Spontaneous vs Imposed Organization in a Model of Social Dynamics

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- **Question addressed:** Competition between collective social self-organization vs. external mass-media or propaganda message

- **Take home result:** Social interactions can lead to a social consensus different from the external message

  provided there are long range links in the social network of interactions

- **OUTLINE:**

  1) Axelrod´s model of cultural dissemination

  R. Axelrod, J. Conflict Res. (1997)
  Klemm et al., J. Economic Dynamics and Control 29, 321 (2005)

  2) Mass Media effects in Axelrod´s model

  González-Avella et al., Phys. Rev. E 73,046119 (2006)
  González-Avella et al., JASSS 10, 1-17 (2007)

  3) Self-organization vs. external mass-media message:
  The role of long range links

Axelrod's model of social influence

J. Conflict Res. 41, 203 (1997))

Proposal: Model to explore mechanisms of competition between *globalization* and persistence of *cultural diversity ("polarization")*

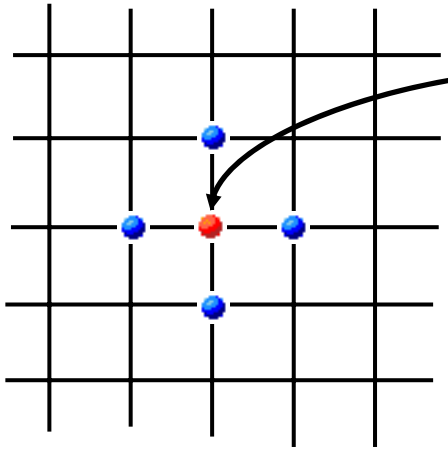
Definition of culture: Set of individual attributes subject to social influence

Principle of Homophily: Promotes interaction between similar.
"*like attracts like*"

Principle of Social Influence: Promotes cultural similarity. *The more two interact the more similar they become.*

Axelrod´s conclusion: Combination of homophily and social influence produces and sustains polarization (cultural diversity)

Axelrod's agents based model: interaction



$$\begin{pmatrix} \sigma_{i1} \\ \sigma_{i2} \\ \vdots \\ \sigma_{iF} \end{pmatrix}$$

F = # **Features**

q = # **Traits** per feature

$\sigma_{if} \in \{0, \ldots, q-1\}$

F=3; q=10

q^F (10^3) *equivalent* cultural options.

0	5
0	9
7	7

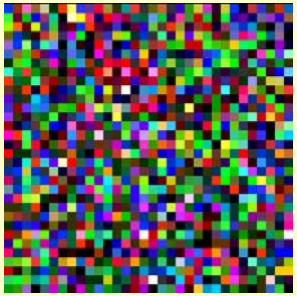
Mechanism of local convergence:

