



Selective Advantages of Syntactic Language

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Language has evolved!

Nativists:

language shows signs of complex design for the communication of propositional structures, and the only explanation for the origin of organs with complex design is the process of natural selection. (Pinker & Bloom, 1990)

Evolutionary biologists:

if language is [a] modified [spandrel], then natural selection was the modifying force. [...] Since language is a very late and complex evolutionary invention, it cannot be an unmodified spandrel. (Maynard Smith & Szathmáry, 1995).

Connectionists:

once it finally appeared on the planet, it is quite likely that language itself began to apply adaptive pressure on the organization of the human brain [...] (Bates & Goodman, 1999)

What is it for?

1. P&B: *“communicating propositional structures”*
2. MS&S: *“to communicate about time, possession, beliefs, desires, tendencies, obligations, truth, probability, hypotheticals and counterfactuals. The intellectual arms race took place within the species itself.”*
3. Desalles (1998): *“Relevant information is given in exchange for status”*
4. Costly signalling / sexual selection

5. Thinking / byproduct of “language of thought”

6. Coordinating cooperation

7. Friendship / “grooming”

Theoretical constraints?

Can we check the internal consistency of different theories?

The key is *formalisation*.

- Explicit assumptions
- 'Automatic' argument

However, what are the proper elements for such formal models?

Explorative modelling

Computational models

- that are *intuitive* and relatively *complex*
- can be studied *experimentally*, and
- thus “talk back” to us and help us to develop new hypotheses, concepts, measures etc, and
- enforce fewer unpleasant simplifications.

Not intended

- to replace mathematical models,
- to simulate reality, or
- to be the perfect model.

Rather, they are *MIRROR* systems (Hogeweg & Hesper, 1983), much like model organisms in biology.

Model design

Individuals

Interpretation

I-Language

Payoff

E-Language

Selection

Production

Mutation

Model details

Individuals

*Unstructured population of $P=10$,
20 or 100 individuals*

I-Language

*Context-free grammars with 3 or
5 nonterms, and 2 or 4 terminals.*

E-Language

*Strings of 2 or 4 different symbols
of maximum length 6.*

Production

Apply random rules

Interpretation

*Exhaustive parsing with
maximum depth $d=8$ or 10*

Payoff

(next slide)

