I said to myself about the language of men, when they prove God, and see that they themselves are beasts: the case of humans and the case of beasts are the same

Ecclesiastes III, 18-19



Noam Chomsky

As to language in humans, I think G-d distinguished them from beasts only to show that they are one and the same Ecclesiastes III, 18-19

because what you lack is infinite recursion



King Solomon



\_yet we cannot speak \_







What else do I need / before I can actually begin to talk ?



You definitely need infinite recursion !

 $\bigcirc$ 

Noam Chomsky



## Embeddings:

..that John saw Peter help Mary make the children swim ...  $N_1V_1N_2V_2N_3V_3N_4V_4$ 

..the realization that the talk they attend has not yet finished makes them weep...  $N_1N_2N_3V_3V_2V_1$  (palindrome, or stack memory)

...*dat Jan Piet Marie de kinderen zag helpen laten zwemmen*...  $N_1N_2N_3N_4V_1V_2V_3V_4$  (interleaving, or queue memory)

Finite recursion, it seems...

A capacity for infinite recursion may have evolved for reasons unrelated to language.

Other complex cognitive capacities, seemingly unique to humans, may require infinite recursion.

Such capacities are likely grounded in a memory system that allows for fine discriminations.

Others (e.g. Ullman) have emphasized the roots of language in semantic and procedural memory.



Repainted to menotive netted et k (Faktors, & 2005) psoblen?) (Fulvi Mari & Treves, 1998)

connectivity

<sup>1</sup> Yasser tells us that modules (compartments) are irrelevant

С Х 1 J 2 Q Μ Z 3 L Κ В 4 R А Z Х 5 B N 6 T Y

pattern

591 Potts states dates

## Sparse Rottsipatternsss

Iddo Kanter (1988) Potts-glass models of neural networks. Phys Rev A 37:2739-2742.



+ continuous (graded response) Potts units

simulations indicate that storage capacity is not affected single-unit adaptation can lead to smooth latching behaviour



## Latching, if transition probabilities are structured, and not uniform, may be a neural basis for infinite recursion.



# + multi-factor coding model (correlated patterns) $p_c \propto C 5^2$ ? $p_l \propto 5$ ?

### a percolation transition to infinite recursion?





Computer simulations of Frontal Latching Networks with

N = 300 Potts units a = 0.25 sparse coding S = 3,4,5,7,10 + 1 states C = 12,17,25,50,100 connections p = 25-400 patterns generated by 20 relevant factors How to quantify retrieval ? and latching ?



### 1 1 0.8 + c025s10 0.8 + c100s07 + c100s05 + c100s07 + c10s





Retrieval and latching appear to coexist only above critical values of both *C* and *S* 

Is that to FLNs a percolation phase transition?