Prob to interact = $\frac{\text{Common features}}{F} = \frac{1}{3}$

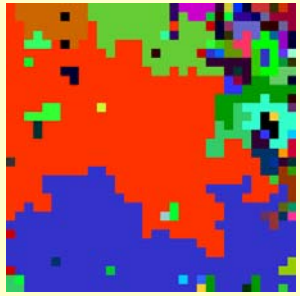
5	5
0	9
7	7

Visualization of Axelrod´s Dynamics

$F = 3,\ q = 10$



$t = 0 \longrightarrow$



System freezes in an absorbing multicultural state

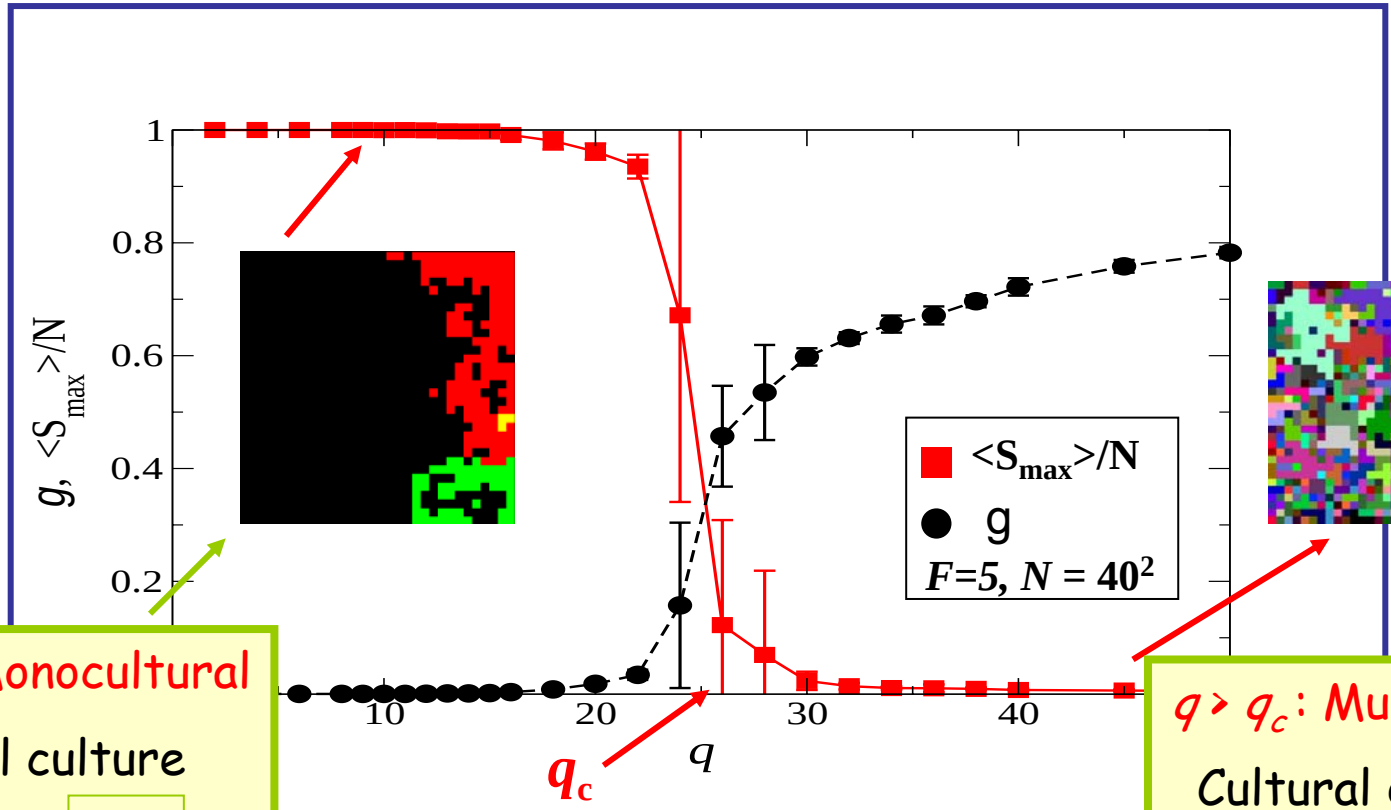
http://ifisc.uib-csic.es/research_topics/socio/culture.html

- 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

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

$\frac{\langle S_{max} \rangle}{N} \to 1$ g→0

$q > q_c$: Multicultural

Cultural diversity

Global polarization

$\frac{\langle S_{max} \rangle}{N} \to 0$ g→1

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

San Miguel et al., Computing in Science and Engineering ***7****, 67 (2005)*

Mass media effects on cultural dynamics

"The mass media (plurality information feedback), *contrary to lay beliefs of their strong uniforming power, would rather contribute to creating differences in the long run"*

Shibanai et al., J. Conflict Resolution. ***45****, 80 (2001)*

General question: Identify the mechanisms, and their efficiency, by which different forms of mass media modify processes of cultural dynamics based on local agent interaction.

Specific questions to be addressed:

Q1. What is a more important influence in making up your mind: what your acquaintances tell you (viral marketing) or TV and newspapers ?

Q2. Are you influenced by mass media messages on, say perfumes, if you do not use perfumes?

Q3. Do you follow insistent and recurrent mass media messages or occasional apparently weak messages are more influential?

Q4. What is more efficient in producing cultural homogeneity, local mass media or global mass media ?

Q5. **What social structure is needed to reach consensus opposed to a mass media message ?**

Modelling Mass Media

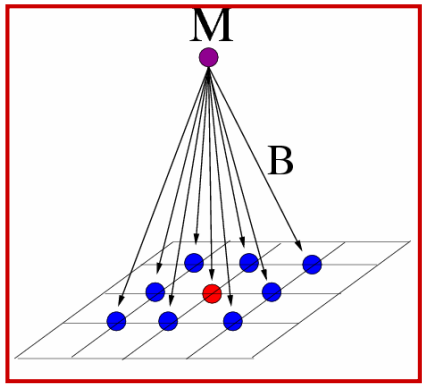
Mass Media message or field: $M = (\mu_1, \mu_2, ..., \mu_f, ..., \mu_F)$ $\mu_f \in \{0, ..., q-1\}$

External media:

(Big brother)

μ_f *given*

- *Uniform for all agents i*
- *Fixed for all times*



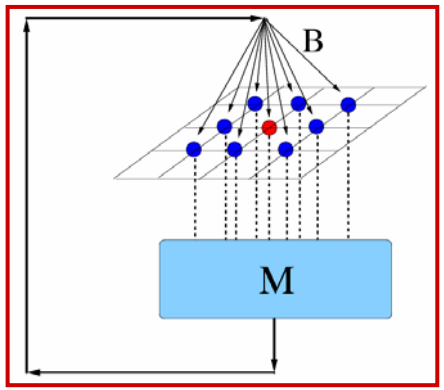
Propaganda or advertising

Endogenous media:

(4th democratic power)

