Opinion formation through language games

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Department of Comp. Sc. & Engg.,
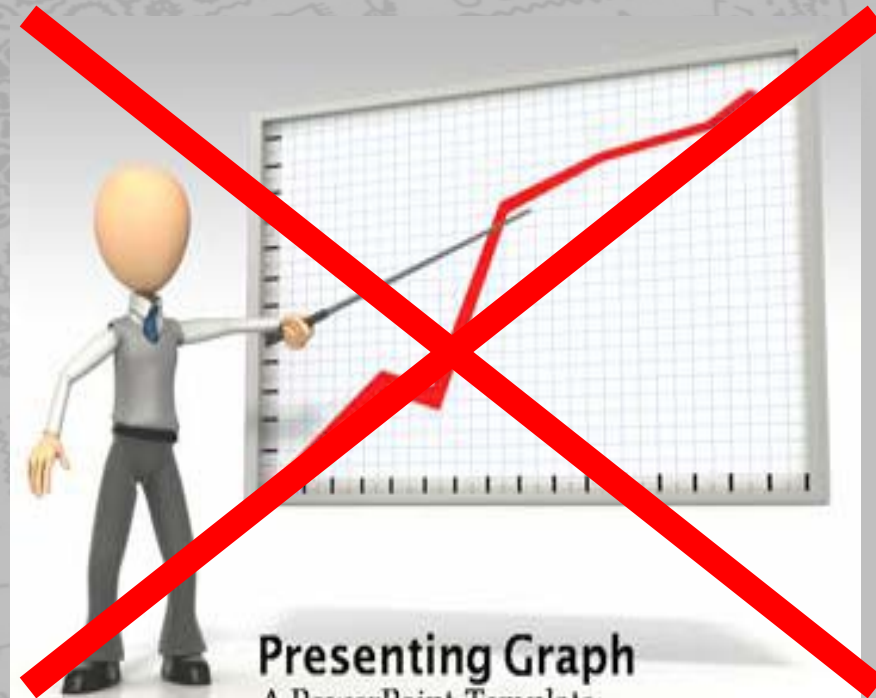
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Language and its meaning!

- Once a teacher asked one of his students to get a good presentation the next day ...

Language and its meaning!

- And on that fine next day …

Language dynamics:
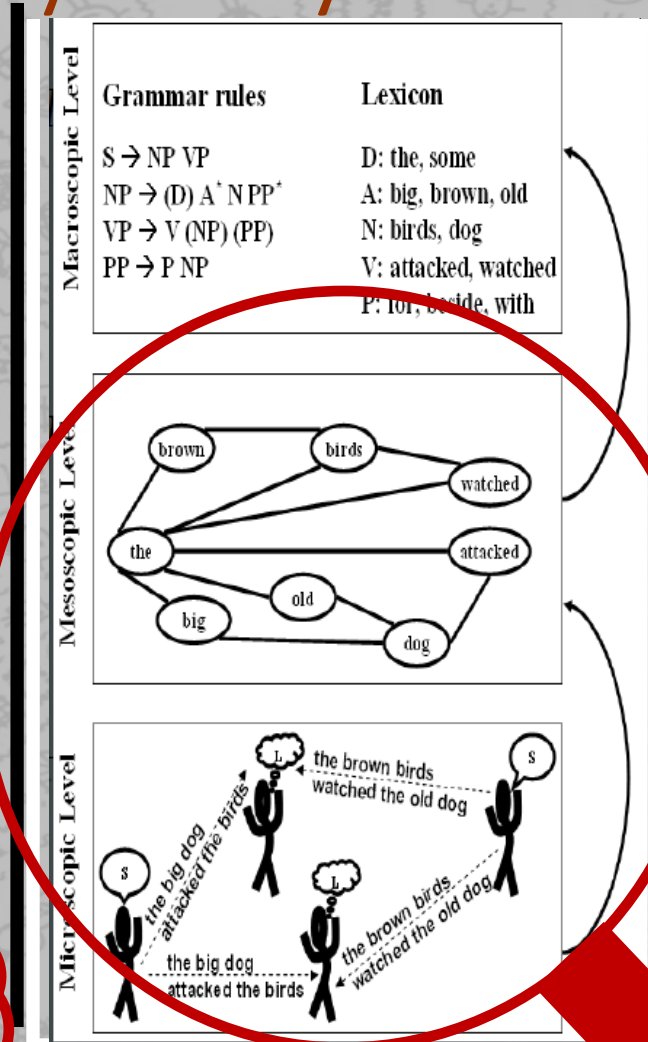# A Physical System Perspective

Language as a whole
(grammatical constructs)

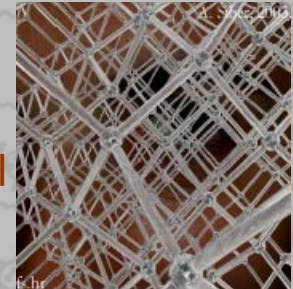Language as a set of
interactions among
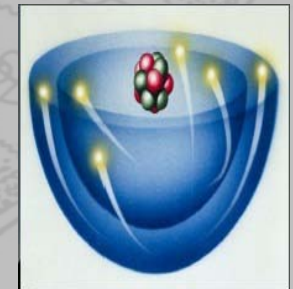linguistic units

