

Cycles and Stability in Linguistic Signaling

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Outline

1 Introduction

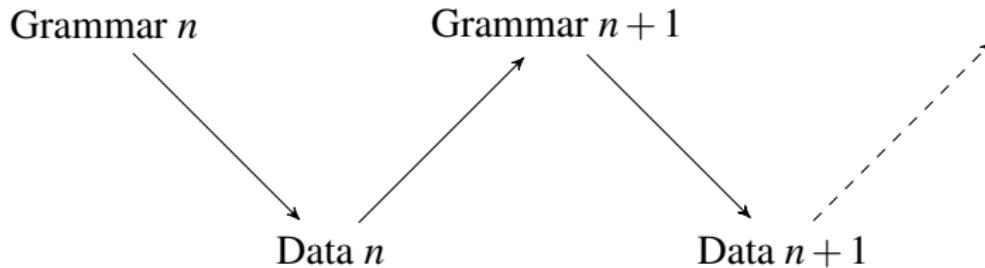
2 Background

3 Signaling

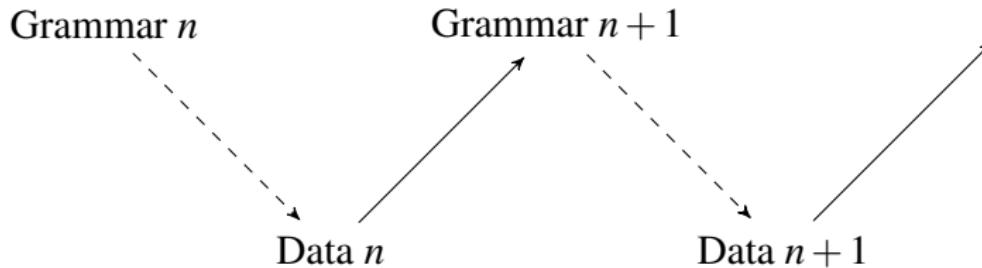
4 Cycles

5 Stability

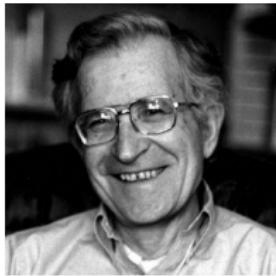
Language Change



Acquisition

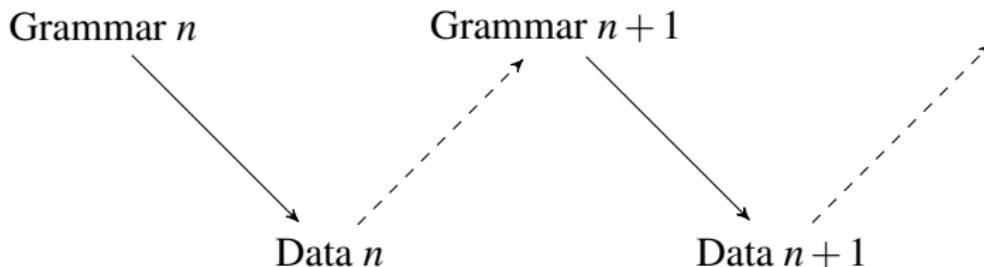


[Chomsky(1980)]

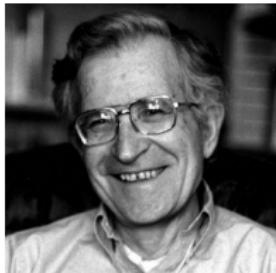


By grammatical competence I mean the cognitive state that encompasses all those aspects of form and meaning and their relation.

Use

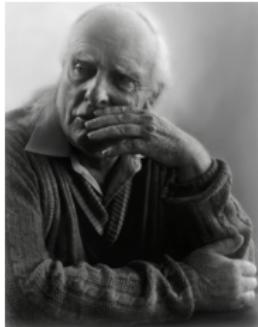


[Chomsky(1980)]



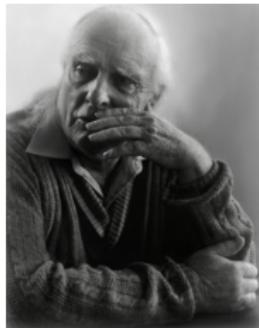
*By **grammatical competence** I mean the cognitive state that encompasses all those aspects of form and meaning and their relation...**Pragmatic competence** underlies the ability to use such knowledge along with the conceptual system to achieve certain ends or purposes.*

[Grice(1975)]