Global media

Broadcast: Feedback of dominant global cultural trend

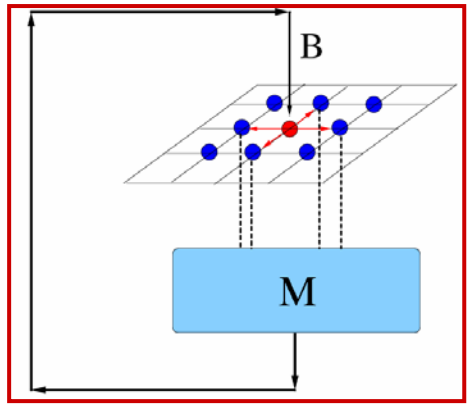


$\mu_f = \sigma_{jf}$ most abundant in system

- *Uniform*
- *Time dependent*

Local media

Narrowcast: Feedback of dominant local cultural trend



$\mu_f = \sigma_{jf}$ most abundant in neighborhood

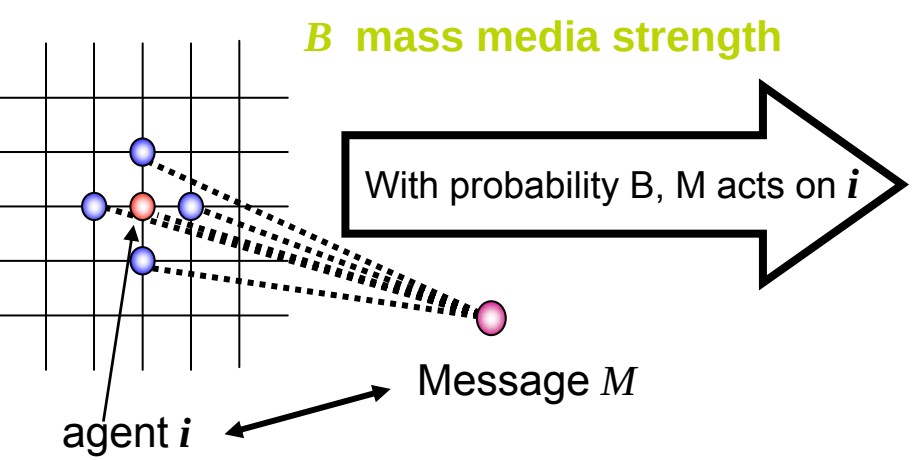
- *Non-uniform*
- *Time dependent*

Dynamics of interaction with mass media field

Agent i: $C_i = (\sigma_{i1}, \sigma_{i2}, ..., \sigma_{if}, ..., \sigma_{iF}) \longleftrightarrow$ Mass media: $M = (\mu_1, \mu_2, ..., \mu_f, ..., \mu_F)$

Parameter $B \in [0, 1]$: probability that M acts on element i in one time step: "*strength*" of mass media

$1 - B$: probability to interact with j selected at random among nearest neigbors of i. $\Rightarrow$ M acts as a 5th effective neighbor of i.

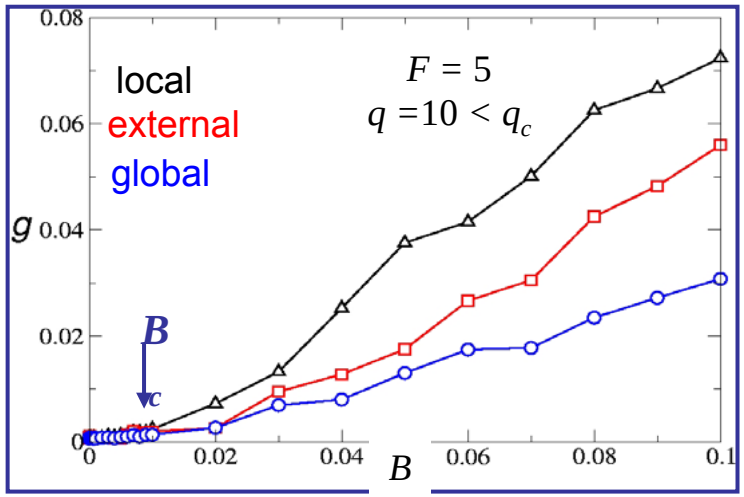


1) If M acts on agent i, the probability of interaction p_{iM} is proportional to the cultural overlap between i and M

2) Agent-Mass Media interaction results in agent i adopting a cultural feature of M

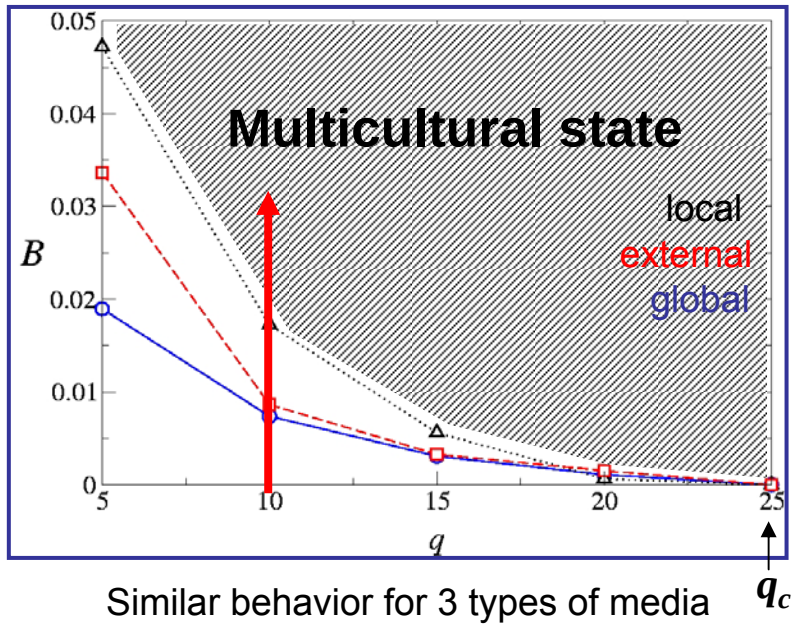
Mass media effects: monocultural state $(q < q_c)$

