

Cycles and stability in linguistic signaling

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Outline

1 Language change

2 Jespersen's cycles

3 The functional cycle

4 The formal cycle

Language change

Grammar $n \neq$ Grammar $n + 1$

(Chomsky and Halle, 1968)

Language change



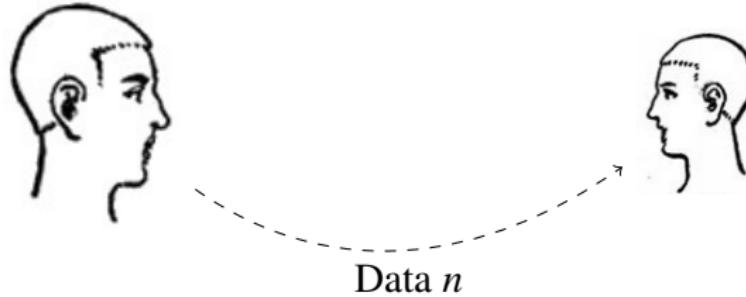
Language change

Grammar n

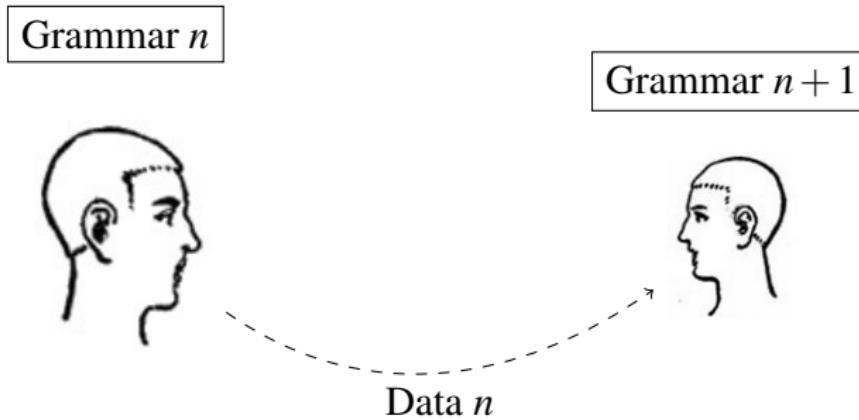


Language change

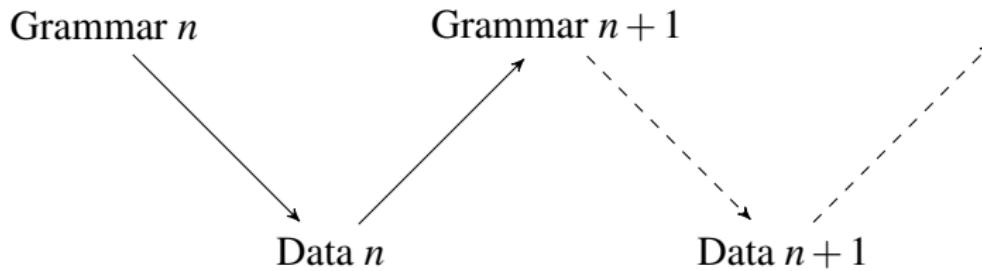
Grammar n



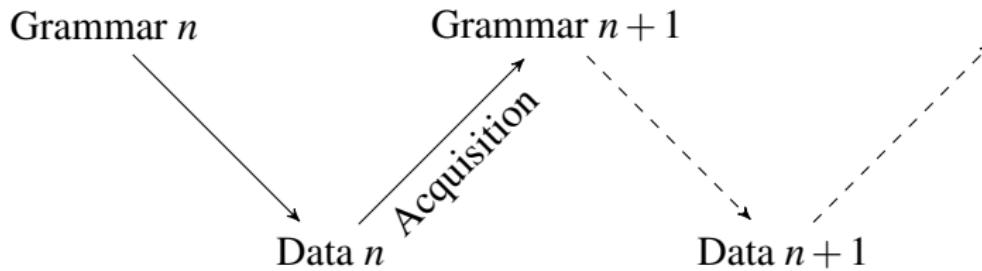
Language change



Language change



Language change



Language change



Language change

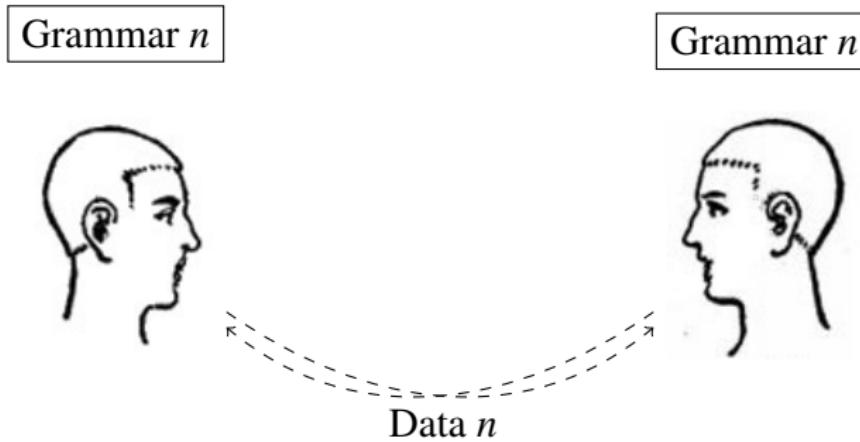
Grammar n



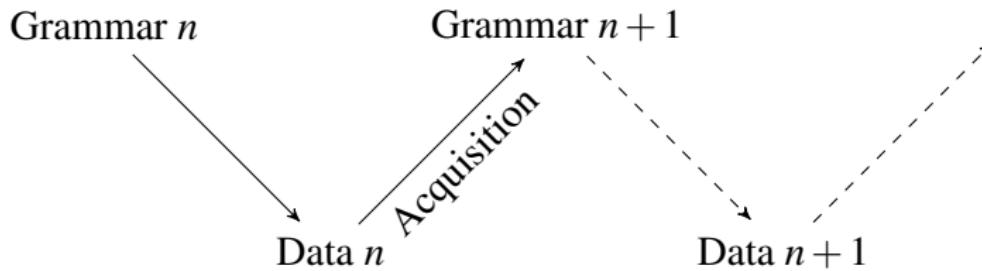
Grammar n



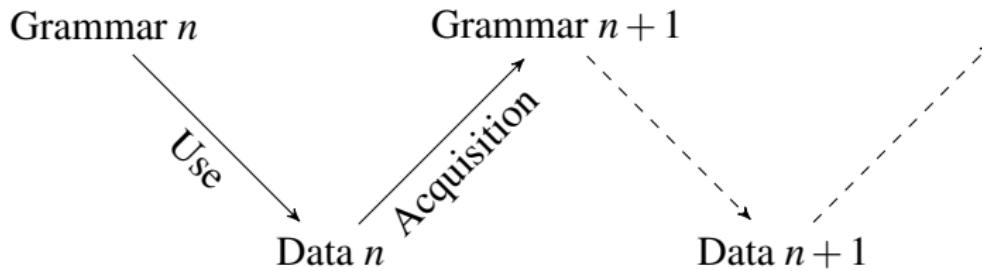
Language change



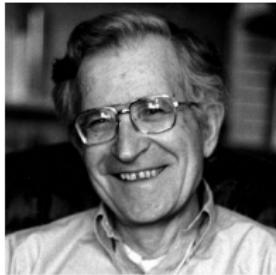
Language change



Language change



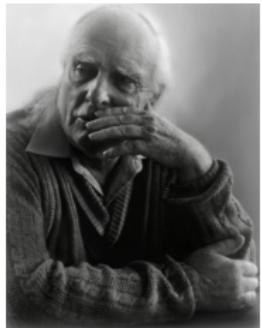
Kinds of competence



By grammatical competence I mean the cognitive state that encompasses all those aspects of form and meaning and their relation...Pragmatic competence underlies the ability to use such knowledge along with the conceptual system to achieve certain ends or purposes.

(Chomsky, 1980)

Kinds of competence



*I am, however, enough of a **rationalist** to want to find a basis that underlies these facts, undeniable though they may be; I would like to be able to think of the standard type of conversational practice not merely as something that all or most do **in fact** follow but as something that it is **reasonable** for us to follow, that we **should not abandon**.*

(Grice, 1975)

Kinds of competence



*The principle of **bounded rationality**, the capacity of the human mind for formulating and solving complex problems is very small compared with the size of the problems whose solution is required for objectively rational behavior in the real world — or even for a reasonable approximation to such objective rationality.*

(Simon, 1947)

Kinds of competence

Something we might reasonably abandon (cf. Grice, 1975)



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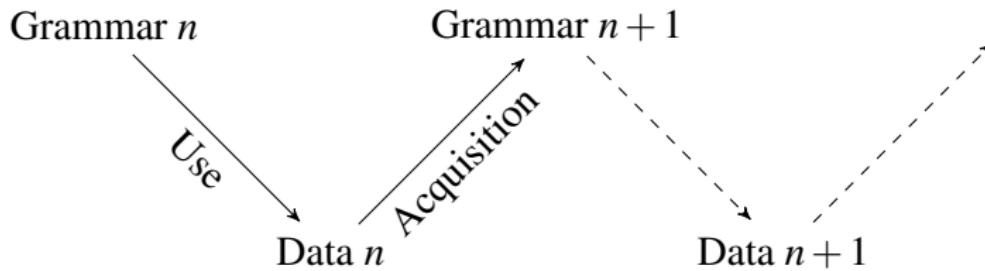
(Simon, 1947)

Kinds of competence



(cf. [reddit.com/r/desirepath/](https://www.reddit.com/r/desirepath/); Keller, 1994)

Kinds of competence



Jespersen's cycle



The history of negative expressions in various languages makes us witness the following curious fluctuation: the original negative adverb is first weakened, then found insufficient and therefore strengthened, generally through some additional word, and this in its turn may be felt as the negative proper and may then in course of time be subject to the same developments as the original word.

(Jespersen, 1917)

Jespersen's cycle

1

2

3

4

(cf. Posner 1985; Schwegler 1988; Ladusaw 1993, *inter alia*)

Jespersen's cycle

1

2

3

4

NEG V

(cf. Posner 1985; Schwegler 1988; Ladusaw 1993, *inter alia*)

Jespersen's cycle

1

2

3

4

NEG V

NEG V (NEG)

(cf. Posner 1985; Schwegler 1988; Ladusaw 1993, *inter alia*)

Jespersen's cycle

1

2

3

4

NEG V

NEG V (NEG)

(Emphatic)

(cf. Posner 1985; Schwegler 1988; Ladusaw 1993, *inter alia*)

Jespersen's cycle

1

2

3

4

NEG V

NEG V (NEG)

NEG V NEG

(Emphatic)

(cf. Posner 1985; Schwegler 1988; Ladusaw 1993, *inter alia*)

Jespersen's cycle

1

2

3

4

NEG V

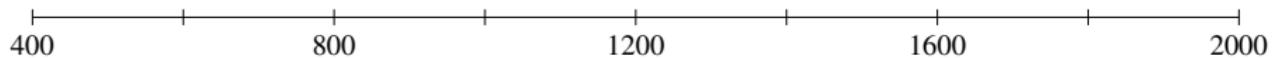
NEG V (NEG)

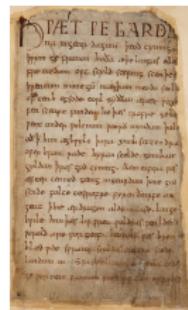
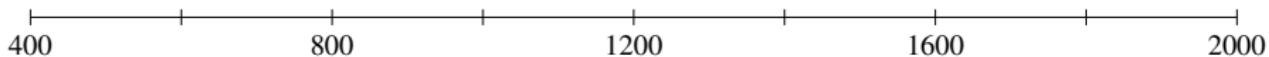
NEG V NEG

V NEG

(Emphatic)

(cf. Posner 1985; Schwegler 1988; Ladusaw 1993, *inter alia*)











