

Evolução da Cultura e da Linguagem



Prof. Fabiano Ribeiro

DEX - UFLA



Grupo Ic-Complex



O que um Físico pode dizer sobre Cultura e Linguagem?



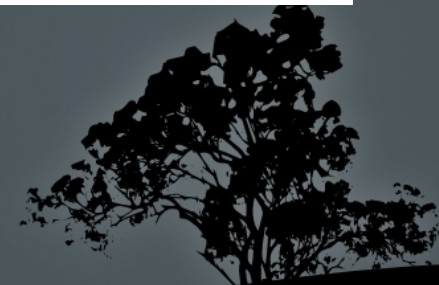
**O que nos torna
diferentes dos demais seres?**



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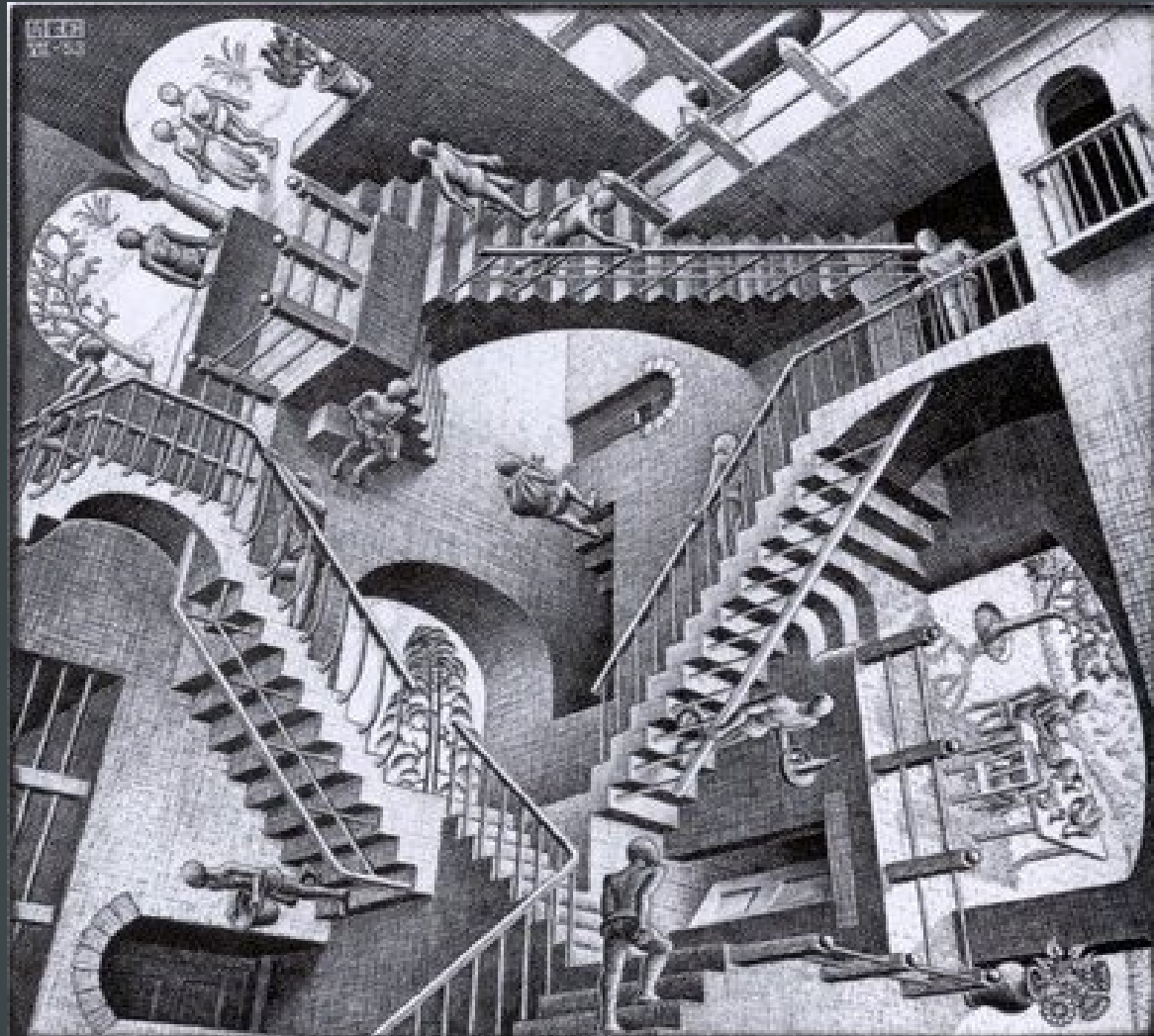
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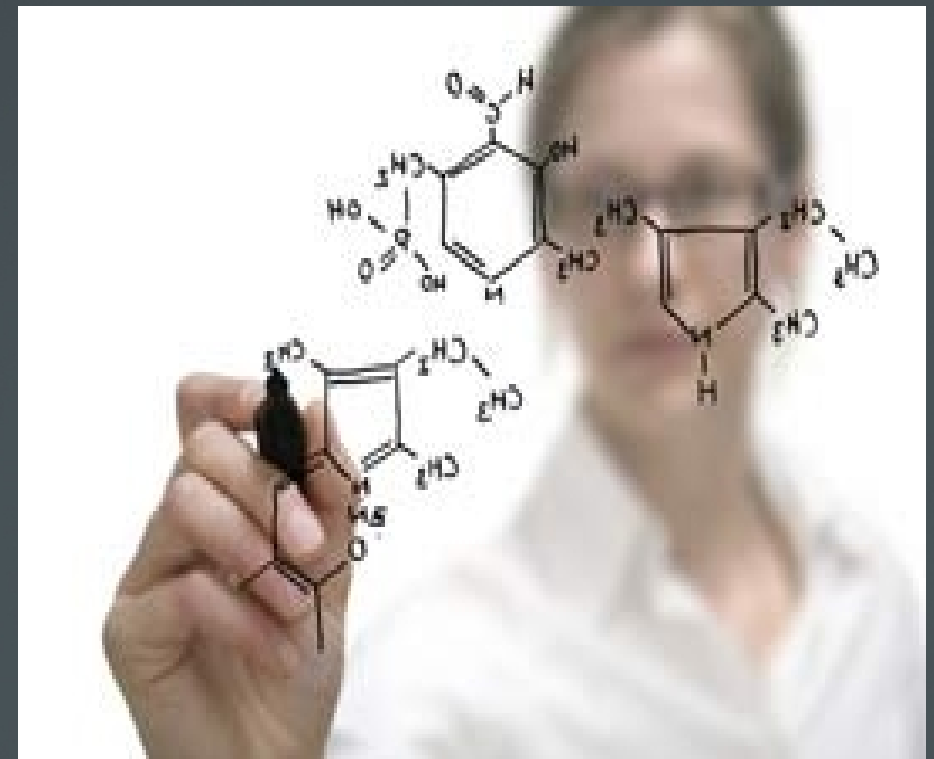
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**O que nos torna
diferentes dos demais seres?**



O que nos torna diferentes dos demais seres?

- Capacidade Criativa;
- Mente Simbólica;
- Ideia de Religião (Sobrenatural):



Quando e Como essas
Características "humanas"
Surgiram?



Sumário

- Evidencias Arqueológicas;
- Hipóteses para explicar essas características exclusivamente humanas.
- Uso de Modelos Matemáticos para descrição;



Evolução Humana

A WALK THROUGH HUMAN EVOLUTION

The newest fossils have brought scientists tantalizingly close to the time when humans first walked upright—splitting off from chimpanzees. Their best guess is that it happened at least 6 million years ago

Last common ancestor
The species should have features reminiscent of both apes and humans—but that's true of several species already found, so identification may be tough

Orrorin tugenensis
("Millennium Man"; possible human ancestor)

Ardipithecus ramidus kadabba

Ardipithecus ramidus ramidus

Australopithecus anamensis

A. afarensis
(includes Lucy)

A. garhi

A. aethiopicus

A. africanus

Kenyanthropus platyops

H. ergaster

Homo rudolfensis

A. robustus

A. boisei

H. antecessor

H. erectus

H. heidelbergensis

H. neanderthalensis

H. sapiens
(modern humans)

Chimpanzees

Gorillas

PRESENT

7 MILLION YEARS AGO

All dates are approximate

6 MILLION YEARS AGO

TIME Diagram by Joe Lertola

5 MILLION YEARS AGO

4 MILLION YEARS AGO

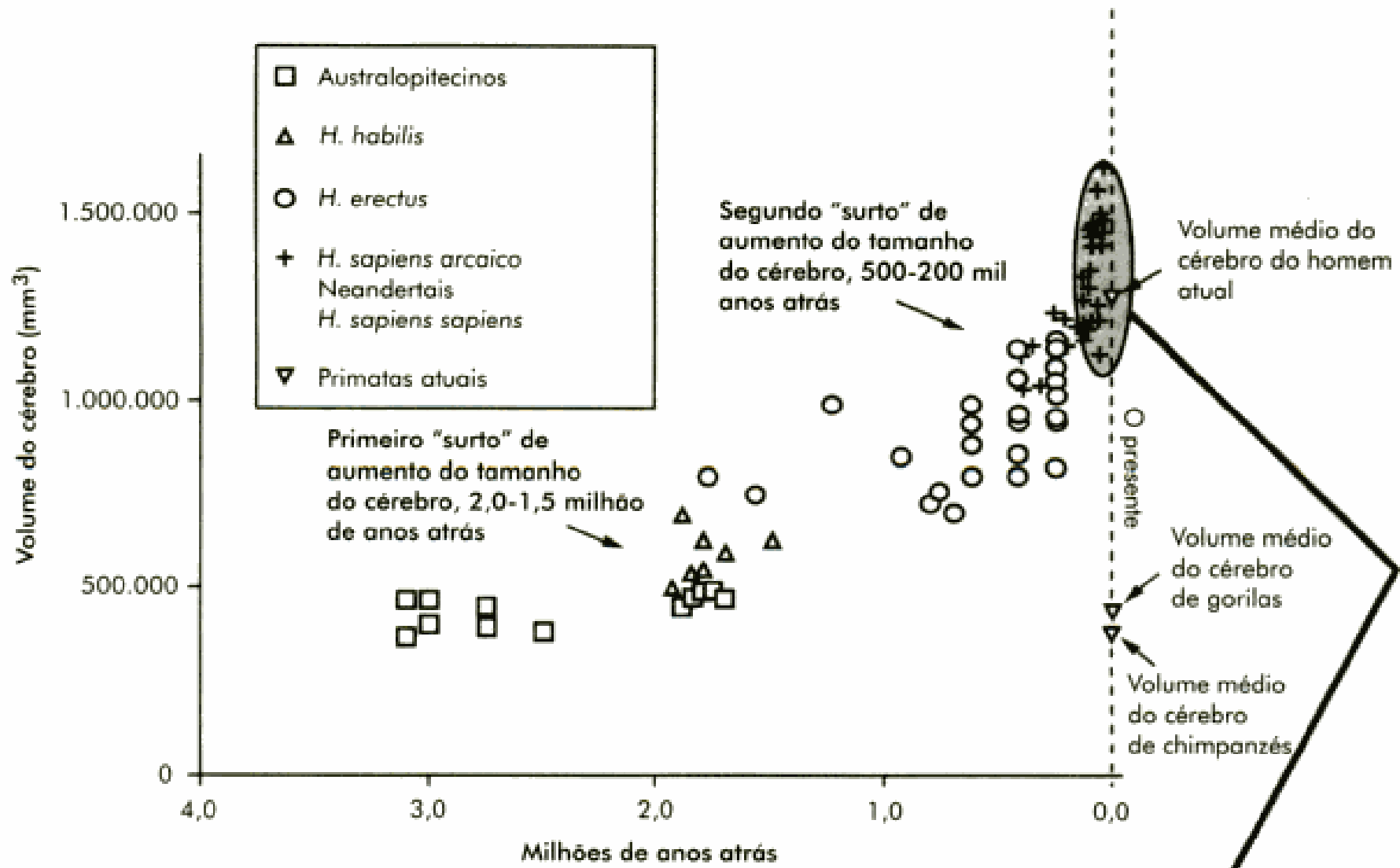
3 MILLION YEARS AGO

2 MILLION YEARS AGO

1 MILLION YEARS AGO

family tree. According to University of Tokyo paleontologist Gen Suwa, a co-discoverer of the 4.4. million-year-old





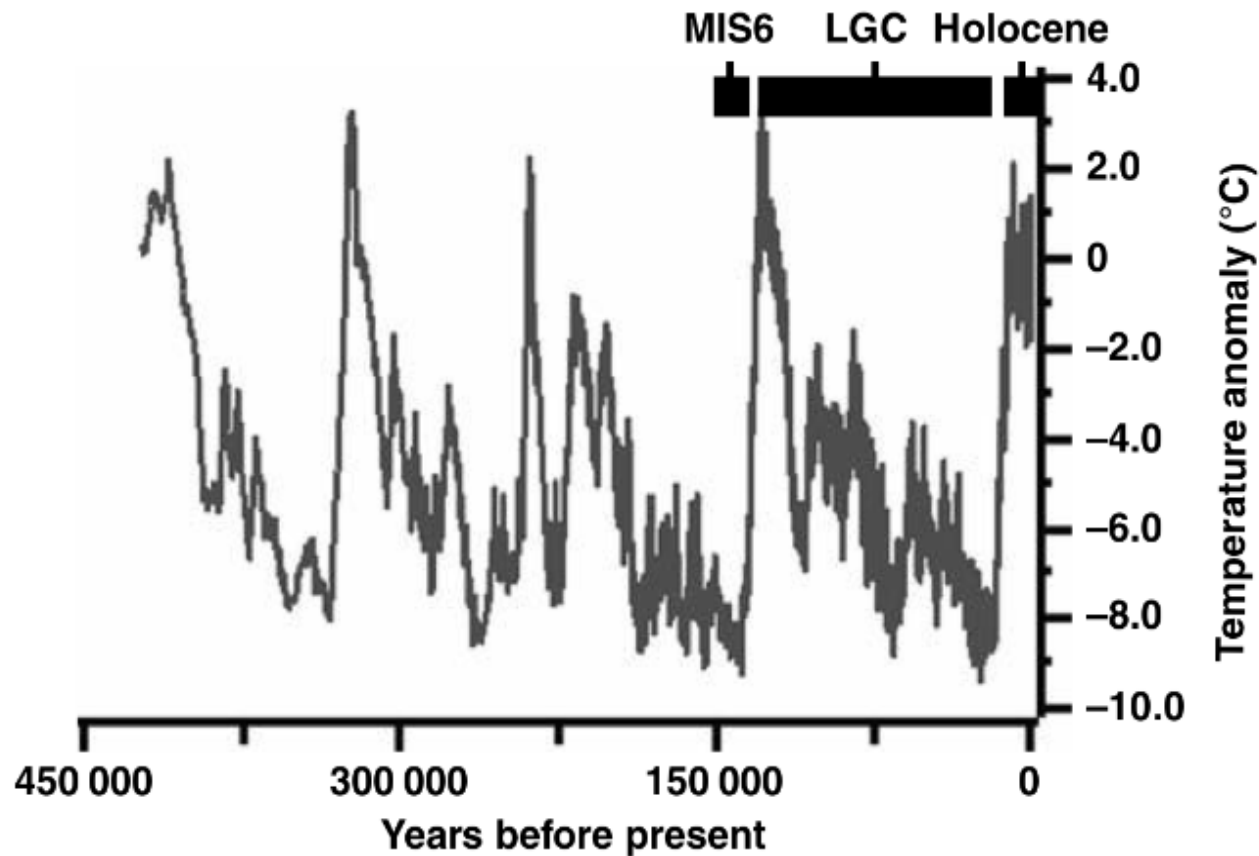
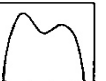
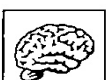
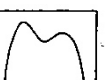
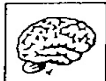
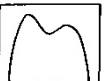
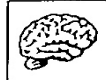
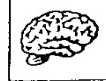
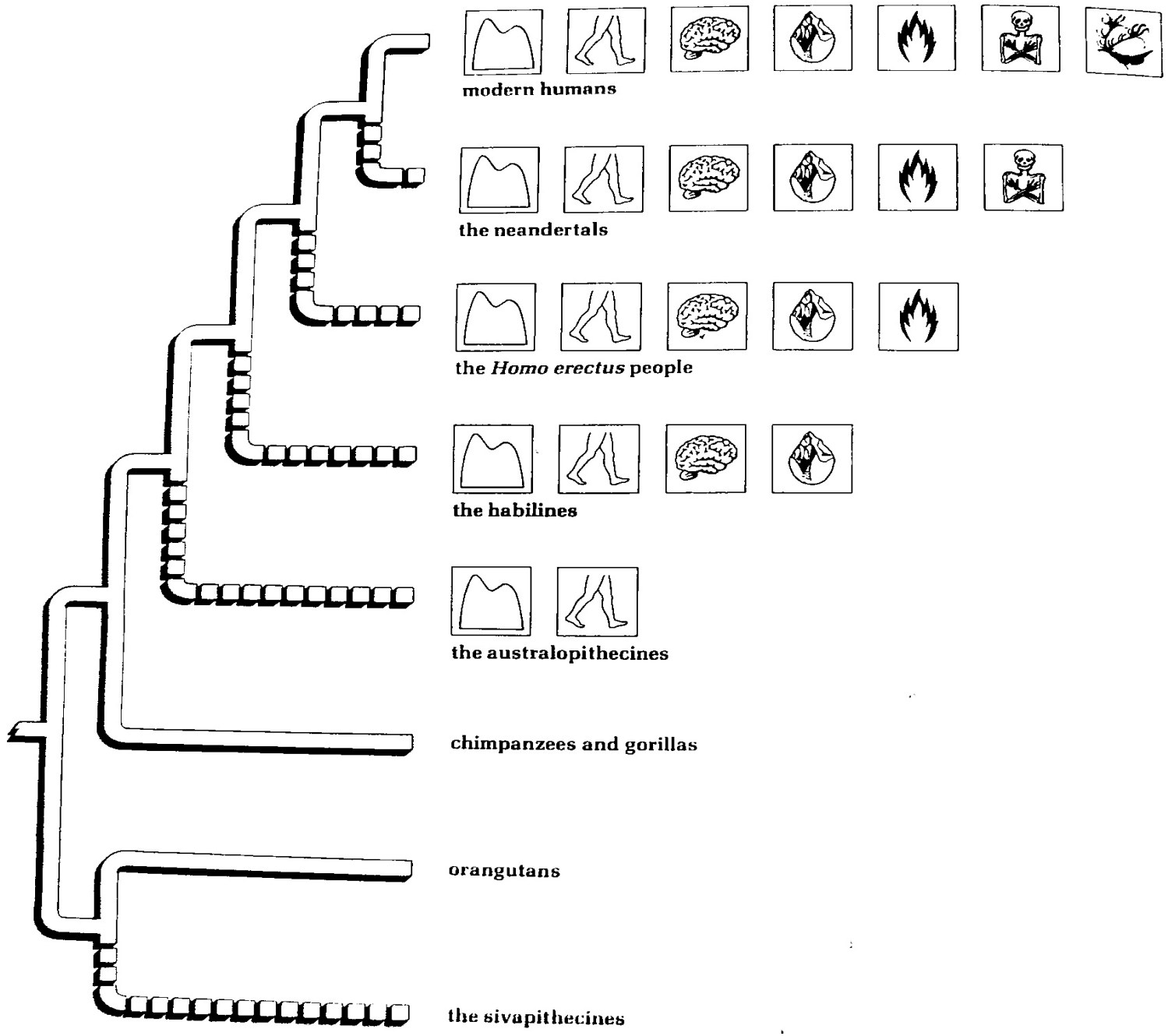
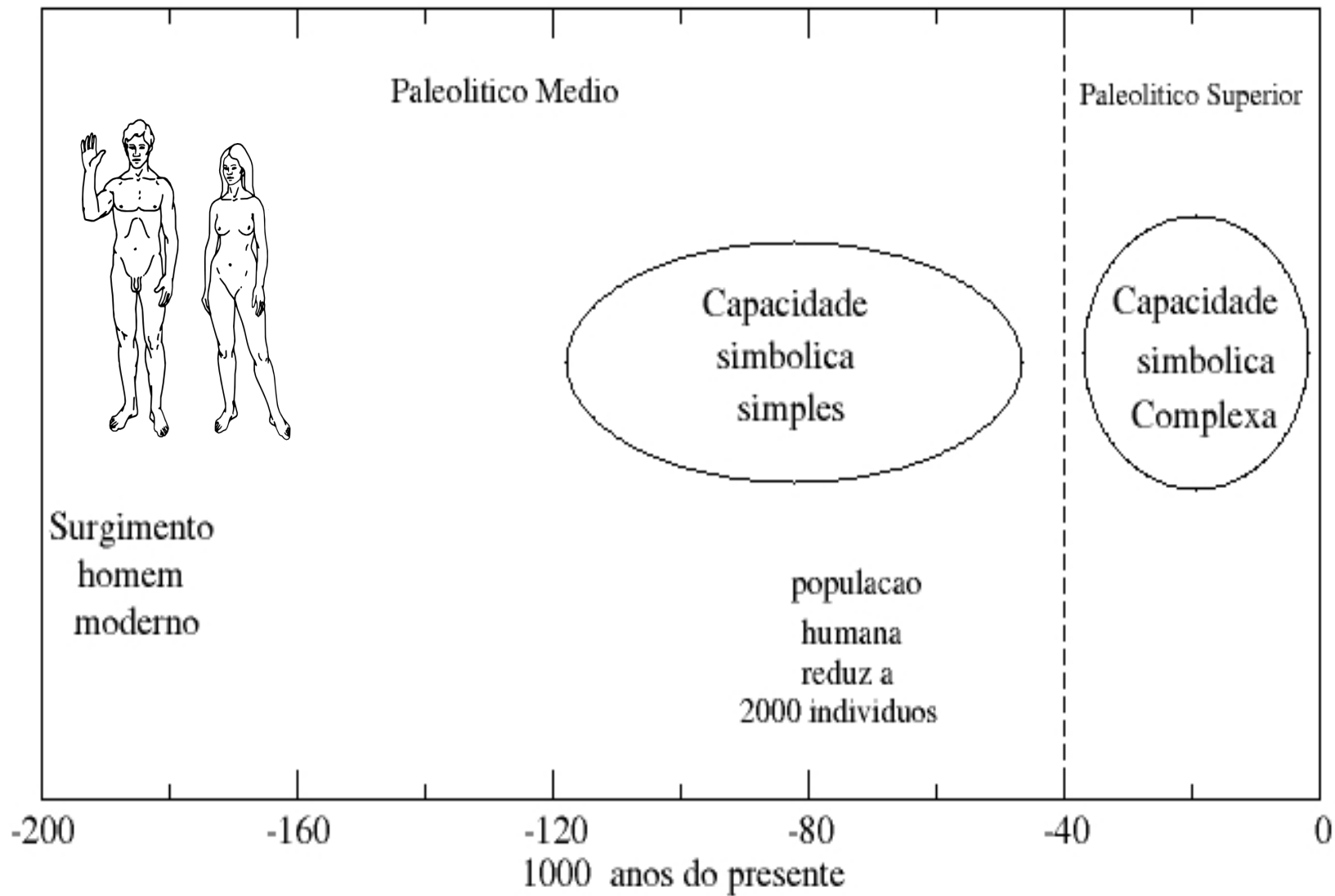