Language as a set
of utterances

dynamic

Macroscopic level

Mesoscopic level

Microscopic level

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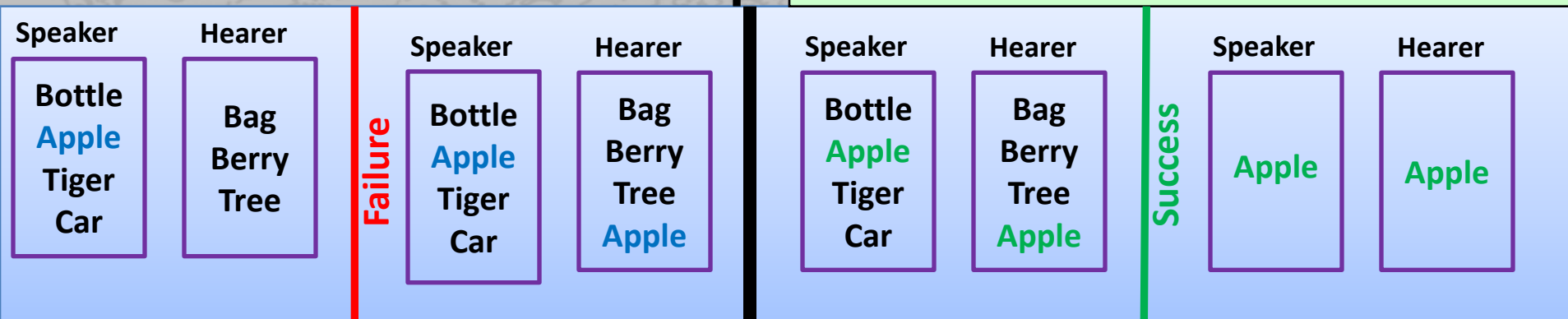# The Naming Game

Speaker **Hearer**

In silico abstraction

- Perceive scene
- Choose topic
- Conceptualize
- Verbalize

- Interpret utterance
- Perceive scene
- Apply meaning
- Point to referent

Interaction of **N** artificial agents communicate to agree on the **name** of an object in the environment.

Each interaction counts as a time step of the dynamics

Agents can keep in their memory an unlimited number of words

Games proceed through a series of **success** and **failure** interactions

One studies the phenomenological properties – total number of words in the system $N_w(t)$, number of unique words $N_d(t)$, maximum memory N_w^{max}, time to reach agreement t_{conv} etc.

Failure

Speaker	Hearer
Bottle Apple Tiger Car	Bag Berry Tree

Speaker	Hearer
Bottle Apple Tiger Car	Bag Berry Tree Apple

Speaker	Hearer
Bottle Apple Tiger Car	Bag Berry Tree Apple

Success

Speaker	Hearer
Apple	Apple

Scaling relations for various topologies

|	$N^w{}_{max}$	t_{max}	t_{conv}
Mean-field	$N^{1.5}$	$N^{1.5}$	$N^{1.5}$
Scale-free	N	N	$N^{1.4}$
Erdos-Renyi	N	N	$N^{1.4}$
Small-world	N	N	$N^{1.4}$

What about time-varying networks?

