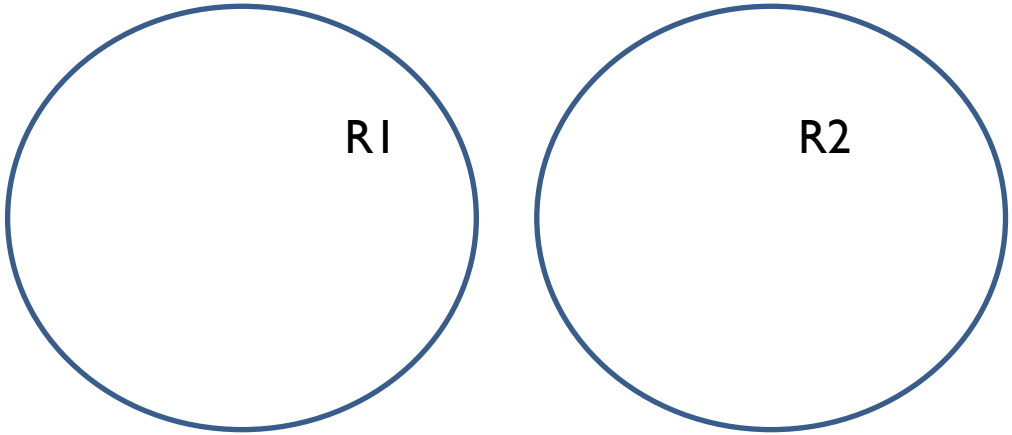
R1 = A → β [p=1.0]
if: (↑a)=v [p=0.0]

R2 = B → γ [q=0.0]
if: (↑a)=v [q=1.0]

=

Defining functional constraints: The endpoint of syntactic changes

~~Rc=~~



R1 = A → β [p=1.0]

R2 = B → γ [q=1.0]
(↑a)=v

Defining functional constraints: The endpoint of syntactic changes

Examples:

Defining functional constraints: The endpoint of syntactic changes

Examples:

(a) conditional V-to-C -> obligatory V-to-C in interrogatives

Defining functional constraints: The endpoint of syntactic changes

Examples:

(a) conditional V-to-C -> obligatory V-to-C in interrogatives

(14) Hwæþer we scylen biddan þone godcundan fultum
Q we should ask the divine help
'Should we ak for divine help'
(coboeth,Bo:33.79.2.1481)

Defining functional constraints: The endpoint of syntactic changes

Examples:

(a) conditional V-to-C -> obligatory V-to-C in interrogatives

(14)a. Hwæþer we scylen biddan þone godcundan fultum
Q we should ask the divine help
'Should we ask for divine help'
(coboeth,Bo:33.79.2.1481)

(14)b.Πότερον / Πότερα λέγεις τὸν Σκράτη
Q you.mean the Socrates
'(Which of the two:) Do you mean Sokrates (or Platon)?'

Defining functional constraints: The endpoint of syntactic changes

Examples:

(a) conditional V-to-C -> obligatory V-to-C in interrogatives

$$
Rc = \left\{ \begin{array}{llll} C^{\circ} & \rightarrow & \text{VHEAD} & p = 0.01 \\ & & (\uparrow = \downarrow) & \\ & & \text{if: } (\uparrow \text{CLAUSETYPE}) = \text{INT} & p = 0.99 \\ I^{\circ} & \rightarrow & \text{VHEAD} & q = 0.99 \\ & & (\uparrow = \downarrow) & \\ & & \text{if: } (\uparrow \text{CLAUSETYPE}) = \text{INT} & q = 0.01 \end{array} \right\} \quad (p<1.0)
$$

Defining functional constraints: The endpoint of syntactic changes

Examples:

(a) conditional V-to-C -> obligatory V-to-C in interrogatives

$$
Rc = \left\{ \begin{array}{llll} C^{\circ} & \rightarrow & \text{VHEAD} & p = 0.0 \\ & & (\uparrow = \downarrow) & \\ & & \text{if: } (\uparrow \text{CLAUSETYPE}) = \text{INT} & p = 1.0 \\ I^{\circ} & \rightarrow & \text{VHEAD} & q = 1.0 \\ & & (\uparrow = \downarrow) & \\ & & \text{if: } (\uparrow \text{CLAUSETYPE}) = \text{INT} & q = 0.0 \end{array} \right\} \quad (p<1.0)
$$

Defining functional constraints: The endpoint of syntactic changes

Examples:

(a) conditional V-to-C -> obligatory V-to-C in interrogatives

C° → VHEAD p= 1.0
(↑CLAUSETYPE)=INT

I° → VHEAD q= 1.0
(↑=↓)

Defining functional constraints: The endpoint of syntactic changes

Examples:

Defining functional constraints: The endpoint of syntactic changes

Examples:

(b) rise of the EPP

Defining functional constraints: The endpoint of syntactic changes

Examples:

(b) rise of the EPP

(15) Him fleow þa þæt blod ut
him flowed then that blood out
'Then he was bleeding'
(coaelive,+ALS_[Vincent]:170.7906)

Defining functional constraints: The endpoint of syntactic changes

Examples:

(b) rise of the EPP

(15) a. Him fleow þa þæt blod ut
him flowed then that blood out
'Then he was bleeding'
(coaelive,+ALS_[Vincent]:170.7906)

no EPP:

b. Him [I' fleow [VP þa [VP þæt blod ut]]]

Defining functional constraints: The endpoint of syntactic changes

Examples:

(b) rise of the EPP

$$
Rc = \left\{ \begin{array}{llll}
IP \rightarrow (DP) & I' & p = 0.50 & \\
(\uparrow = \downarrow) & \uparrow = \downarrow & & \\
\text{if: } (\uparrow SUBJ) = \downarrow & & p = 0.30 & \\
 & & & \\
VP \rightarrow (DP) & V' & q = 0.50 & \\
(\uparrow = \downarrow) & \uparrow = \downarrow & & \\
\text{if: } (\uparrow SUBJ) = \downarrow & & q = 0.70 &
\end{array} \right\} \quad (p < 1.0)
$$

Defining functional constraints: The endpoint of syntactic changes

Examples:

(b) rise of the EPP

$$
Rc = \left\{ \begin{array}{llll}
IP \rightarrow (DP) & I' & p = 0.30 & (p<1.0) \\
(\uparrow = \downarrow) & \uparrow = \downarrow & & \\
\text{if: } (\uparrow SUBJ) = \downarrow & & p = 0.70 & \\
 & & & \\
VP \rightarrow (DP) & V' & q = 0.70 & \\
(\uparrow = \downarrow) & \uparrow = \downarrow & & \\
\text{if: } (\uparrow SUBJ) = \downarrow & & q = 0.30 &
\end{array} \right\}
$$

Defining functional constraints: The endpoint of syntactic changes

Examples:

(b) rise of the EPP

$$
Rc = \left\{ \begin{array}{llll}
IP \rightarrow (DP) & I' & p = 0.00 & (p<1.0) \\
(\uparrow = \downarrow) & \uparrow = \downarrow & & \\
\text{if: } (\uparrow SUBJ) = \downarrow & & p = 1.0 & \\
 & & & \\
VP \rightarrow (DP) & V' & q = 1.0 & \\
(\uparrow = \downarrow) & \uparrow = \downarrow & & \\
\text{if: } (\uparrow SUBJ) = \downarrow & & q = 0.00 &
\end{array} \right\}
$$

Defining functional constraints: The endpoint of syntactic changes

Examples:

(b) rise of the EPP

IP	→	(DP) (↑SUBJ)=↓	I' ↑=↓	p= 1.0
VP	→	(DP) ↑=↓	V' ↑=↓	q= 1.0

Defining functional constraints: The endpoint of syntactic changes

Examples:

Defining functional constraints: The endpoint of syntactic changes

Examples:

(c) fixation of I-final IP in German subordinate clauses

Defining functional constraints: The endpoint of syntactic changes

Examples:

(c) fixation of I-final IP in German subordinate clauses

(16) dhazs sie ni eigun eouuihd
that they NEG own anything
'That they have nothing '
Latin: dum non habeant
(Isidor, III.9, 236 (Schlachter 2004: 231,her (10))

Defining functional constraints: The endpoint of syntactic changes

Examples:

(c) fixation of I-final IP in German subordinate clauses

$$
Rc = \left\{ \begin{array}{llll}
I' \rightarrow VP & & I^{\circ} & p = 0.6 \\
(\uparrow = \downarrow) & & \uparrow = \downarrow & \\
 & \text{if: } (\uparrow \text{CLAUSETYPE}) = \text{SUB} & & p = 0.7 \\
 & & & \\
C' \rightarrow & C^{\circ} & IP & q = 0.4 \\
 & (\uparrow = \downarrow) & \uparrow = \downarrow & \\
\text{if: } (\uparrow \text{CLAUSETYPE}) = \text{SUB} & & & q = 0.3
\end{array} \right\} \quad (p < 1.0)
$$

Defining functional constraints: The endpoint of syntactic changes

Examples:

(c) fixation of I-final IP in German subordinate clauses

$$
Rc = \left\{ \begin{array}{llll}
I' \rightarrow VP & & I^{\circ} & p = 0.3 \\
(\uparrow = \downarrow) & & \uparrow = \downarrow & \\
 & \text{if: } (\uparrow \text{CLAUSETYPE}) = \text{SUB} & & p = 0.9 \\
 & & & \\
C' \rightarrow & C^{\circ} & IP & q = 0.7 \\
 & (\uparrow = \downarrow) & \uparrow = \downarrow & \\
\text{if: } (\uparrow \text{CLAUSETYPE}) = \text{SUB} & & & q = 0.1
\end{array} \right\} \quad (p < 1.0)
$$

Defining functional constraints: The endpoint of syntactic changes

Examples:

(c) fixation of I-final IP in German subordinate clauses

$$
Rc = \left\{ \begin{array}{llll}
I' \rightarrow VP & I^{\circ} & p = 0.0 & (p<1.0) \\
(\uparrow=\downarrow) & \uparrow=\downarrow & & \\
\text{if: } (\uparrow \text{CLAUSETYPE})=\text{SUB} & & p = 1.0 & \\
 & & & \\
C' \rightarrow C^{\circ} & IP & q = 1.0 & \\
(\uparrow=\downarrow) & \uparrow=\downarrow & & \\
\text{if: } (\uparrow \text{CLAUSETYPE})=\text{SUB} & & q = 0.0 &
\end{array} \right\}
$$

Defining functional constraints: The endpoint of syntactic changes

Examples:

(c) fixation of I-final IP in German subordinate clauses

I' → VP (↑=↓) I° ↑CLAUSETYPE)=SUB p= 1.0

C' → C° (↑=↓) IP ↑=↓ q= 1.0

Conclusion

Conclusion

1. variation as probability that a grammar is used to analyse a sentence
2. change is directed by penalty probability (Yang 2000)
3. grammar rules in competition instead of grammars in competition
4. context dependency via conditional functional constraints
5. may also allow modelling more complex interaction
6. model is broad enough for investigation of various syntactic changes
7. model is rigid enough for quantitative testing

Thanks for your attention!

References

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