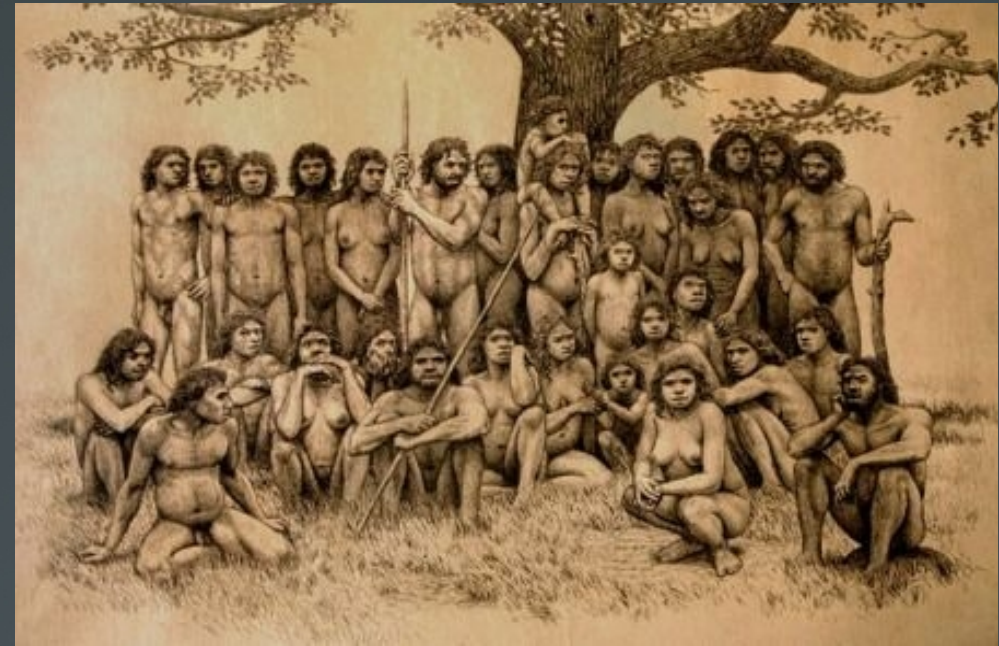
Figure 1.2 Temperature reconstruction of lower atmosphere over the last 450 000 years, expressed as an anomaly relative to present-day values. The data, described in Petit *et al.* (1999), is derived from analysis of historical stable isotopes from the Vostok ice core. Also indicated are marine isotope stage 6 (MIS6), last glacial cycle (LGC) and Holocene intervals.





Paleolítico Médio (antes de 40.000 a.C.)

- 300.000 a.C. : Cova dos Ossos;
- 285.000 a.C. : Ocre no Kenya;
- 233.000 a.c.: Estatueta em Israel;
- 200.000 a.C. : Ocre na Zambia;
- 130.000 a.C. : Mais antigo registro de enterro intencional (Croácia);
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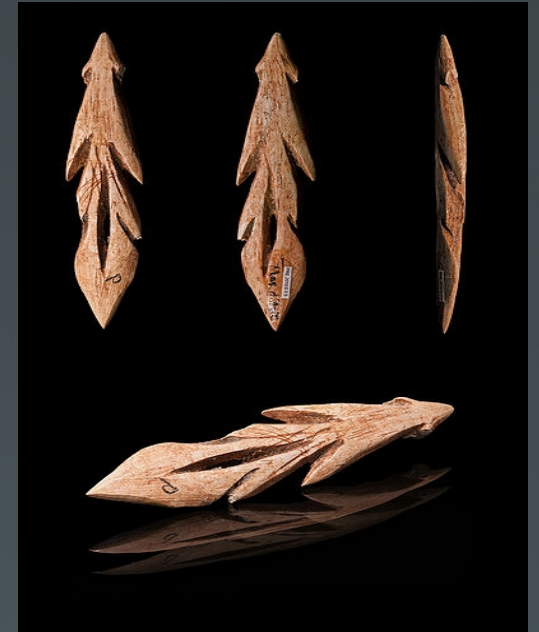
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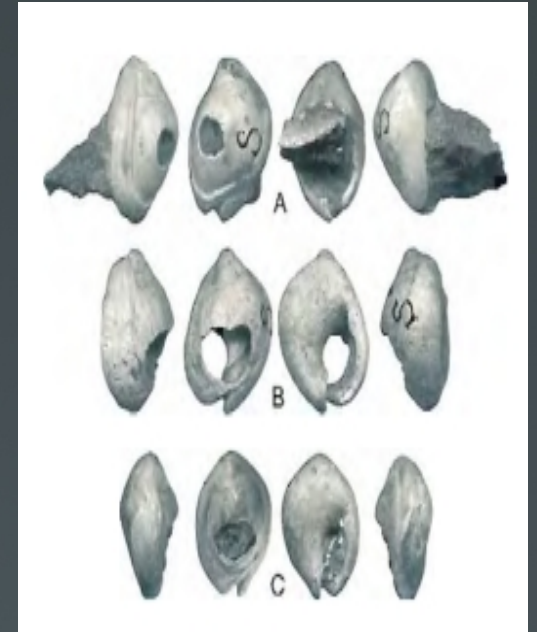
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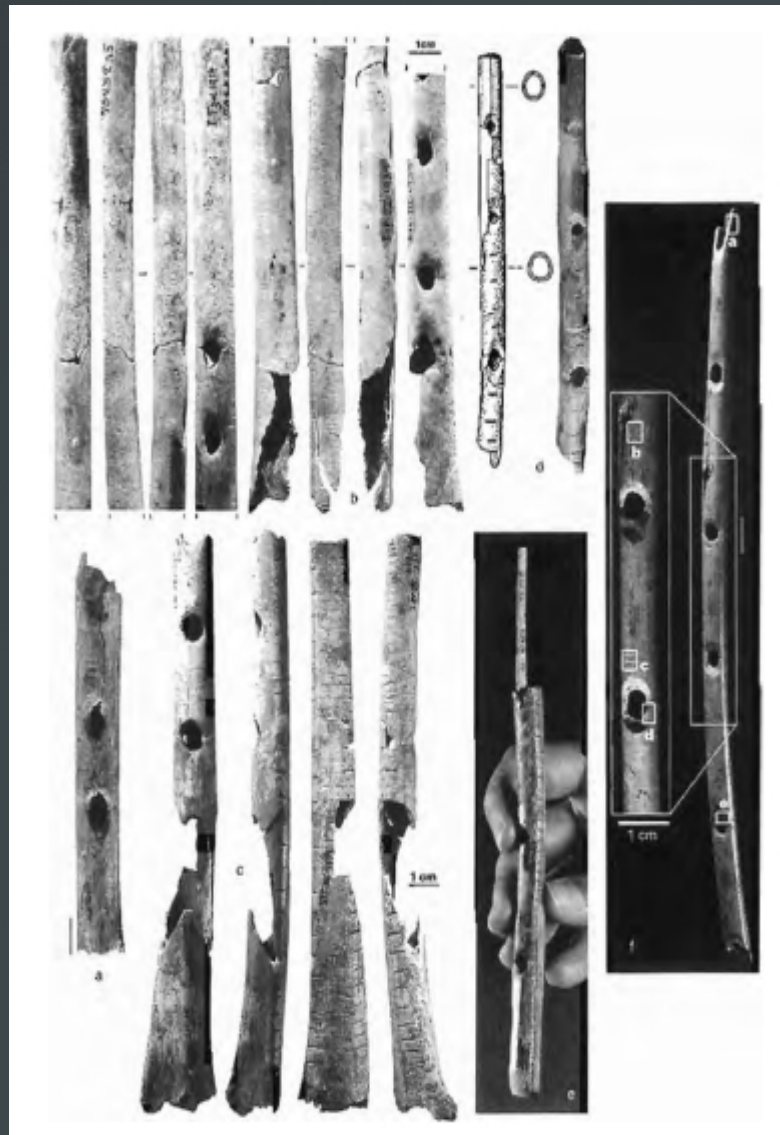
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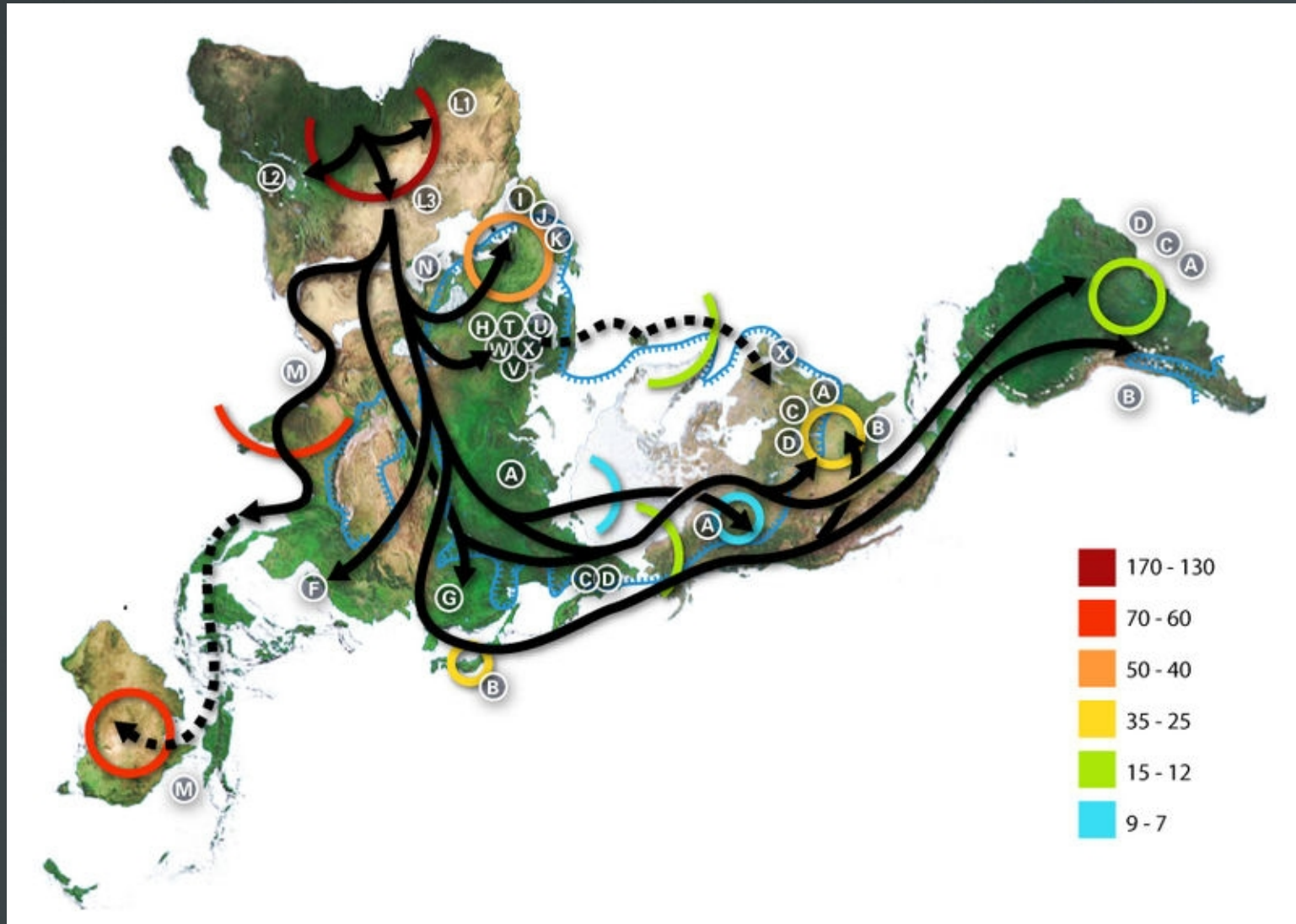
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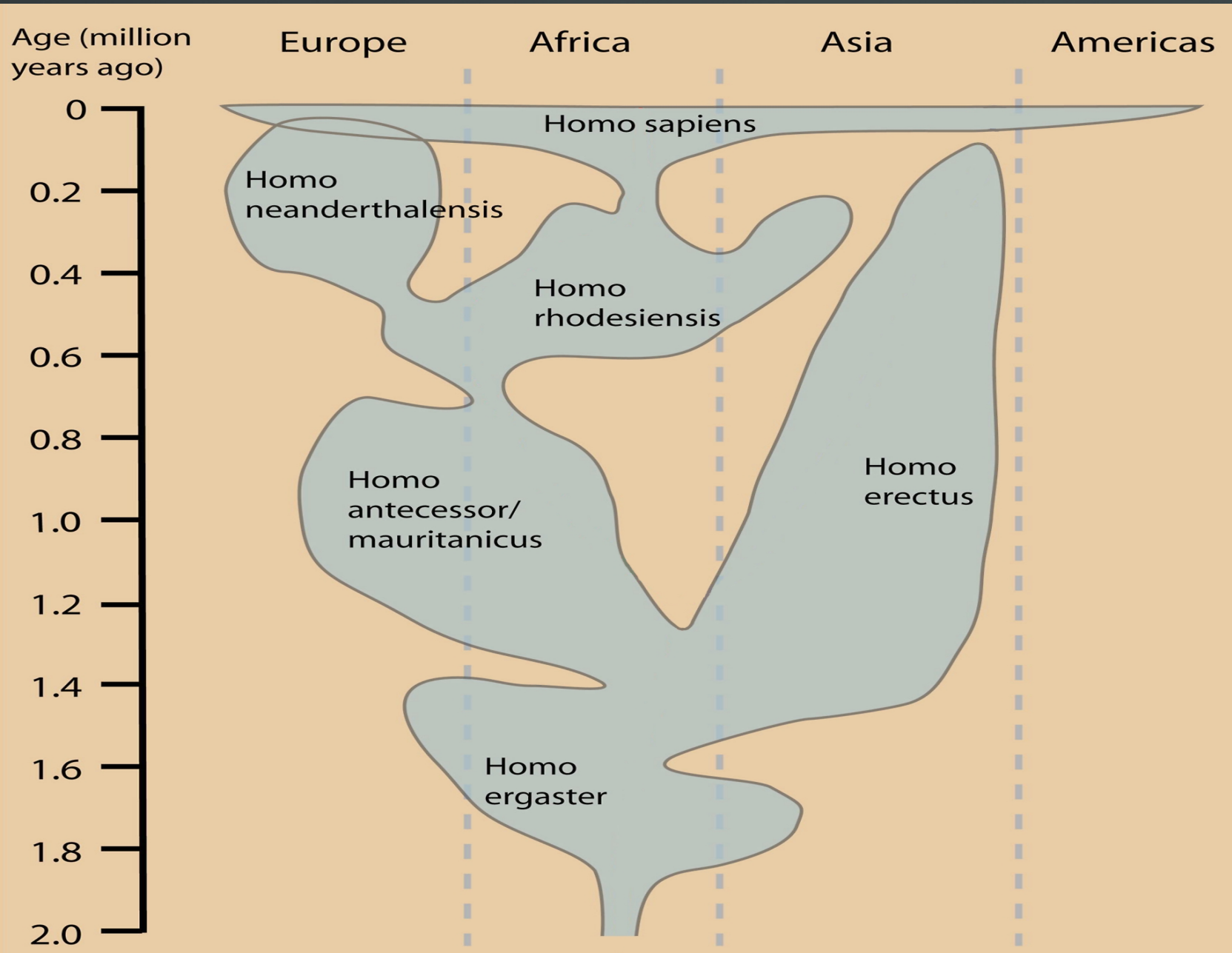