- Social interactions and human activities are intermittent

- Links appear and disappear from the system

- As time progresses, societal structure keeps changing with social conventions, shared cultural and linguistic patterns reshaping themselves
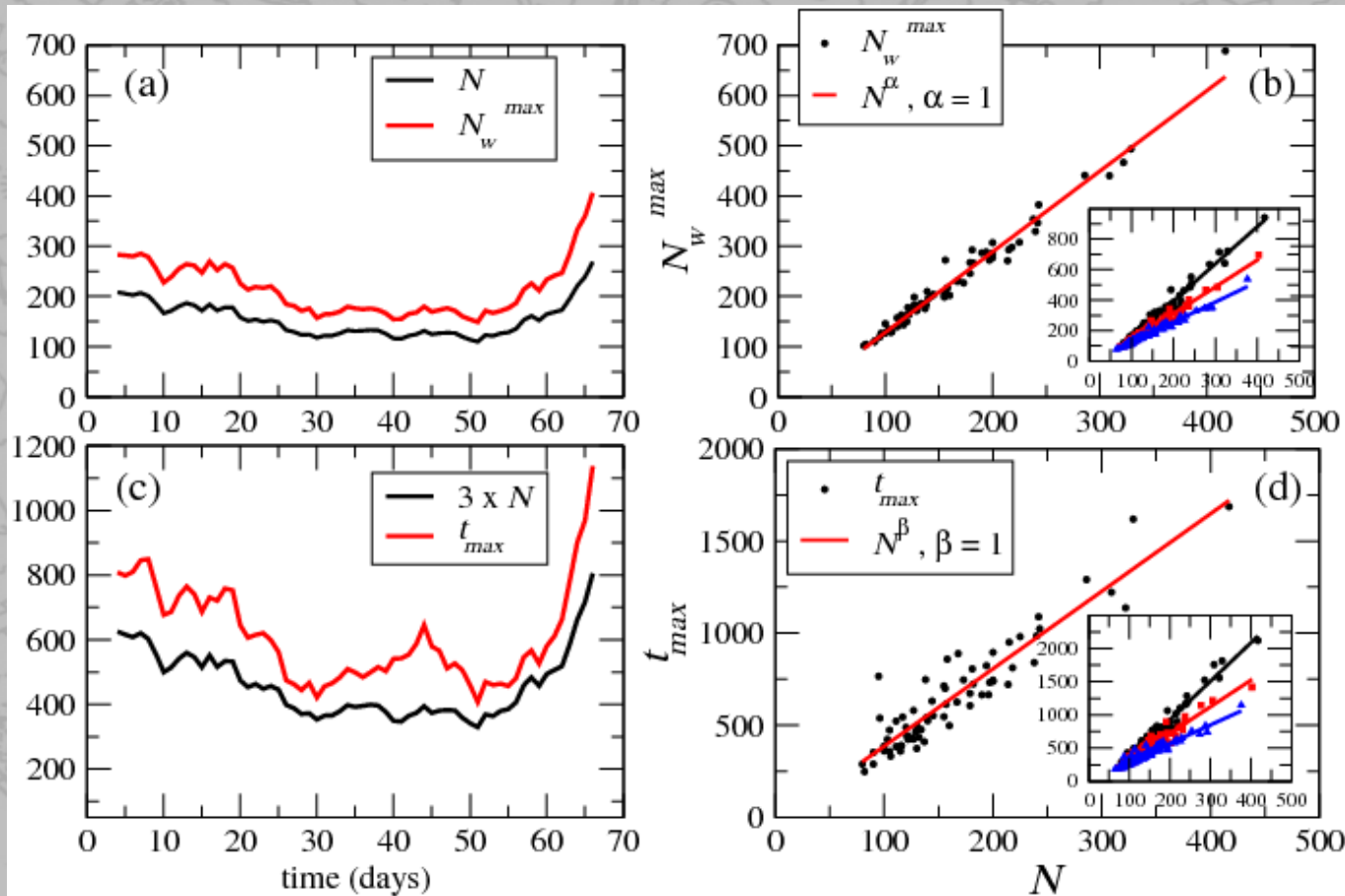
CNeRG lab (time *t*)
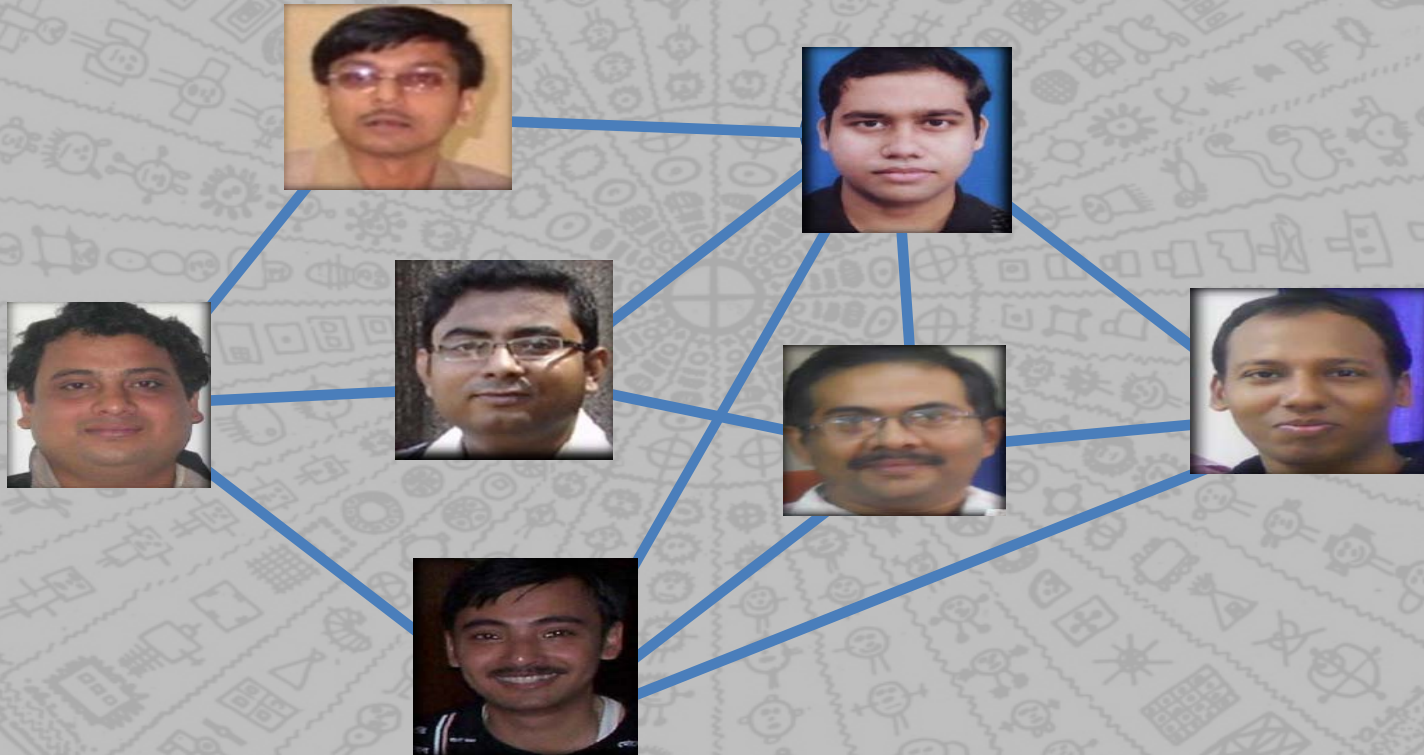
CNeRG lab (time $t + 1$)
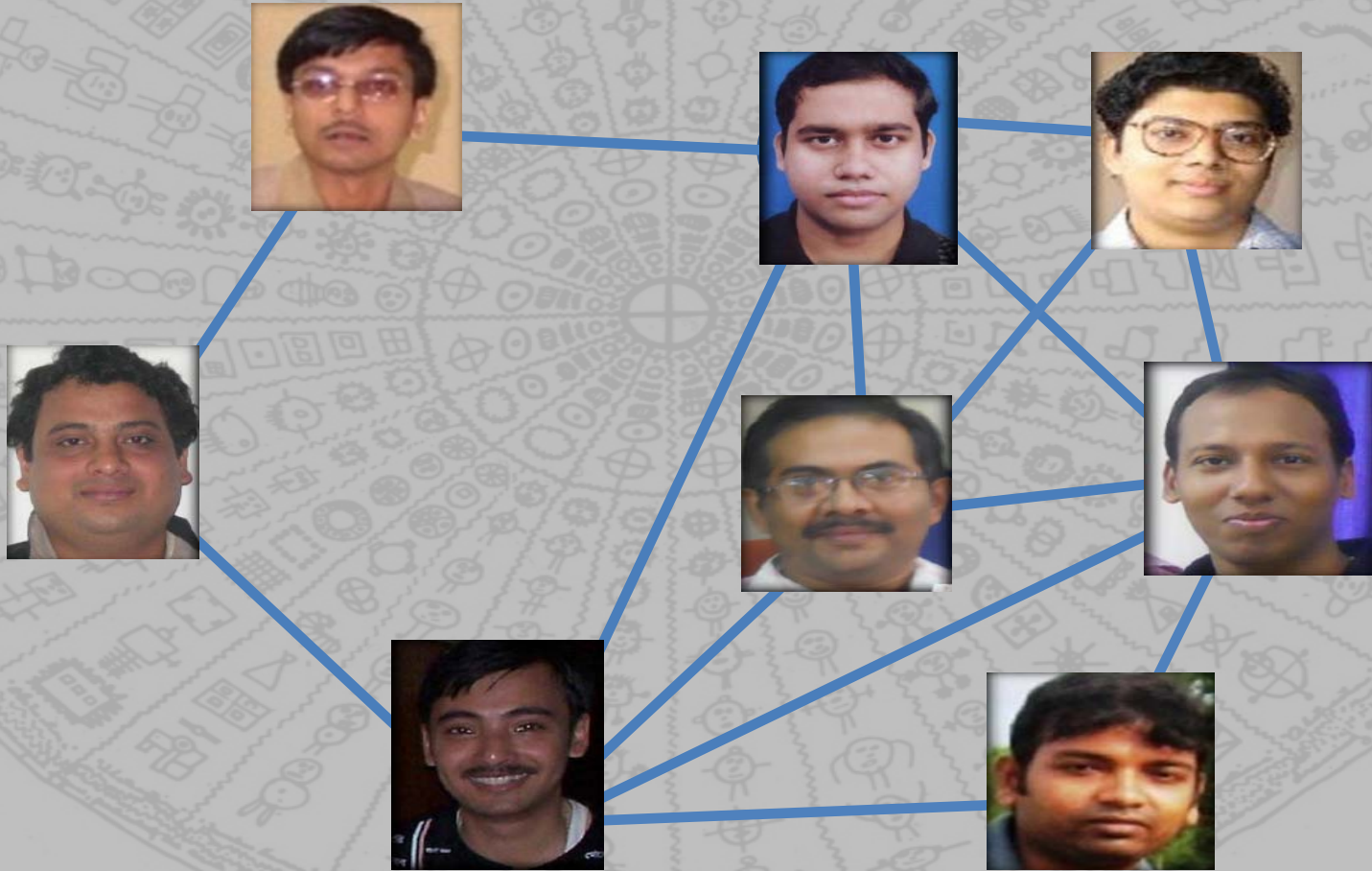
Datasets