Old English



Old English

Middle English

400

800

1200

1600

2000







Ic ne secge



Ic ne secge

I ne seye not

Old English

Middle English

E. Modern English

Modern English

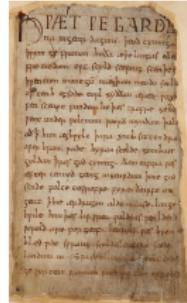
400

800

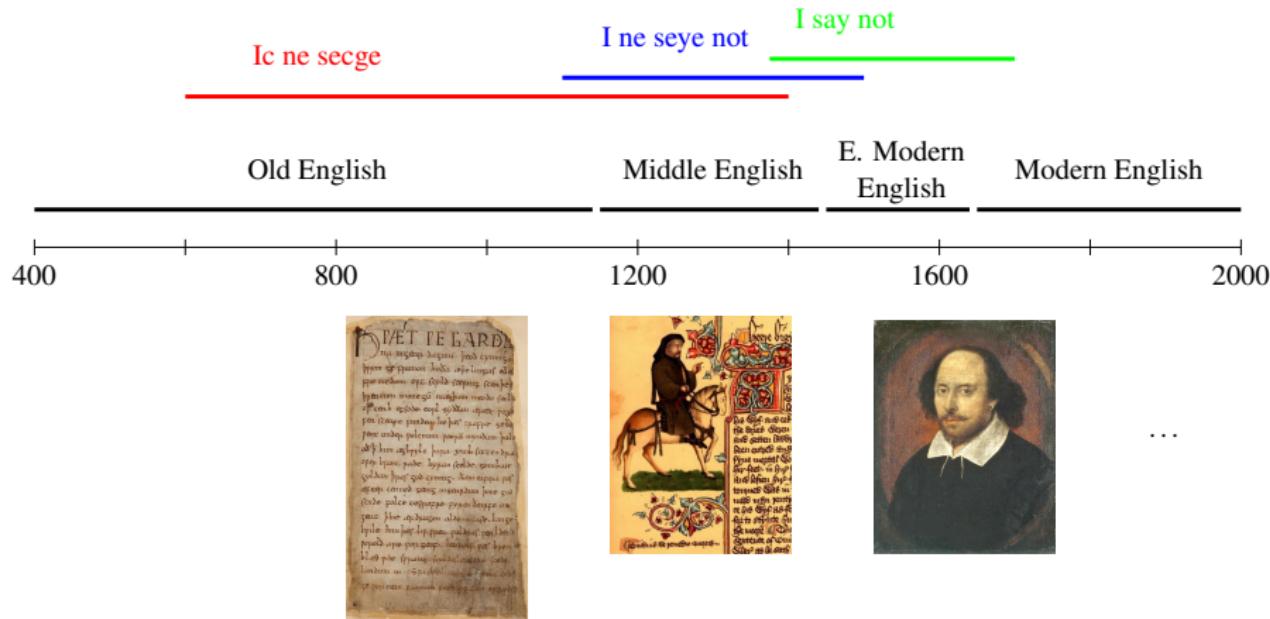
1200

1600

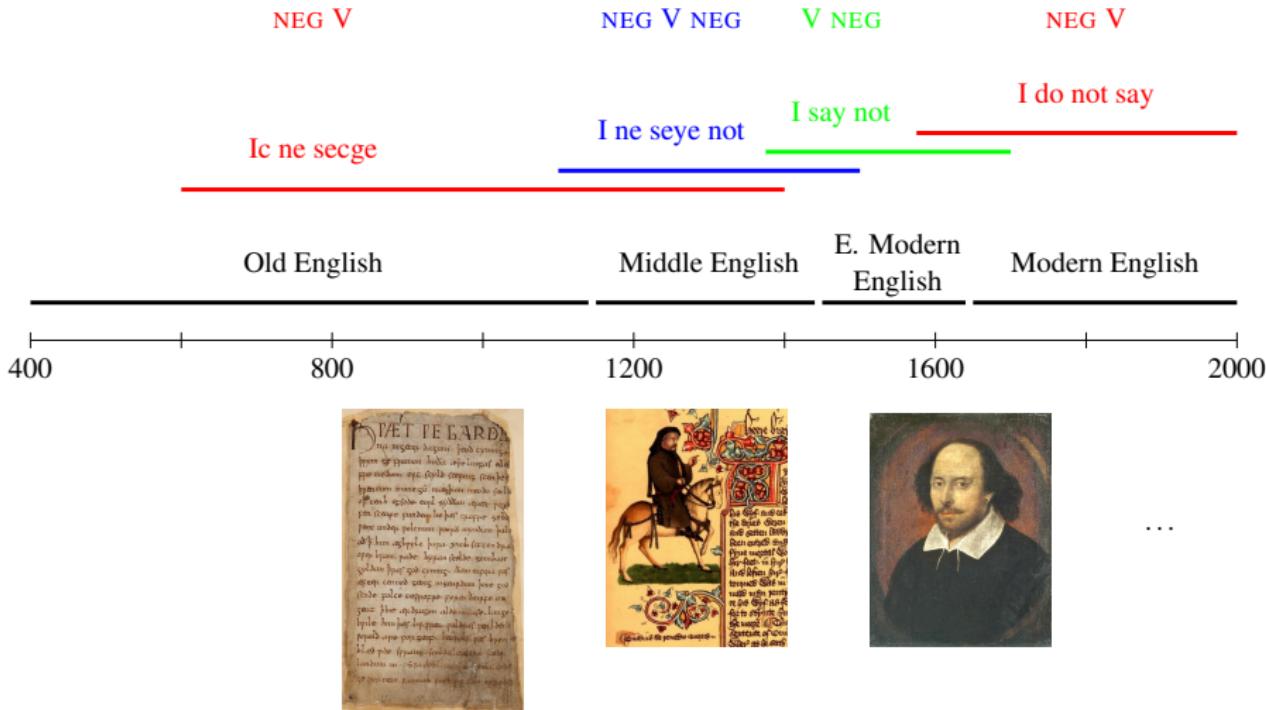
2000

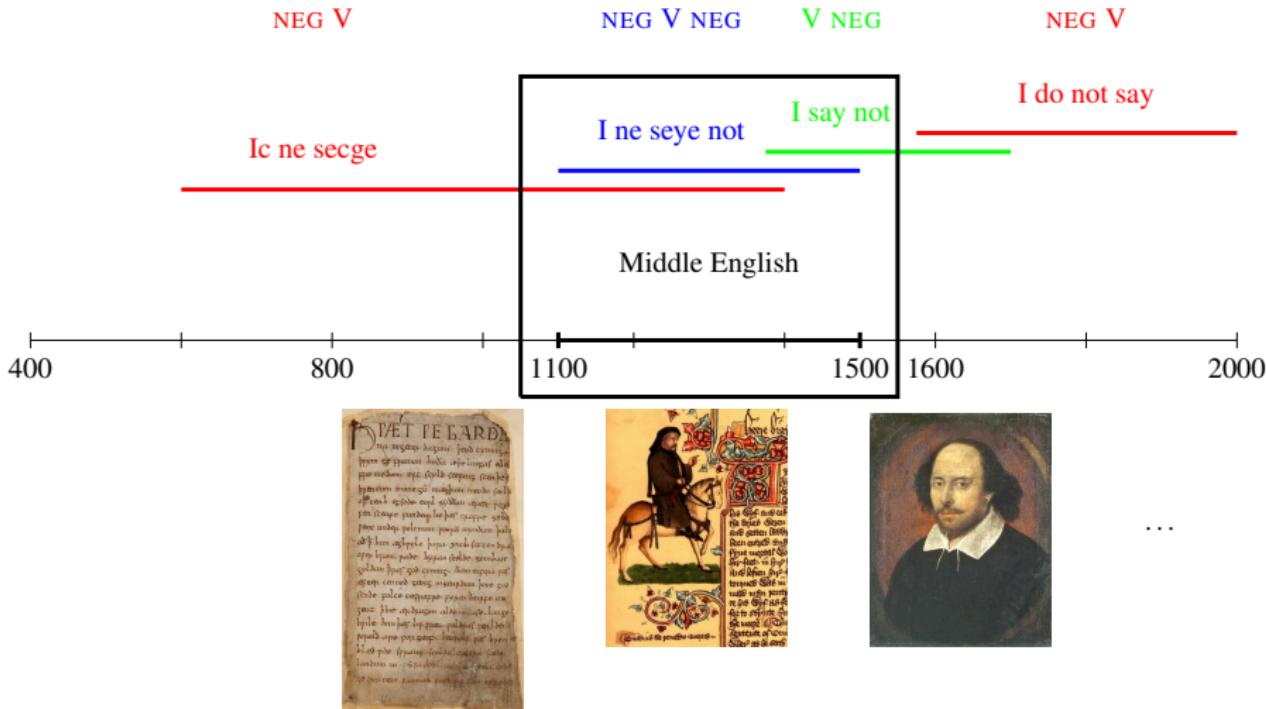


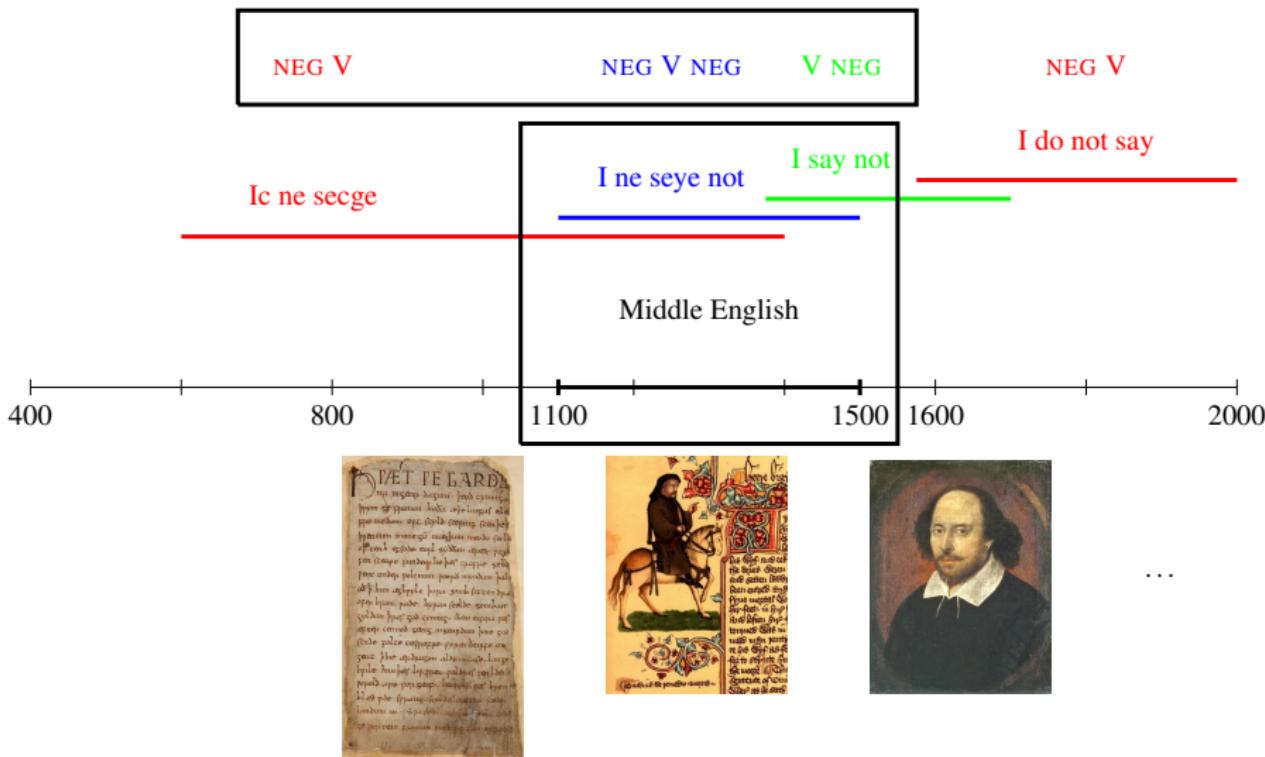
...











The formal cycle

NEG V

NEG V NEG

V NEG

NEG V

Ic ne secge

I ne seye not

I say not

I do not say

Middle English

400

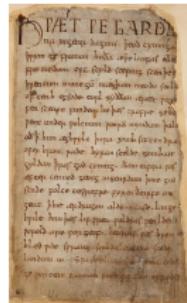
800

1100

1500

1600

2000



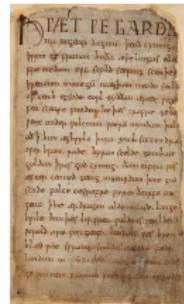
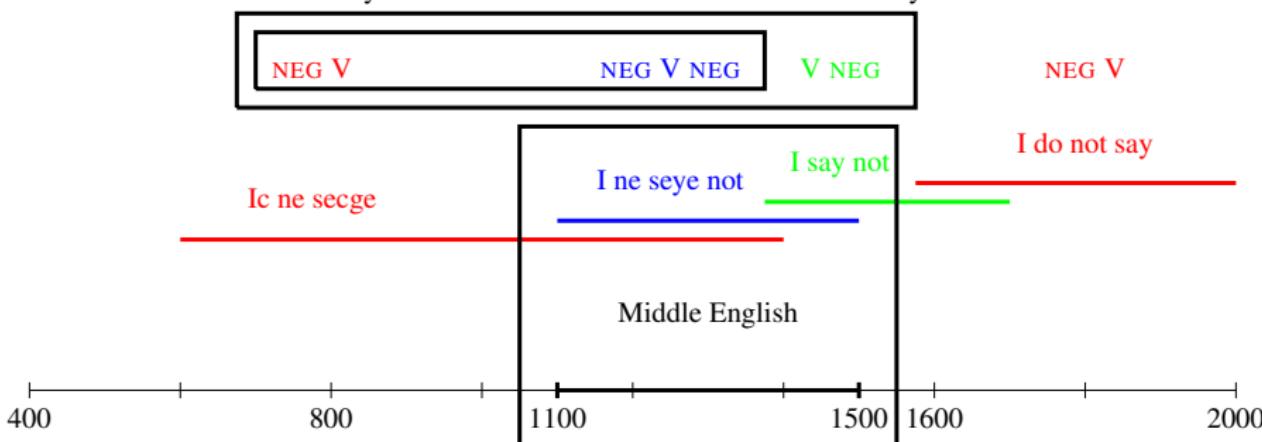
...

The formal cycle

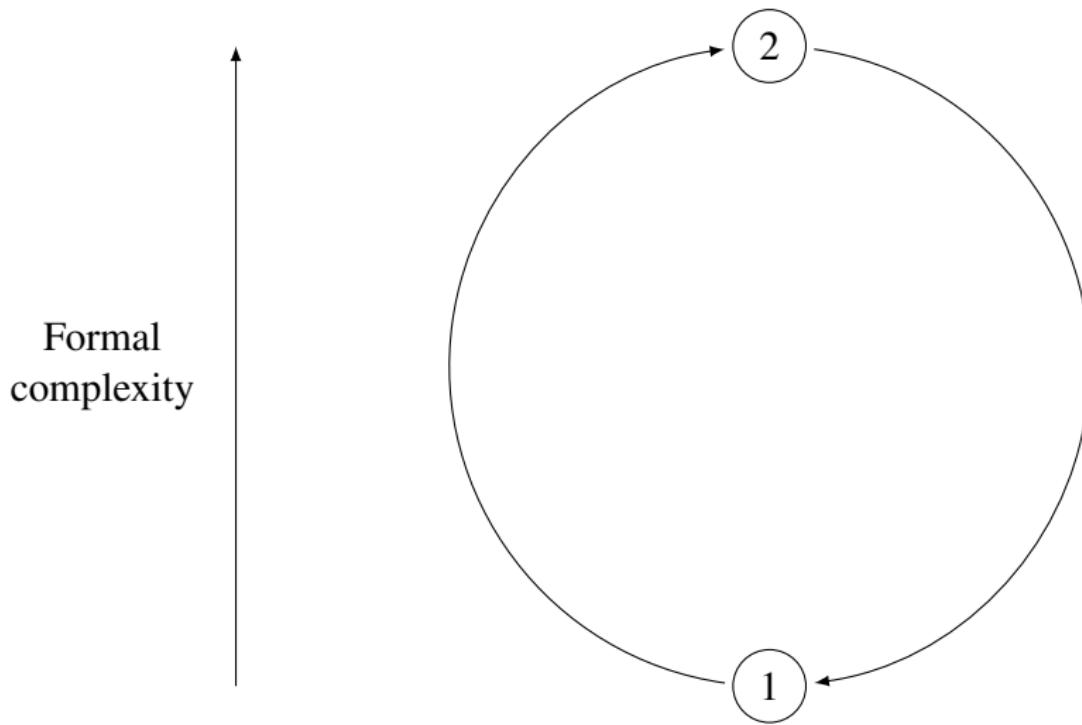


The functional cycle

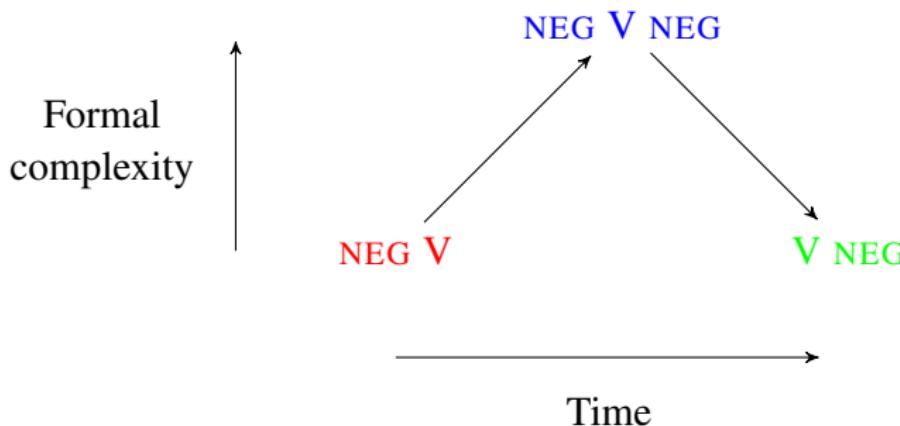
The formal cycle



The formal cycle



The formal cycle



The formal cycle

Doesn't require return to pre-verbal negation:

- (1) I do **not** say
- (2) I **don't** say

(EME: Ellegård, 1953)

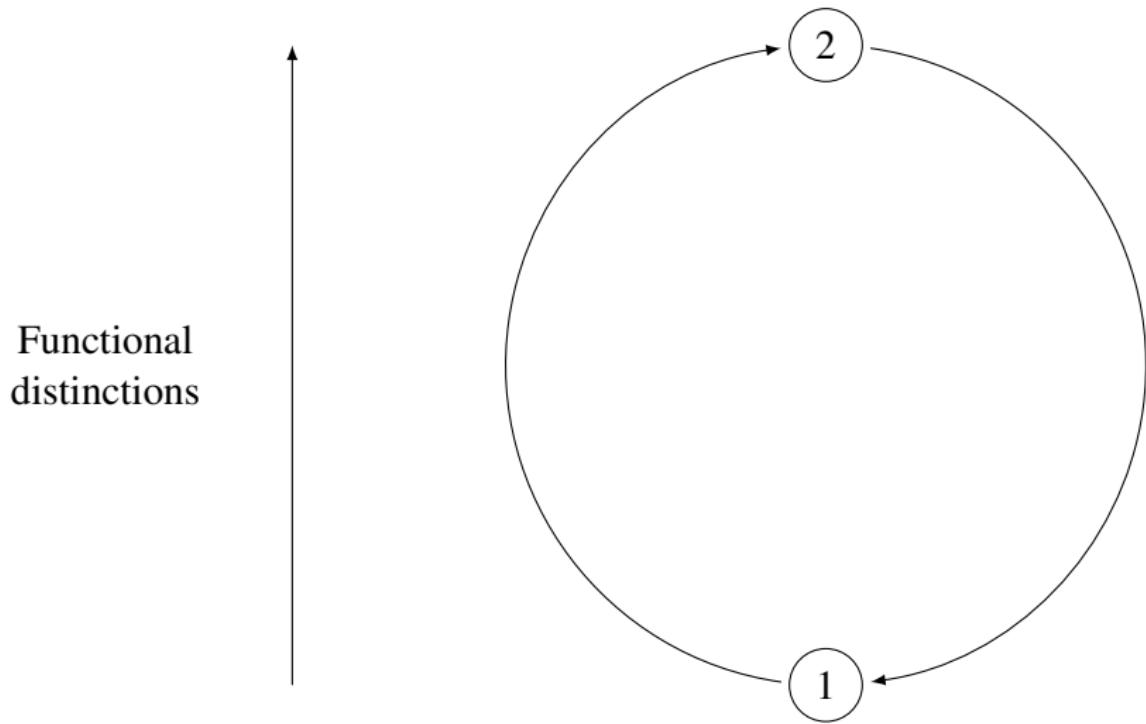
The formal cycle

Doesn't require post-verbal element for increased complexity:

- (3) You don't eem know.
- (4) You eem know.

(AAVE: Jones, 2015)

The functional cycle



The functional cycle



*But in most cases the addition serves to make the negative more impressive as being **more vivid or picturesque**, generally through an **exaggeration**, as when substantives meaning something very small are used as subjuncts.*

(Jespersen, 1917)

The functional cycle

Could have been called *Meillet's spiral* (van der Auwera, 2009):



*Thus, languages follow a sort of spiral development: they **add extra words to intensify expression**; these words fade; decay and fall to the level of simple grammatical tools; **one adds new or different words** on account of expressiveness; the fading begins again, and so on endlessly.*

(Meillet, 1912)

The functional cycle

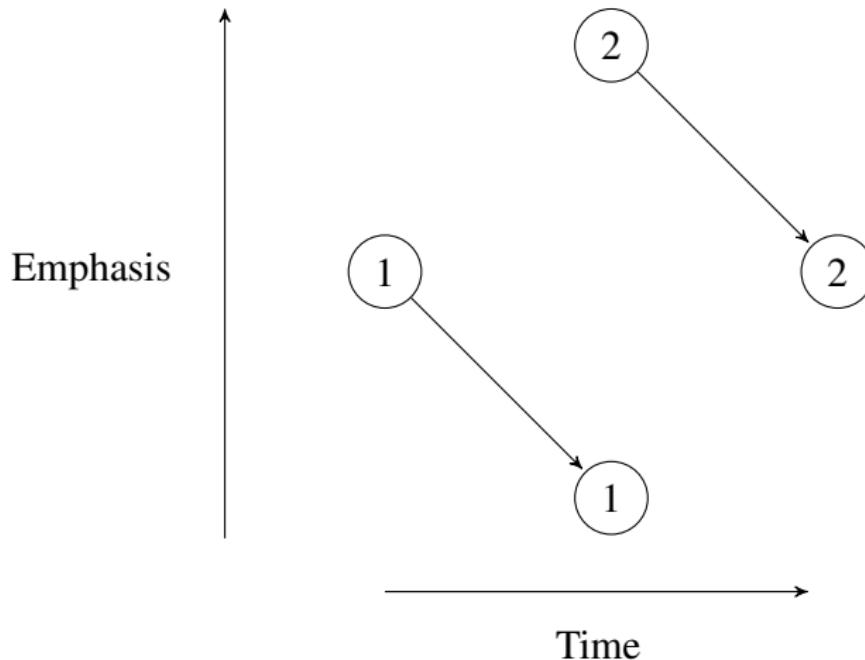
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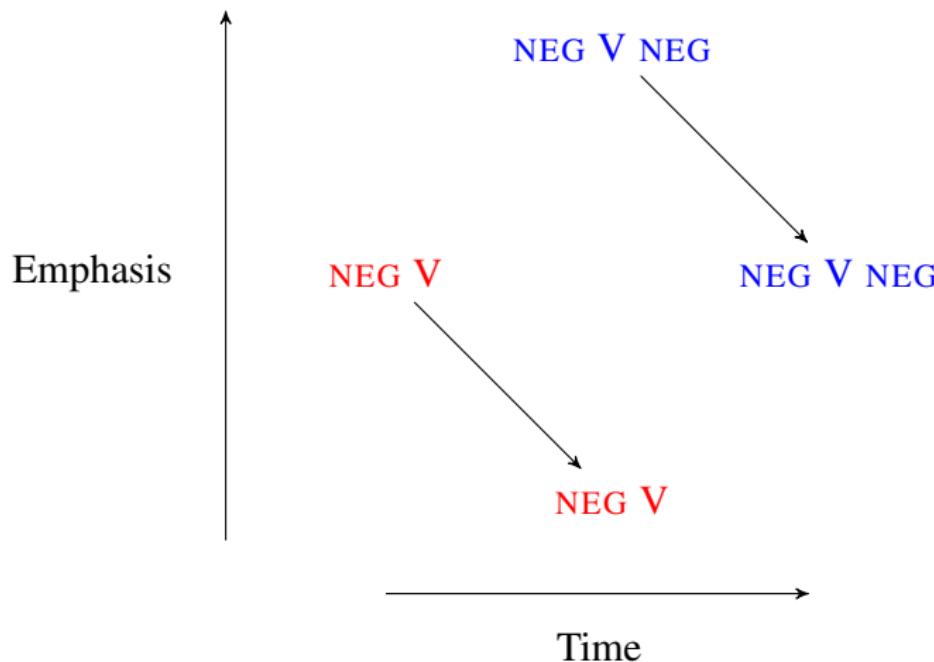
Thus, languages follow a sort of spiral development: they add extra words to intensify expression; these words fade; decay and fall to the level of simple grammatical tools; one adds new or different words on account of expressiveness; the fading begins again, and so on endlessly.

(Meillet, 1912)
or *Gardiner's gyre* (1905)

The functional cycle



The functional cycle



The functional cycle

Doesn't coincide with the formal cycle:

$$\text{NEG V} \subset \text{NEG V NEG} \not\subset \text{V NEG}$$

(Frege, 1884)

The functional cycle

Doesn't require a formal cycle:

PLAIN	EMPHATIC	SOURCE
οὐ...τι	οὐ-δε...εν	Ancient Greek
(οὐ)δεν...τι	δεν...τιποτε	Early Medieval Greek
δεν...τιποτε	δεν... πραμα	Greek Dialects
δεν... πραμα	δεν...απαντοξη	Modern Cretan

(Kiparsky and Condoravdi, 2006)

The functional cycle

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NEG V

NEG V NEG

V NEG

NEG V

NEG V NEG

V NEG

The formal cycle

NEG V

NEG V NEG

V NEG

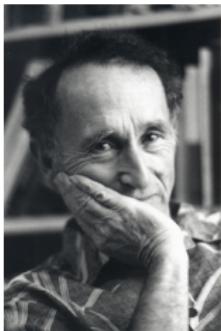
A pull chain between elements



*The incongruity between the notional importance and the formal insignificance of the negative (often, perhaps, even **the fear of the hearer failing to perceive it**) may then cause the speaker to add something to make the sense perfectly clear to the hearer.*

(Jespersen, 1917)

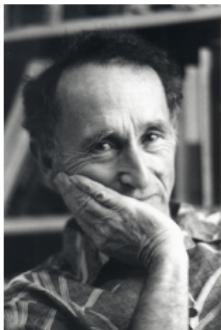
A pull chain between elements



*A very common utterance among residents of this Northern New Jersey area was “**Did you say C-A-N or C-A-N-T?**,” since the vowel is tense in both words and the /t/ is often neutralized before a following apical obstruent (as in “I can’t tell you”).*

(Labov, 2010)

A pull chain between elements

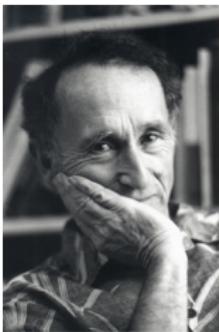


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I can't tell!

A pull chain between elements

Speakers **don't** necessarily correct for ambiguity:



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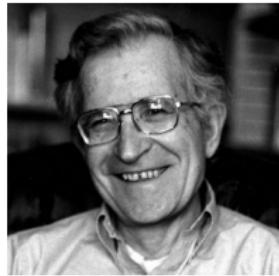
(Labov, 2010)
I can't tell!

A push chain between elements

*[T]he reanalyzed construction structurally contains two items which are equally labeled NEG. As a reaction, the ellipsis of ne is generalized to all sorts of contexts as well. By way of this process, a "simple" function such as unmarked negation comes to be represented by a morphosyntactically "simple" form. The direction of this change is determined by the principle of **constructional iconicity***

(Detges and Waltereit 2002, cf. Frisch 1997)

A push chain between elements



Colorless green ideas sleep furiously

(Chomsky, 1957)

A push chain between elements

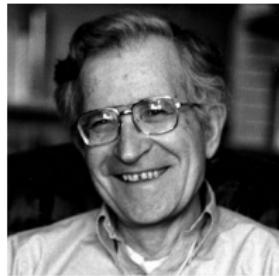


*As ideias verdes incolores dormem
furiosamente*

(Chomsky, 1957)

A push chain between elements

Speakers **don't** necessarily eliminate redundancy:



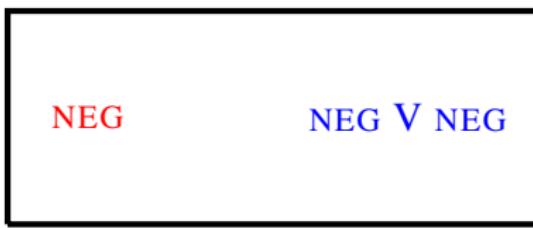
*As ideias verdes incolores dormem
furiosamente*

(Chomsky, 1957)

NEG

NEG V NEG

NEG



The functional cycle



A push chain between forms

Emphatic negation tends to increase in frequency due to pragmatically motivated overuse which is characteristic of inherently bounded evaluative scales. This rise in frequency at the expense of plain negation has an inflationary effect, well attested also in politeness systems, hypocoristics, pejoratives, and scalar adjectives of all kinds

(Kiparsky and Condoravdi, 2006, cf. Dahl, 2001)

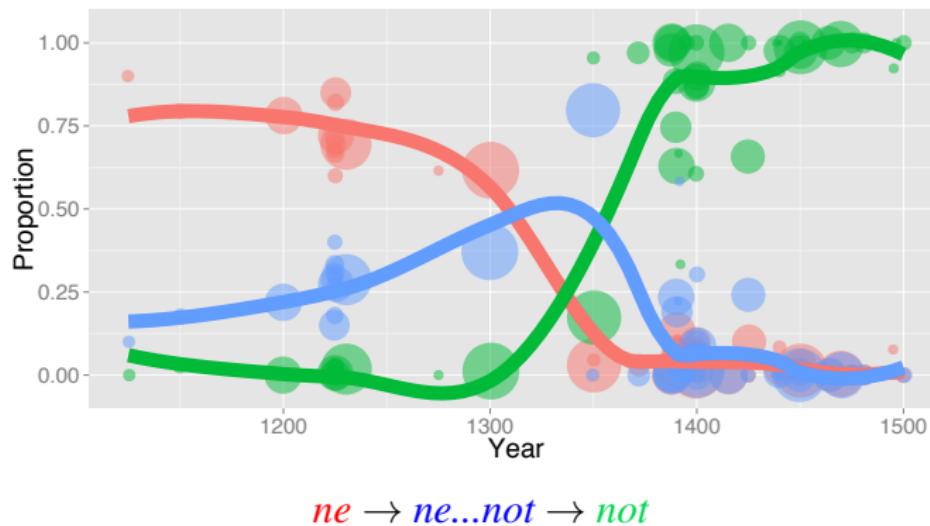
A push chain between forms

Depends on what we mean by **emphatic**:

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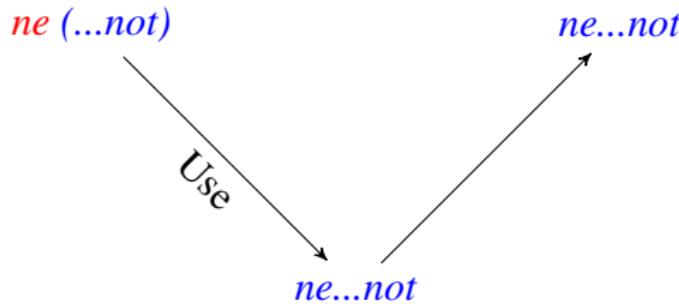
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The facts to be explained

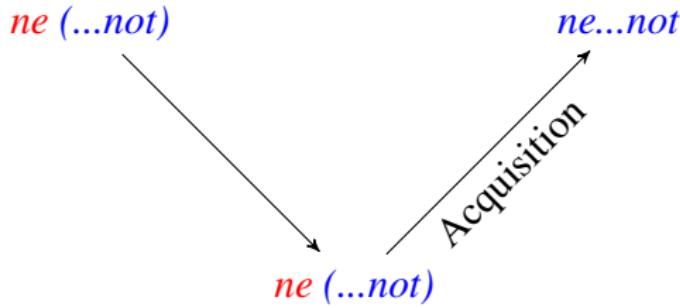


Data from PPCME (Kroch and Taylor, 2000)

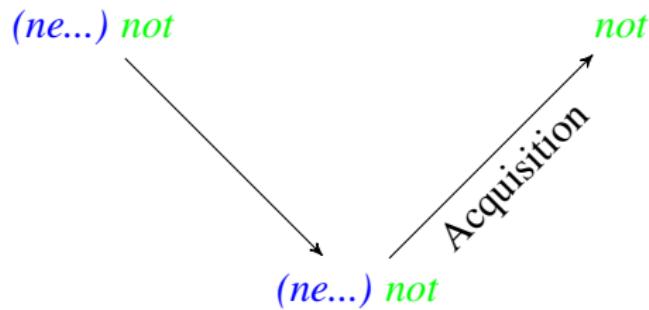
The role of use in the functional cycle



The role of acquisition in the formal cycle



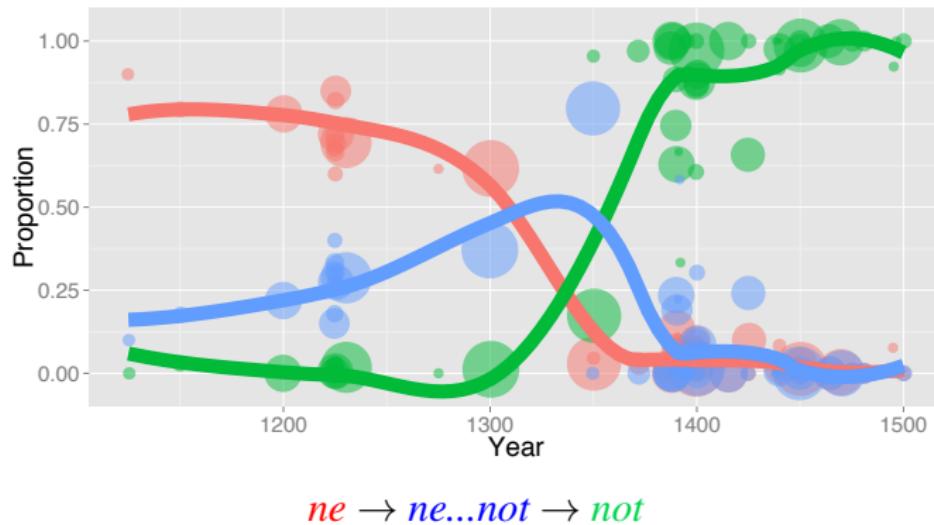
The role of acquisition in the formal cycle



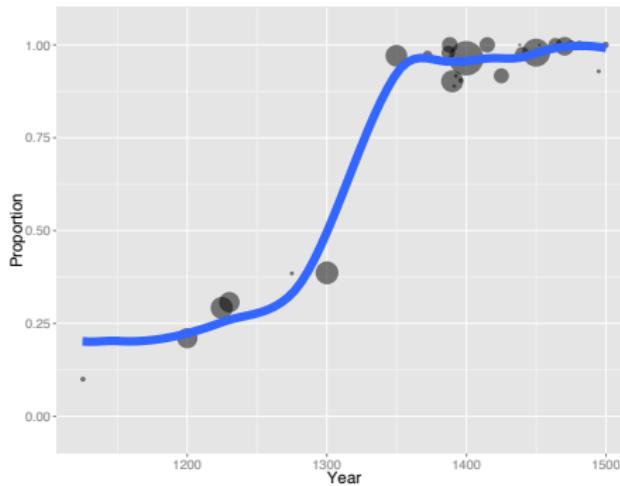
Main contributions

- Distinction between formal and functional Jespersen cycles
- Model of the dynamics of use in the functional cycle
- Model of the dynamics of acquisition in the formal cycle
- Application of statistical method for detecting random drift

The functional cycle



The functional cycle



ne → (*ne...*) *not*

Emphasis as activation

- (5) If u ne cnawest e seolf ... If u *ne* cnawest *naut* e seolf
If you not know the self ... If you NEG know not the self
"If you do not know yourself...If you do not know yourself"

(CMANCRIW, II.80.941-948, 1230 CE)

Emphasis as activation

(6) and te lage hadde to alle te mihtes te haueð nu fulluht for
and the law had then all the virtues that has now baptism for
ðat clensede te man of sinne: swa doð nu fulluht ac it *ne*
that cleansed the man of sin: as does now baptism but it neg
openede hem *noht* te blisse of heuene also fulcneng doð us.
opened them not the bliss of heaven as baptism does us.
**"And that rite had then all the virtues which baptism now has, for
that cleansed man of sin even as baptism now does, but it opened not
to them the bliss of heaven as baptism does to us."**

(CMTRINIT, 87.1165, 1225 CE)

Emphasis as activation



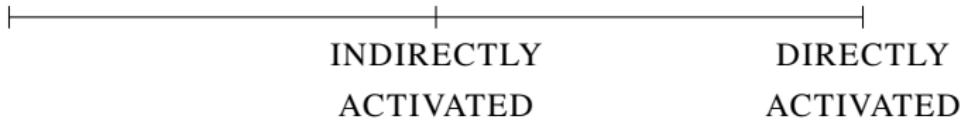
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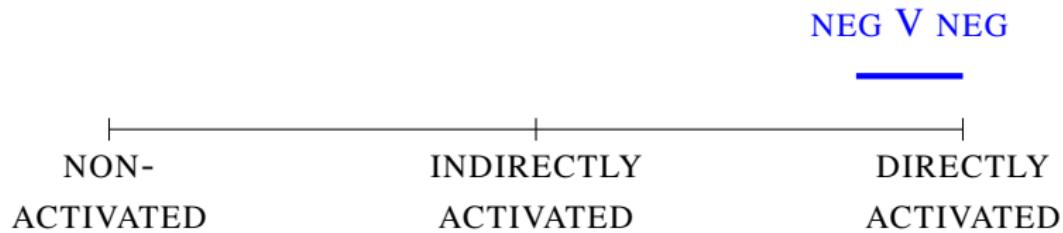
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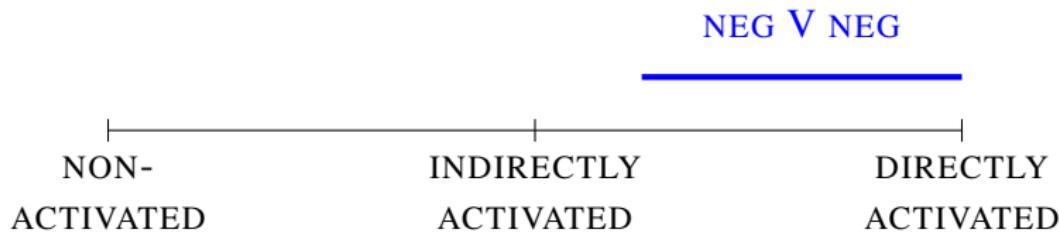
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Emphasis as activation



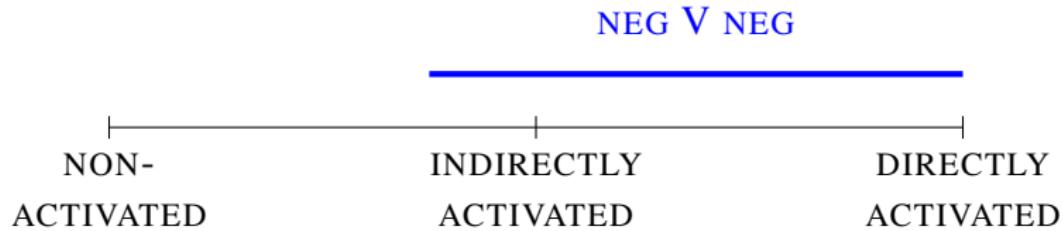
(Hansen and Visconti, 2009; Hansen and Visconti, 2012; Wallage, 2013)

Emphasis as activation



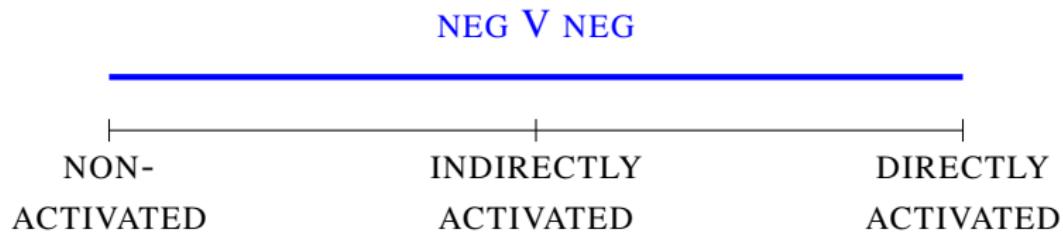
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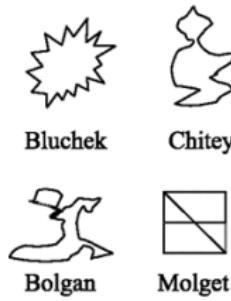
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Experimental evidence on activation



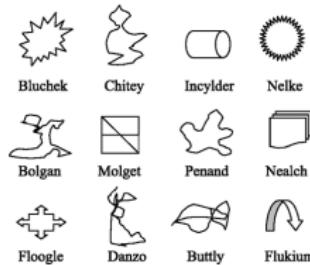
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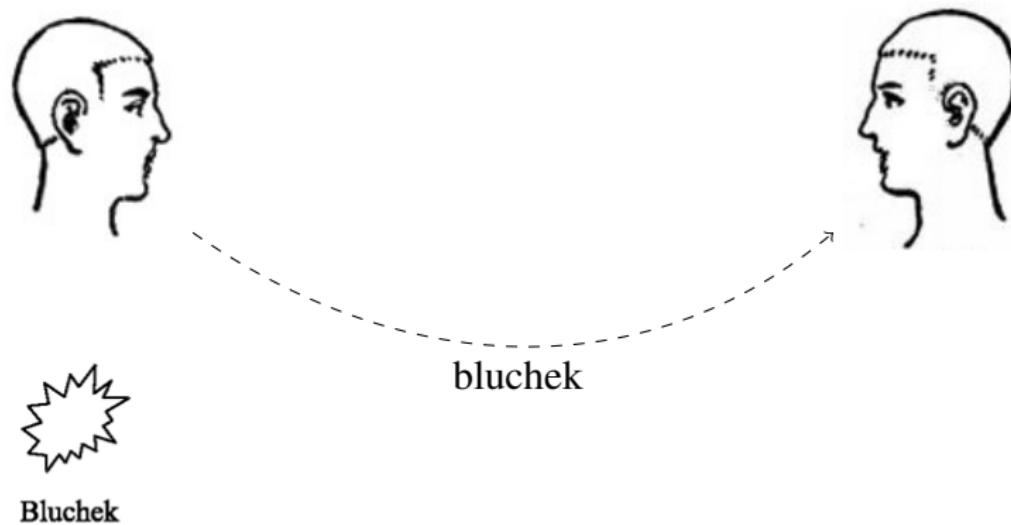
Experimental evidence on activation



