How Misinformation Spreads Online

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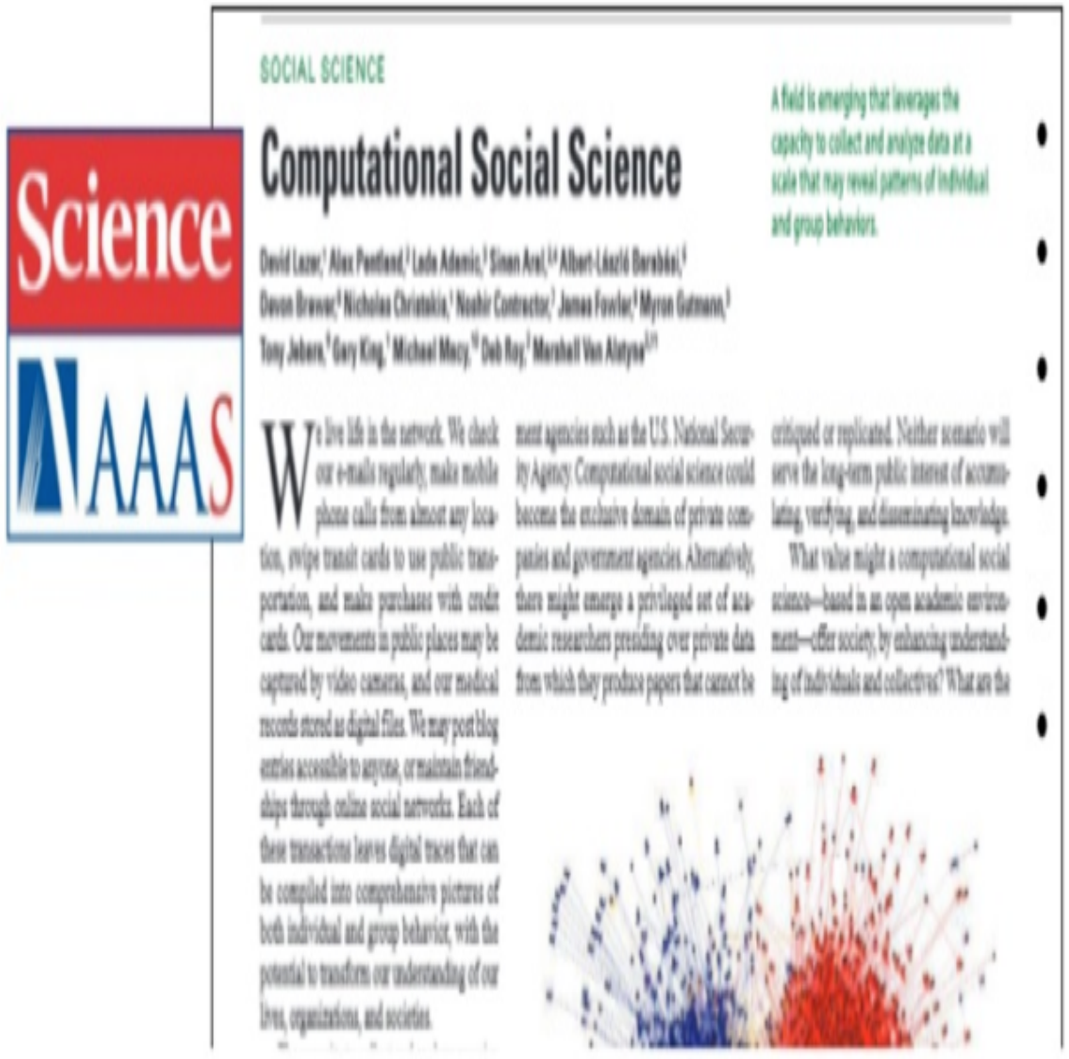
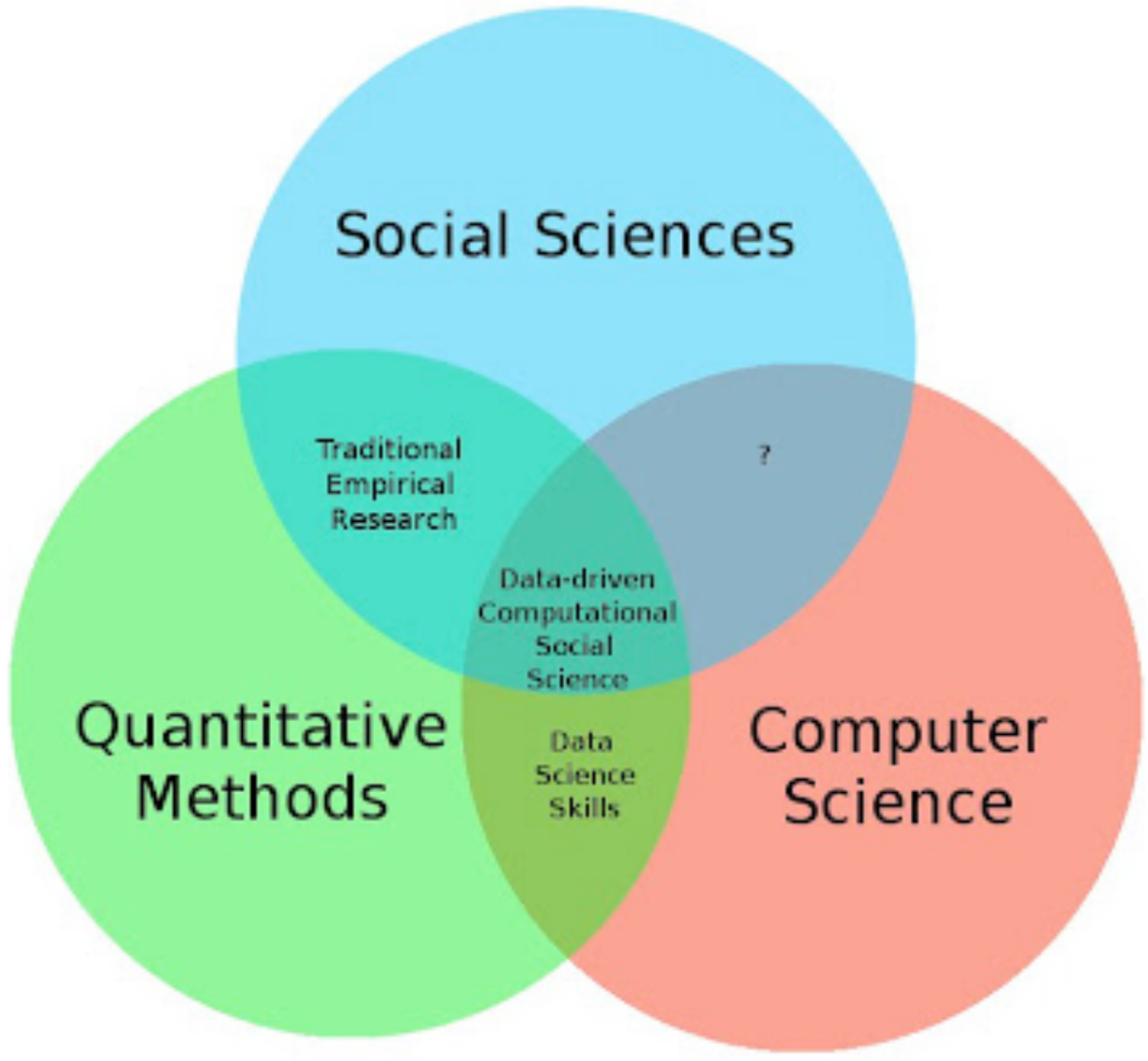