- Face-to-face interaction (SG)
  - Science Gallery in Dublin, Ireland (2009)
  - "INFECTIOUS:STAY AWAY" initiative for 69 days
- Face-to-face interaction (HT)
  - conference attendees of the ACM Hypertext 2009
- Nodes   -> visitors/participants
- Edges   -> close-range face-to-face proximity existent for 20 seconds
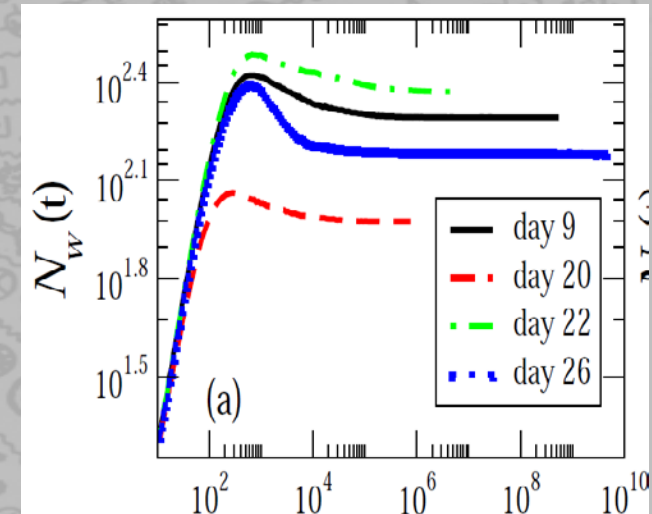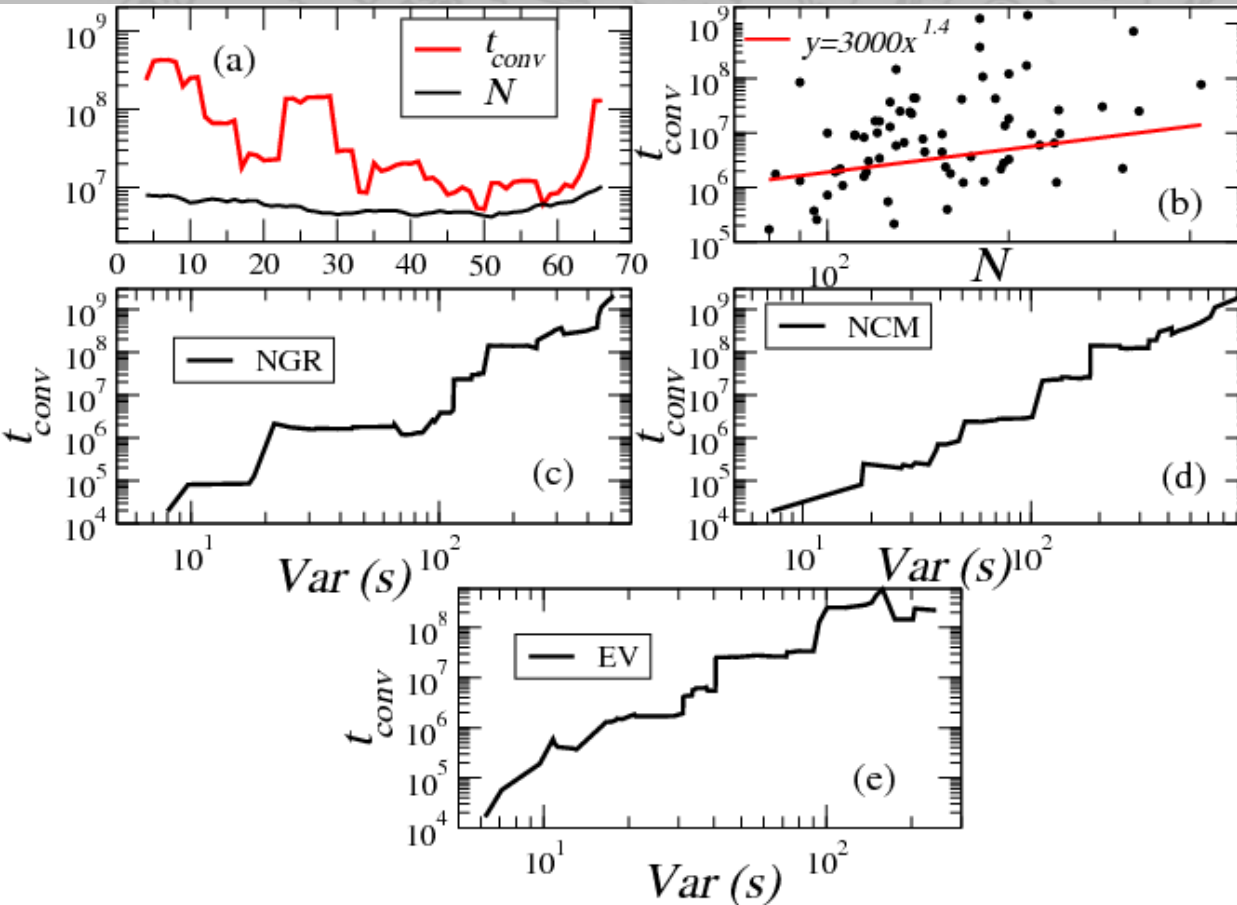
Scaling of N_w^{max} and t_{max}