Selection

*Fixed population size,
 $E(\text{\#offspring}) \sim \text{payoff}$*

Mutation

*Deletion/duplication of rules,
deletion/insertion of symbols*

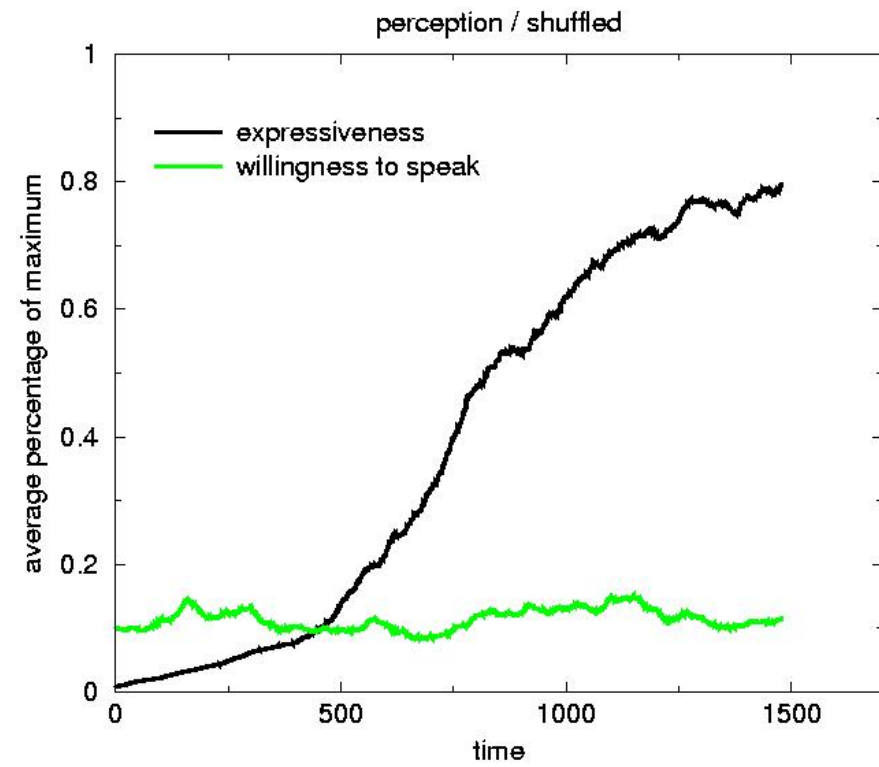
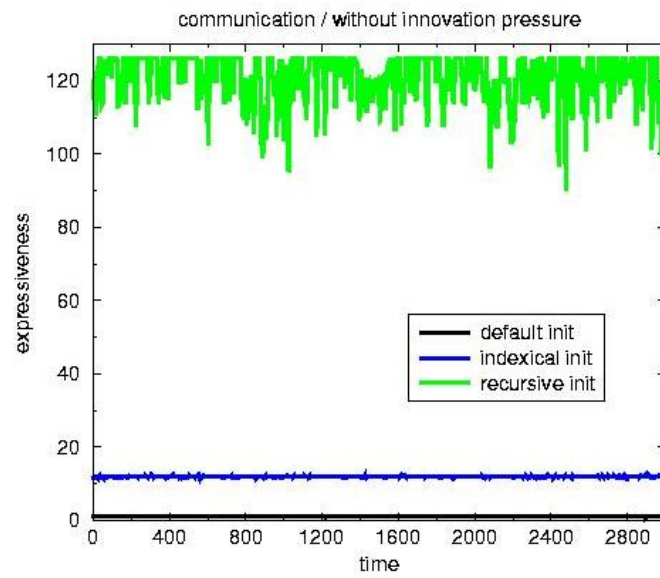
Selection pressures: payoff

“perception”	hearer	speaker	“manipulation”	hearer	speaker
success	r	0	success	0	r
failure	0	0	failure	0	0

“intimidation”	hearer	speaker
success	0	0
failure	0	r

“communication”	hearer	speaker	“cognition”	hearer	speaker
success	r	r	success	0	r
failure	0	0	failure	0	r

Paradox



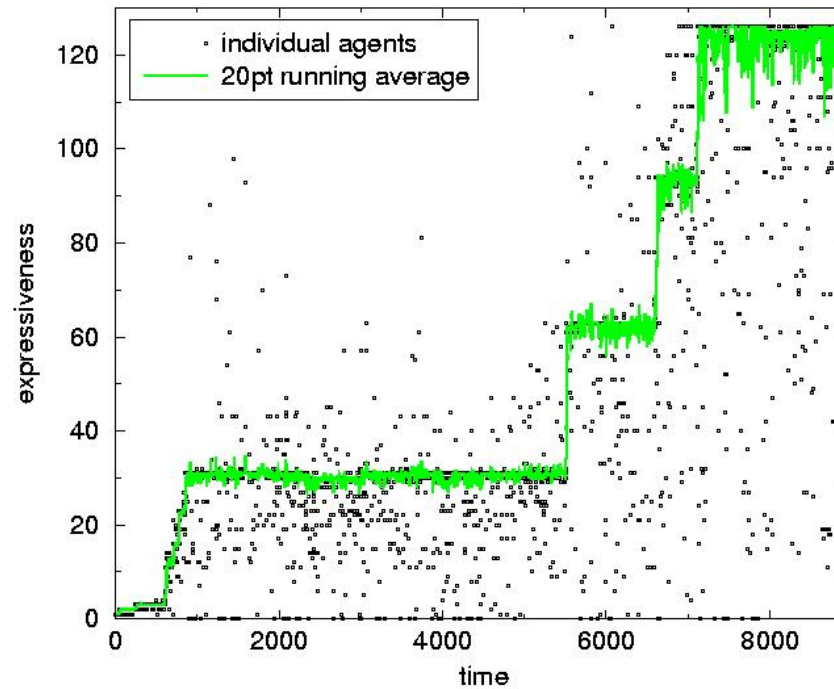
Is expressiveness selectively advantageous?