Globalization-polarization transition induced by mass media:



$B > B_c$: any Mass Media leads to cultural diversity

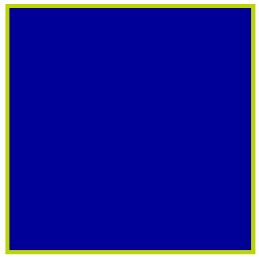
Phase Diagram



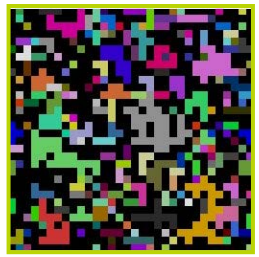
Similar behavior for 3 types of media

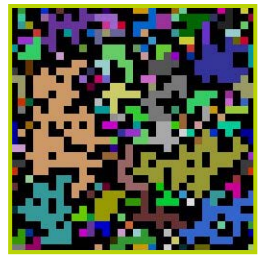
Asymptotic states for **external** mass media

$M \rightarrow$ 

B=0 

B=0.0084 

B=0.5 

B=0.9 

Mass media effects: monocultural state $(q < q_c)$

Globalization-polarization transition induced by mass media:

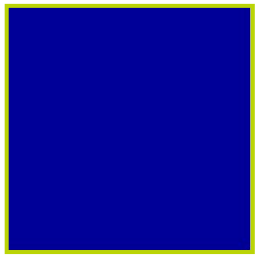
Mass media message produces polarization

Asymptotic states for **external** mass media

F=5, q=10

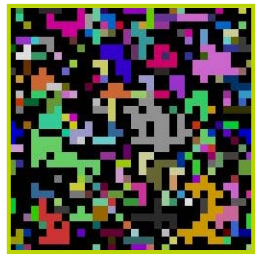
$M \rightarrow$ 

B=0

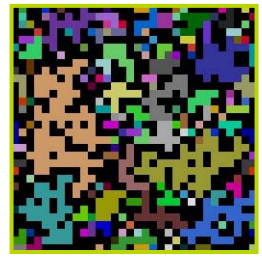


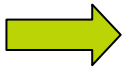
B=0.0084

B=0.5



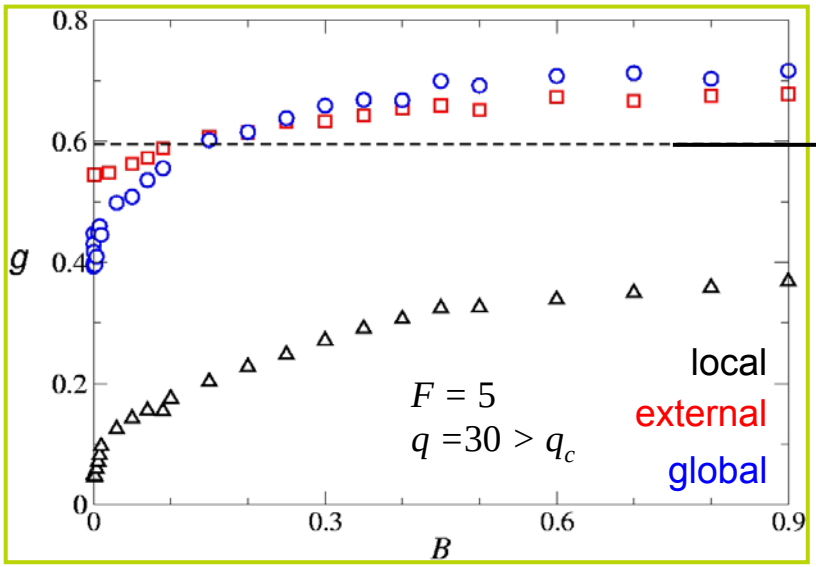
B=0.9





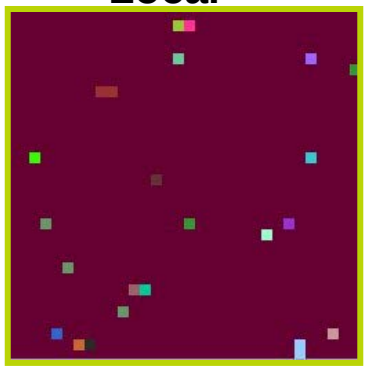
http://ifisc.uib-csic.es/eng/lines/APPLET_Axelrod/Culture.html