Scaling Relations

- N_w^{max} ~ O(N) [✓]
- t_{max} ~ O(N) [✓]
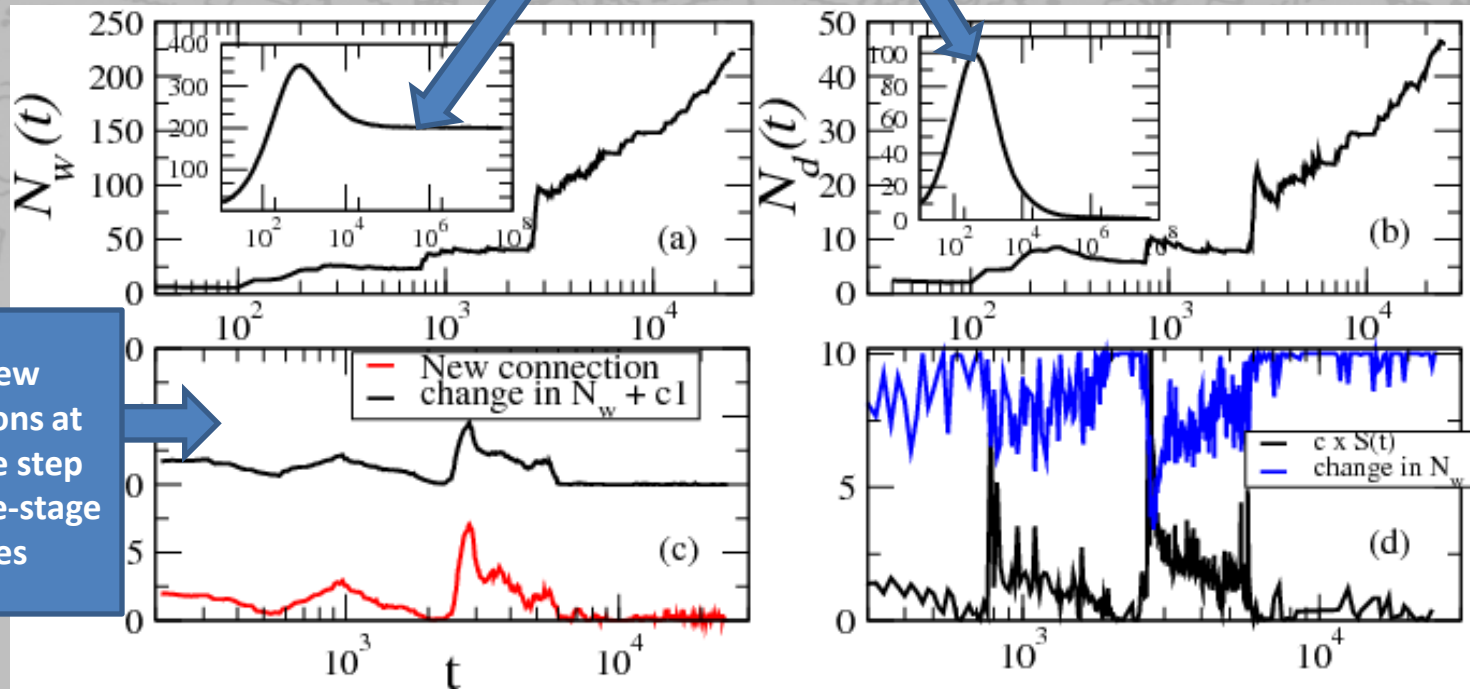- But what about t_{conv} ? O(N^{1.4})
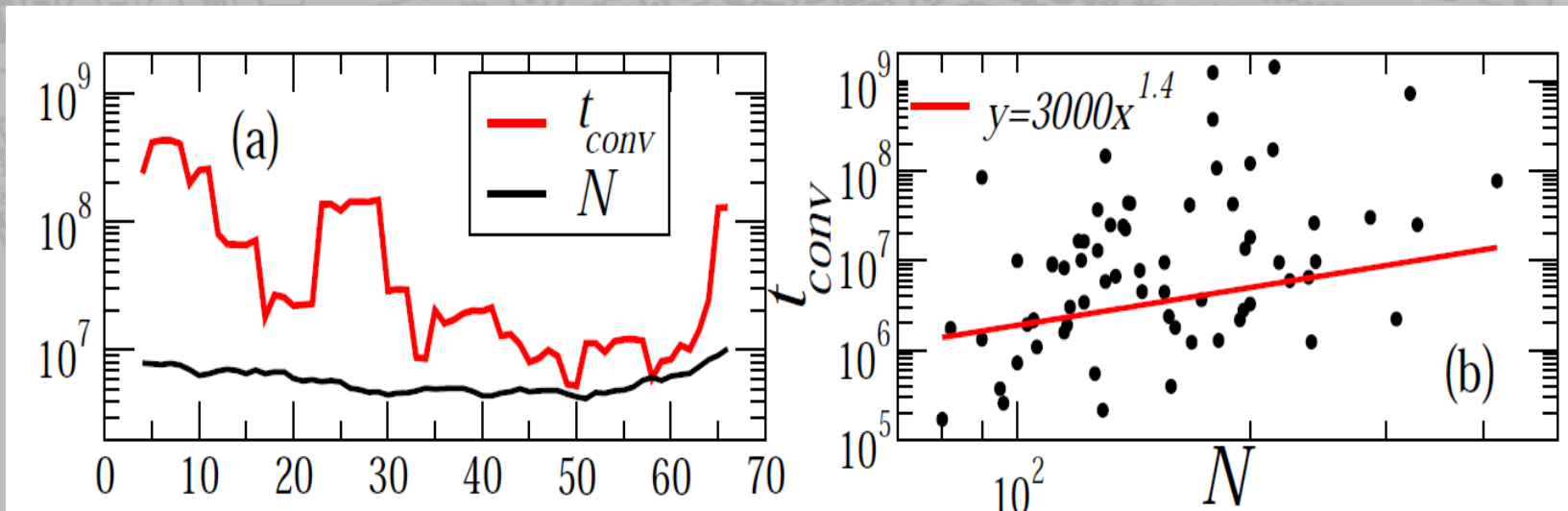
Opinions trapped in communities