With (i) an *explicit* innovation pressure, the average score per agent has its optimum at maximal expressiveness. However, *implicitly* expressiveness influences the rewards in other ways as well: (ii) expressive speakers are more likely not to be understood, and (iii) expressive listeners are more likely to understand.

The tragedy of nonconformism

Very expressive individuals are not successful if they do not conform to the group.

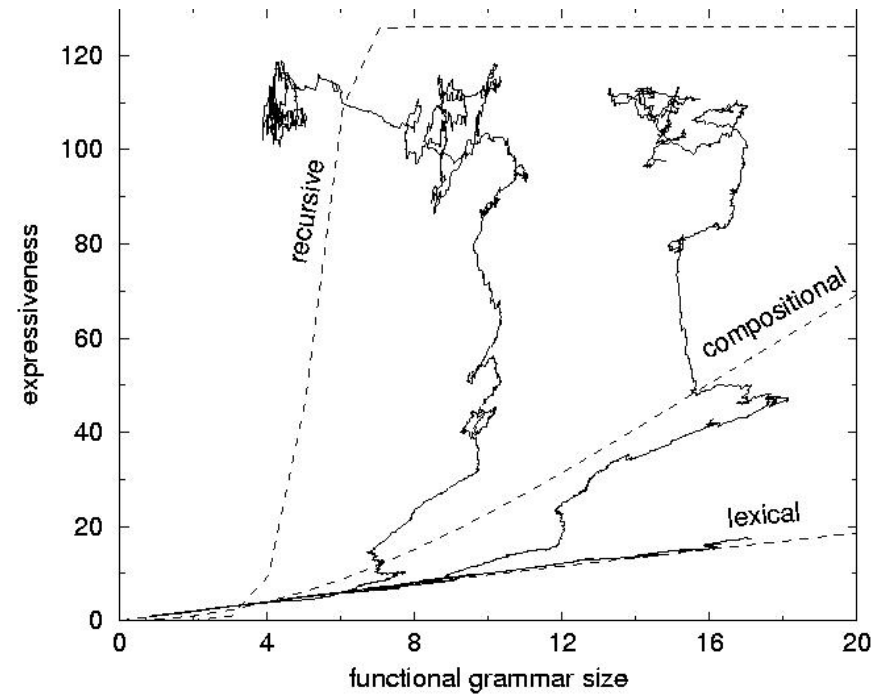
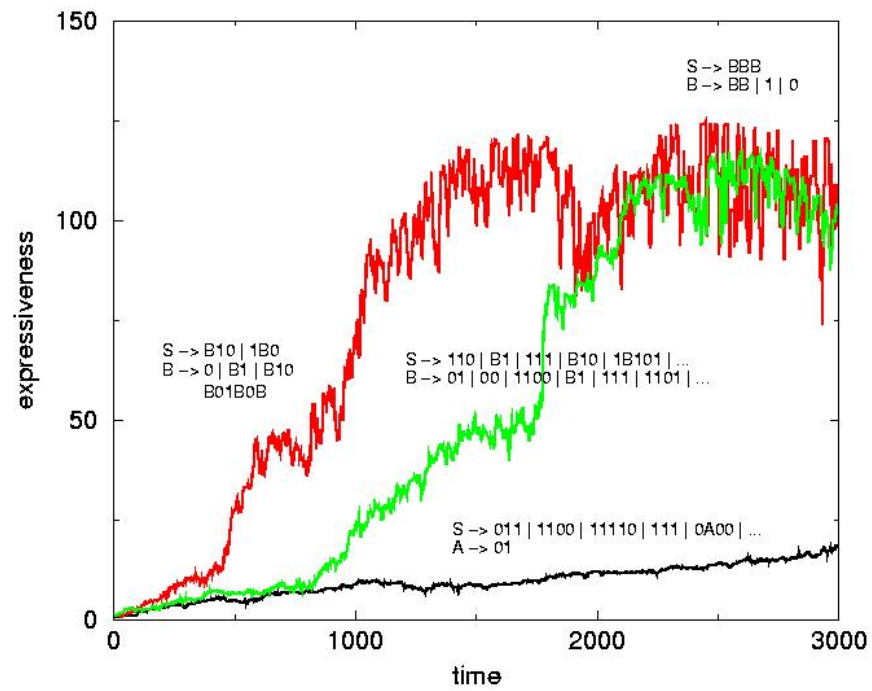
$$r_{string} = \frac{1}{\text{number of usages}}$$