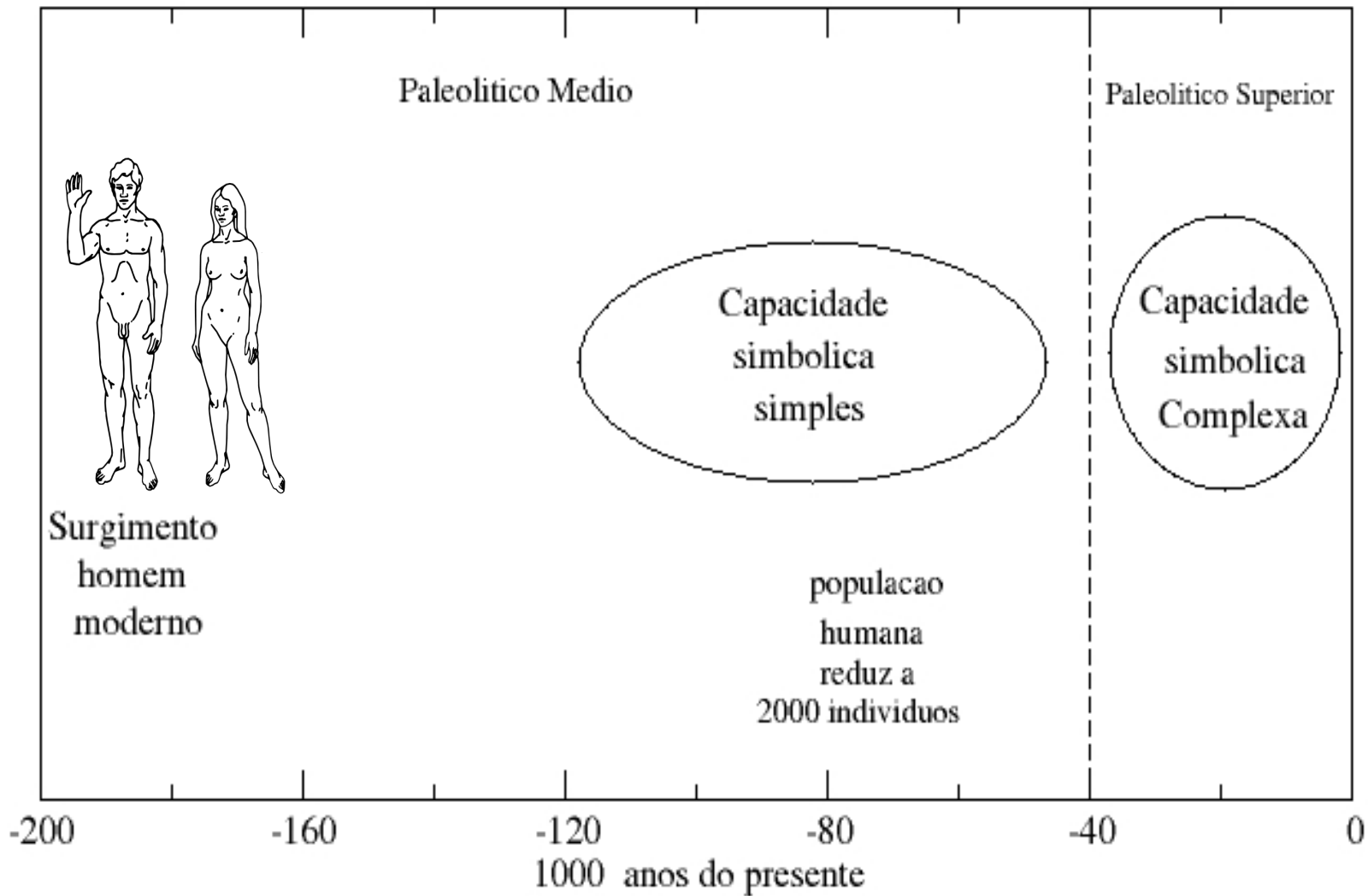
Paleolítico Superior (após 40.000 a.c.)



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O que aconteceu por volta de

40.000 a.C. ?

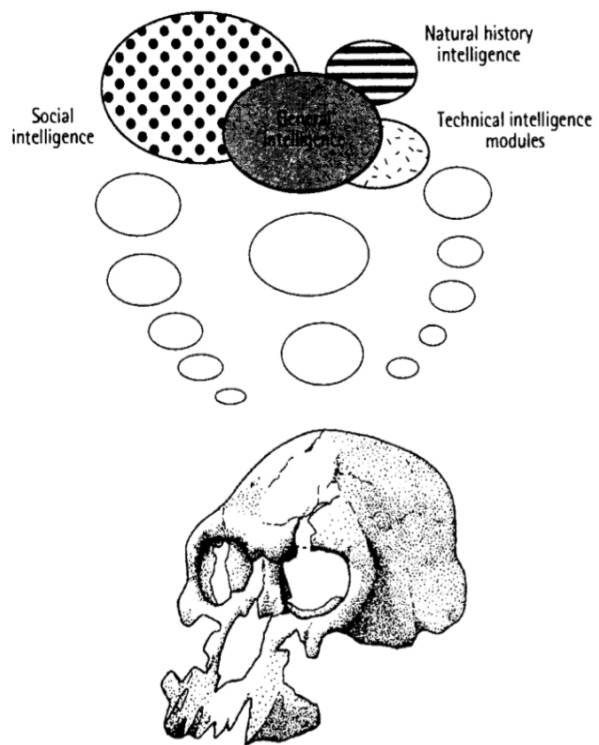


Hipoteses I: Mutação



The mind of the first stone toolmaker

127

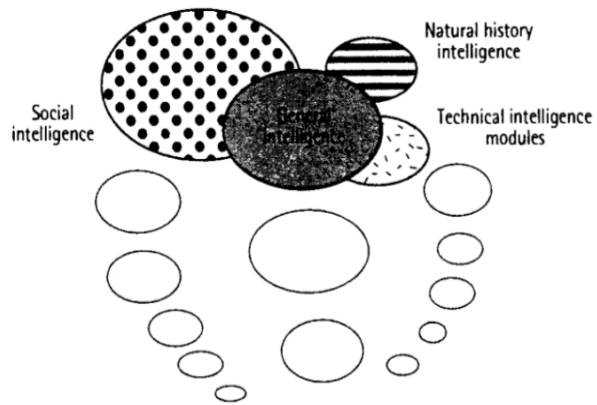


10 The mind of early Homo. The drawing depicts the H. habilis skull known as KNM-ER 1470. This was discovered in 1972 at Koobi Fora, Kenya, and dates to 1.9 million years ago.

1,5M ~ 40.000 a.C.



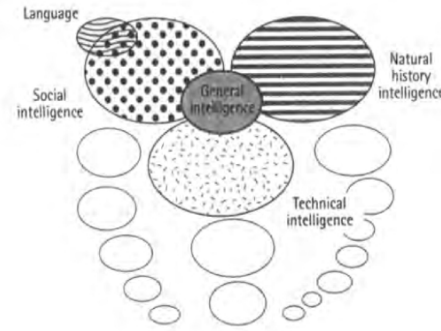
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The multiple intelligences of the Early Human mind



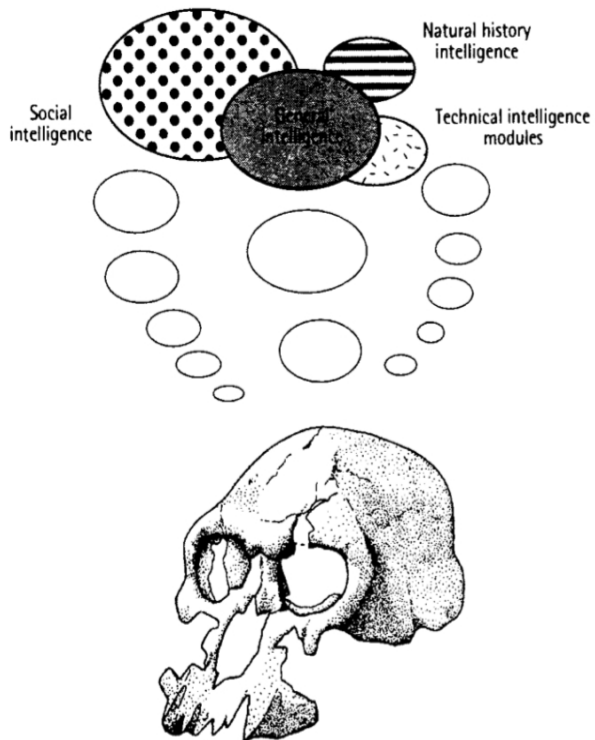
16 The mind of H. erectus. The drawing depicts the skull denoted by KNM-WT 15000, otherwise known as the Nariokotome boy. This was discovered in Kenya in 1984 and dates to around 1.6 million years ago.

100.000 ~ 40.000 a.C.



The mind of the first stone toolmaker

127

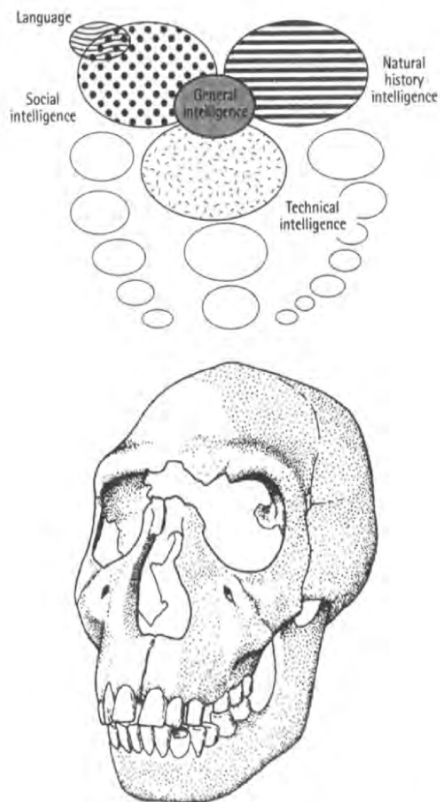


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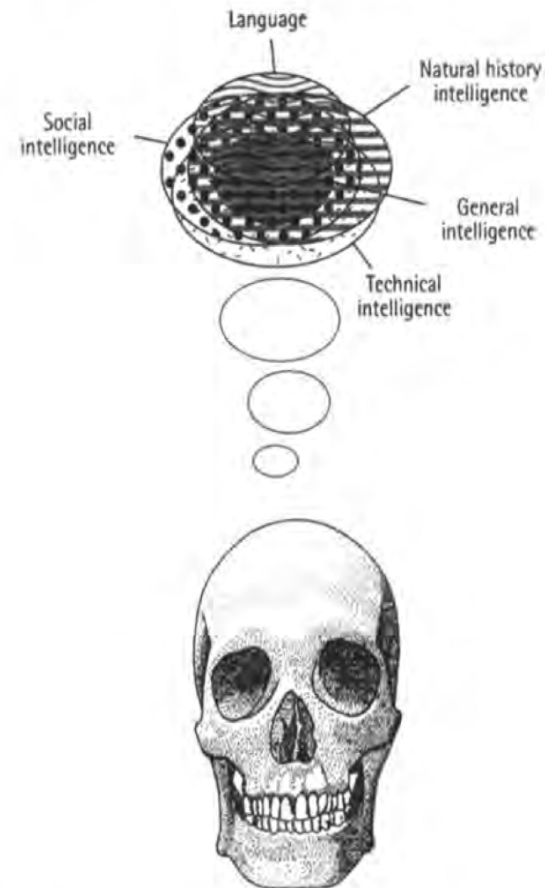
The multiple intelligences of the Early Human mind

165



16 The mind of H. erectus. The drawing depicts the skull denoted by KNM-WT 15000, otherwise known as the Nariokotome boy. This was discovered in Kenya in 1984 and dates to around 1.6 million years ago.

100.000 ~ 40.000 a.C.



17 The modern hunter-gatherer mind.

40.000 a.C.



Deficiências da Hipótese

- Escala de tempo:
rápida dissiminação
do pensamento simbólico;
- Lampejos Simbólicos do Paleolítico Médio.



Hipótese II: Emergência

- Homem moderno seria anatomica e mental-mente idêntico há 195.000 anos;
- Acontecimento de um evento (que não foi mutação) em torno de 40.000 atrás;
- Este evento proporcionou a Emergência de Comportamento Simbólico.

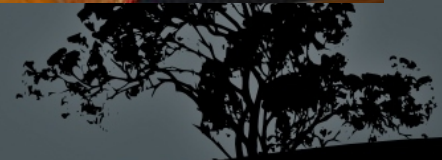


Que Evento foi esse?