Time resolved SG data

- Day 9 (representative)
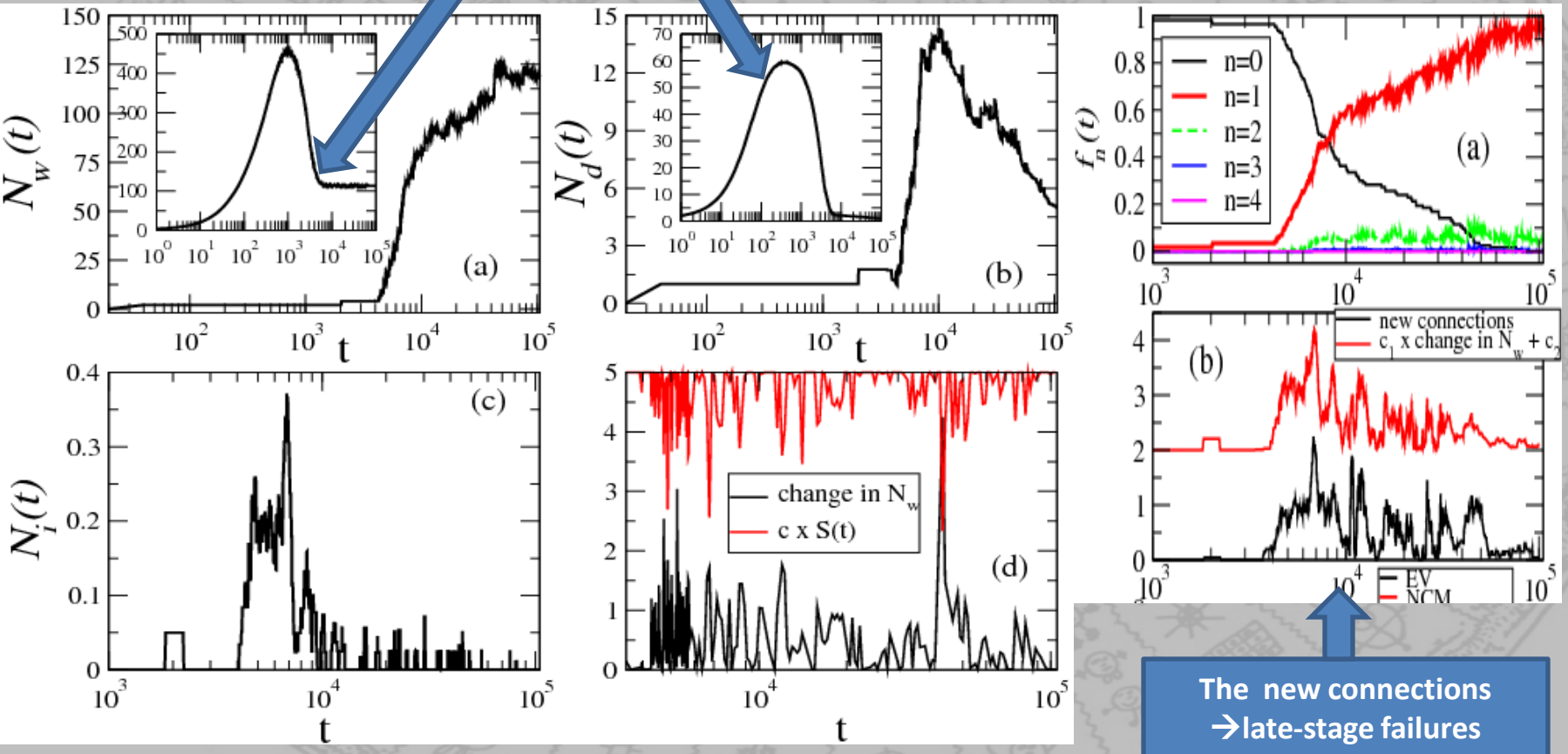
Composite Network

The new connections at each time step causes late-stage failures

HT Dataset

Composite Network

The new connections → late-stage failures

Maity, Venkat and Mukherjee, Opinion formation in time-varying social networks: the case of the naming game, *Physical Review E*, September 14, 2012, **86**, 036110.

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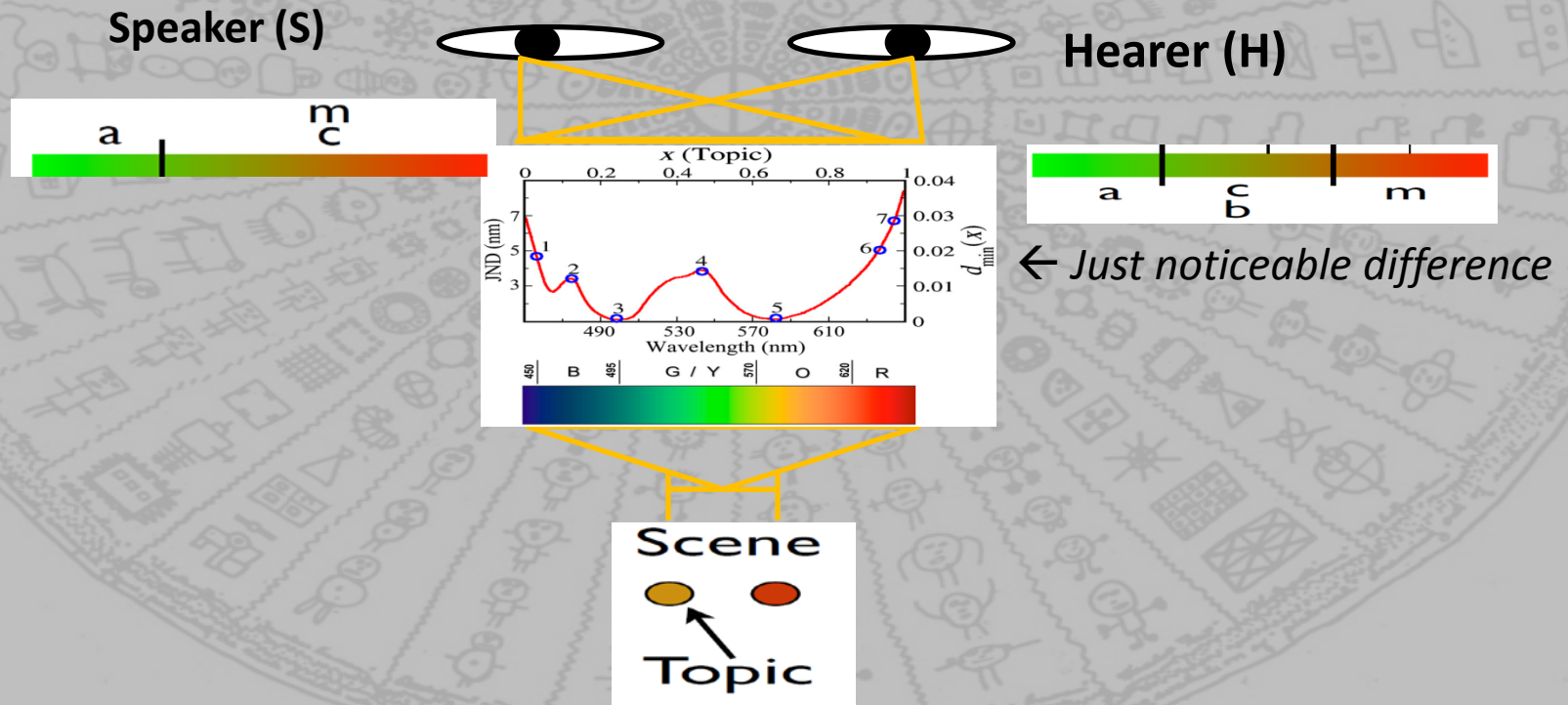
From Naming to Color Naming