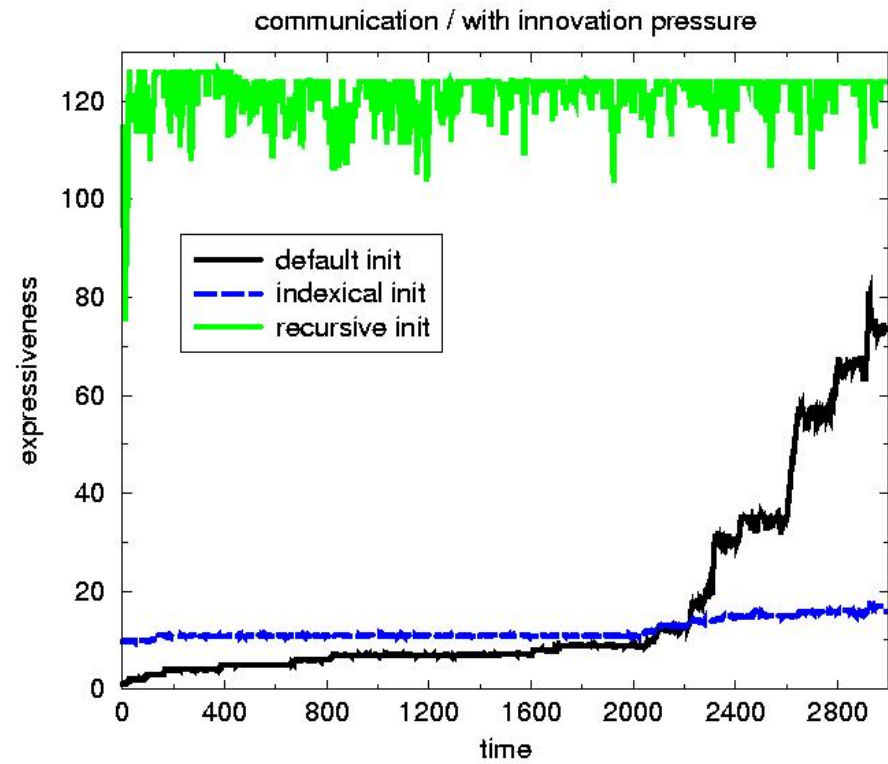
The tragedy of nonconformism

This leads to an interesting interplay between each of these roles of expressiveness and the group effect. Under communication settings (ii) not being recognized is *disadvantageous*, while (iii) recognition is *advantageous* and in both scoring dimensions similarity to the group's language is important. Under perception settings (ii) not being recognized and (iii) recognition are beneficial, while similarity to the group's language is important for recognition, but *dissimilarity* is better for not being recognized (and thus hindering one's competitors). Moreover, the strength of the "conformism effect" depends on the size of the group's language and the variation within the group.

Self-enforcing dynamical regimes



Innovation pressure



Spatial model: localised selection