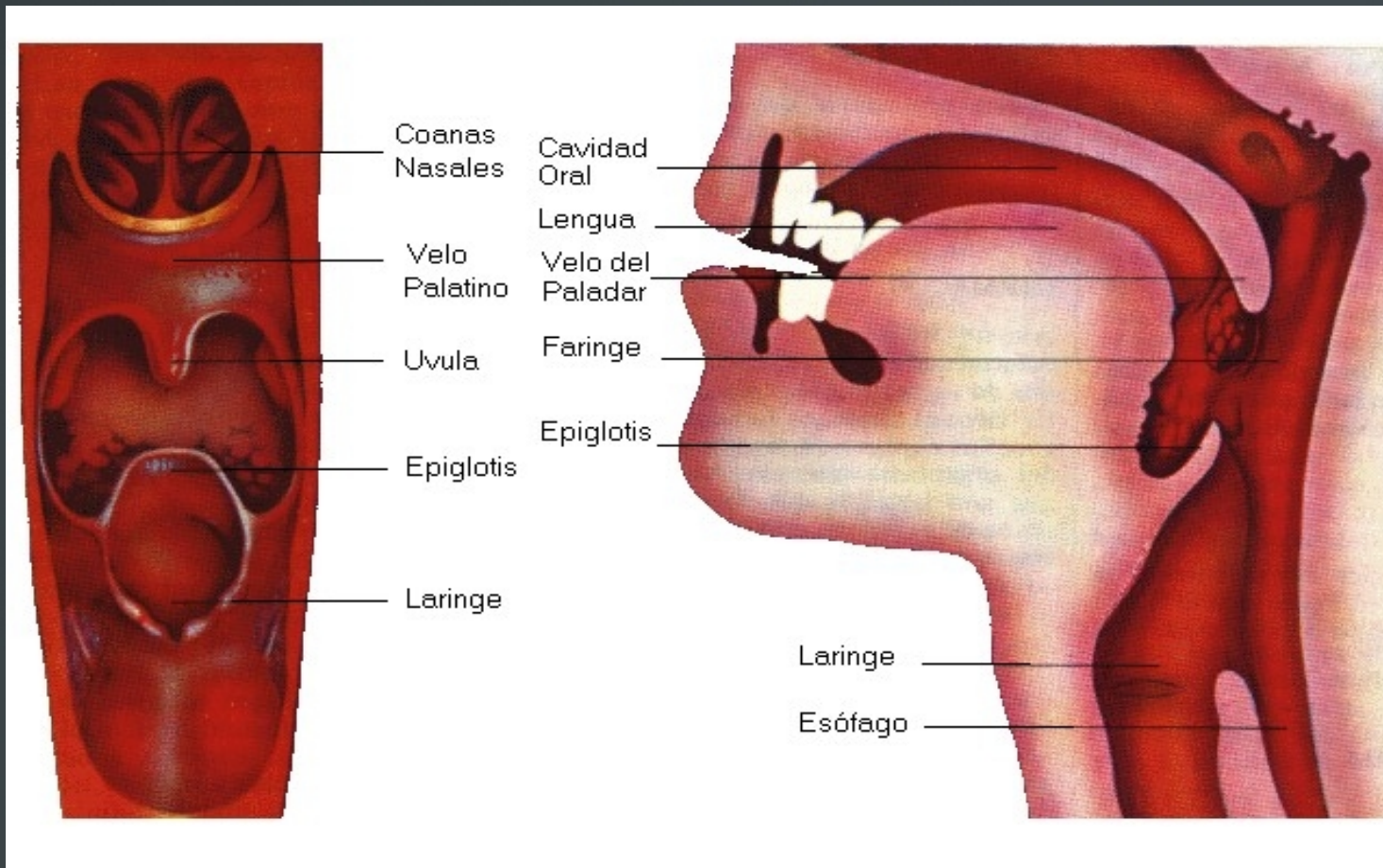




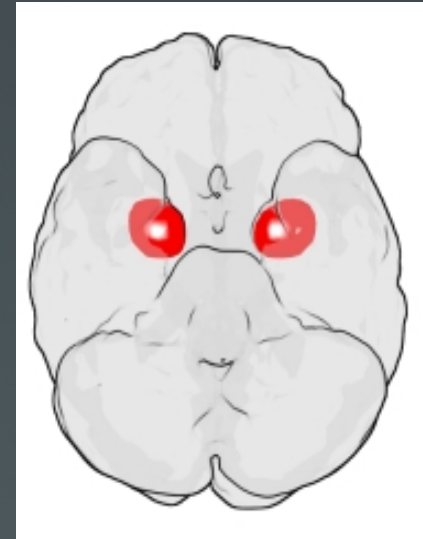
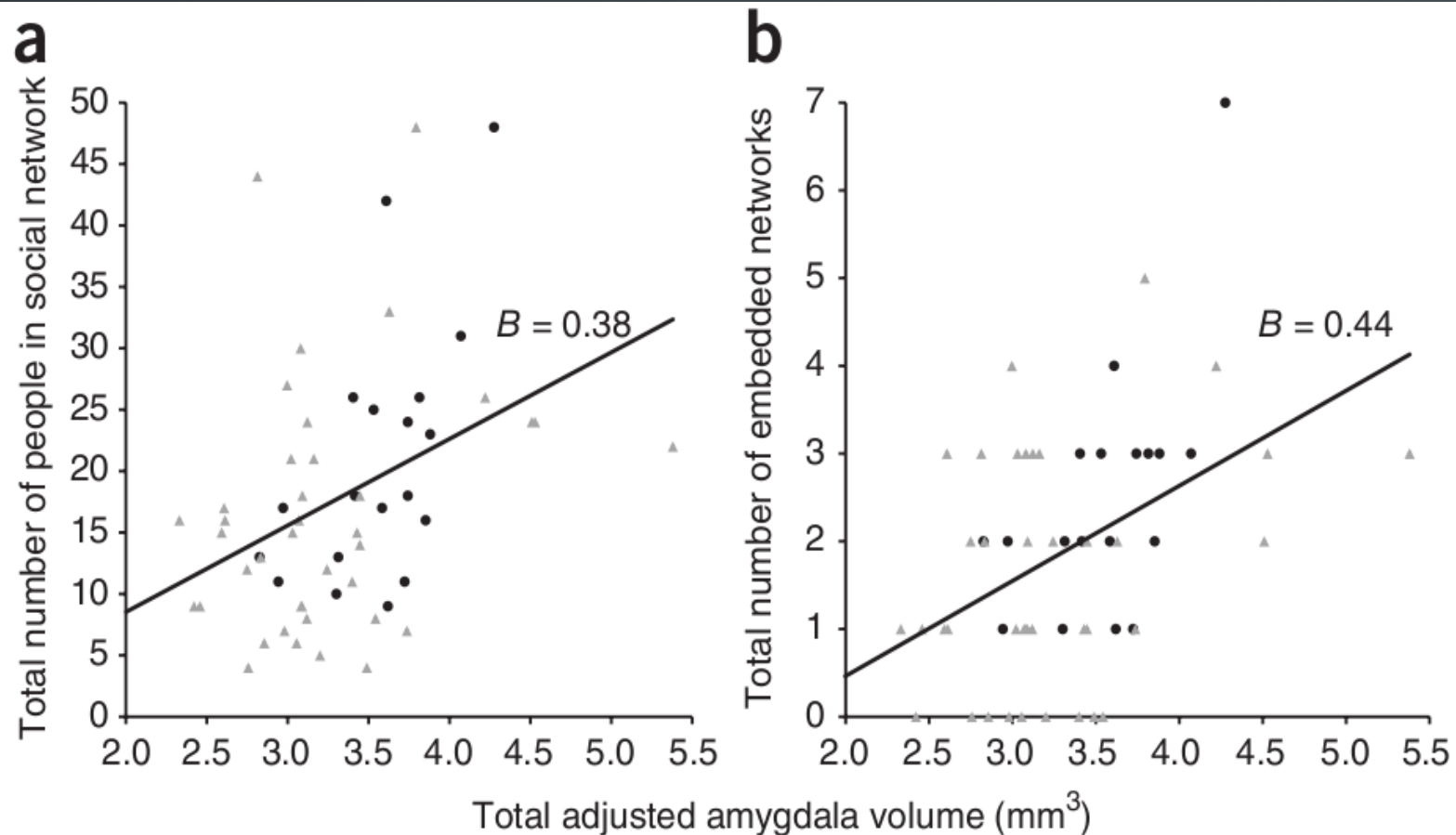
Evento Candidato: Linguagem Falada



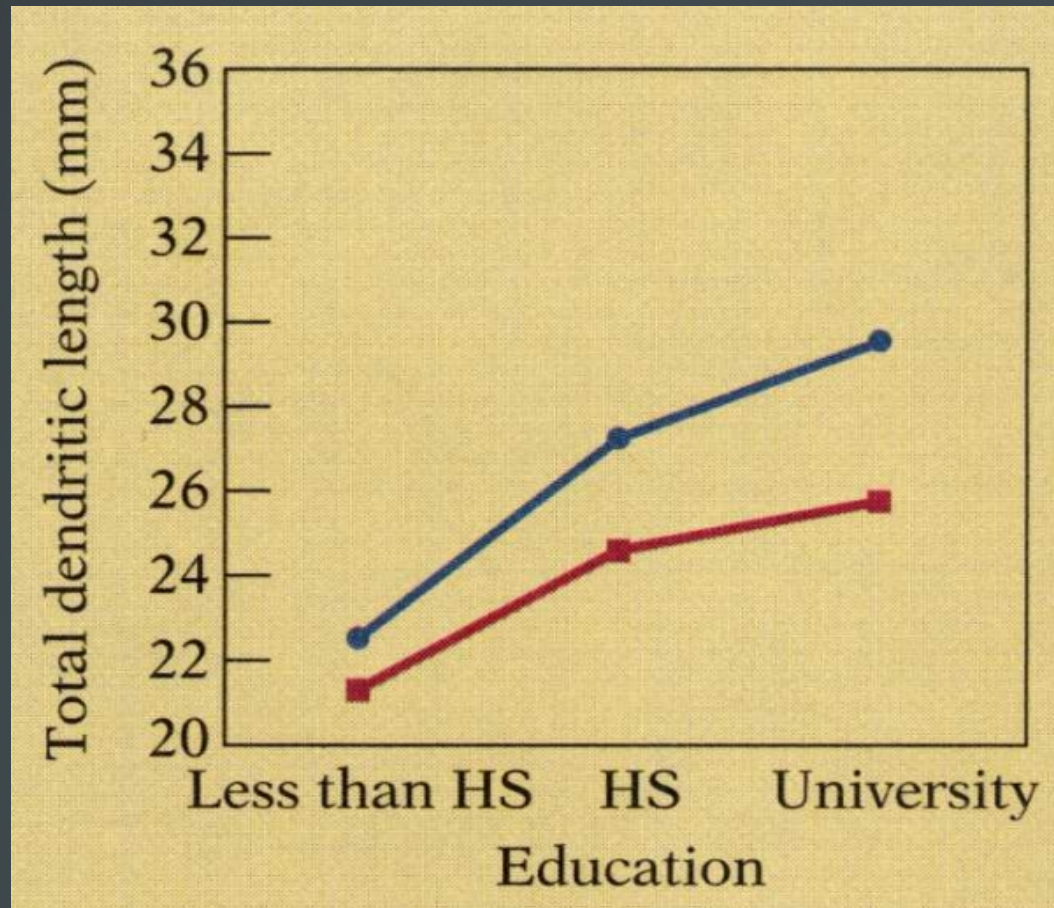
Evento Candidato: Linguagem Falada



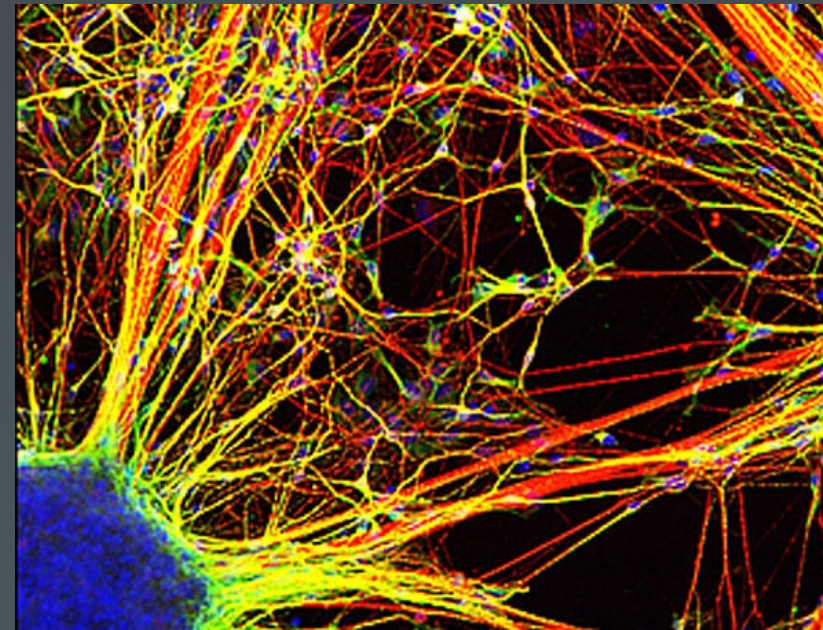
Cérebro Humano se diferencia de acordo com estímulos



Cérebro Humano se diferencia de acordo com estímulos



Linguagem → Trocas de informação → Complexidade Neural



**Modelos Matemáticos
para o estudo da
Emergência de Linguagem**





Modelo

1. Seleciona aleatoriamente 2 sítios da rede: i (passivo) e j (ativo);

$$i : (\sigma_{i1}, \sigma_{i2}, \dots, \sigma_{iF})$$

$$j : (\sigma_{j1}, \sigma_{j2}, \dots, \sigma_{jF})$$

onde

$$\sigma_{kf} = 0, 1, \dots, q - 1$$

2. Calcula o numero de sinais comuns entre i e j :

$$R_{ij} = \sum_{f=1}^F \delta_{\sigma_{if}\sigma_{jf}}$$

3. Se $R_{ij} > R_{trans}$, i adquire uma característica de j .

i

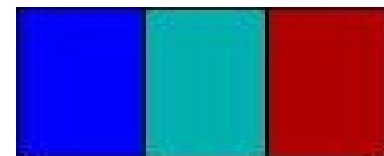


j



$$R_{ij} = 3$$

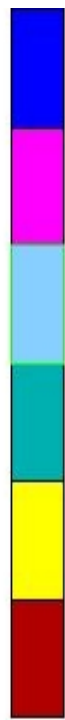
Informação Comum:



$$\text{Se } \mathbf{R}_{ij} > \mathbf{R}_{\text{trans}}$$

i

j



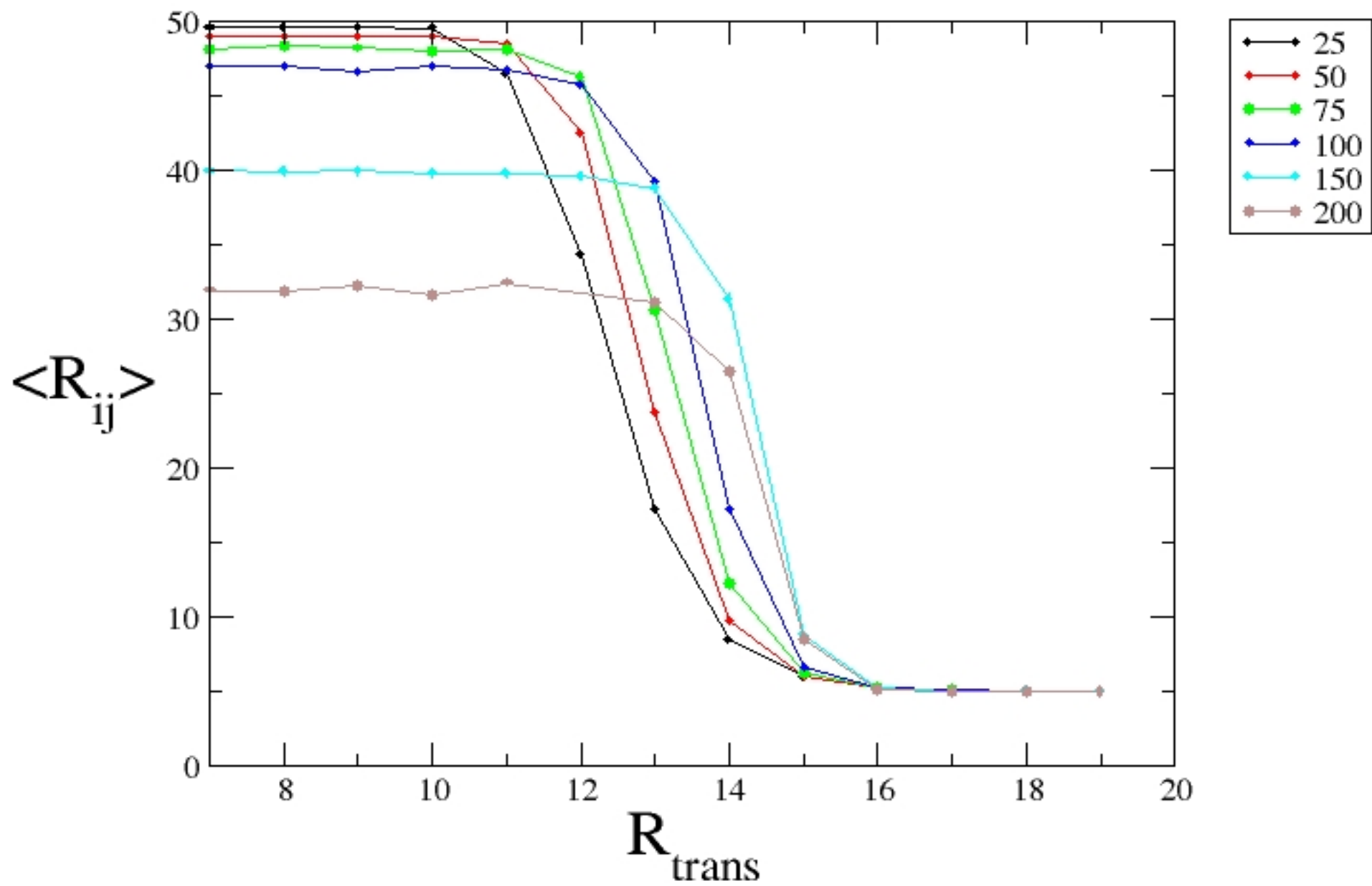
i

j

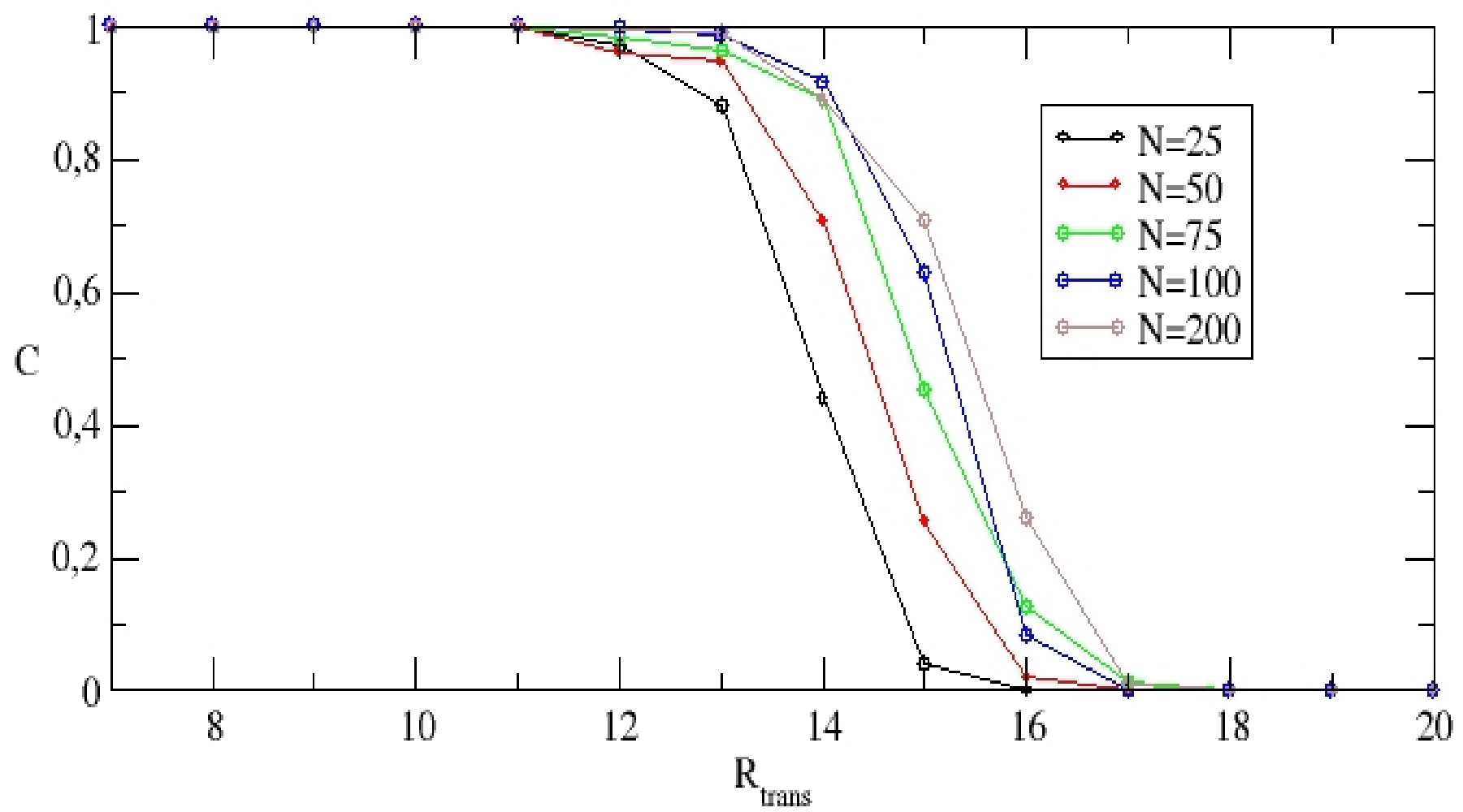


$$\mathbf{R}_{ij} = 3$$

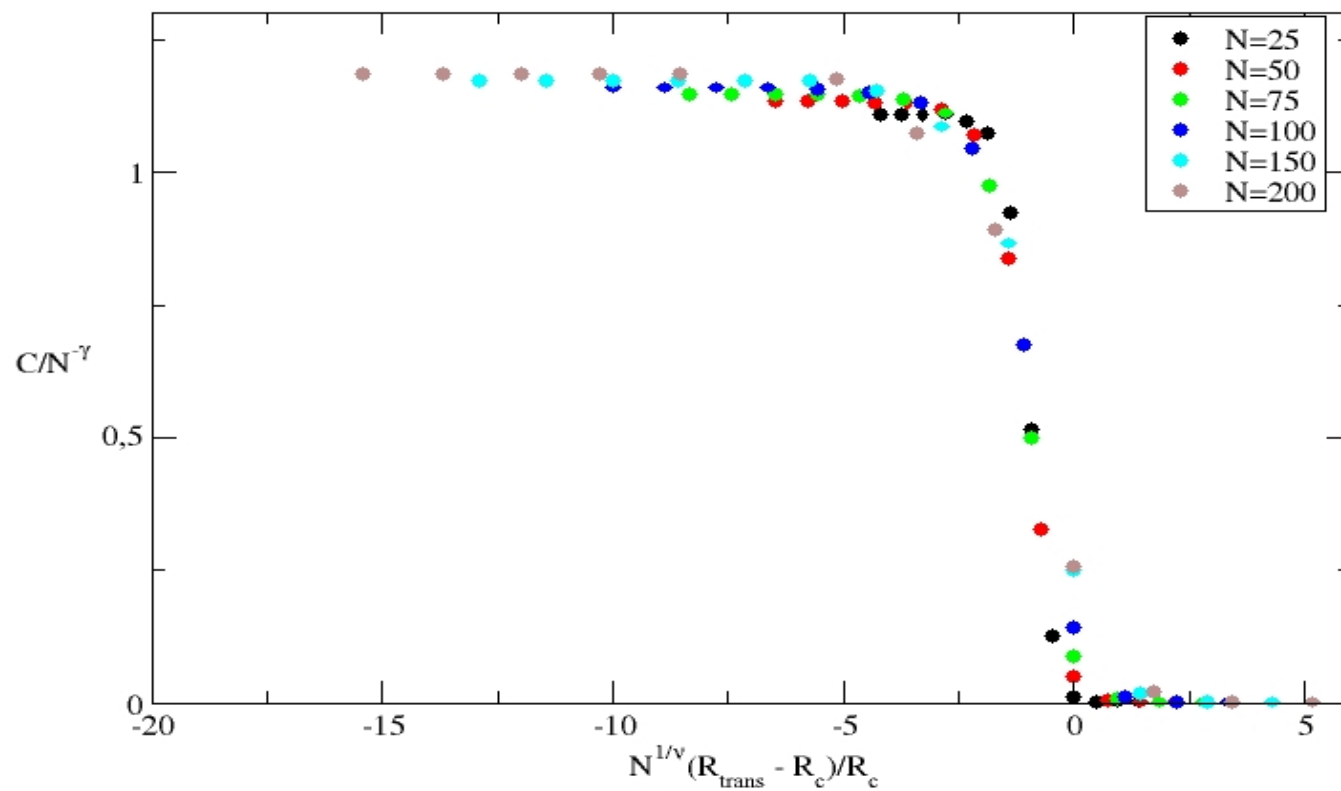
$$\mathbf{R}_{ij} = 4$$



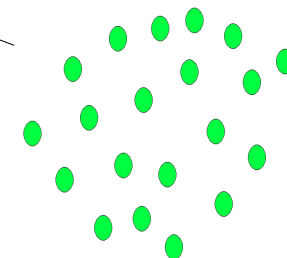
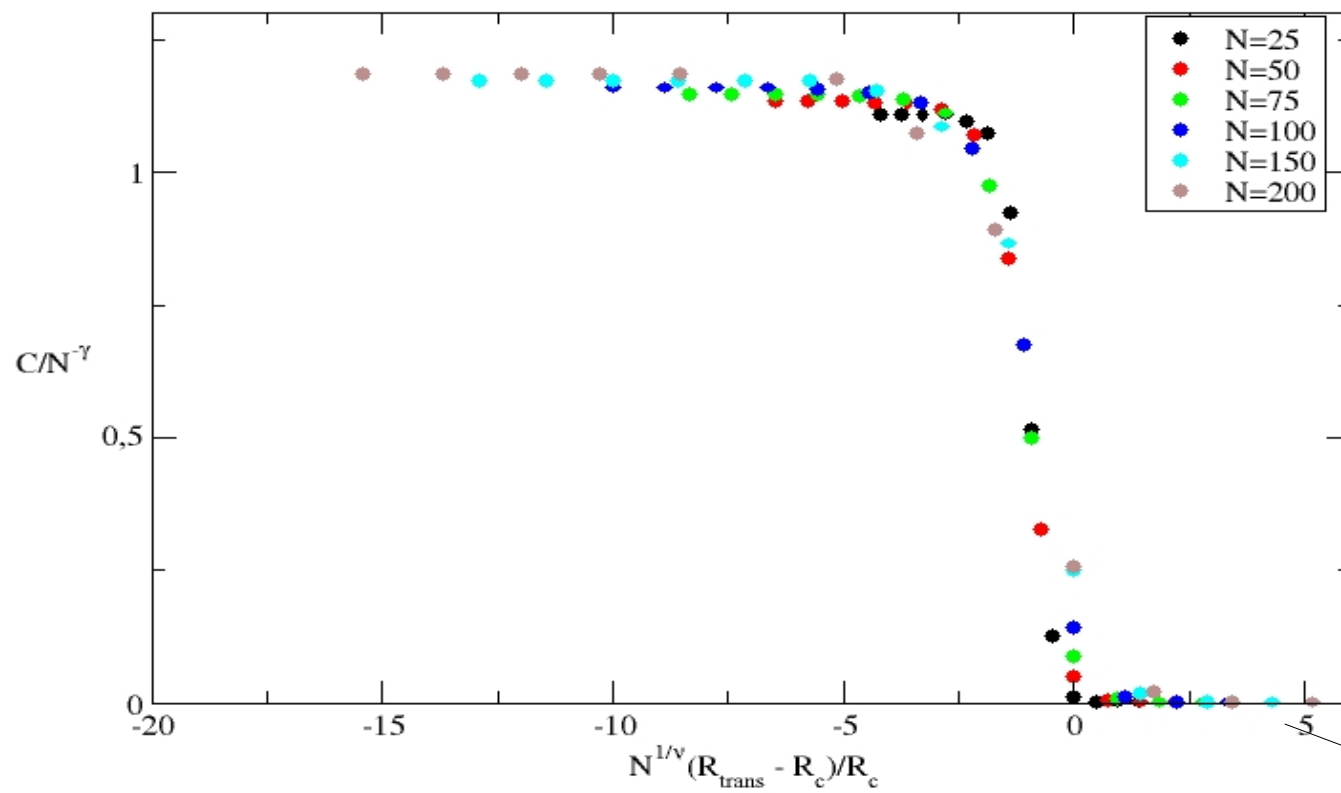
F=50 , q=10



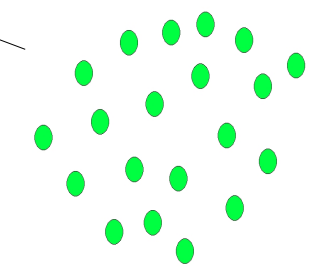
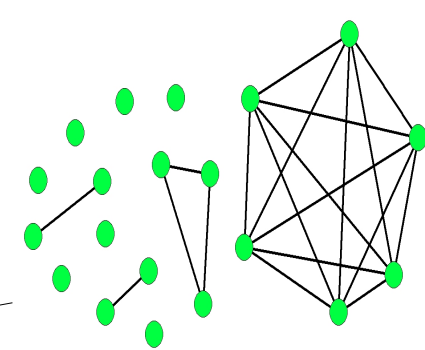
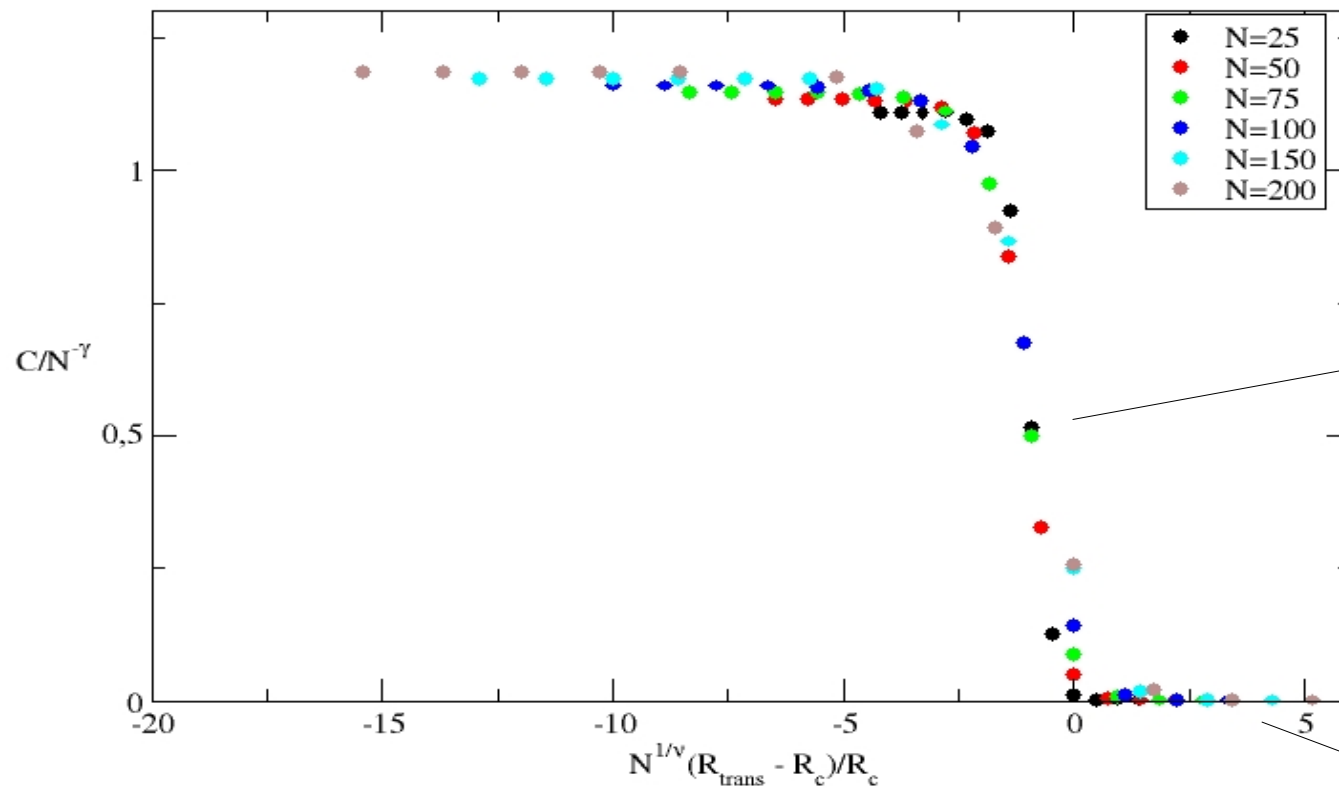
$\gamma=0.032$, $\nu=1.6$, and $R_c=16$

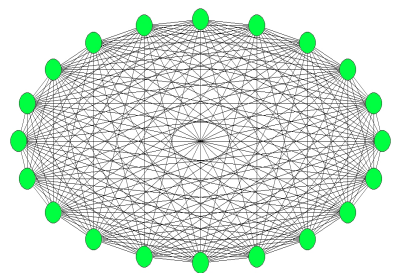


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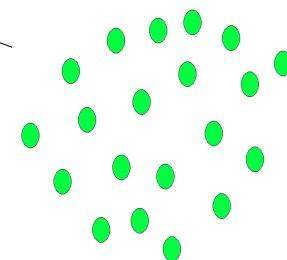
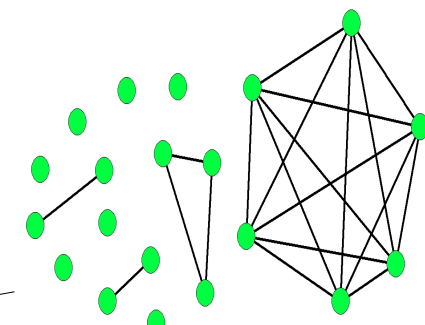
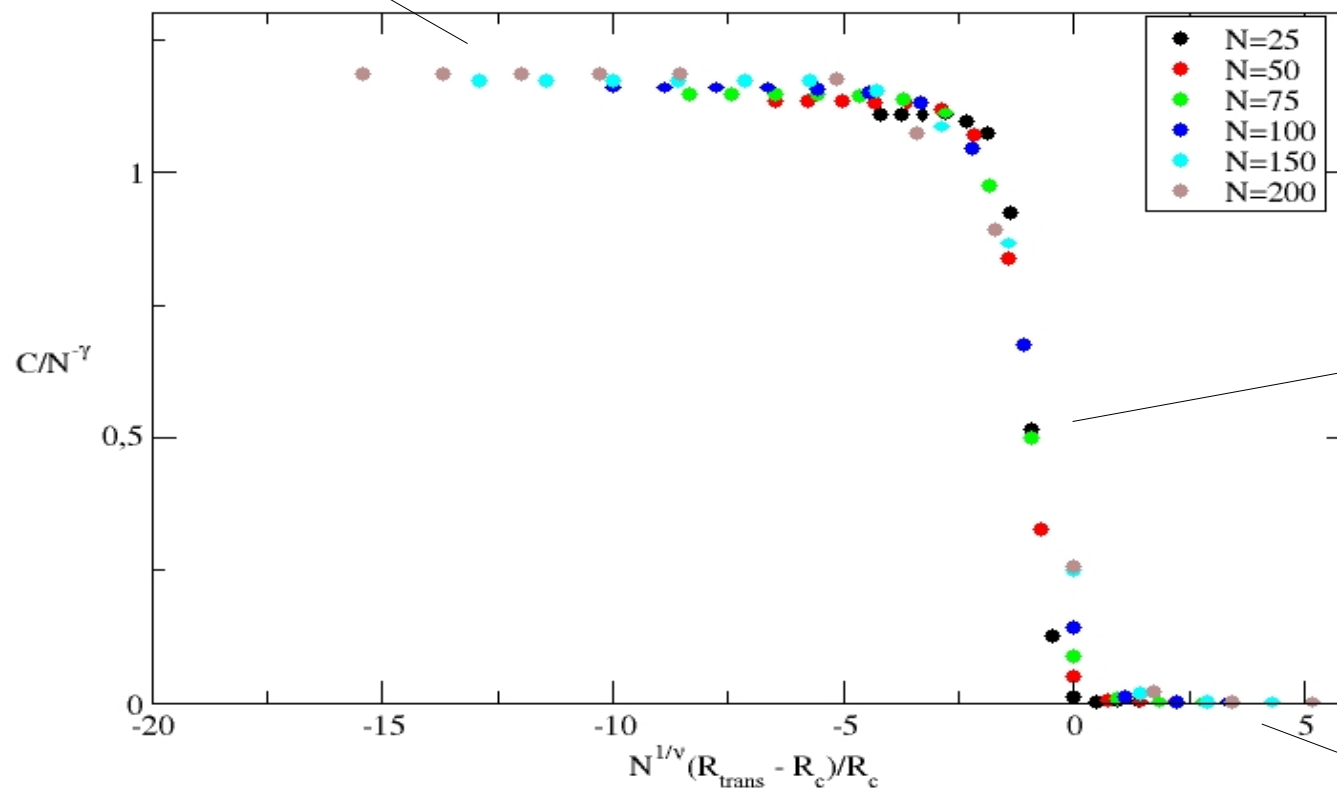