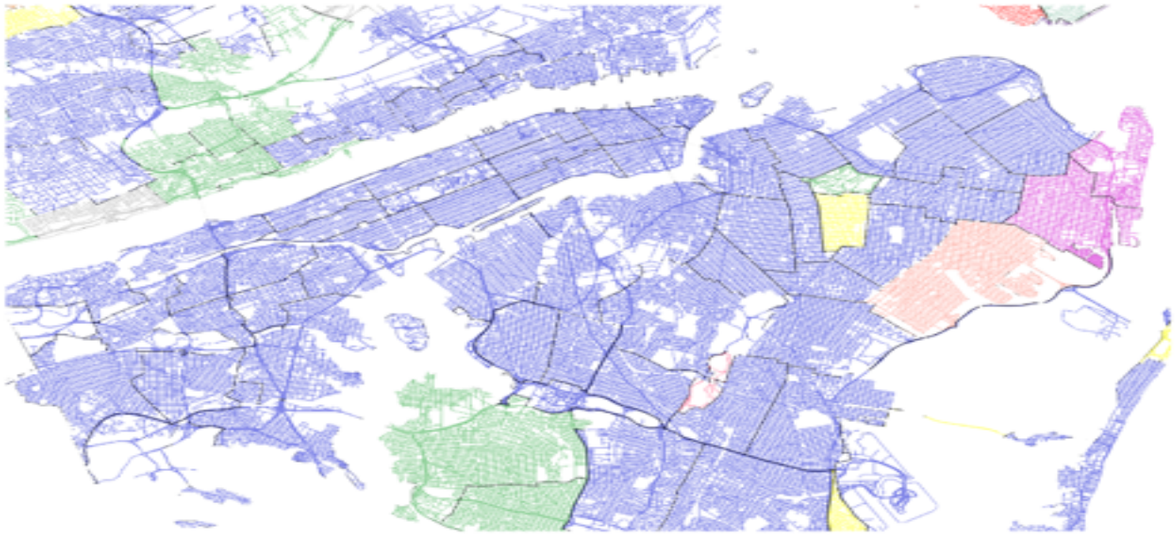
Computational social science refers to the academic sub-disciplines concerned with **computational approaches** to the **social sciences**.