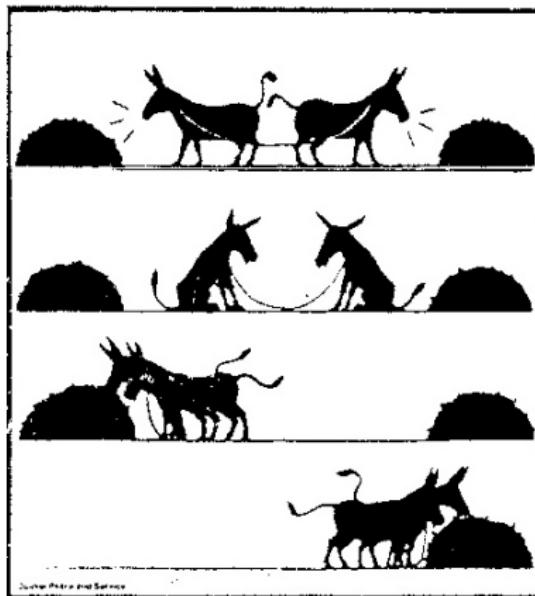
*I am, however, enough of a rationalist to want to find a basis that underlies these facts, undeniable though they may be; I would like to be able to think of the standard type of conversational practice not merely as something that all or most do **in fact** follow but as something that it is **reasonable**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

[Grice(1975)]



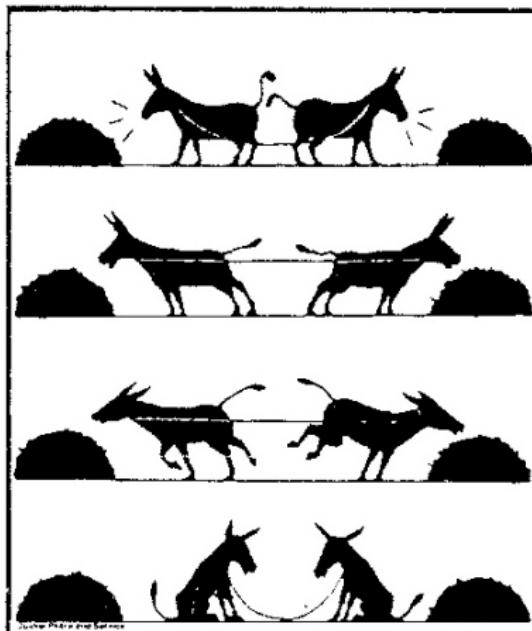
Make your conversational contribution such as is required, at the stage at which it occurs, by the accepted purpose or direction of the talk exchange in which you are engaged. One might label this the Cooperative Principle.

[Grice(1975)]



Source: Peter and Sophie

[Grice(1975)]



[Jespersen(1917)]



The Negative Cycle

- ① N V
- ② N V N
- ③ V N

[Jespersen(1917)]



The Negative Cycle

- ① N V
- ② N V N
- ③ V N

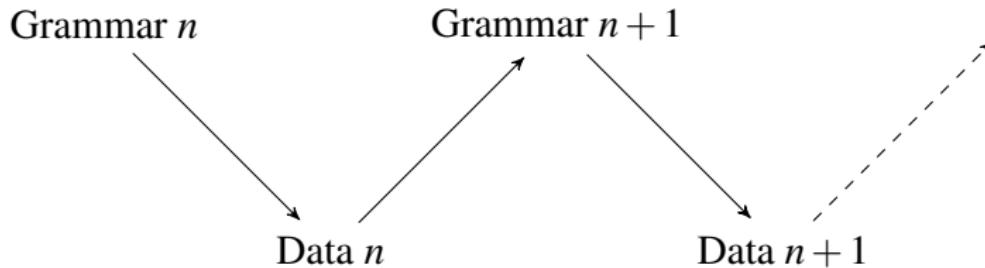
[Jespersen(1917)]



The Negative Cycle

- ① N V
- ② N V N
- ③ V N

Language Change



Background

- ① Jespersen's Cycle
- ② Emphatic Negation

[Jespersen(1917)]



The Negative Cycle

- ① N V
- ② N V N
- ③ V N

[Jespersen(1917)]



The Negative Cycle

- ① N V
- ② N V (N)
- ③ N V N
- ④ (N) V N
- ⑤ V N

[Jespersen(1917)]

	Stage 1	Stage 2	Stage 3
English	ic ne secge (Old English)	I ne seye not (Middle English)	I say not (Early Modern English)
French	jeo ne dis (Old French)	je ne dis pas (Middle French)	je dis pas (Colloquial French)

Pull-Chain

*The original negative adverb is first **weakened**, then found insufficient and therefore **strengthened**, generally through some additional word, and this in turn may be felt as the negative proper and may then in the course of time be subject to the same development as the original word.*

Sometimes it seems as if the essential thing were only to increase the phonetic bulk of the adverb...



Pull-Chain?

- Greek [Kiparsky and Condoravdi(2006)]
- Italo-Romance [Posner(1985)]
- Morphosyntactic Change

Push-Chain

*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.*

Push-Chain?

- Greek [Kiparsky and Condoravdi(2006)]
- Inflation [Dahl(2001)]
- Redundancy [Detges and Waltereit(2002)]

[Kiparsky and Condoravdi(2006)]



Emphatic negation tends to increase in frequency due to pragmatically motivated overuse which is characteristic of inherently bounded evaluative scales...an obligatory element cannot be emphatic, for to emphasize everything is to emphasize nothing.