Bluchek

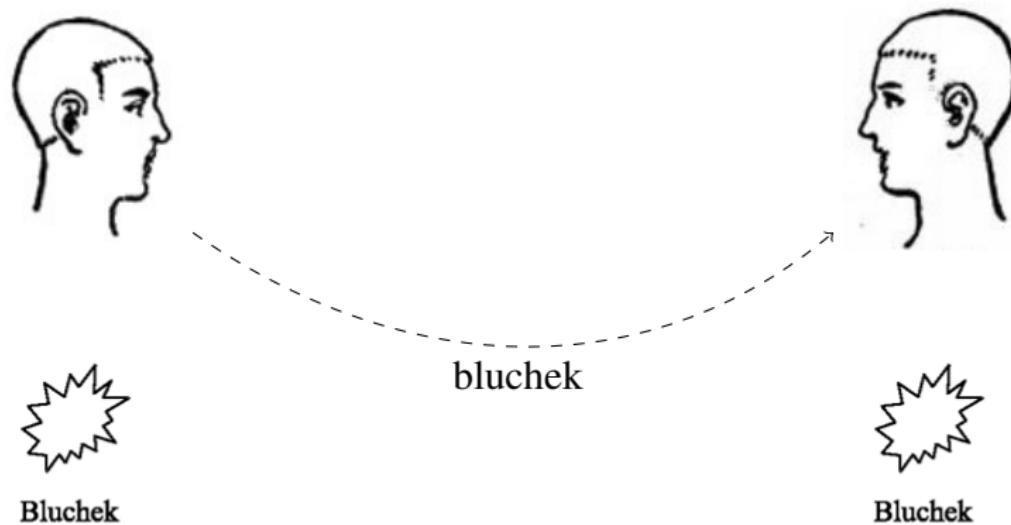
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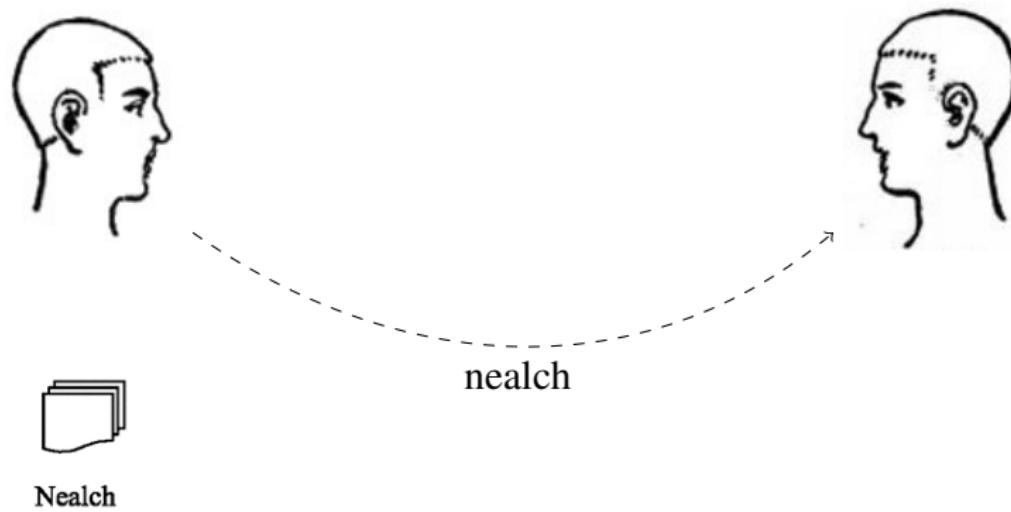
Experimental evidence on activation



Nealch

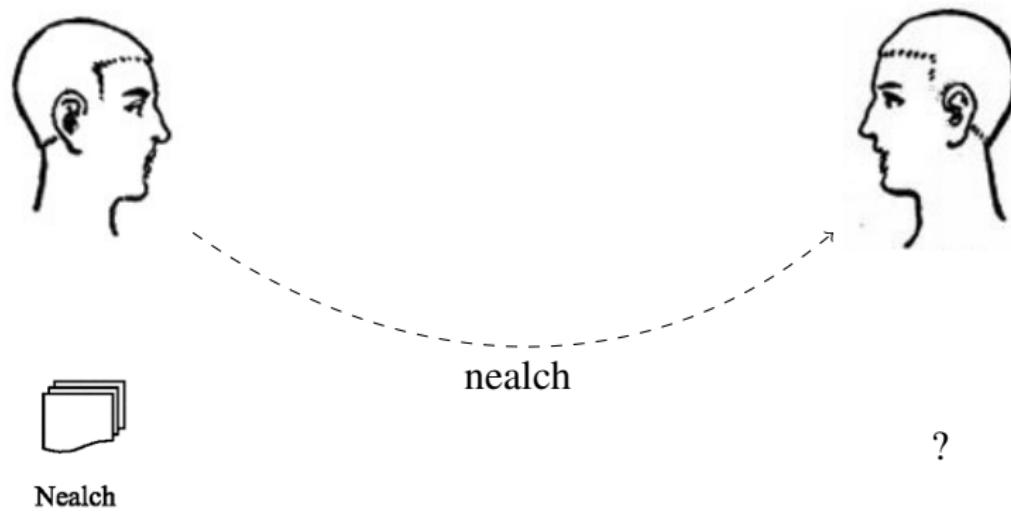
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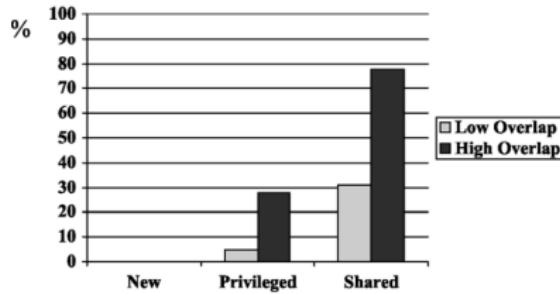
(Wu and Keysar, 2007)

Experimental evidence on activation



(Wu and Keysar, 2007)

Experimental evidence on activation



Panel b. Use of name of a figure before any description.

(Wu and Keysar, 2007)

The activation signaling game



The activation signaling game

$$t \in T$$



The activation signaling game

$$t \in T$$



$$s : \mathcal{P}(T) \rightarrow M$$

The activation signaling game

$$t \in T$$



$$s : \mathcal{P}(T) \rightarrow M$$

$$\{ m_1, m_2 \}$$

The activation signaling game

$$t \in T$$

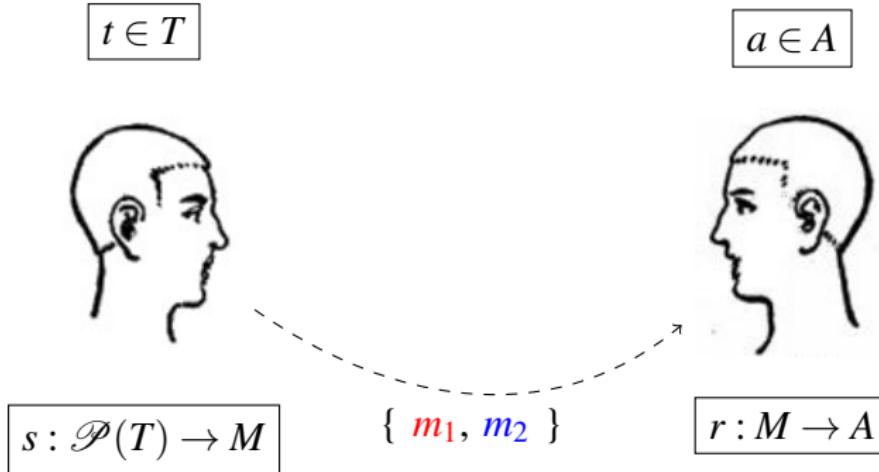


$$s : \mathcal{P}(T) \rightarrow M$$

$$\{ m_1, m_2 \}$$

$$r : M \rightarrow A$$

The activation signaling game



The activation signaling game

Bias parameter, b , encodes tendency to overestimate activation:

$$U_S(t, a) = 1 - (a - t - (1-t)b)^2 \quad (1)$$

$$U_R(t, a) = 1 - (a - t)^2 \quad (2)$$

(Crawford and Sobel, 1982)

The equilibria of the signaling game

Evolutionarily stable strategies are jointly strict maxima of expected utilities:

$$E[U_S(s, r)] = \int_T [1 - (r(s(t)) - t - (1-t)b)^2] p(t) dt \quad (3)$$

$$E[U_R(s, r)] = \int_T [1 - (r(s(t)) - t)^2] p(t) dt \quad (4)$$

(Selten, 1980)

The equilibria of the signaling game

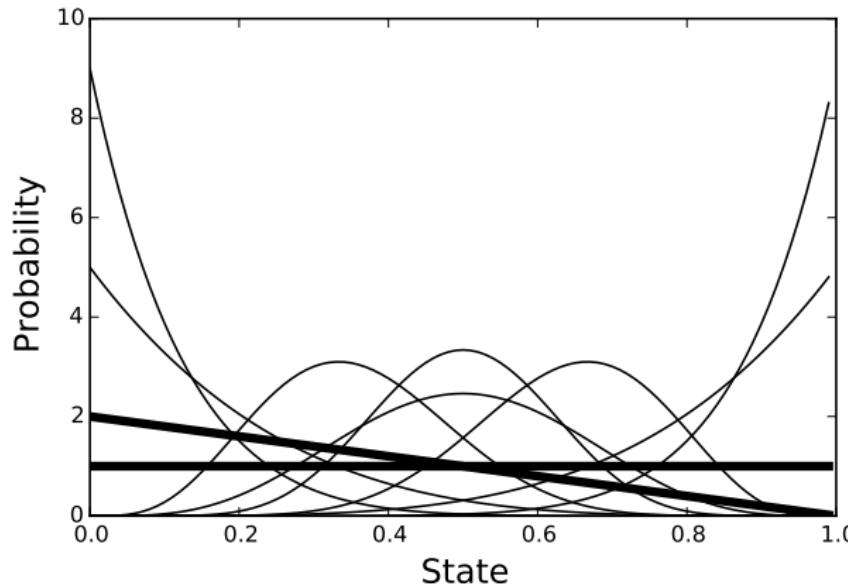
Prior probability distribution estimated from PPCME (Kroch and Taylor, 2000) by Wallage (2013):

PERIOD	NON-ACTIVATED	INDIRECTLY ACTIVATED	DIRECTLY ACTIVATED
1150-1250	393	203	52
1250-1350	346	296	42
1350-1420	294	179	60
TOTAL	1033	678	154

(cf. Tottie, 1991; Thompson, 1998)

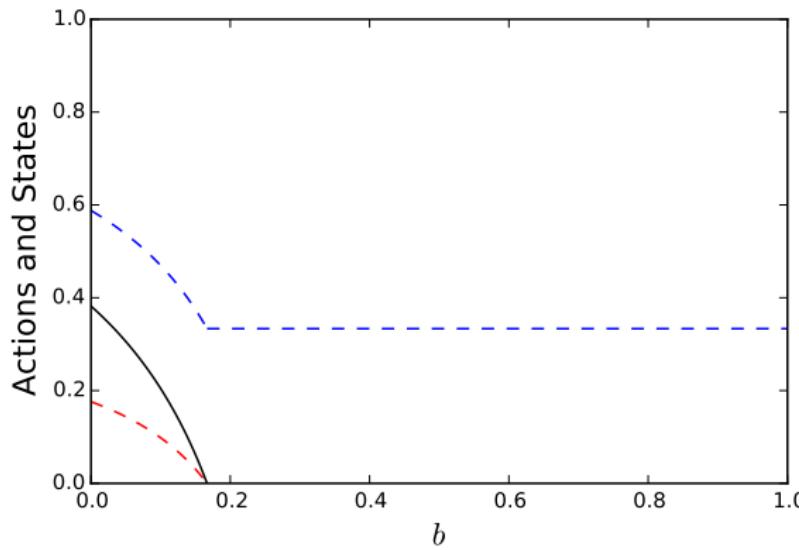
The equilibria of the signaling game

Prior probability distribution as a beta distribution $\mathcal{B}(1, 2)$:



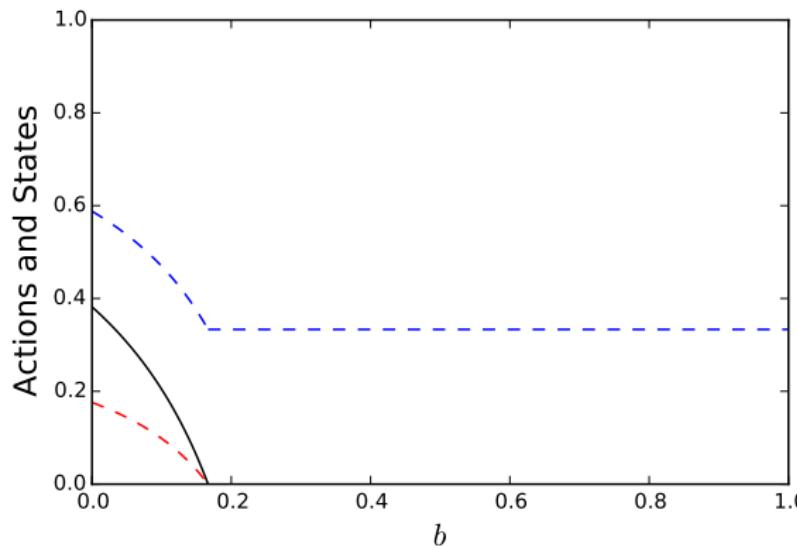
The equilibria of the signaling game

Evolutionarily stable speaker and hearer strategies as a function of the amount of speaker bias:



The equilibria of the signaling game

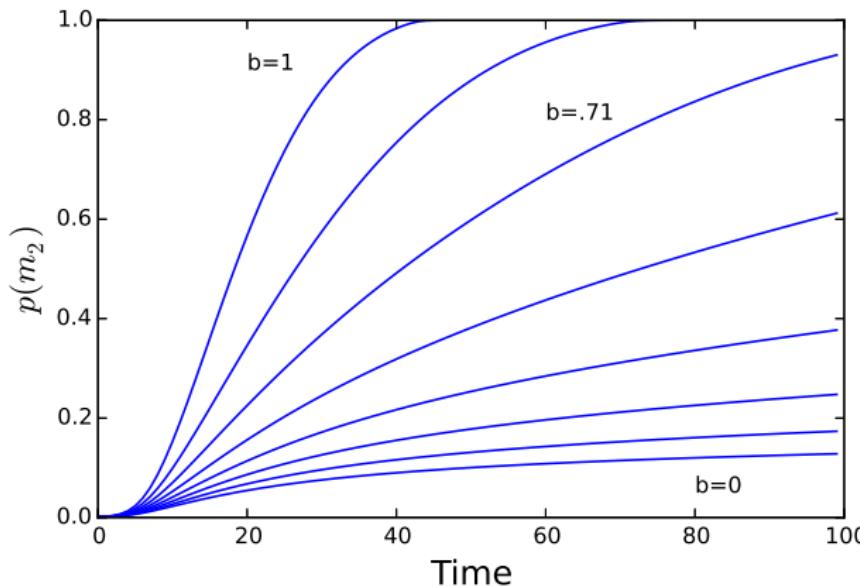
Evolutionarily stable speaker and hearer strategies as a function of the amount of speaker bias:



No equilibria are *neologism proof* (Farrell, 1993)