- Color categorization: a central issue both in linguistics and in cognitive science
- Evolution of English color categories [English color terms → gradual semantic shift from largely brightness color concepts (Old English) to almost exclusively hue concepts (Middle English)]
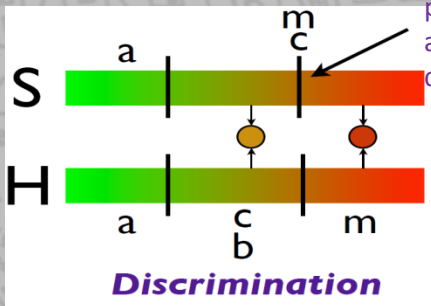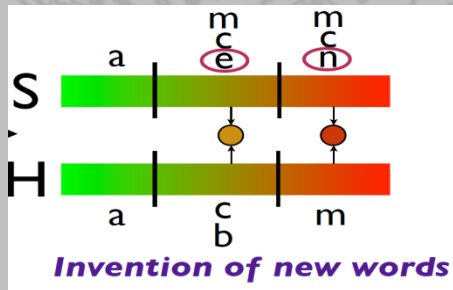
Speaker (S)

Hearer (H)

← *Just noticeable difference*

The Category Game
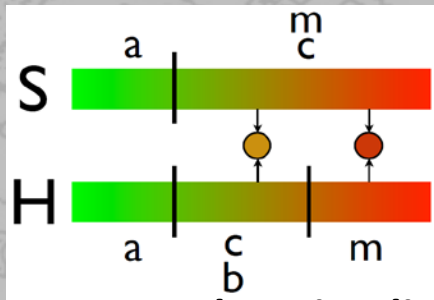
Locate the Stimuli

Discrimination

Invention of new words

two stimuli colliding on the same perceptual category → a new boundary is created
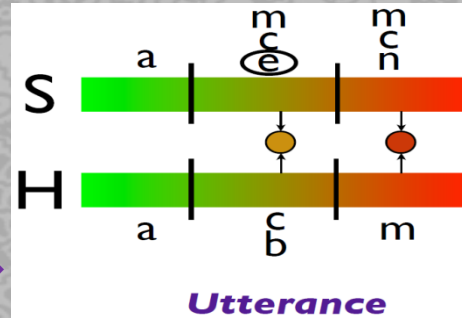
Failure
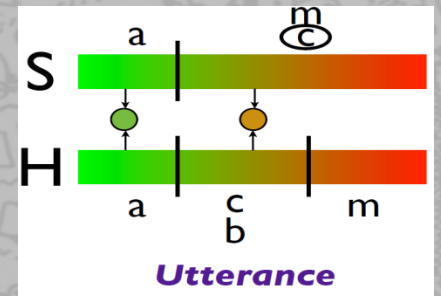
Success

Utterance

Utterance

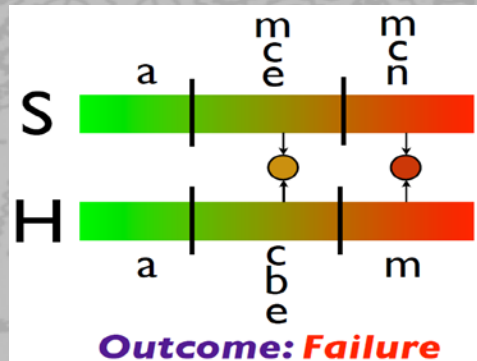*Outcome: Failure*

Outcome: Success

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The Color Hierarchy

$$\begin{bmatrix} \text{white} \\ \text{black} \end{bmatrix} < [\text{red}] < \begin{bmatrix} \text{green} \\ \text{yellow} \end{bmatrix} < [\text{blue}] < [\text{brown}] < \begin{bmatrix} \text{purple} \\ \text{pink} \\ \text{orange} \\ \text{gray} \end{bmatrix}$$

Danke

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