[Eckardt(2006)][Krifka(1995)]

Interpretation

$$\llbracket E \rrbracket^f = \{ \llbracket E \rrbracket^o \} \quad (1)$$

$$\llbracket E_f \rrbracket^f = \{ \llbracket E \rrbracket^o, F_1, F_2, F_3 \dots \} \quad (2)$$

Composition

$$\llbracket AB \rrbracket^f = \{ A_i \infty B_j \mid A_i \in \llbracket A \rrbracket^f, B_j \in \llbracket B \rrbracket^f \} \quad (3)$$

[Eckardt(2006)]

Lexicon

$$\llbracket \text{John}_f \rrbracket^f = \{ \llbracket \text{John} \rrbracket^o, \text{Joe}, \text{Jim} \} = \{ \text{John}, \text{Joe}, \text{Jim} \} \quad (4)$$

$$\llbracket \text{knows the number} \rrbracket^f = \{ \lambda x. \text{know}(x, \text{the number}) \} \quad (5)$$

Result

$$\begin{aligned} \llbracket \text{knows the number} \rrbracket^f(\llbracket \text{John}_f \rrbracket^f) &= \{ \text{know}(\text{John}, \text{the number}), \\ &\quad \text{know}(\text{Joe}, \text{the number}), \\ &\quad \text{know}(\text{Jim}, \text{the number}) \} \end{aligned} \quad (6)$$

[Eckardt(2006)]

Operator

emph(S)

asserts : $\llbracket S \rrbracket^o$ (7)

implicates : $\forall S' \in \llbracket S \rrbracket^f. P(\llbracket S \rrbracket^o) \leq P(\llbracket S' \rrbracket^o)$

Result

emph($\llbracket \text{John}_f \text{ knows the number} \rrbracket^f$)

asserts : John knows the number (8)

implicates : ...of all people!

[Eckardt(2006)]

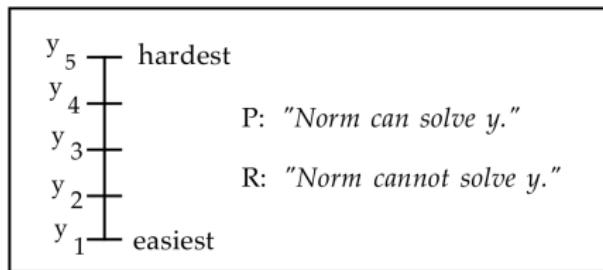
Combined

emph(John didn't drink [a single drop]_f)

asserts : John didn't drink a single drop (9)

implicates : ...not a glassful, not a mouthful,...!

[Fauconnier(1975)]



[Kadmon and Landman(1993)]

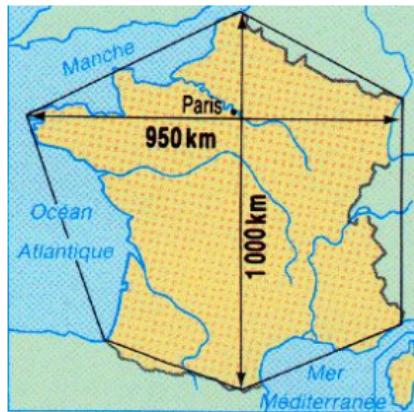
Widening

- (1) a. Will there be French fries tonight?
b. No, I don't have potatoes.
c. Maybe just a couple I could fry in my room?
d. No, I don't have any potatoes.

Strengthening

- (2) a. If you move, I'll shoot.
b. If you budge an inch, I'll shoot.

[Austin(1962)][Lewis(1970), Landman(1991), Krifka(1995)]



[Austin(1962)][Lewis(1970), Landman(1991), Krifka(1995)]