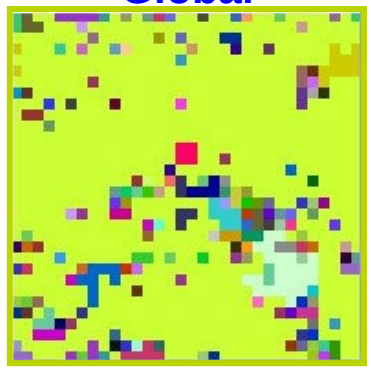
Mass media effects: multicultural states $(q > q_c)$

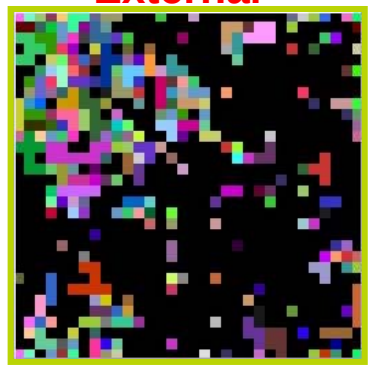


- For B small, $g < g(B=0)\ \forall\ M$:
  Cultural homogenization by weak media.
- Discontinuity for $B \to 0$
  Cultural homogenization produced by same mechanism than cultural drift.
- $\forall\ M$, increasing B enhances diversity.
- *Local M more efficient in cultural homogenization.*

Dynamics of cultural homogenization for weak (B=0.0042) mass media:







Mass media effects: multicultural states $(q > q_c)$

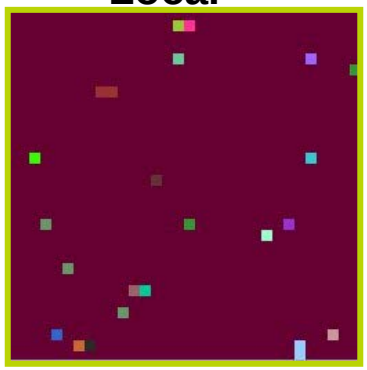
Cultural homogenization for weak mass media:

B=0.0042, F=5, q=28

B=0

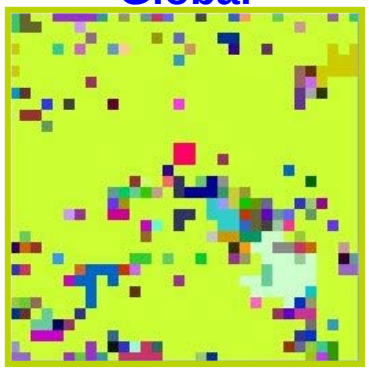
$t = 727$

Local



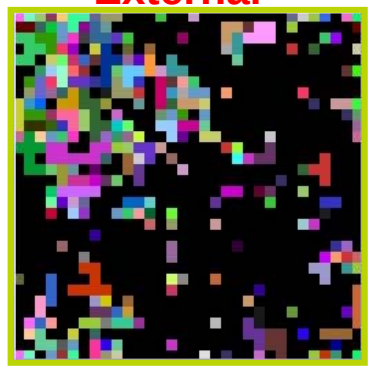
$t = 6058$

Global



$t = 4827$

External

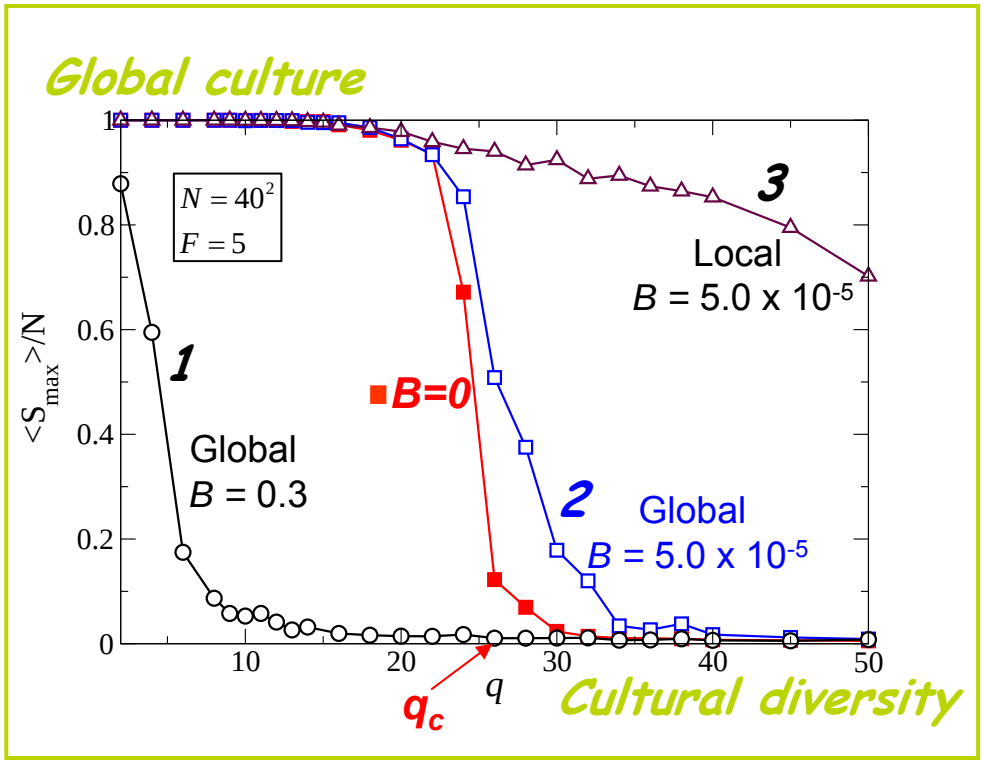


$t = 5748$

http://ifisc.uib-csic.es/eng/lines/APPLET_Axelrod/Culture.html

Mass Media effects: Summary

J. C. González-Avella et al.,
J. of Artificial Societies and Social Simulation 10, 1-17 (2007)



1) Polarization caused by strong media ($B > B_c$)

* Competition of similarity rule applied to agent-agent and agent-media interactions

* Limiting case B=1: agent-agent interaction negligible and no agent-media interaction for zero overlap. No mechanism of cultural dissemination at work

2) Cultural homogenization is caused by weak media

3) Local media (feedback at regional levels) are more efficient in the cultural globalization path.

Mass media is only efficient in producing cultural homogeneity in conditions of weak broadcast of message, so that agent-agent interactions can be still effective in constructing some cultural overlap with the mass media message. Strong media messages do not homogenize because agent-agent interactions become inefficient:

The power of being subtle (and local)

Answers to questions

Q1. What is a more important influence in making up your mind: what your acquaintances tell you (viral marketing) or TV and newspapers ?

A1. Delicate compromise and feedback processes: Mass media reflects local or global cultural trends created by local interactions. Media information processed by agent interaction in a social structure.

Q2. Are you influenced by mass media messages on, say perfumes, if you do not use perfumes?

A2. Present modeling requires cultural overlap with the message for the interaction with the agent to be possible.

Q3. Do you follow insistent and recurrent mass media messages or occasional apparently weak messages are more influential?

A3. Weak coupling to the message is more efficient: ***The power of being subtle***

Q4. What is more efficient in producing cultural homogeneity, local mass media or global mass media ?

A4. Local mass media (regional TV) appear to be more effective in producing cultural homogeneity than global uniform broadcasts (CNN).

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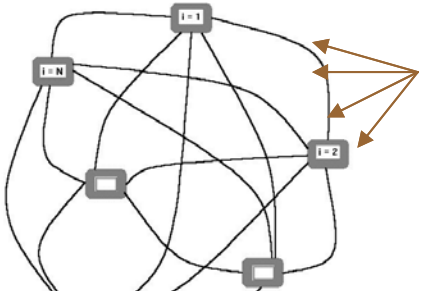
Globally coupled society