$\gamma=0.032$, $\nu=1.6$, and $R_c=16$





$\gamma=0.032$, $\nu=1.6$, and $R_c=16$



Transição de Fase em sistemas Físicos

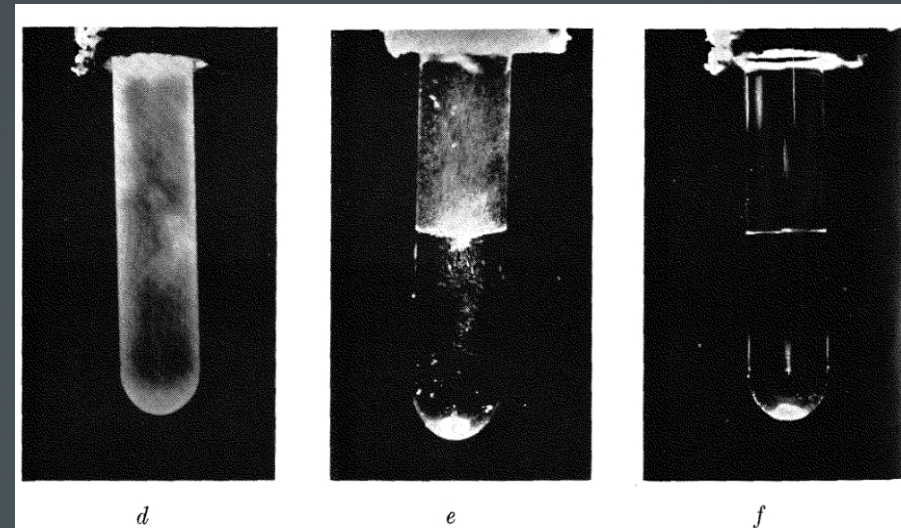
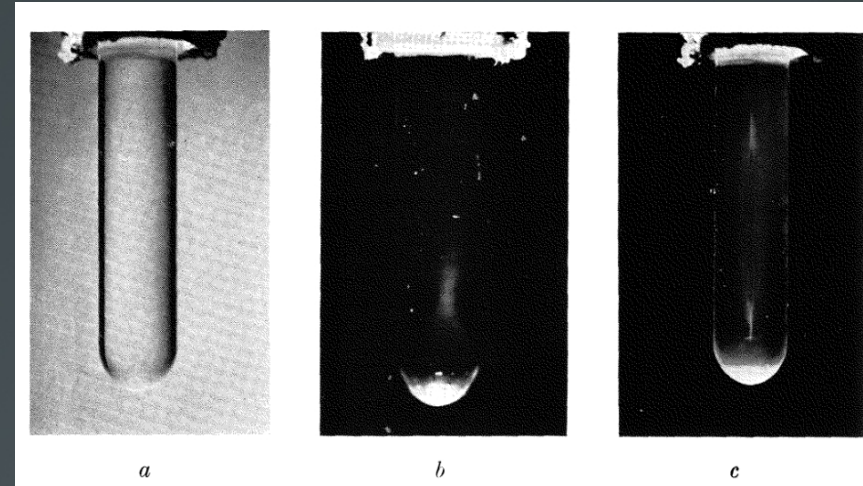
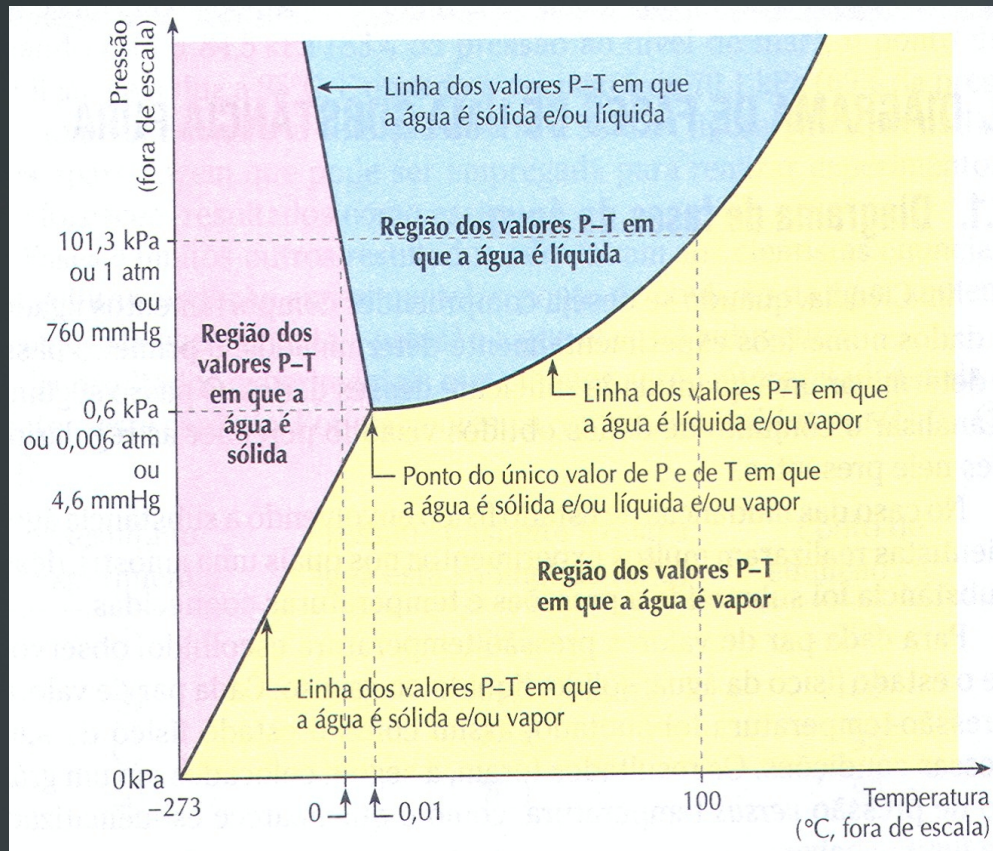
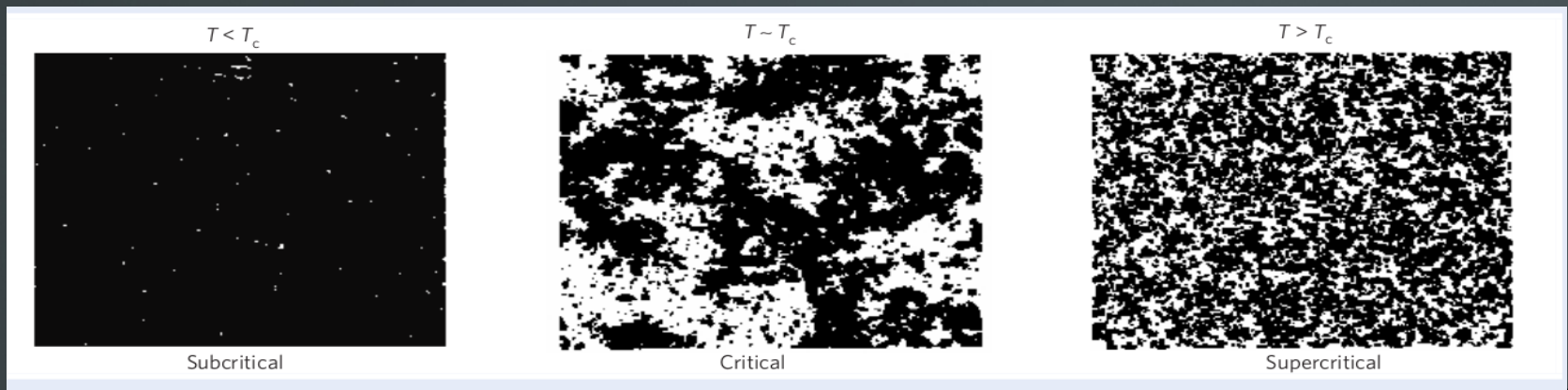
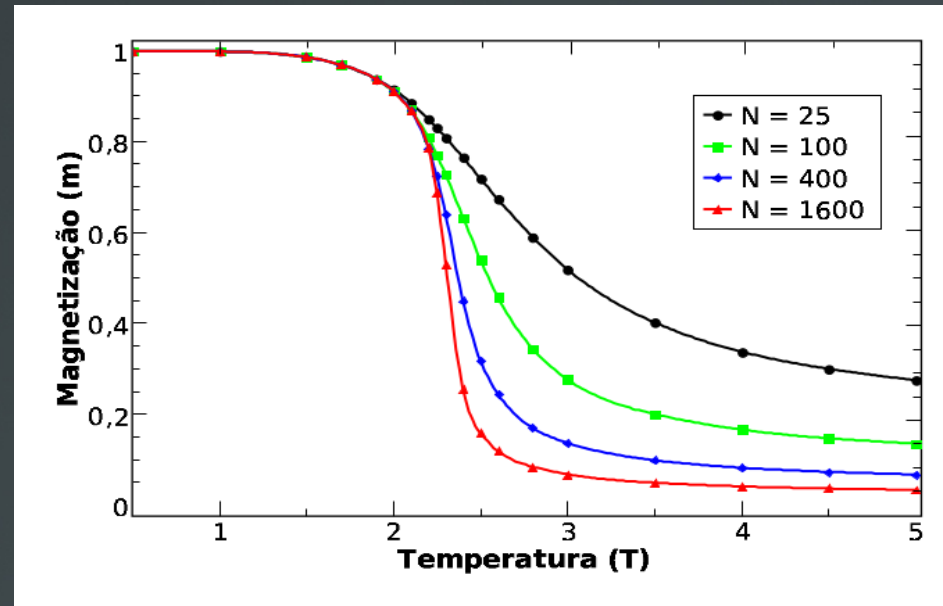


FIG. 1.6. Behaviour of a fluid as the temperature is lowered past the critical temperature: (a), $T \gg T_c$; (b), $T \gtrsim T_c$; (c), $T \simeq T_c$; (d), $T \lesssim T_c$; (e), $T < T_c$; and (f), $T \ll T_c$. The fluid shown is the binary mixture cyclohexane-aniline. After Ferrell (1968).

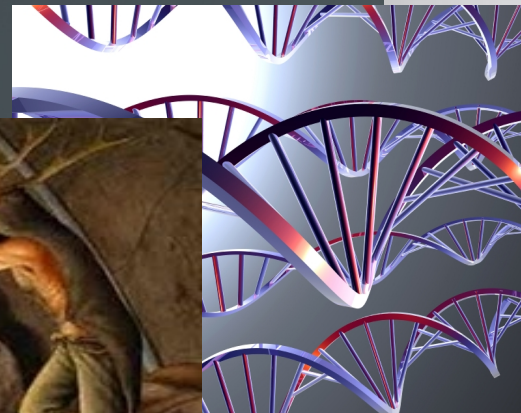
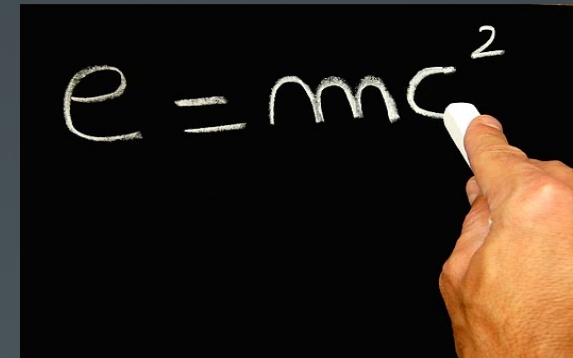
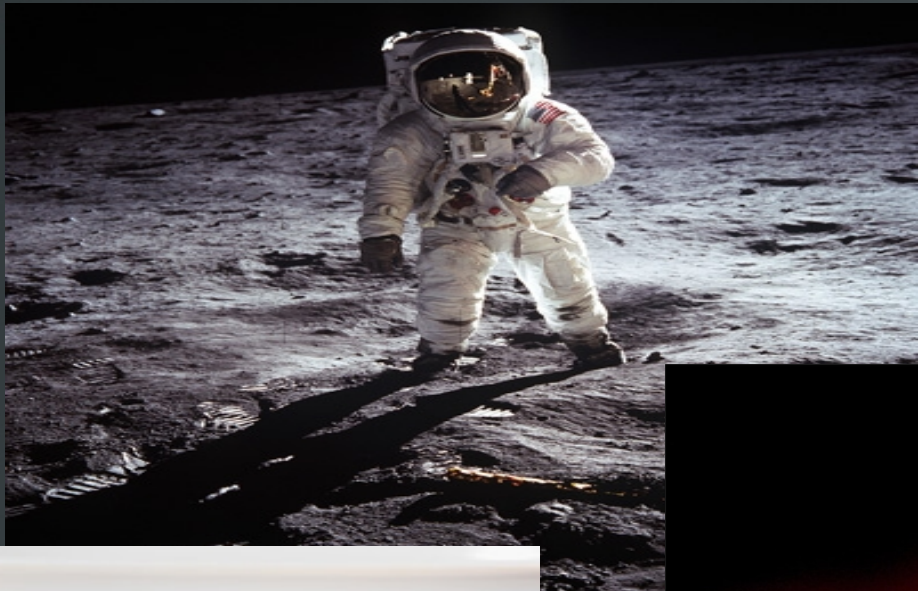
Transição de Fase em sistemas Físicos



Cultura

Crenças, mitos, ideias, conhecimentos e costumes
compartilhados por um grupo de indivíduos



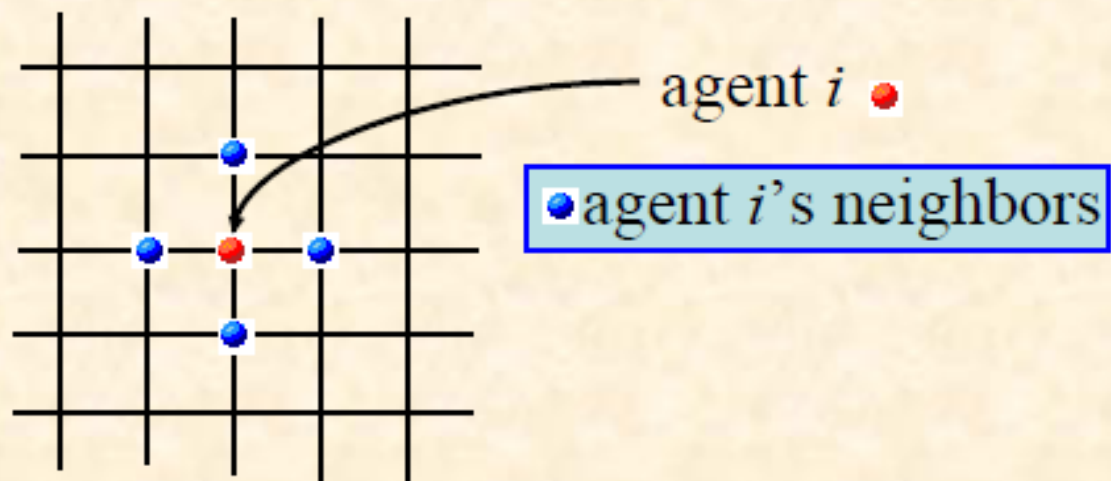








Axelrod's agents based model: interaction

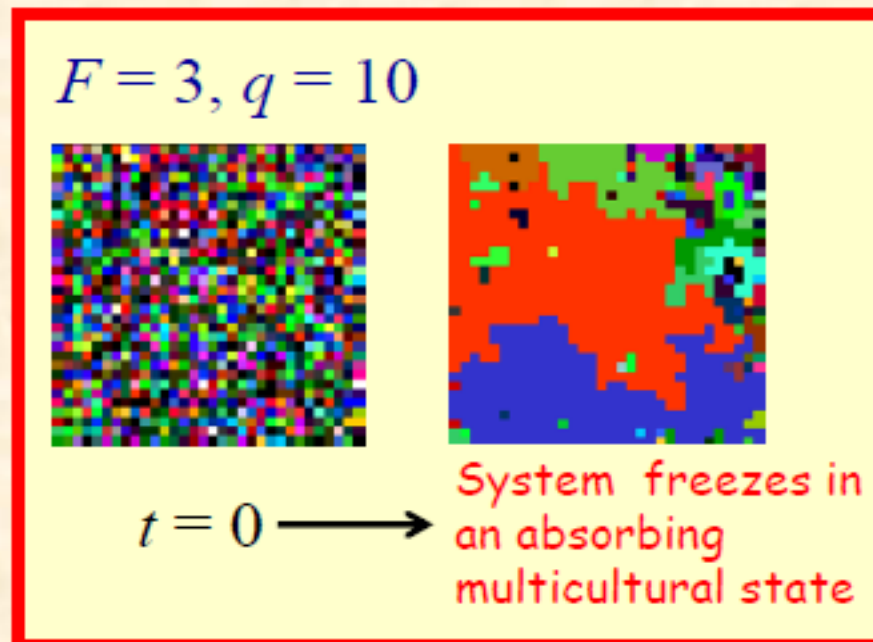


$$\begin{pmatrix} \sigma_{i1} \\ \sigma_{i2} \\ \vdots \\ \sigma_{iF} \end{pmatrix} \quad \begin{array}{l} F = \# \text{ Features} \\ q = \# \text{ Traits per} \\ \text{feature} \\ \sigma_{if} \in \{0, \dots, q-1\} \end{array}$$

$F=3; q=10$ $q^F (10^3)$ equivalent cultural options.

$\begin{pmatrix} 0 \\ 0 \\ 7 \end{pmatrix} \begin{pmatrix} 5 \\ 9 \\ 7 \end{pmatrix}$	<p>Mechanism of local convergence:</p> <div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 0 auto;"> <p>Prob to interact =</p> <hr style="border: 0; border-top: 1px solid black; margin: 5px 0;"/> <p>Common features = $\frac{1}{3}$</p> </div>	$\begin{pmatrix} 5 \\ 0 \\ 7 \end{pmatrix} \begin{pmatrix} 5 \\ 9 \\ 7 \end{pmatrix}$
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Axelrod's Dynamics



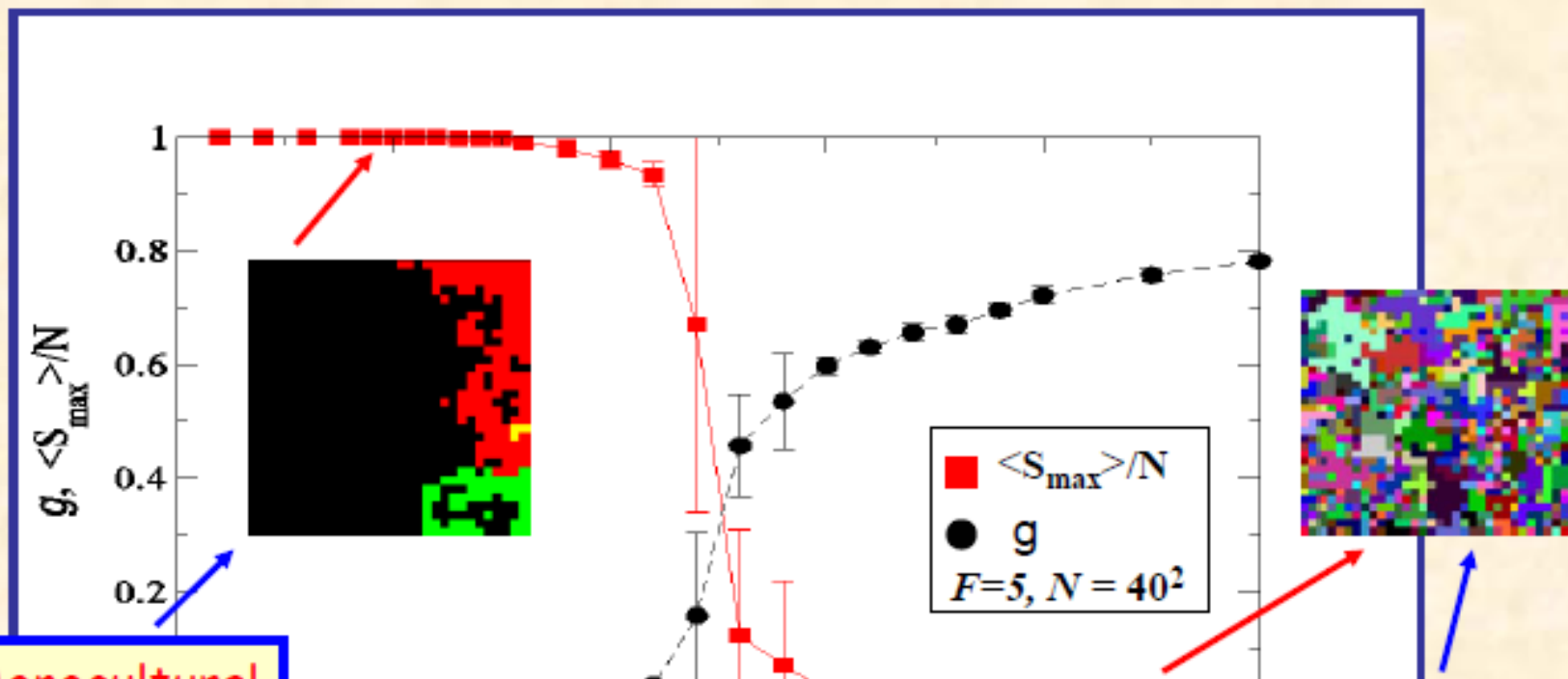
http://www.imedea.uib.es/PhysDept/research_topics/socio/culture.html

- The model illustrates how **local convergence** can generate **global polarization**.
- Number of domains taken as a measure of cultural diversity
- Uniform state always prevails without similarity rule (*Kennedy 1998*)

Polarization-Globalization transition in Axelrod's model

Order parameters: a) S_{\max} size of the largest homogeneous domain

b) $g = \langle N_g \rangle / N$, $N_g = \#$ cultural groups



$q < q_c$: Monocultural

Global culture

$$\frac{\langle S_{\max} \rangle}{N} \rightarrow 1 \quad g \rightarrow 0$$

$q > q_c$: Multicultural

Cultural diversity

Global polarization

$$\frac{\langle S_{\max} \rangle}{N} \rightarrow 0 \quad g \rightarrow 1$$

Castellano, Marsili, Vespignani, *Phys. Rev. Lett.* **85**, 3536 (2000).