Signaling

- ① Game
- ② Equilibria

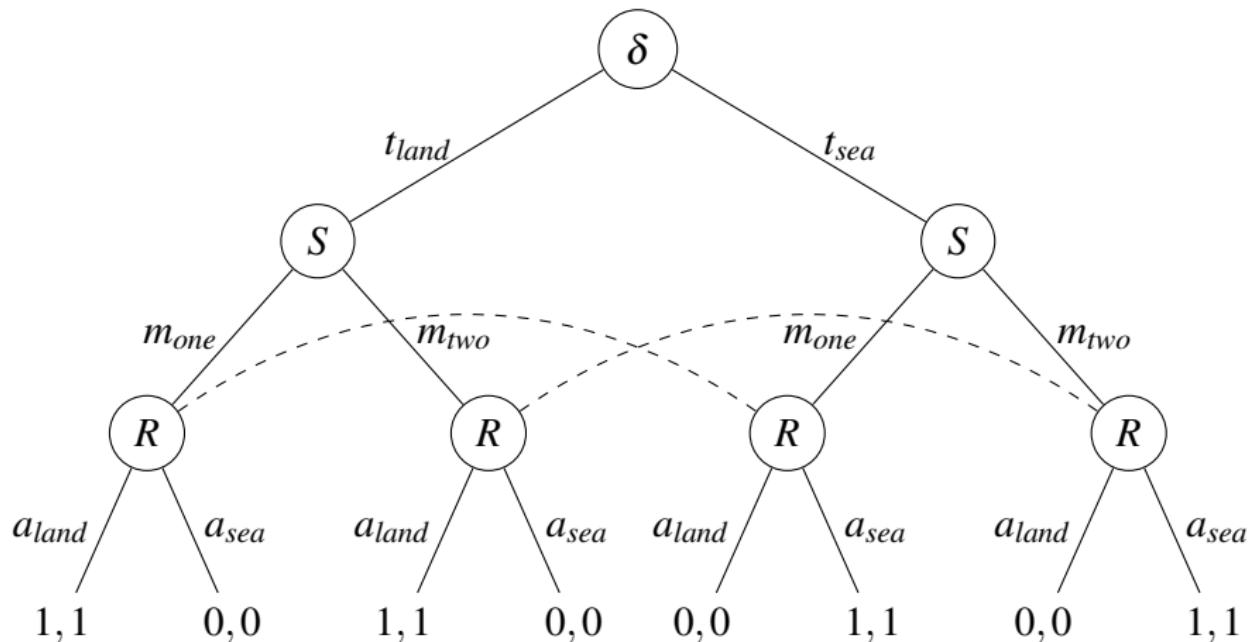
Structure

- ① **Sender** observes some state of the world, $t \in T$, given prior probability distribution over states, δ .
- ② **Sender** chooses message, $m \in M$, based on strategy $s : T \rightarrow M$.
- ③ **Receiver** interprets message with action, $a \in A$, based on strategy $r : M \rightarrow A$.

[Lewis(1969)]

One if by land, two if by sea.





(Expected) Utilities

$$U_S(t_i, a_k) = U_R(t_i, a_k) = \begin{cases} 1 & \text{if } i = k \\ 0 & \text{else} \end{cases} \quad (10)$$

$$\begin{aligned} E[U_S(s, r)] &= \sum_t \delta(t) \cdot U_S(t, r(s(t))) \\ E[U_R(s, r)] &= \sum_t \delta(t) \cdot U_R(t, r(s(t))) \end{aligned} \quad (11)$$

[Nash(1951)]

A strategy profile $\langle s^*, r^* \rangle$ is a **Nash equilibrium** if and only if:

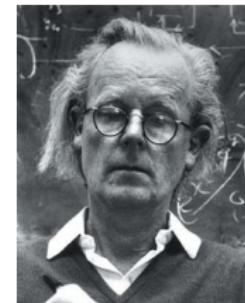
- $\forall s \in S$, such that $s \neq s^*$, $E[U_S(s^*, r^*)] \geq E[U_S(s, r^*)]$
- $\forall r \in R$, such that $r \neq r^*$, $E[U_R(s^*, r^*)] \geq E[U_R(s^*, r)]$



*Something that it is **reasonable** for us to follow. -Grice*

[Maynard Smith and Price(1973)]

*An Evolutionarily Stable Strategy is a strategy that, if all the members of a population adopt it, then **no mutant strategy could invade the population** under the influence of natural selection.*



[Selten(1980)]

A strategy profile $\langle s^*, r^* \rangle$ is evolutionarily stable if and only if it is a **Strict Nash equilibrium**:

- $\forall s \in S$, such that $s \neq s^*$, $E[U_S(s^*, r^*)] > E[U_S(s, r^*)]$
- $\forall r \in R$, such that $r \neq r^*$, $E[U_R(s^*, r^*)] > E[U_R(s^*, r)]$



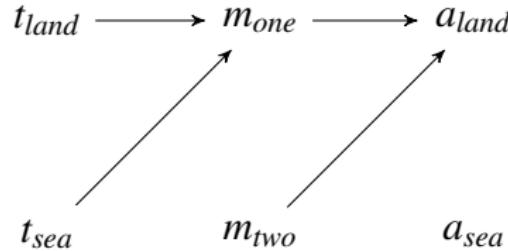
Something that it is reasonable for us to follow, that we should not abandon. -Grice