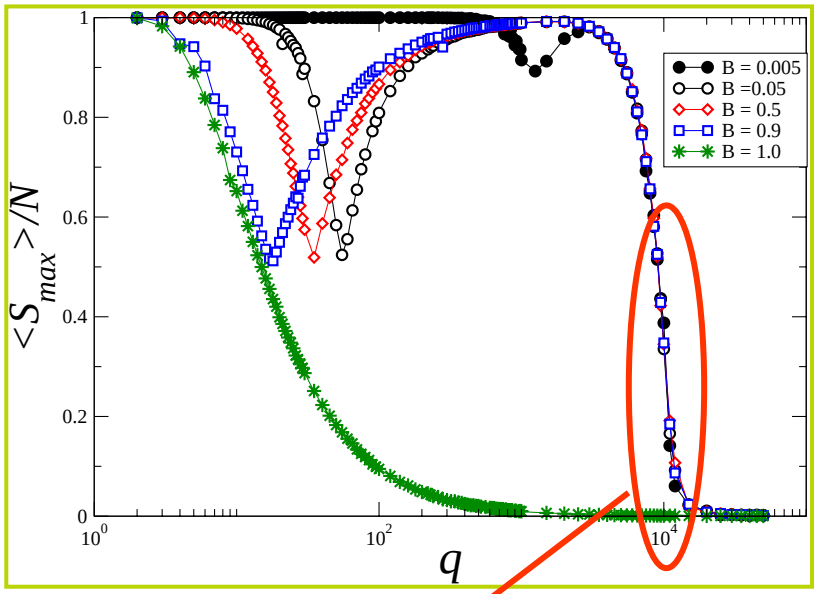
Global coupling: all-to-all



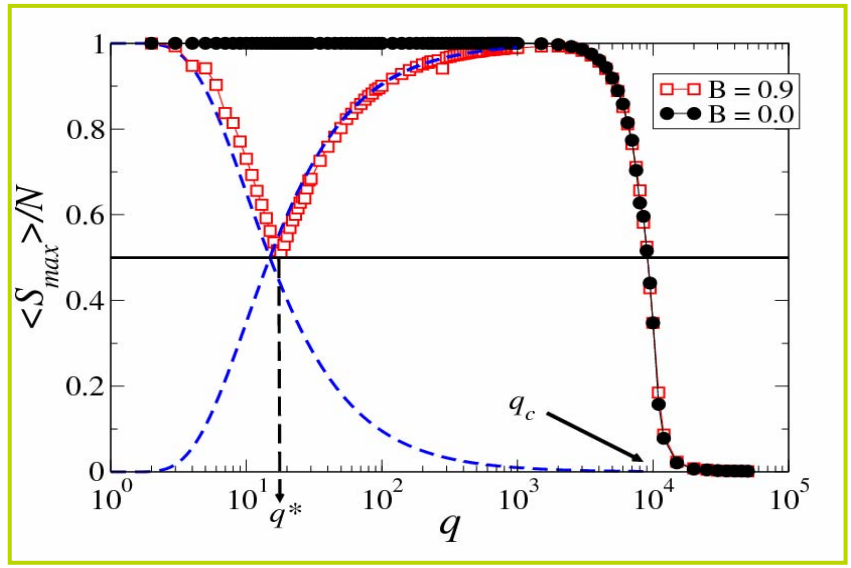
M: external media

$F = 10$

$N = 2500$



$q_{c(G)}$ *is independent of B.*



- $q_{c(G)} >> q_{c(reg.)} \approx 56$
- *Competition between the order induced by an external mass media and spontaneous order.*
- *For B → 1:* *where:*

$$\frac{\langle S_{\max}\rangle}{N} = \begin{cases} 1-\left(1-\frac{1}{q}\right)^F, & if \quad q \le q^* \\ \left(1-\frac{1}{q}\right)^F, & if \quad q > q^* \end{cases}$$

$$q^* = \left[1-\left(\frac{1}{2}\right)^{1/F}\right]^{-1}$$

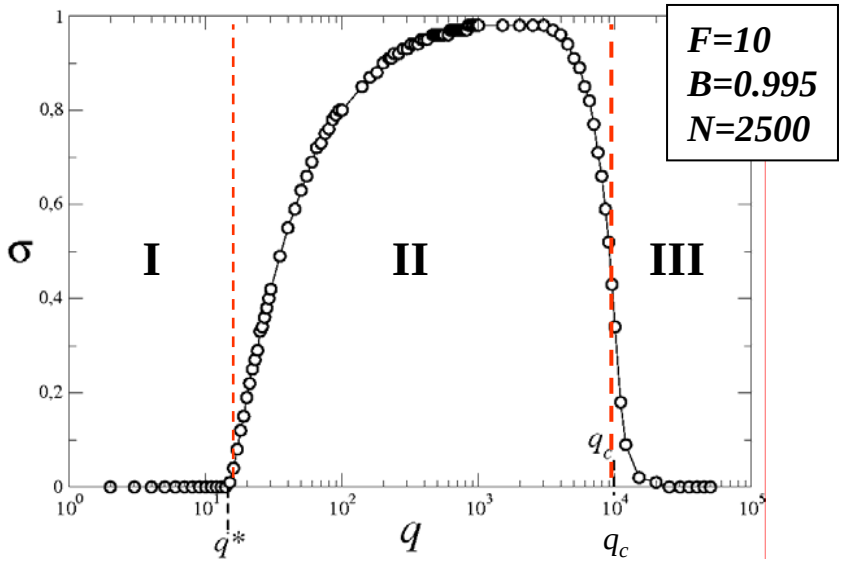
Transitions in globally coupled society

External Media

$$\sigma = \frac{\langle S_{\max} - S_M \rangle}{N}$$

$S_{\max}$: size of largest domain

S_M : size of domain having state equal to M



Phases:

I: homogeneous, ordered = external field

$S_{\max} = S_M \neq 0$ for $q < q^*(B)$

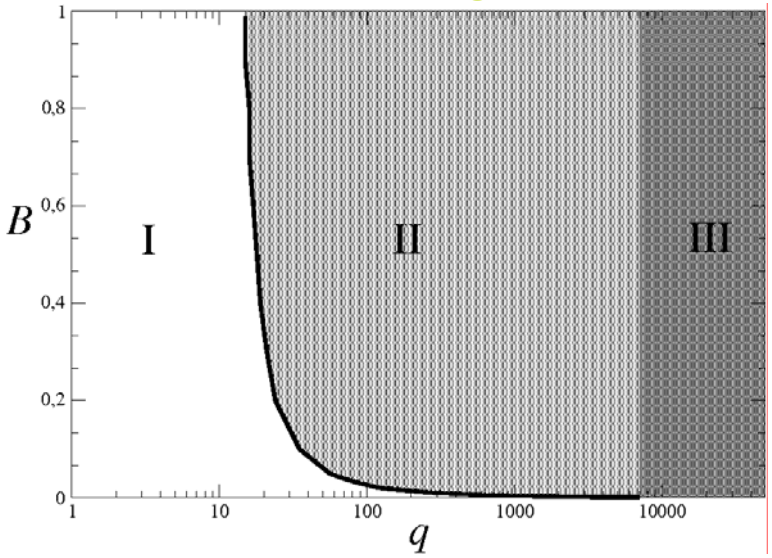
II: alternative ordering state ≠ external field