Klemm, Eguiluz, Toral, San Miguel, *Phys. Rev. E* **67**, 045101R (2003); *Physica A* **327**, 1 (2003)

Repertório de Sinais Vocais (R)

Tamanho de Grupo (G)

Tamanho do Neocortex (r)

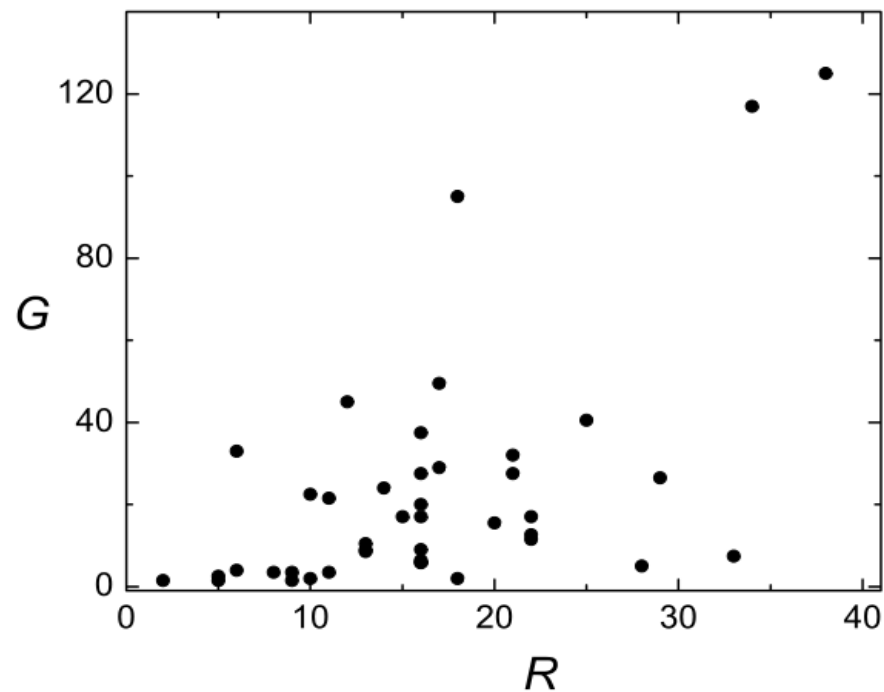


Fig. 1. Group size vs. repertory size among non humans primate species, from [3].

Modelo de Kuperman

- Baseado no modelo de Axelrod
- Probabilidade de interação entre dois sítios:

$$\sigma = 1 - \left(\frac{d_H}{R} \right)^{-\frac{1}{r}} \quad (5)$$

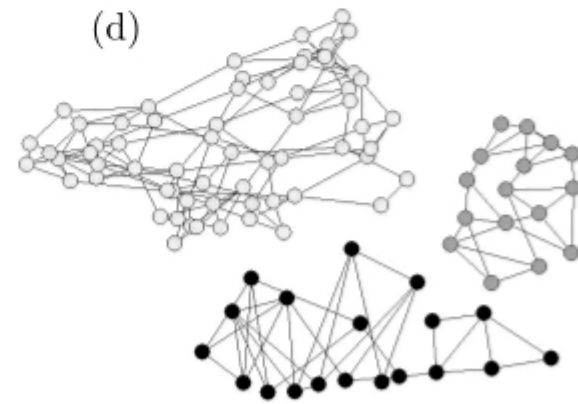
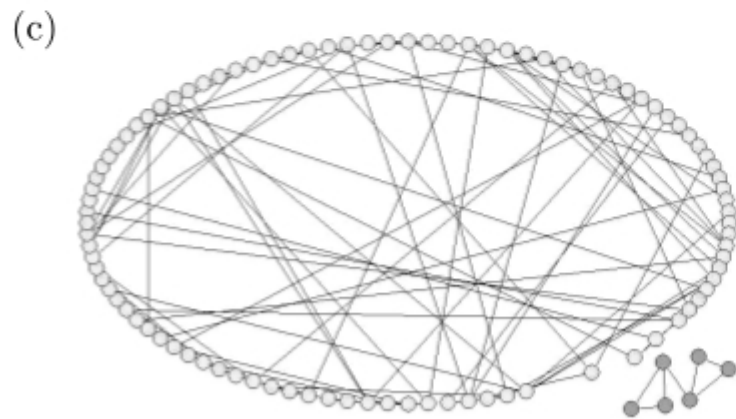
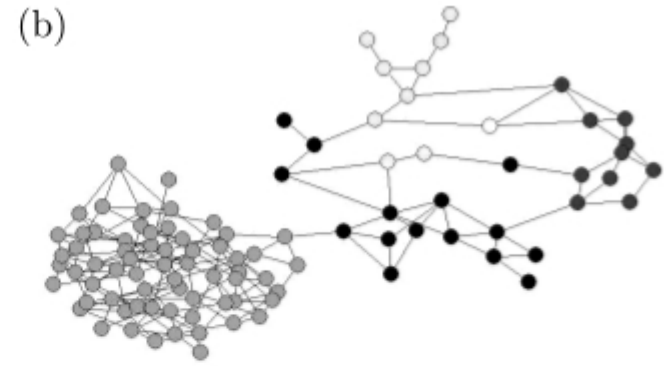
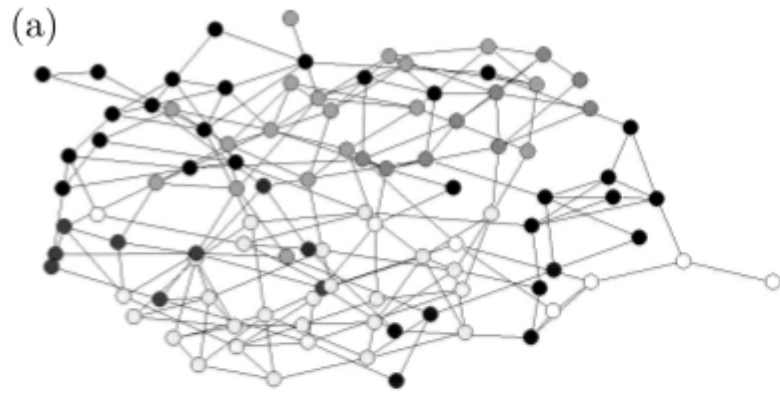
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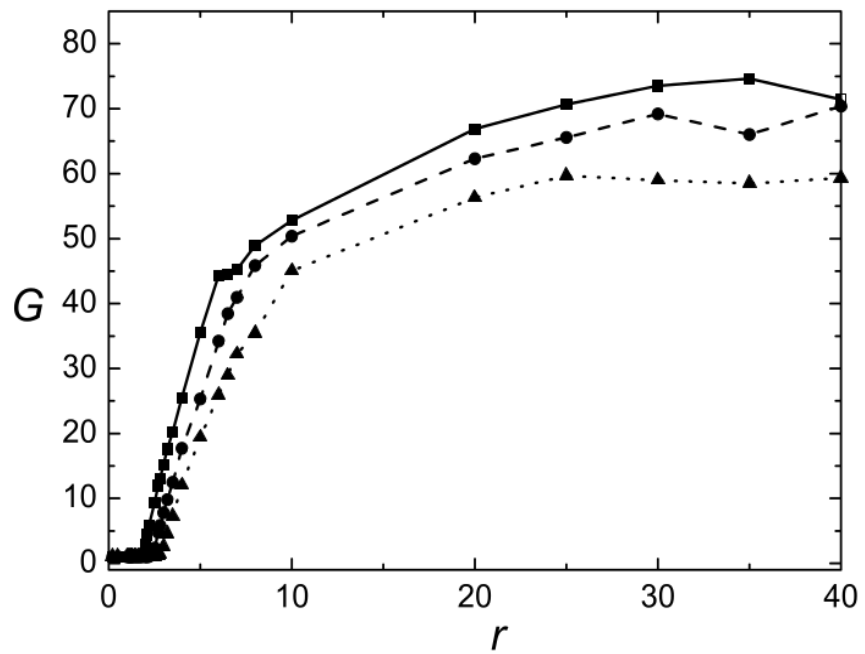
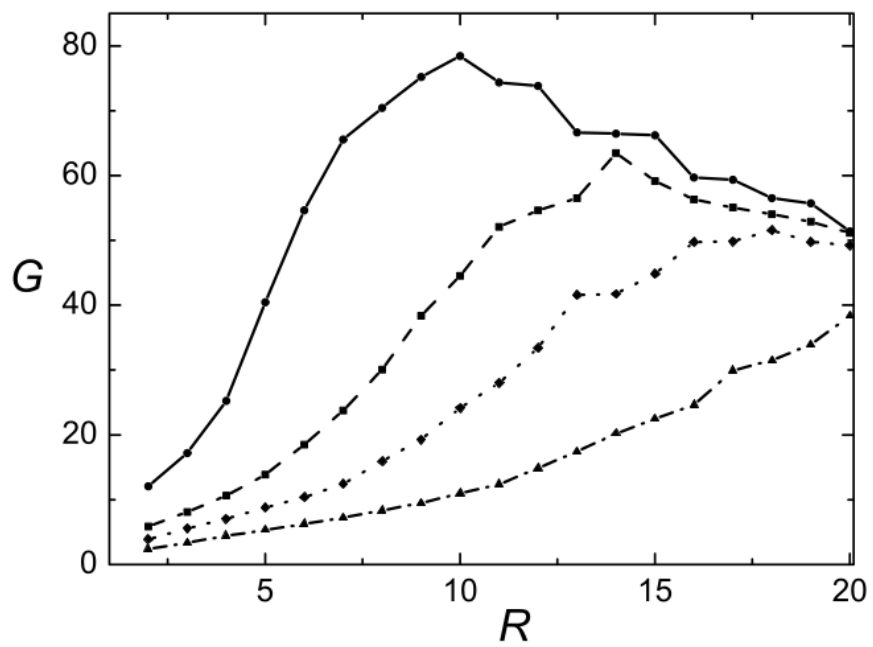
d_H : distancia de hamming entre os dois indivíduos;

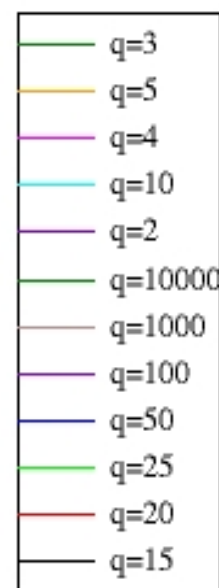
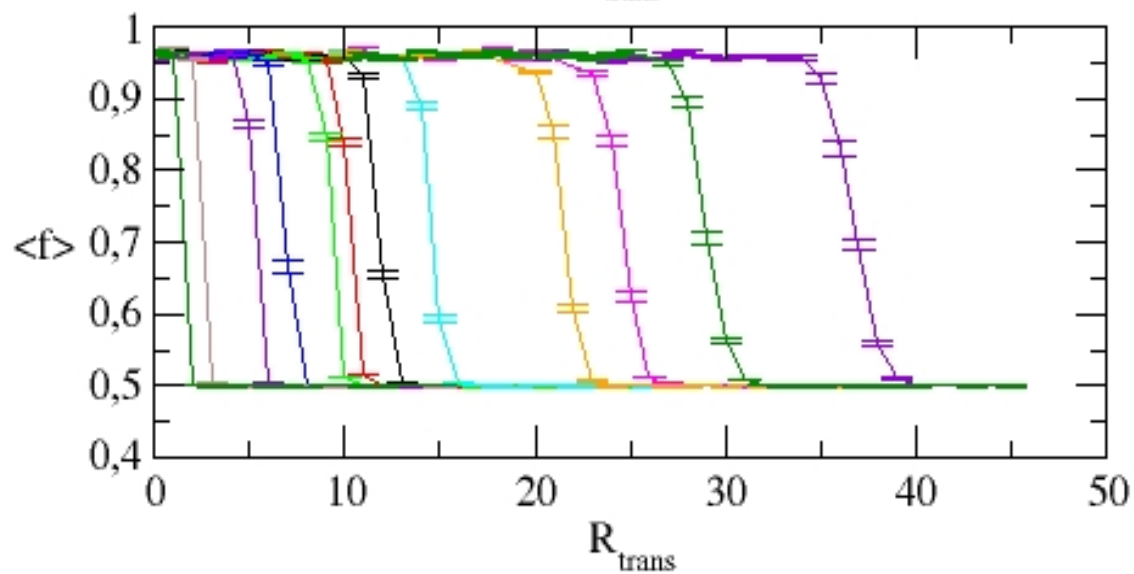
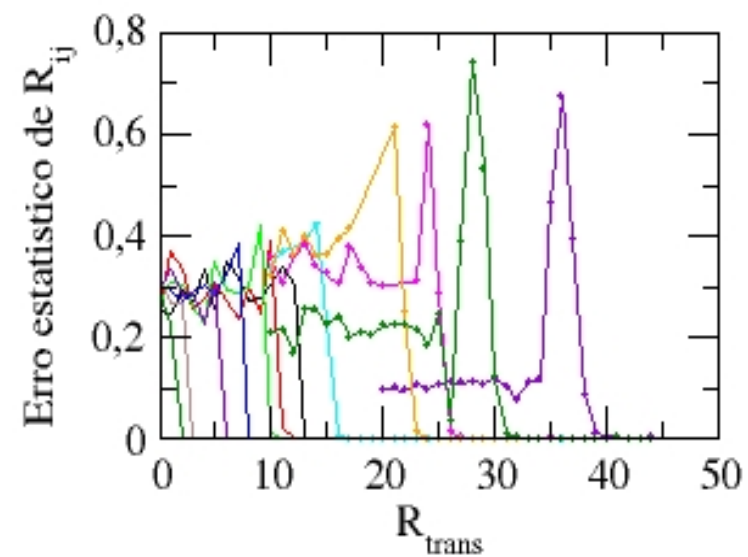
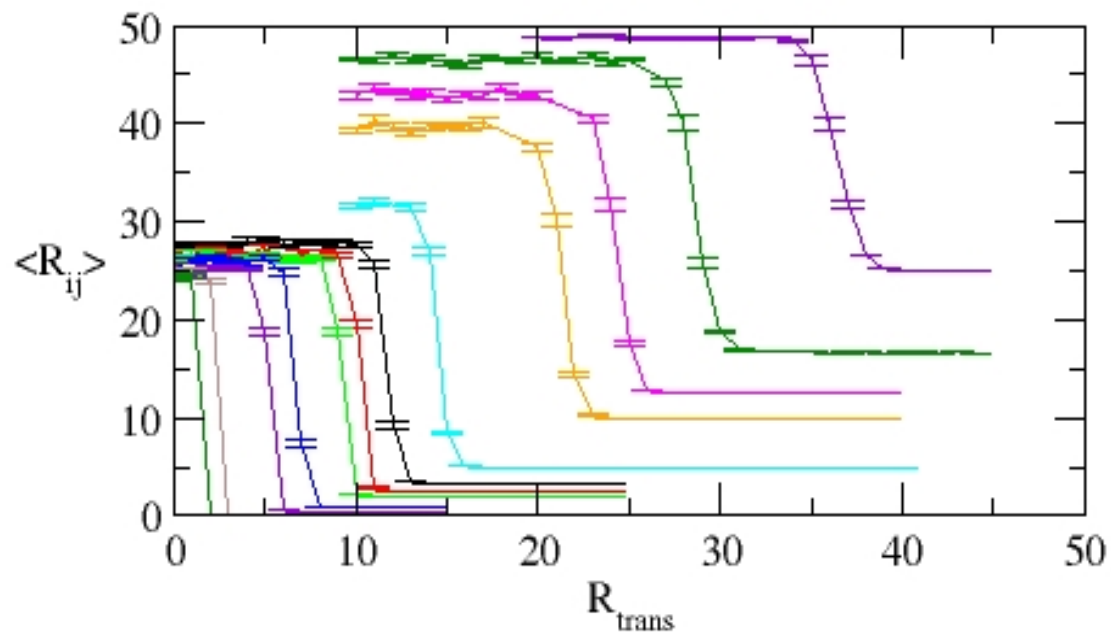
r : parâmetro relacionado com o tamanho do neocortex;

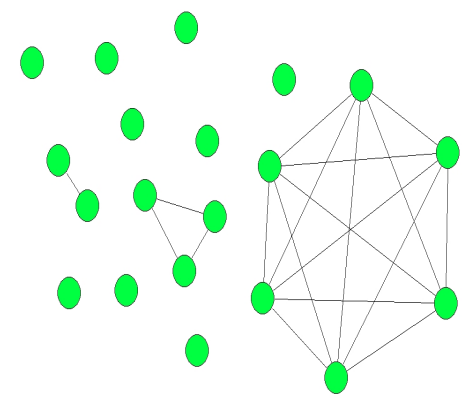
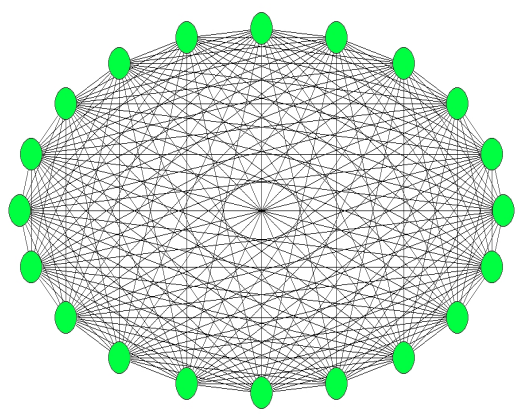
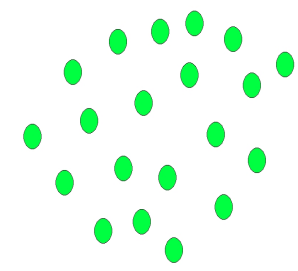
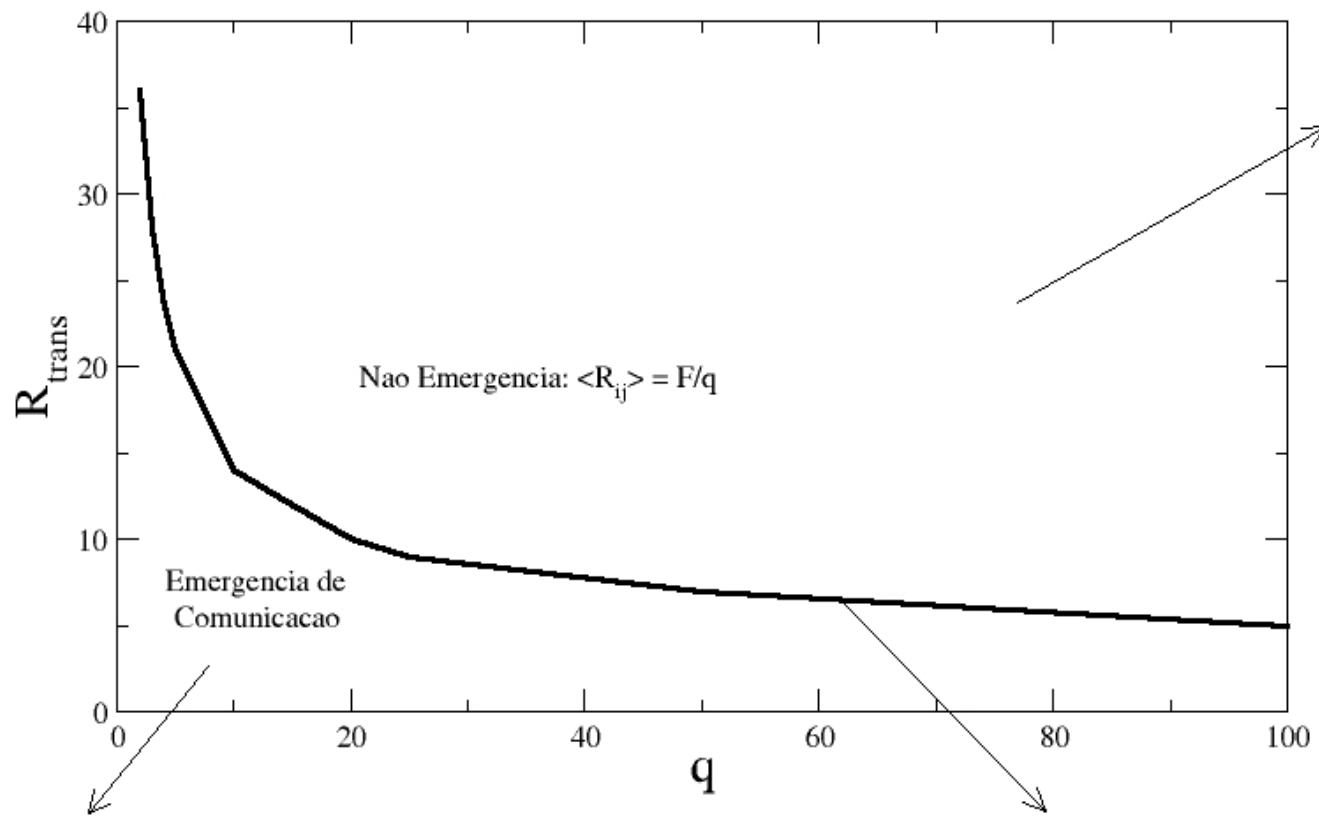
R : repertório de sinais (features);

- De tempos em tempos, um individuo pode substituir um de seus links por outros links com indivíduos mais parecidos.