Separating Equilibria

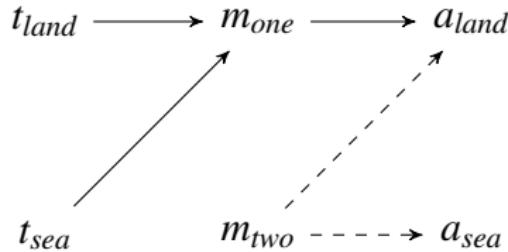
$$t_{land} \longrightarrow m_{one} \longrightarrow a_{land}$$

$$t_{sea} \longrightarrow m_{two} \longrightarrow a_{sea}$$

Pooling Equilibria



Pooling Equilibria



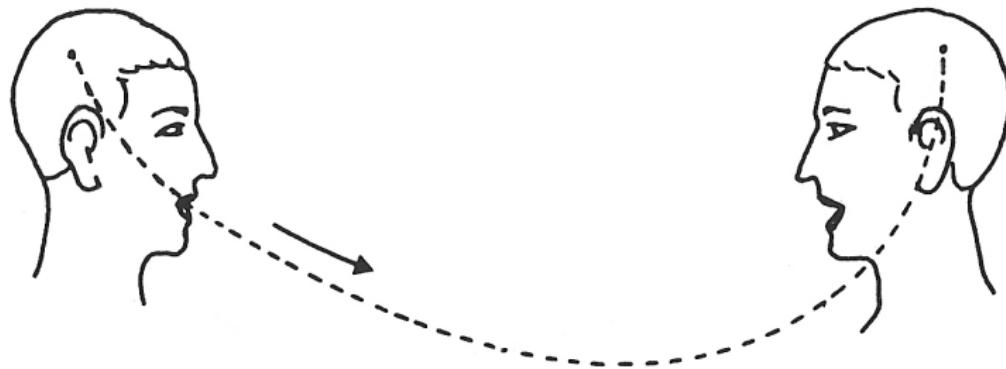
Cycles

- ① Game
- ② Equilibria

Structure

- **Speaker** has evidence for some standard of precision, $t \in T : [0, 1]$, given prior density function over states, δ .
- **Speaker** chooses a form of negation, $m \in M$, based on strategy $s : \mathcal{P}_n(T) \rightarrow M$
- **Hearer** infers standard of precision, $a \in A$, based on strategy $r : M \rightarrow A$.



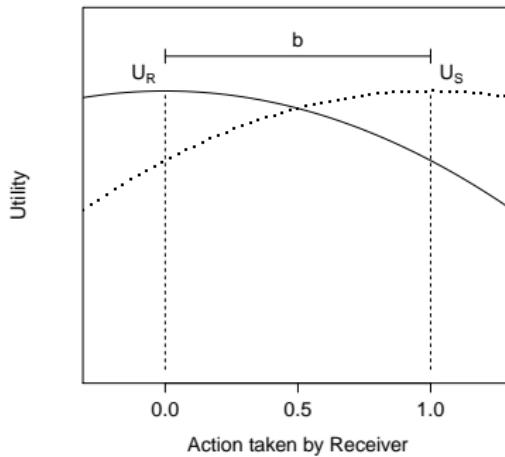
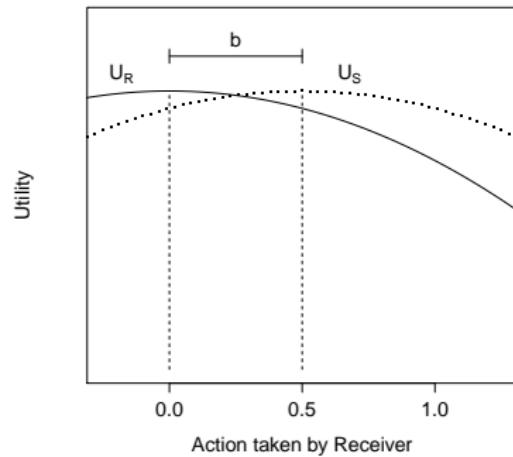


Advice!

- (3) a. If you move, I'll shoot.
 b. If you budge an inch, I'll shoot.

- (4) a. That restaurant's not good.
 b. That restaurant's not worth a cent!

[Crawford and Sobel(1982)]



(Expected) Utilities

$$\begin{aligned} U_S(t, a) &= -(a - t - b)^2 \\ U_R(t, a) &= -(a - t)^2 \end{aligned} \tag{12}$$

$$\begin{aligned} E[U_S(s, r)] &= \int_T \delta(t) \cdot U_S(t, r(s(t))) dt \\ E[U_R(s, r)] &= \int_T \delta(t) \cdot U_R(t, r(s(t))) dt \end{aligned} \tag{13}$$