The dynamics of signaling activation

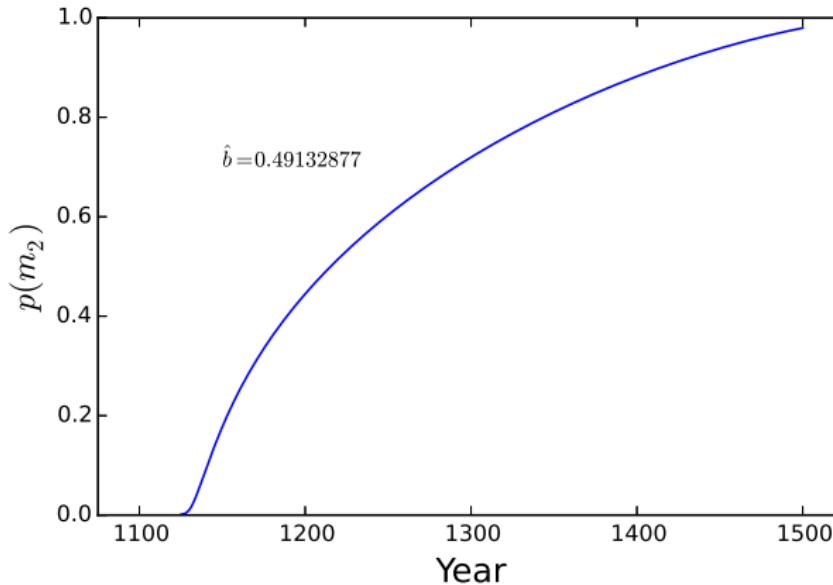
Simulations of population from same starting state with different degrees of sender bias:



(*Replicator dynamics*: Taylor and Jonker, 1978; Börgers and Sarin, 1997)

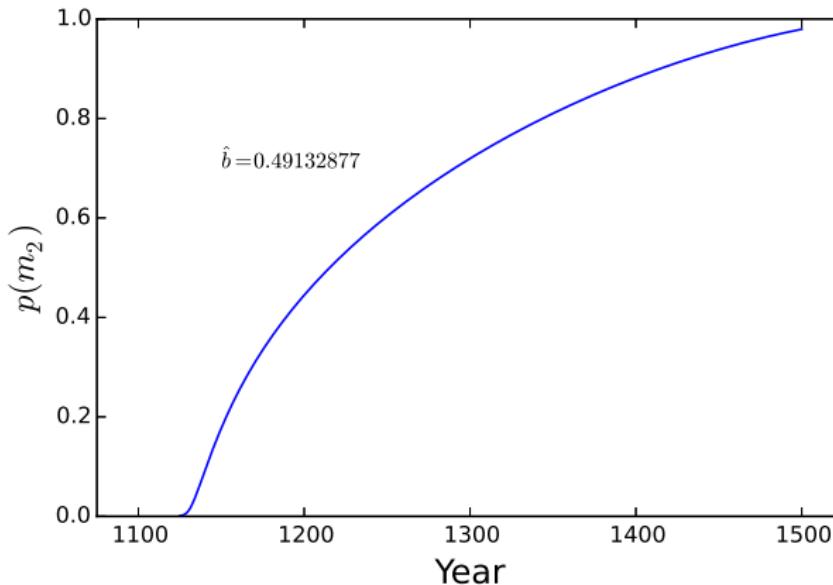
Modeling the dynamics of signaling activation

Model fit to corpus data:



Modeling the dynamics of signaling activation

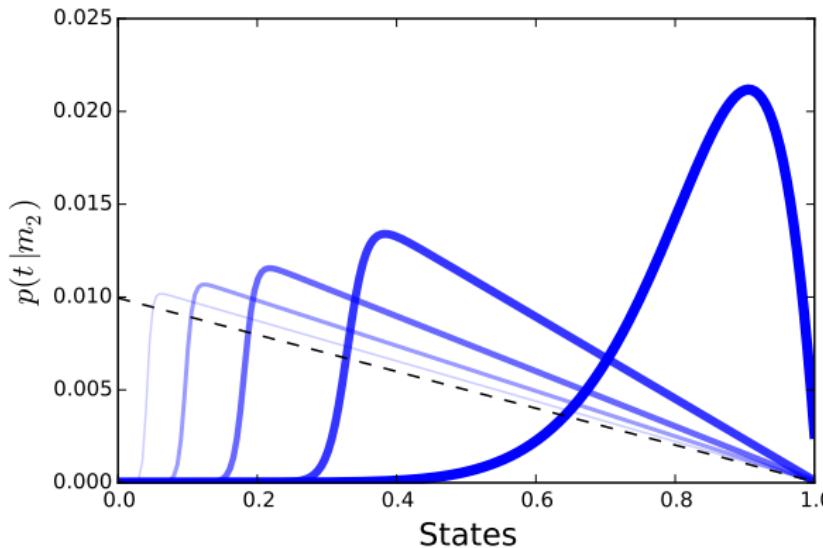
Model fit to corpus data:



$E[b] \in (.1398, .3549)$ estimated from Wu and Keysar (2007)

Modeling the dynamics of signaling activation

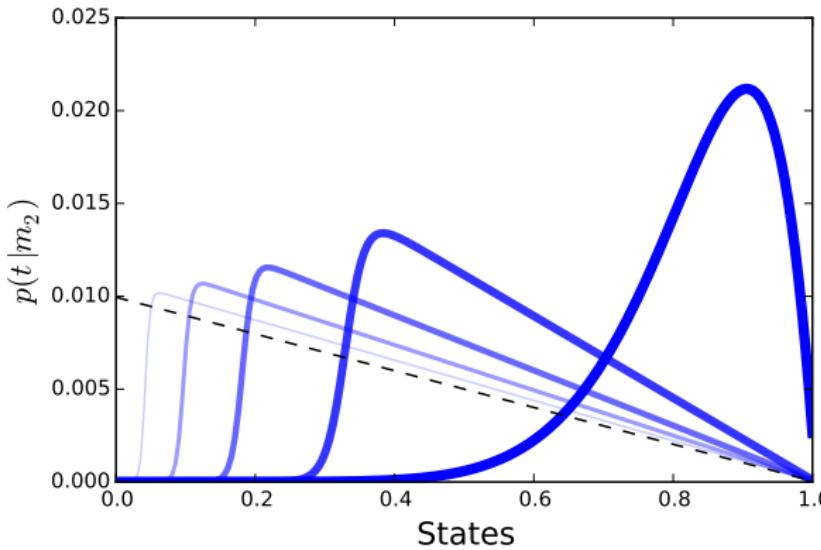
Information-theoretic bleaching of m_2 :



(cf. Kullback and Leibler, 1951)

Modeling the dynamics of signaling activation

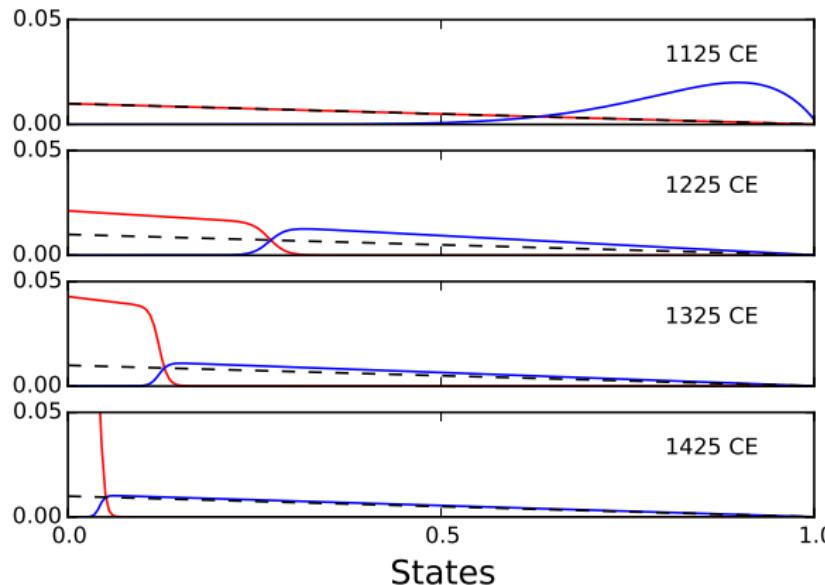
Information-theoretic bleaching of m_2 :



To emphasize everything is to emphasize nothing (Kiparsky and Condoravdi, 2006)

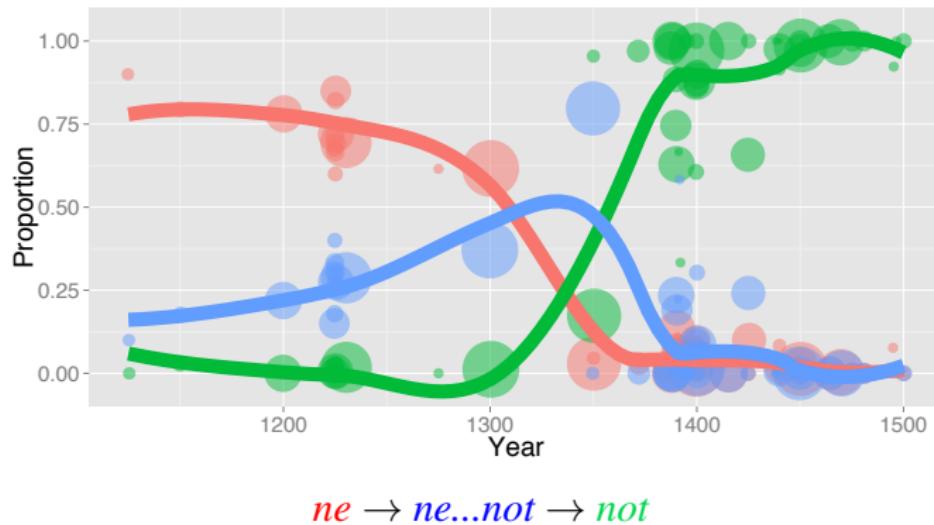
Modeling the dynamics of signaling activation

The functional cycle as a push chain:

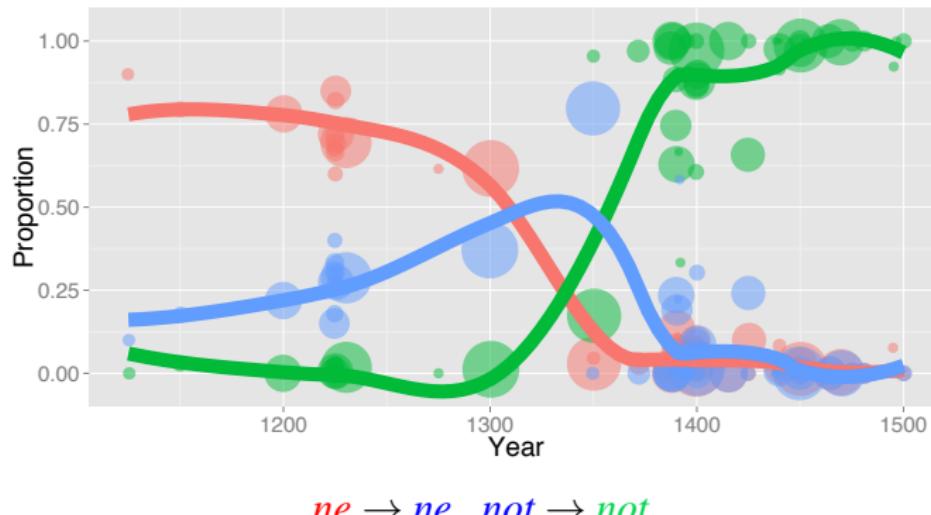


(cf. Wallage, 2013)

The functional cycle



The formal cycle



A model of acquisition

Given input from environment L , learner chooses grammar G_i with probability p_i :

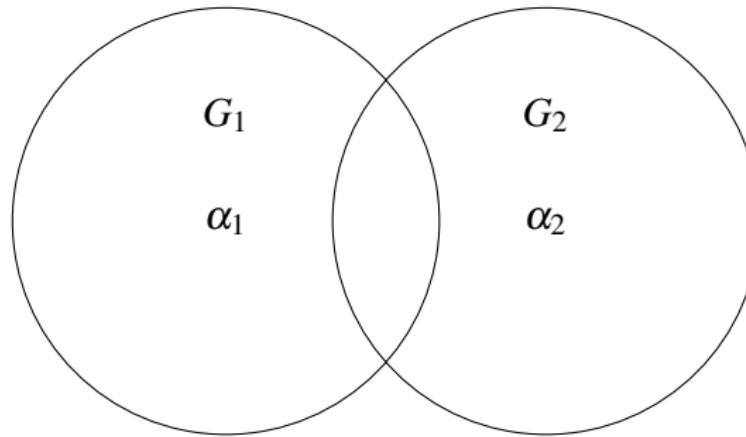
$$\text{If } G_i \rightarrow s \text{ then } \begin{cases} p'_i = p_i + \gamma(1 - p_i) \\ p'_j = (1 - \gamma)p_j \quad \forall j \neq i \end{cases} \quad (5)$$

$$\text{If } G_i \not\rightarrow s \text{ then } \begin{cases} p'_i = (1 - \gamma)p_i \\ p'_j = \frac{\gamma}{N-1} + (1 - \gamma)p_j \quad \forall j \neq i \end{cases} \quad (6)$$

(Yang, 2000)

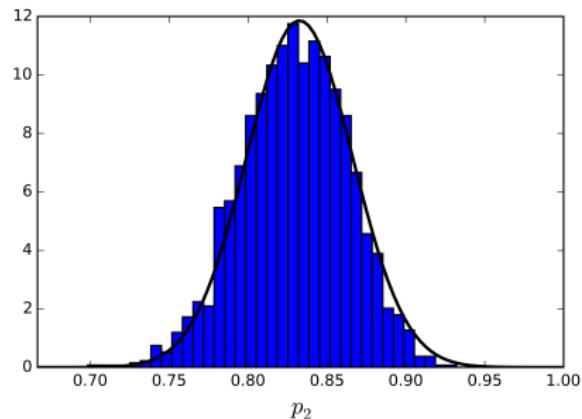
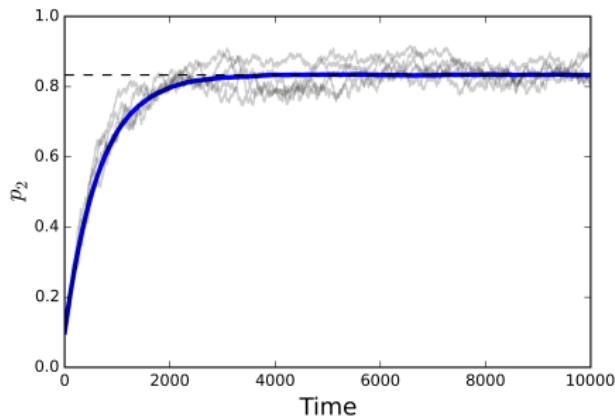
A model of acquisition

Linguistic environment L is distribution over grammars:



(Yang, 2000)

A model of acquisition



(Narendra and Thathachar, 1989)