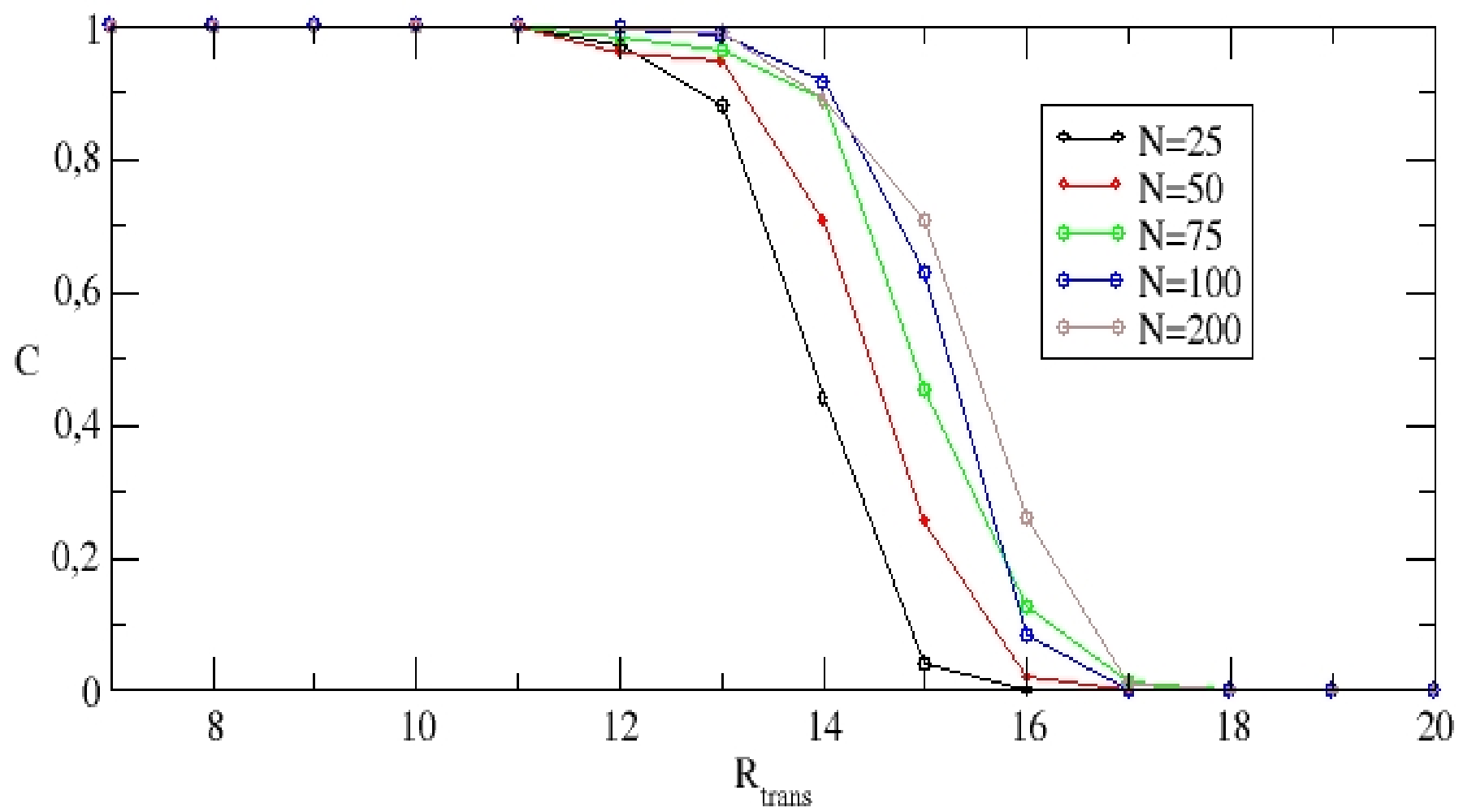








$F=50, q=10$



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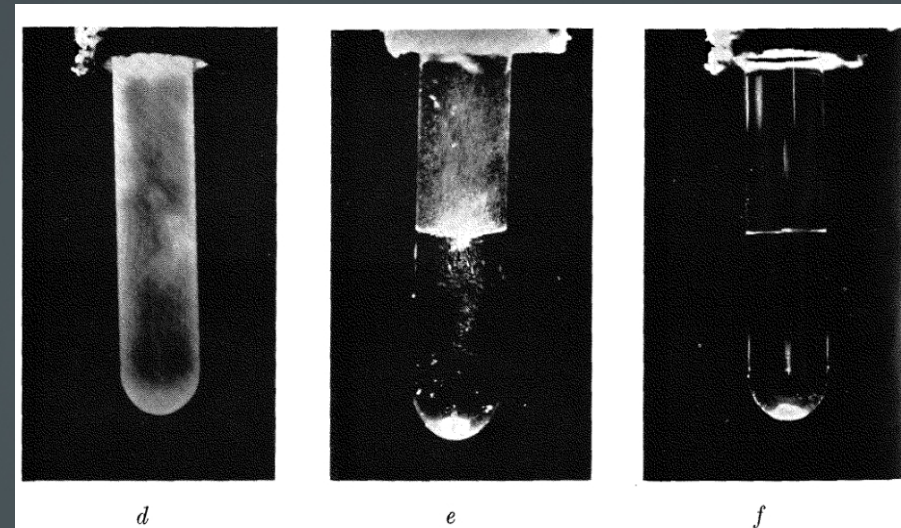
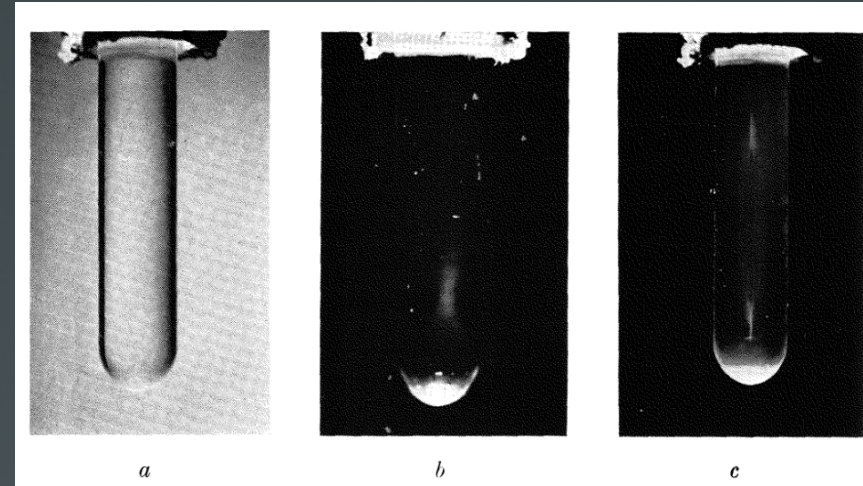
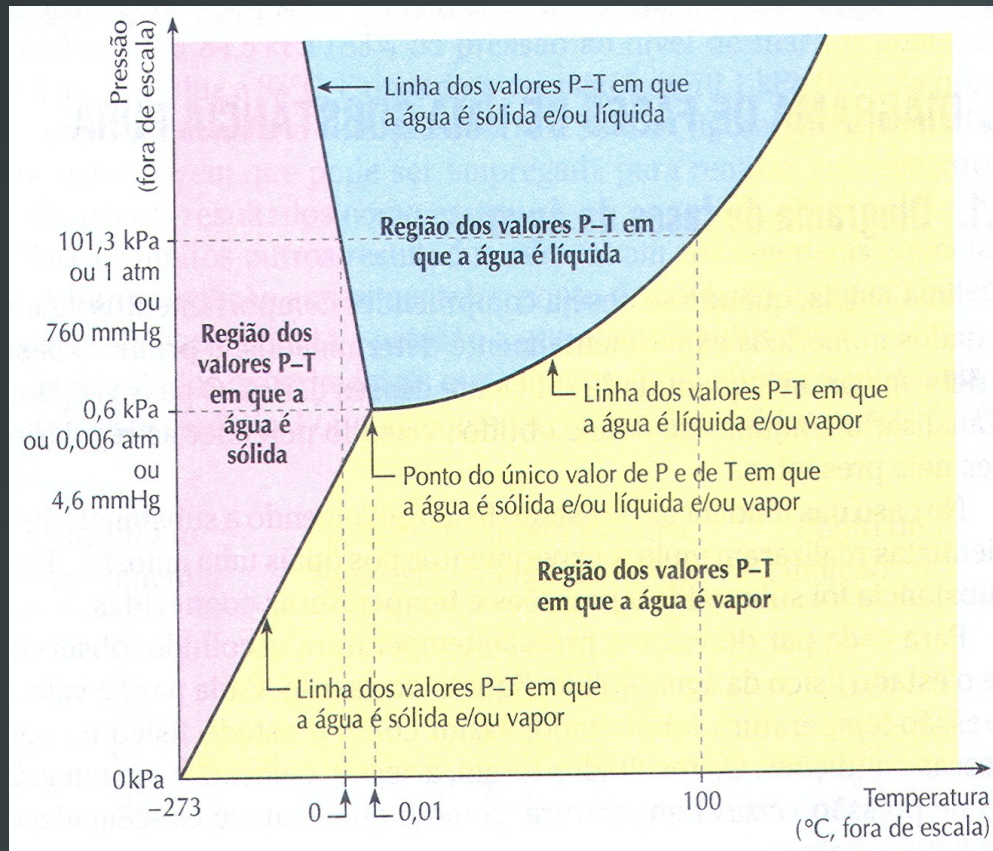
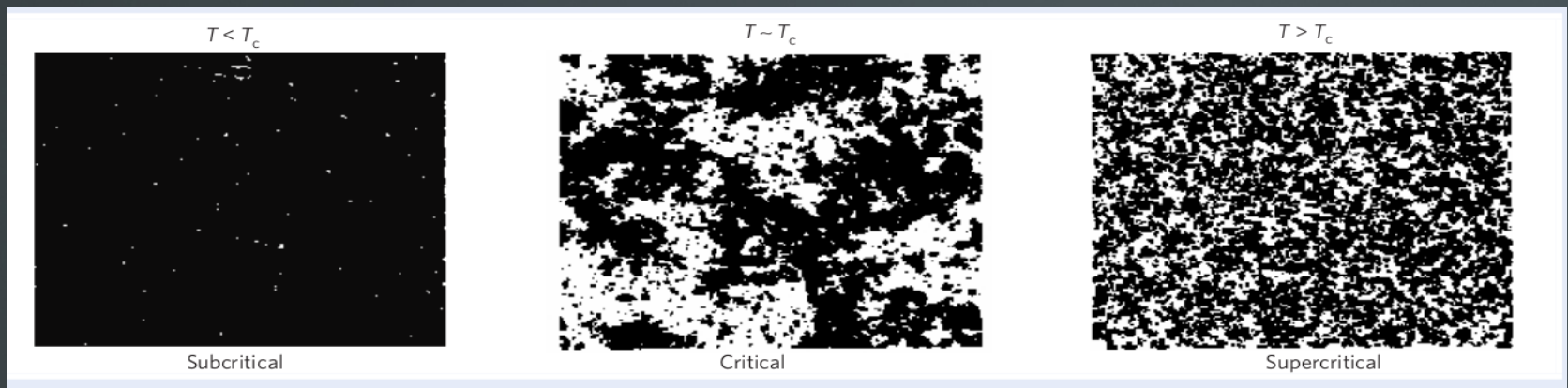
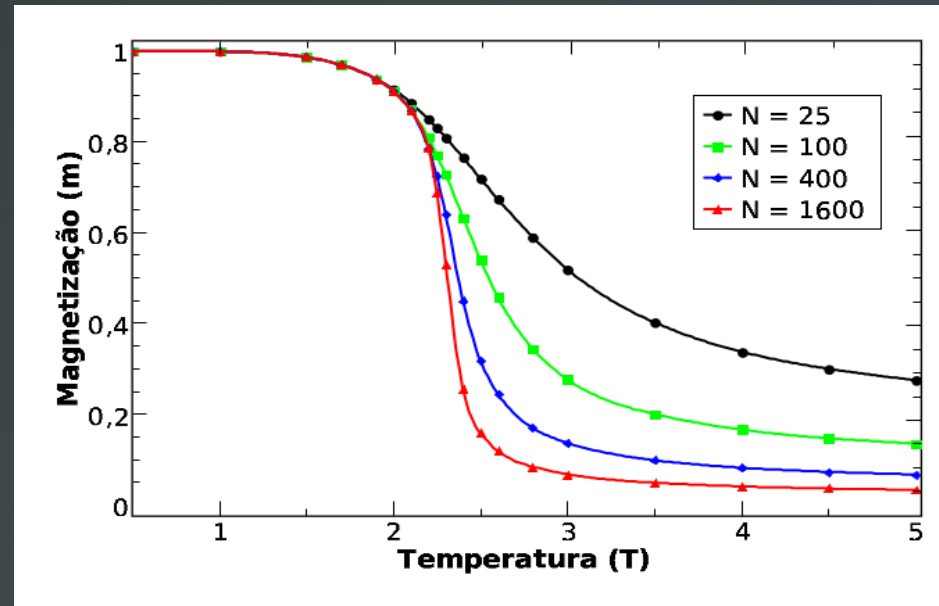
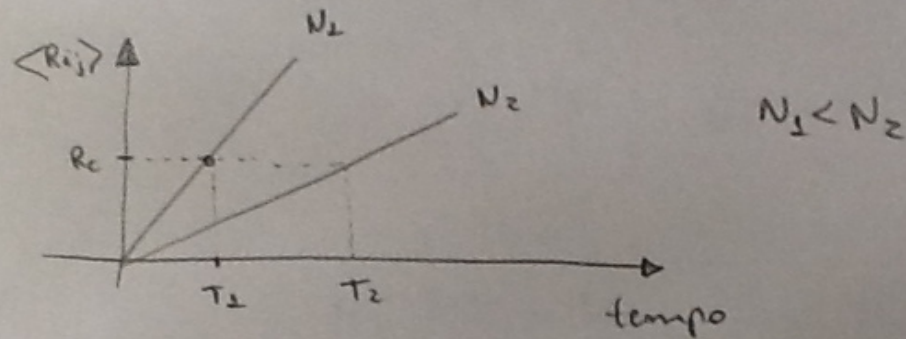


FIG. 1.6. Behaviour of a fluid as the temperature is lowered past the critical temperature: (a), $T \gg T_c$; (b), $T \gtrsim T_c$; (c), $T \simeq T_c$; (d), $T \lesssim T_c$; (e), $T < T_c$; and (f), $T \ll T_c$. The fluid shown is the binary mixture cyclohexane-aniline. After Ferrell (1968).

Transição de Fase em sistemas Físicos

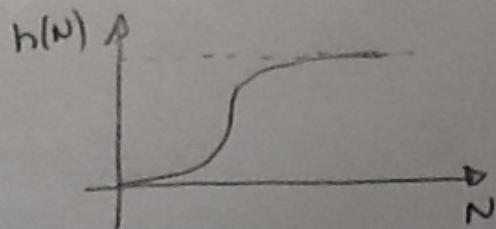


→ $\langle R_{ij} \rangle$: # Medo de reportários comuns
entre os pares da população



$$T \propto N$$

→ $h(N)$: payoff da população



Sugestão de
Pombal & Baner

$$h(N) = \begin{cases} 0 & \text{se } t < T \\ \frac{1}{1 + e^{-\gamma(B - \gamma N)}} & \text{otherwise} \end{cases}$$

→ Payoff individual como resultado de "Symbolic Learning"

$$b_{se}(N) = \frac{h(N)}{N} - \gamma \cdot T(N)$$

payoff global dividido igualmente entre os membros do grupo

custo da comunicação

→ Suponha se o indivíduo pode decidir por "Symbolic Learning" ou "Observational Learning"

$b_{oe} = cte$ ← payoff do "observ. learning" individual

→ Haverá emergência de línguas
símbólicas quando:

Payoff individual
Si-b. learning $>$ Payoff ind.
observational learning

$$b_{sl}(N) > b_{ob}$$