Pooling Equilibria

Always m_1

$$t^* = 1 \quad (14)$$

$$a_1^* = \frac{t^*}{2} \quad (15)$$

Pooling Equilibria

Always m_2

$$t^* = 0 \quad (16)$$

$$a_2^* = \frac{1+t^*}{2} \quad (17)$$



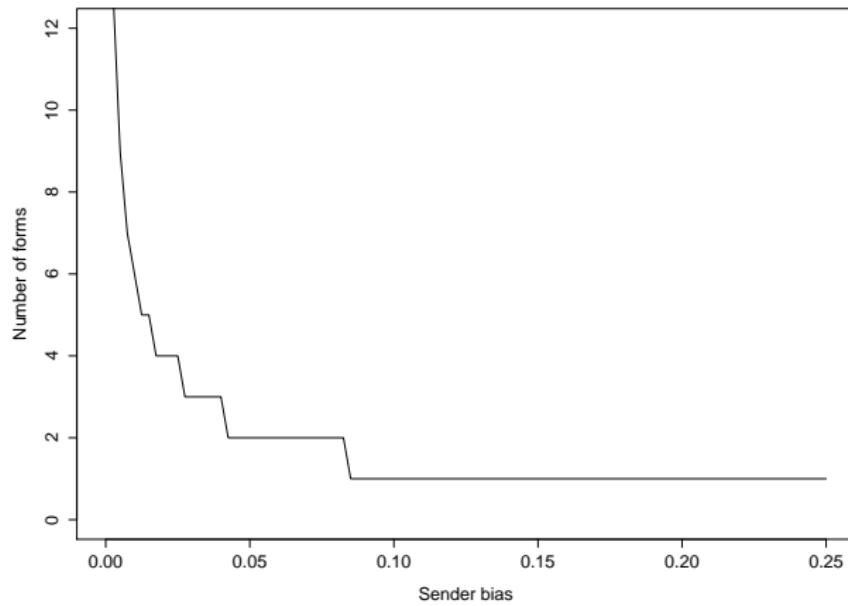
(Partially-)Separating Equilibrium

Differentiate m_1 and m_2

$$t^* = \frac{1}{2} - 6b \quad (18)$$

$$\begin{aligned} a_1^* &= \frac{t^*}{2} \\ a_2^* &= \frac{1+t^*}{2} \end{aligned} \quad (19)$$

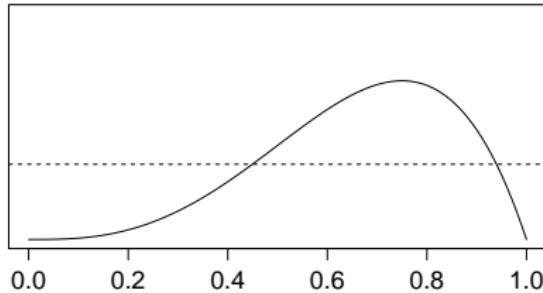
[Crawford and Sobel(1982)]



Push-Chain

PLAIN	EMPHATIC
N V	N V
N V	N V (N)
N V (N)	N V N
N V N	N V N

[Kullback and Leibler(1951)]



$$D_{KL}(P||Q) = \int_{-\infty}^{\infty} \log \left(\frac{p(x)}{q(x)} \right) p(x) dx \quad (20)$$

[Jespersen(1917)]



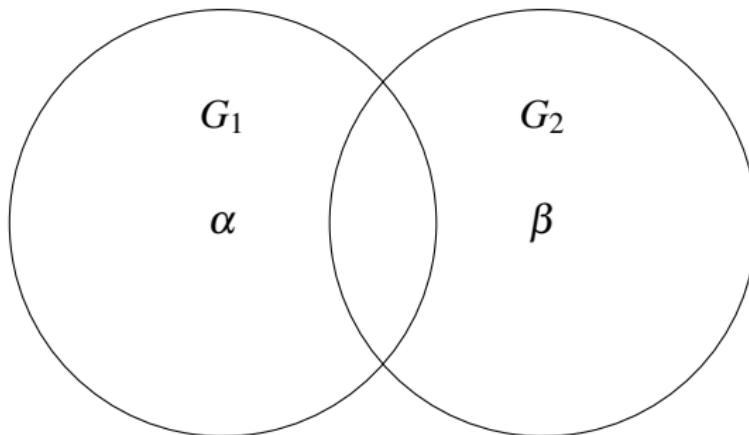
The Negative Cycle

- ① N V
- ② N V (N)
- ③ N V N
- ④ (N) V N
- ⑤ V N

Stability(?)

- ① Learning
- ② Mechanisms
- ③ Data

[Yang(2000)]

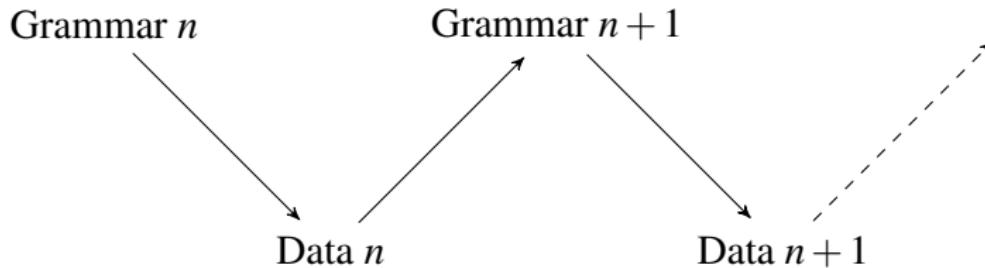


[Yang(2000)]