$S_{\max} > S_M$ for $q^*(B) < q < q_c$

III: disordered

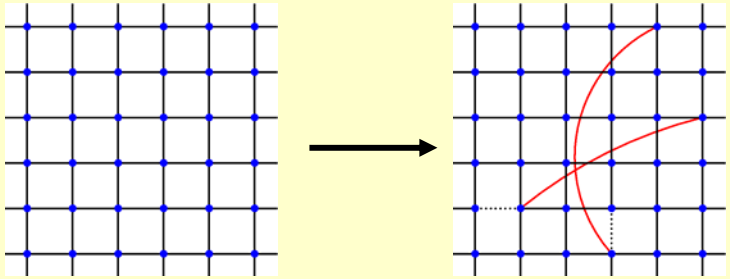
$S_{\max} \to 0,\ S_M \to 0$ for $q > q_c$

Phase Diagram

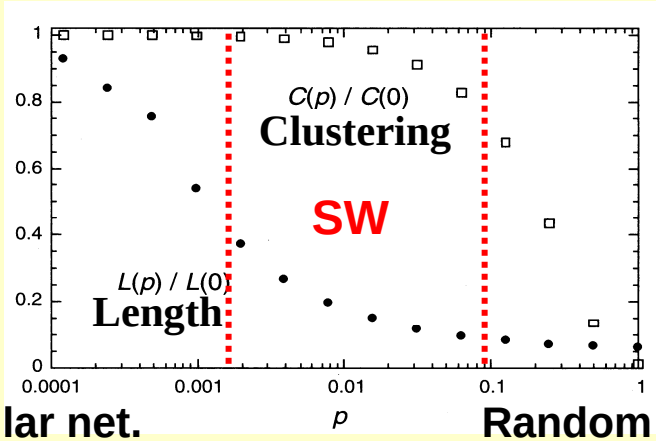


The role of long range social links

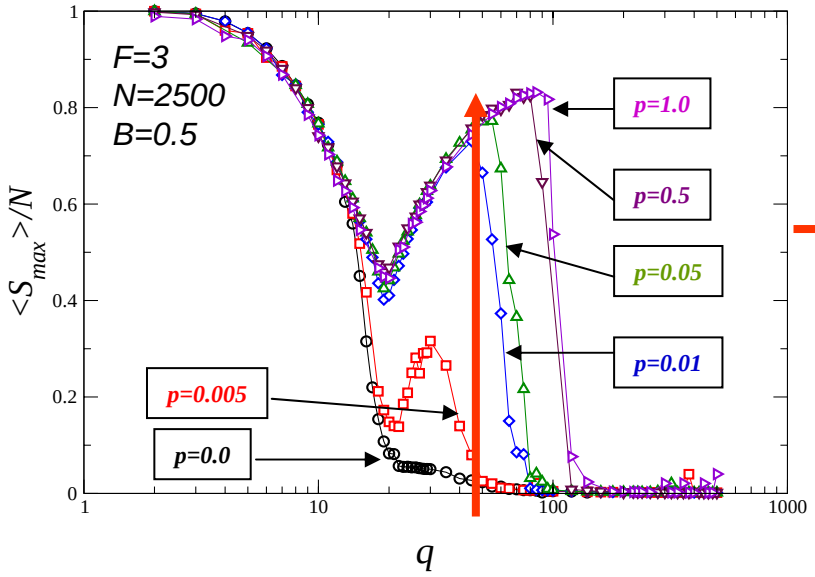
Small World Networks

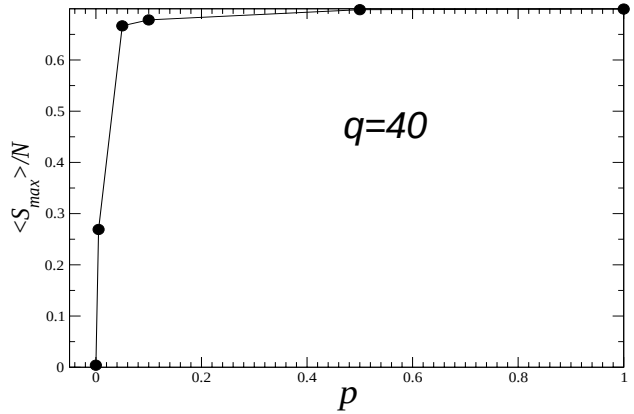


Rewire with prob. *p*



Regular net. **Random net.**





The emergence of a self-organized group opposed to the external message is possible because of the existence of long range social links.