The dynamics of acquisition

Mean dynamics of acquisition:

$$\dot{p}_2 = p_2(1-p_2) \frac{\alpha_2 - \alpha_1}{p_1\alpha_1 + p_2\alpha_2} \quad (7)$$

The dynamics of acquisition

Mean dynamics of acquisition:

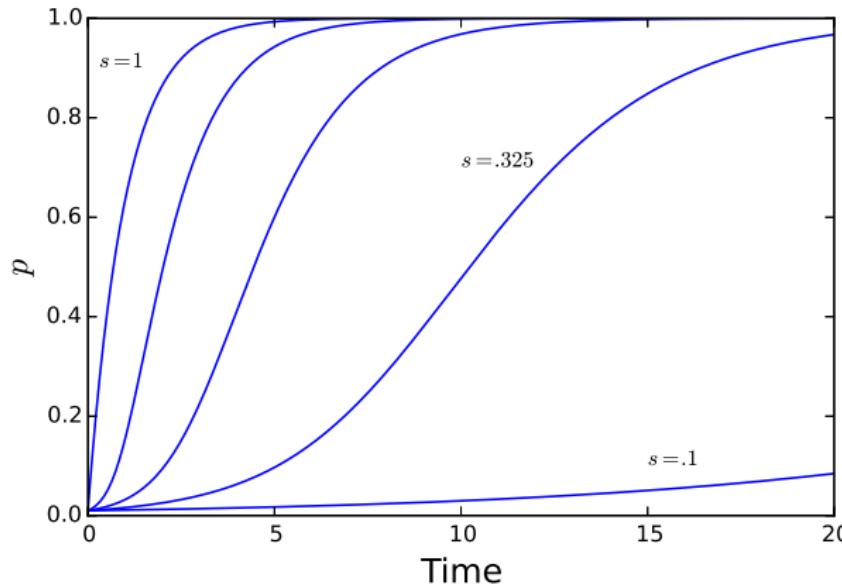
$$\dot{p} = p(1-p) \frac{s}{1-s(1-p)} \quad (7)$$

$$s = \frac{\alpha_2 - \alpha_1}{\alpha_2} \quad (8)$$

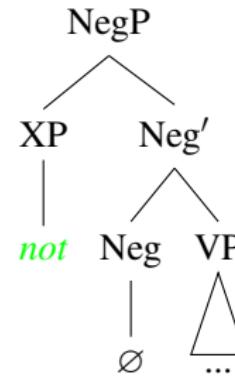
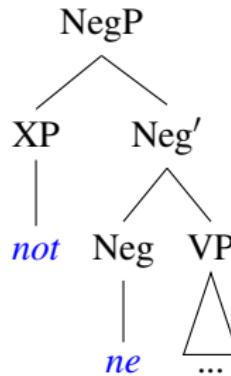
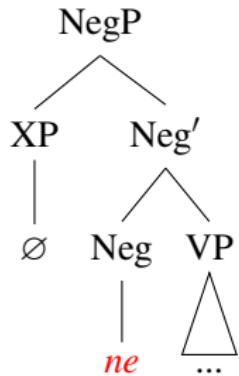
(cf. Ingason, Legate, and Yang, 2013)

The dynamics of acquisition

Simulations of population from same starting state with varying selection coefficient:

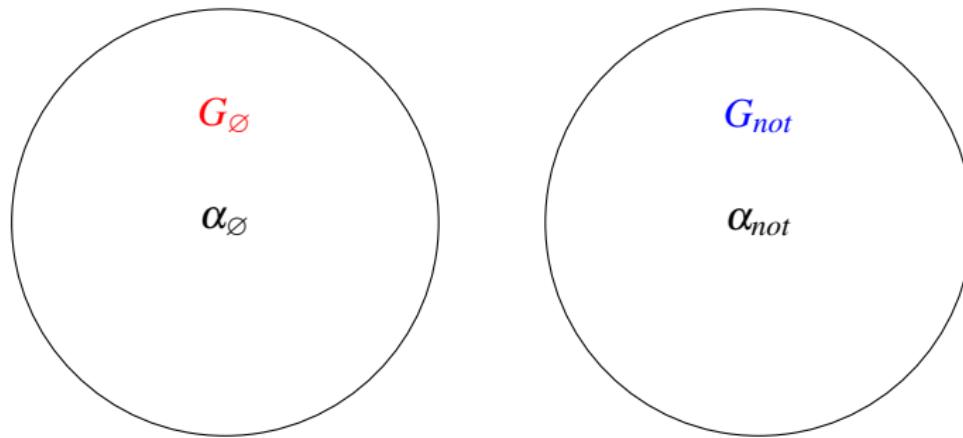


The syntax of the formal cycle

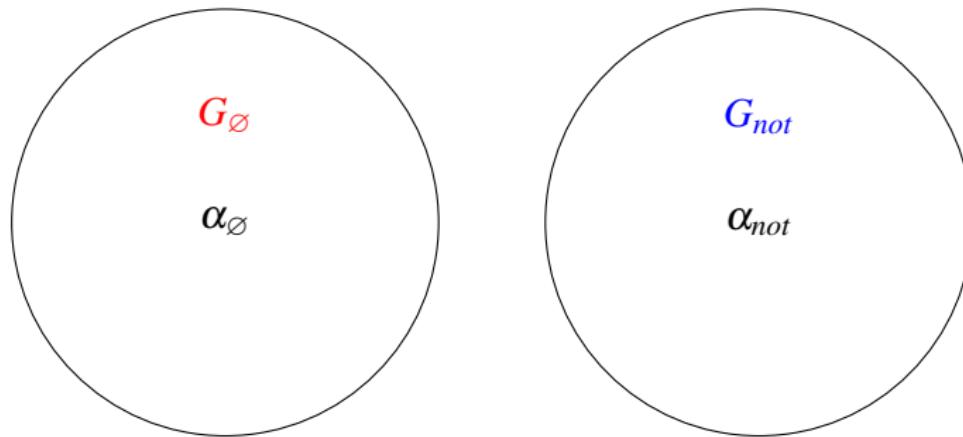


(Frisch, 1997)

The syntax of the formal cycle



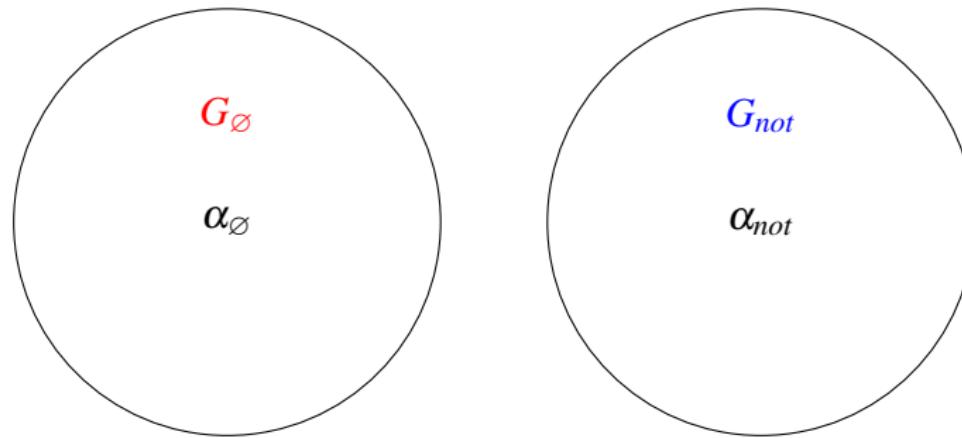
The syntax of the formal cycle



$$s = \frac{\alpha_{not} - \alpha_\emptyset}{\alpha_{not}} = 0$$

The syntax of the formal cycle

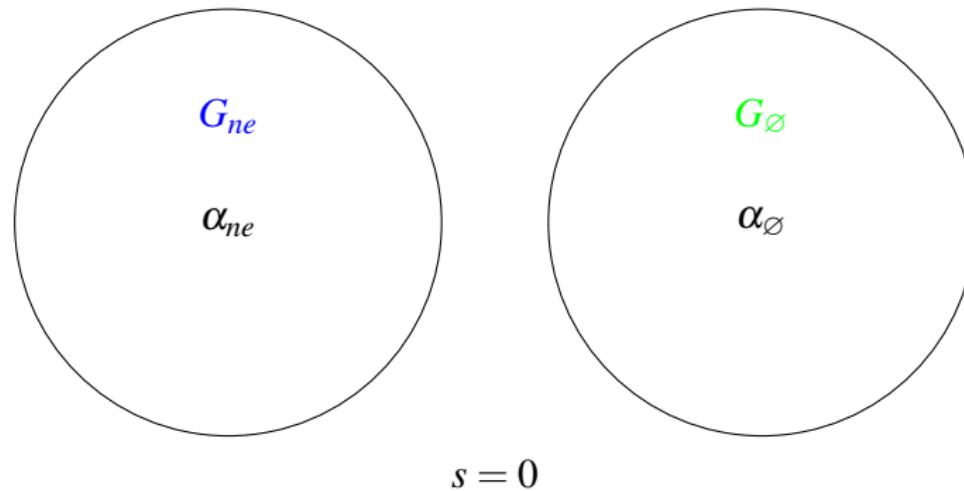
Acquisition dynamics **do not** predict transition from *ne* to *ne...not*:



$$s = \frac{\alpha_{not} - \alpha_\emptyset}{\alpha_{not}} = 0$$

The syntax of the formal cycle

Acquisition dynamics **do not** predict transition from *ne...not* to *not*:



The role of random drift



*It may be urged that change in language is due ultimately to the deviations of individuals from the rigid system. But it appears that even here individual variations are ineffective; **whole groups** of speakers must, for some reason unknown to us, **coincide in a deviation**, if it is to result in a linguistic change*

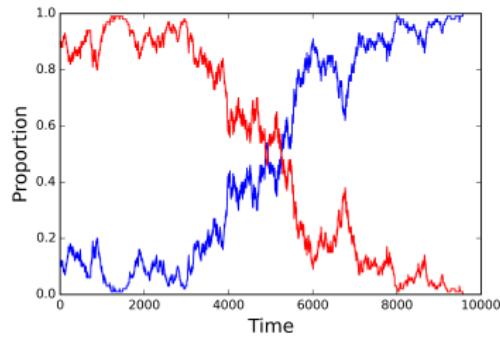
(Bloomfield, 1927)

The role of random drift

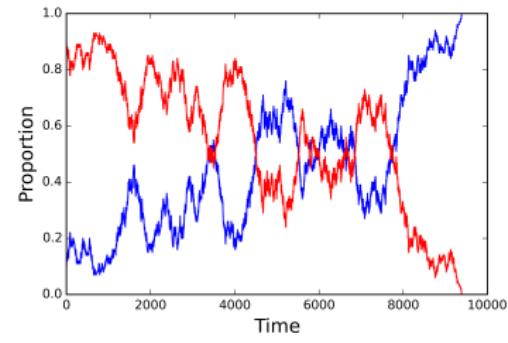


The role of random drift

Moran process:



?

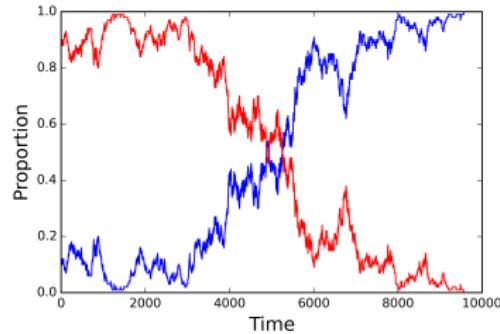


?

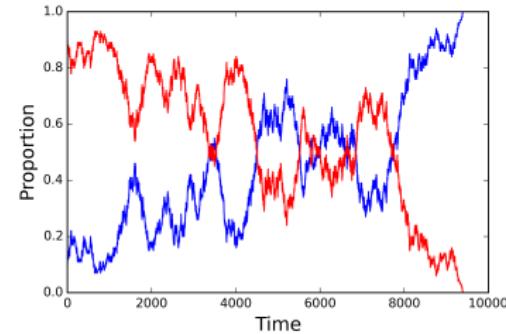
(Moran, 1958)

The role of random drift

Moran process:



Drift ($s = 0, N = 100$)

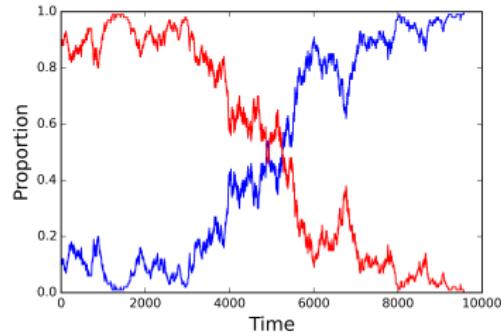


?