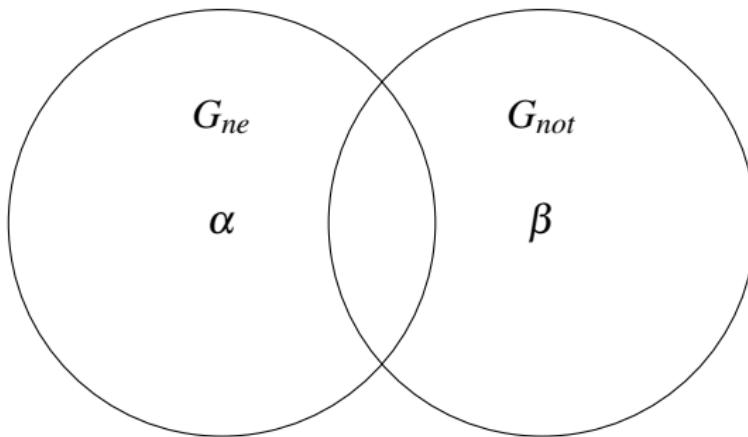
Over time

$$\frac{p_t}{(1-p_t)} = \left(\frac{\alpha}{\beta}\right)^t \frac{p_0}{(1-p_0)} \quad (21)$$

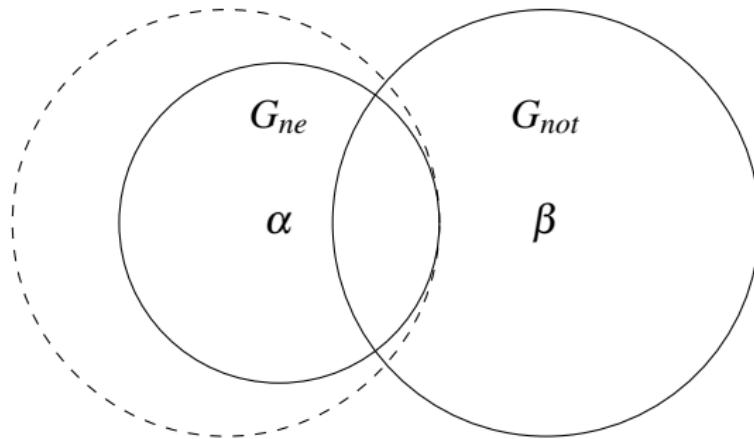
Language Change



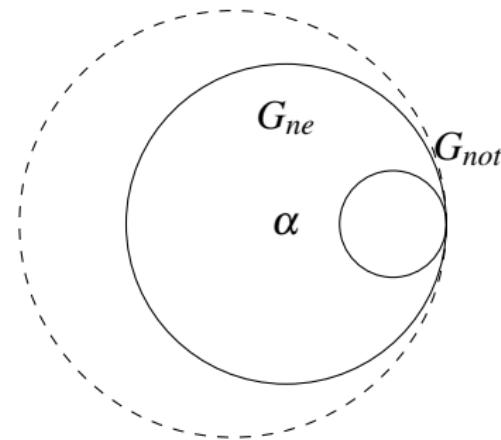
[Wallage(2008)]



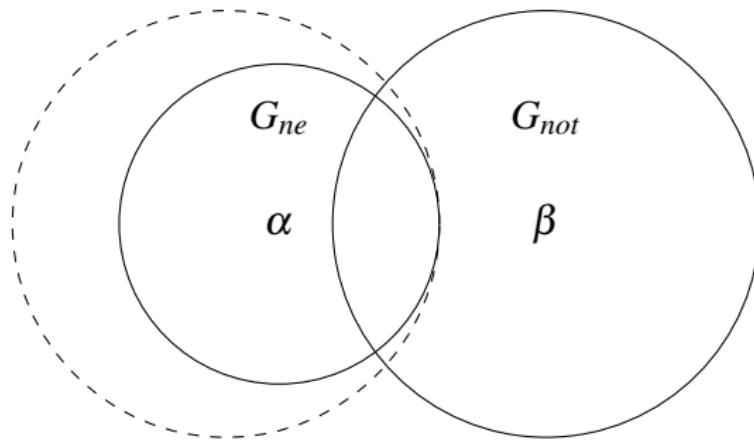
N V > N V N



N V > N V N



N V > N V N



[Wallage(2008)]

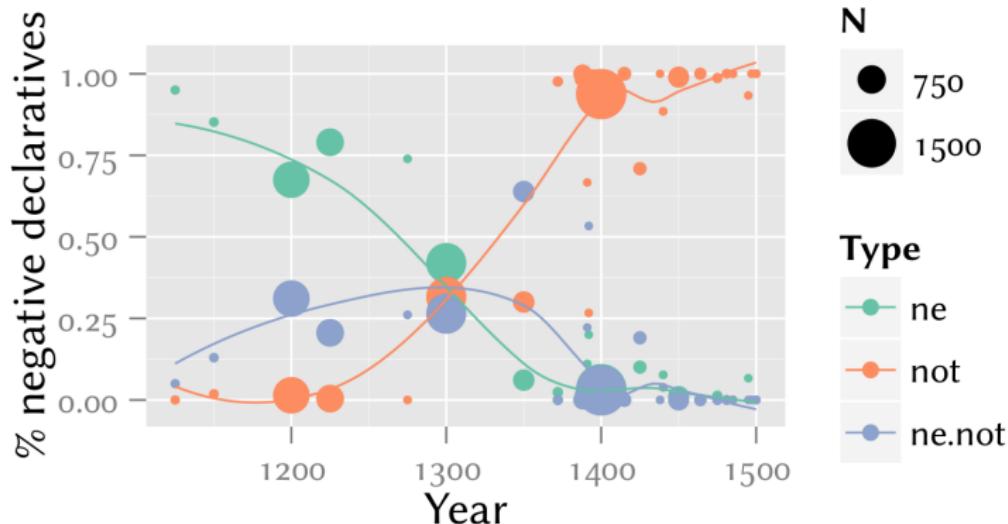
Period	Main Clauses			Subordinate Clauses		
	<i>ne</i>	<i>ne...not</i>	<i>not</i>	<i>ne</i>	<i>ne...not</i>	<i>not</i>
1150-1250	91	152	3	279	112	4
1250-1350	48	329	48	87	147	15
1350-1420	3	108	935	17	115	905
1420-1500	1	12	928	7	4	821

[Wallage(2008)]

Period	<i>if</i> -clauses			In scope of negation		
	<i>ne</i>	<i>ne...not</i>	<i>not</i>	<i>ne</i>	<i>ne...not</i>	<i>not</i>
1150-1250	33	10	0	33	3	0
1250-1350	12	8	3	19	6	2
1350-1420	9	5	64	14	8	55
1420-1500	2	1	51	4	1	43

[Wallage(2008)]

Period	α	β	$\frac{\beta}{\alpha}$	ne...not
1150-1250	370	40	.108	277
1250-1350	137	65	.474	490
1350-1420	75	1799	23.986	236
1420-1500	51	1704	33.411	18



*Thanks to Aaron Ecay for queries and code.

Actuation

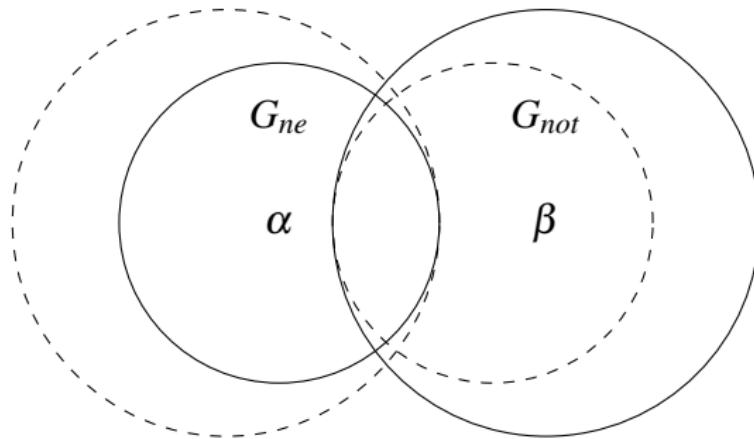
Over time

$$\frac{p_t}{(1-p_t)} = \left(\frac{\alpha}{\beta}\right)^t \frac{p_0}{(1-p_0)} \quad (22)$$

Misperception

$$P(not) = P(ne...not) * \varepsilon \quad (23)$$

N V > N V N



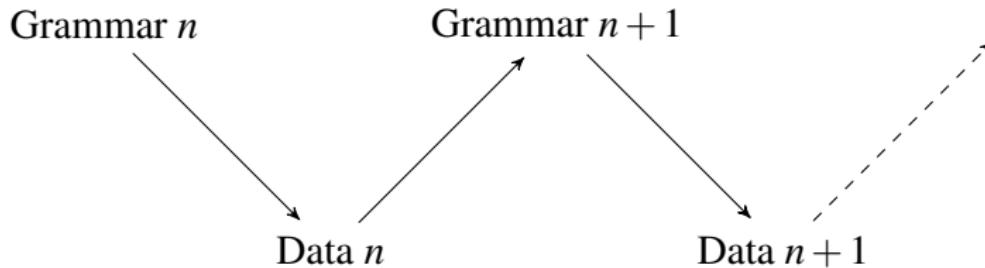
[Jespersen(1917)]



The Negative Cycle

- ① N V
- ② N V (N)
- ③ N V N
- ④ (N) V N
- ⑤ V N

Language Change



Future Directions

- *Common prior assumption* [Harsanyi(1967)].
 - Theoretical implications of prior.
 - Empirical evidence about prior.
-
- More articulated theory of change [Frisch(1997), Wallage(2008)].
 - Detailed analysis of Middle English data.
 - Comparison to parallel change in French.

Thanks!



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