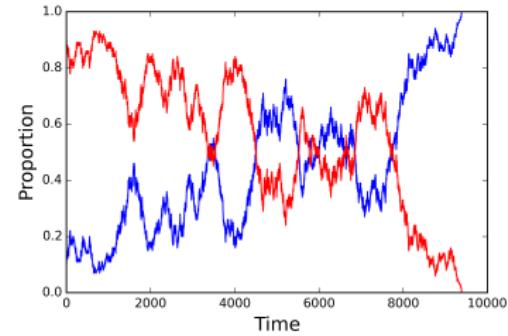
(Moran, 1958)

The role of random drift

Moran process:



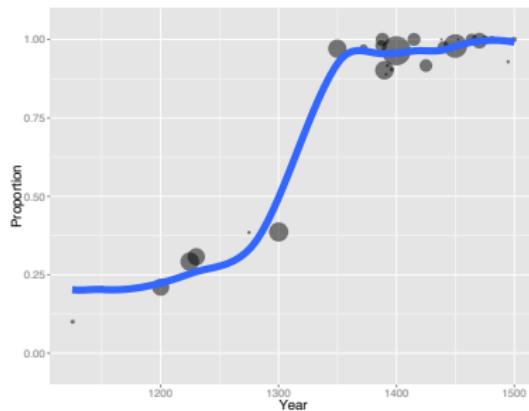
Drift ($s = 0, N = 100$)



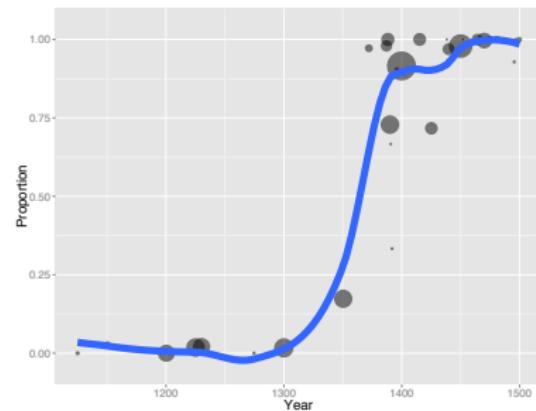
Selection ($s = 0.1, N = 100$)

(Moran, 1958)

The role of random drift



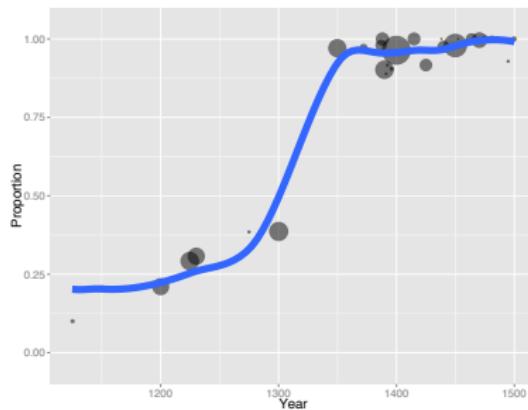
ne → (*ne...*) *not*



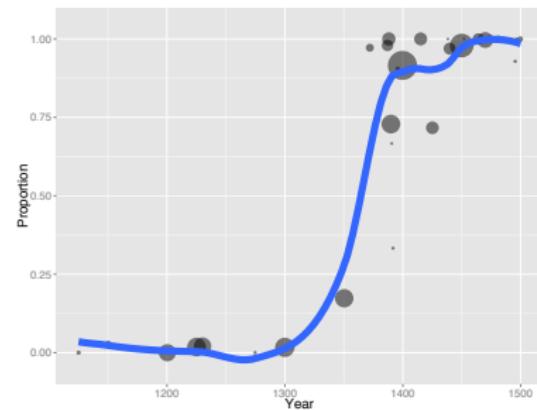
ne (...not) → *not*

The role of random drift

Gaussian approximation to Moran process:



ne → (ne...) *not*



ne (...not) → *not*

(Feder, Kryazhimskiy, and Plotkin, 2014)

The role of random drift

Fitness Increment Test:

	$ne \rightarrow (ne...) not$	$ne (...not) \rightarrow not$
H_0	Drift ($\mu = 0$)	Drift ($\mu = 0$)
H_1	Selection ($\mu > 0$)	Selection ($\mu > 0$)

(cf. Feder, Kryazhimskiy, and Plotkin, 2014)

The role of random drift

Fitness Increment Test:

	$ne \rightarrow (ne...) not$	$ne (...not) \rightarrow not$
H_0	Drift ($\mu = 0$) ✗	Drift ($\mu = 0$)
H_1	Selection ($\mu > 0$) ✓	Selection ($\mu > 0$)
	$t(5) = 2.6394$	
	$p = 0.0288$	

(cf. Feder, Kryazhimskiy, and Plotkin, 2014)

The role of random drift

Fitness Increment Test:

	$ne \rightarrow (ne...) not$	$ne (...not) \rightarrow not$
H_0	Drift ($\mu = 0$) ✗	Drift ($\mu = 0$)
H_1	Selection ($\mu > 0$) ✓	Selection ($\mu > 0$)
	$t(5) = 2.6394$	
	$p = 0.0288$	
	$\hat{s} = 0.01913$	
	$\hat{N} = 15900$	

(cf. Feder, Kryazhimskiy, and Plotkin, 2014)

The role of random drift

Fitness Increment Test:

	$ne \rightarrow (ne...) not$	$ne (...not) \rightarrow not$
H_0	Drift ($\mu = 0$) ✗	Drift ($\mu = 0$) ?
H_1	Selection ($\mu > 0$) ✓	Selection ($\mu > 0$) ?
	$t(5) = 2.6394$	$t(5) = 1.7021$
	$p = 0.0288$	$p = 0.0820$
	$\hat{s} = 0.01913$	
	$\hat{N} = 15900$	

(cf. Feder, Kryazhimskiy, and Plotkin, 2014)

The role of random drift

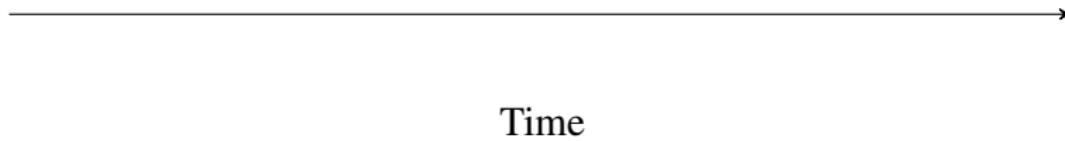
Fitness Increment Test:

	$ne \rightarrow (ne...) not$	$ne (...not) \rightarrow not$
H_0	Drift ($\mu = 0$) ✗	Drift ($\mu = 0$) ?
H_1	Selection ($\mu > 0$) ✓	Selection ($\mu > 0$) ?
	$t(5) = 2.6394$	$t(5) = 1.7021$
	$p = 0.0288$	$p = 0.0820$
	$\hat{s} = 0.01913$	$s = 0$
	$\hat{N} = 15900$	$\hat{N} = 506$

(cf. Feder, Kryazhimskiy, and Plotkin, 2014)

The role of random drift

Varying time for transition **NEG V NEG → V NEG:**



(Wallage, 2008; Jäger, 2008; Breitbarth, 2009; Martineau and Mougeon, 2003; Burridge, 1993; Auwera and Neuckermans, 1997; Zeijlstra, 2004)

The role of random drift

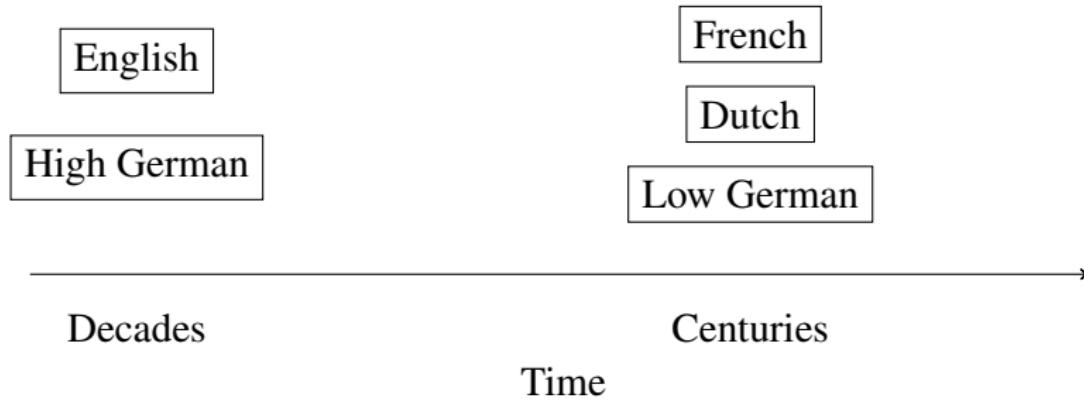
Varying time for transition NEG V NEG → V NEG:



(Wallage, 2008; Jäger, 2008; Breitbarth, 2009; Martineau and Mougeon, 2003; Burridge, 1993; Auwera and Neuckermans, 1997; Zeijlstra, 2004)

The role of random drift

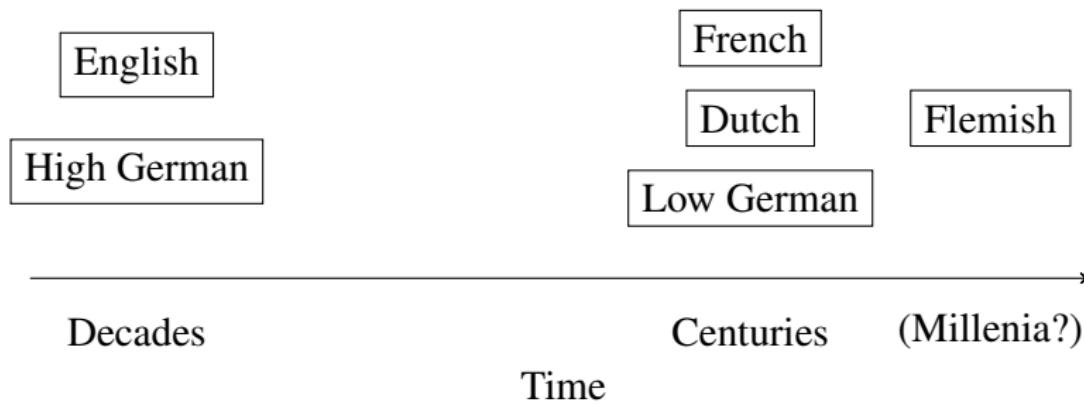
Varying time for transition NEG V NEG → V NEG:



(Wallage, 2008; Jäger, 2008; Breitbarth, 2009; Martineau and Mougeon, 2003; Burridge, 1993; Auwera and Neuckermans, 1997; Zeijlstra, 2004)

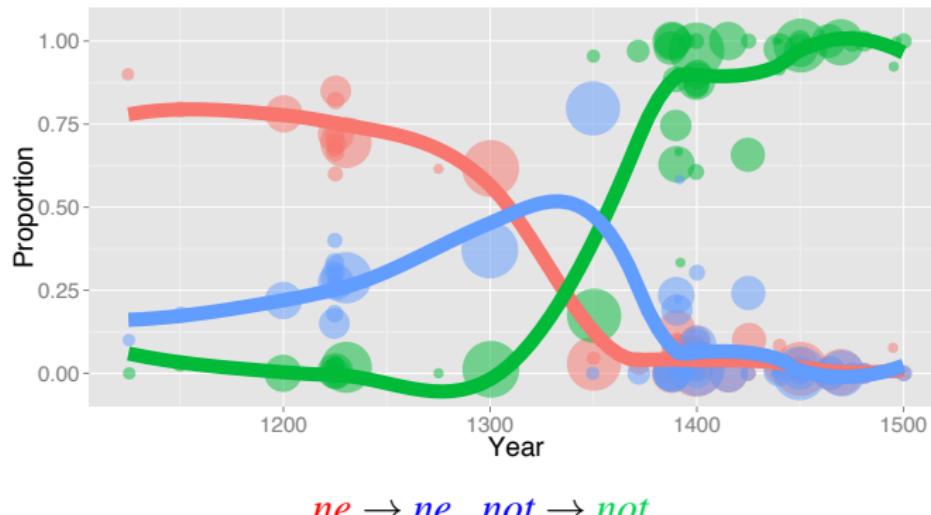
The role of random drift

Varying time for transition NEG V NEG → V NEG:

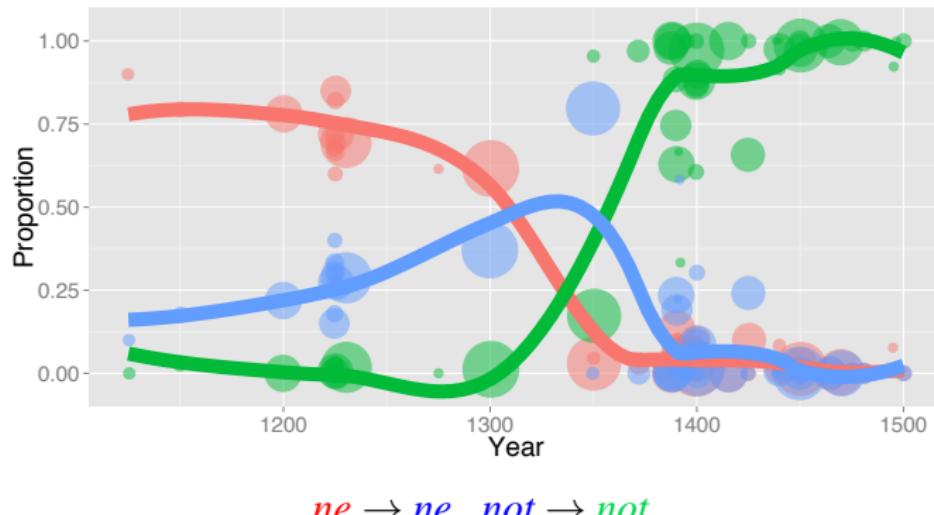


(Wallage, 2008; Jäger, 2008; Breitbarth, 2009; Martineau and Mougeon, 2003; Burridge, 1993; Auwera and Neuckermans, 1997; Zeijlstra, 2004)

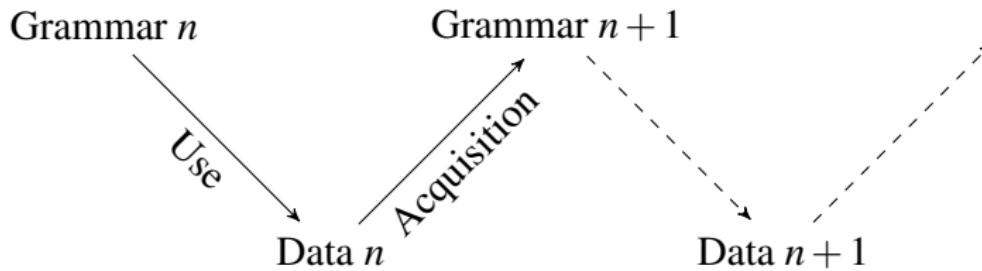
The formal cycle



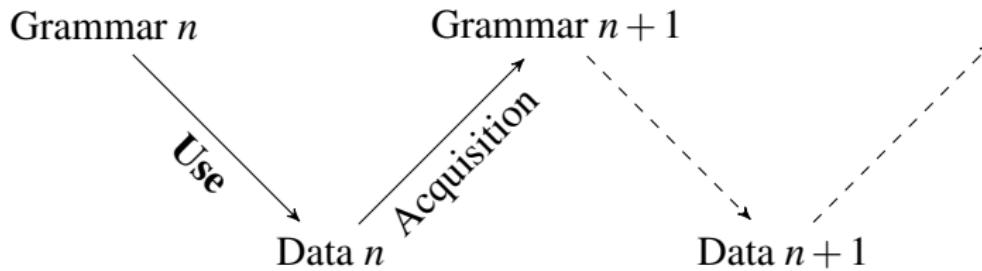
The facts to be explained



Language change



Language change



Thank you!

Thanks in particular to:

- Robin Clark, Mark Liberman, and Florian Schwarz
- Jon Stevens for ideas and discussions
- Aaron Ecay for PPCME queries, code, and discussion
- Josh Plotkin and Mitchell Johnson for code and discussion
- Penn graduate students and faculty

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