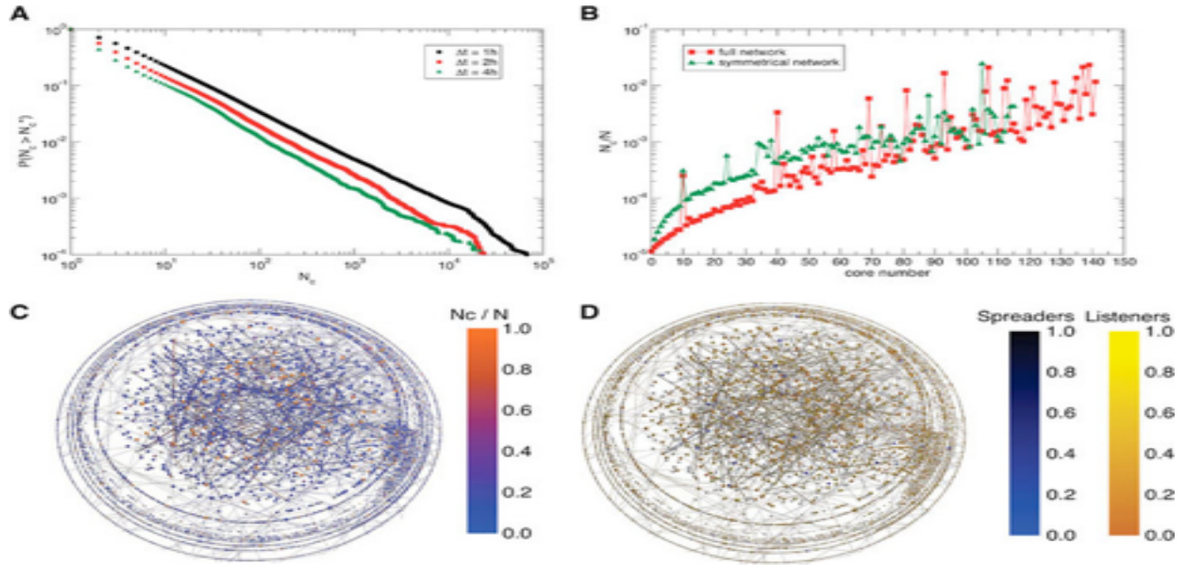


OBSERVING SOCIAL PHENOMENA

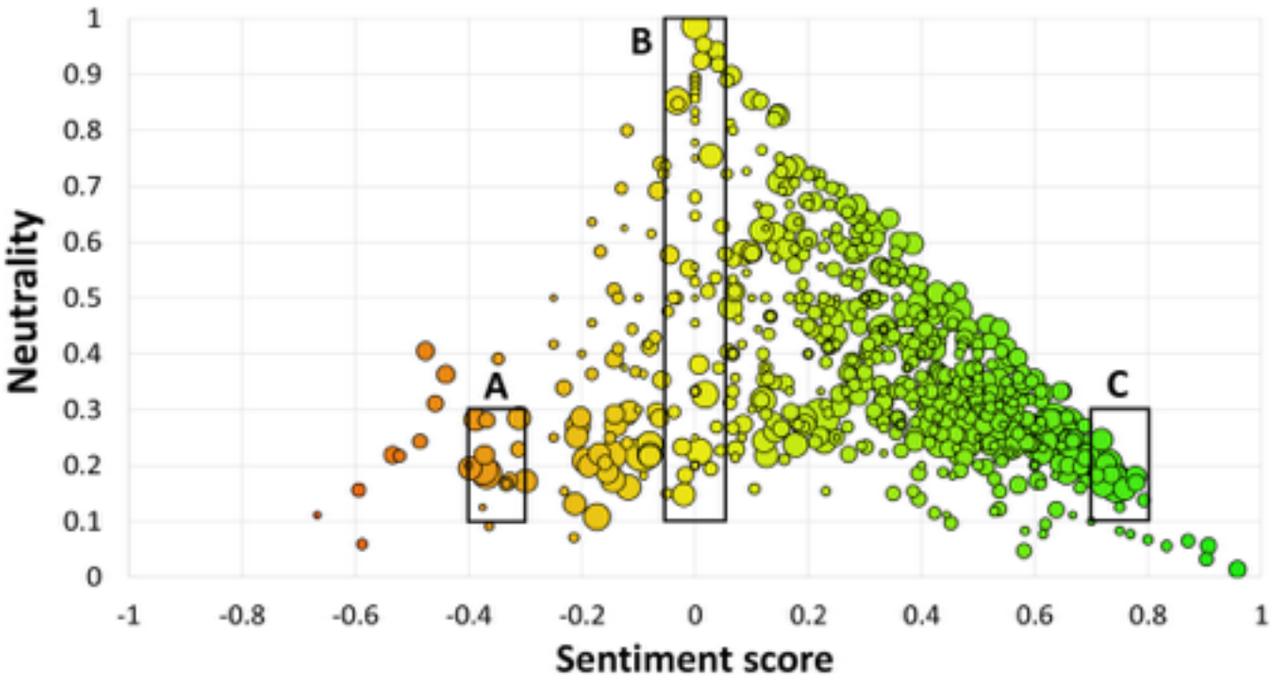
The Twitter of Babel: Mapping World Languages through Microblogging Platforms
(Mocanu et al PlosOne 2013)



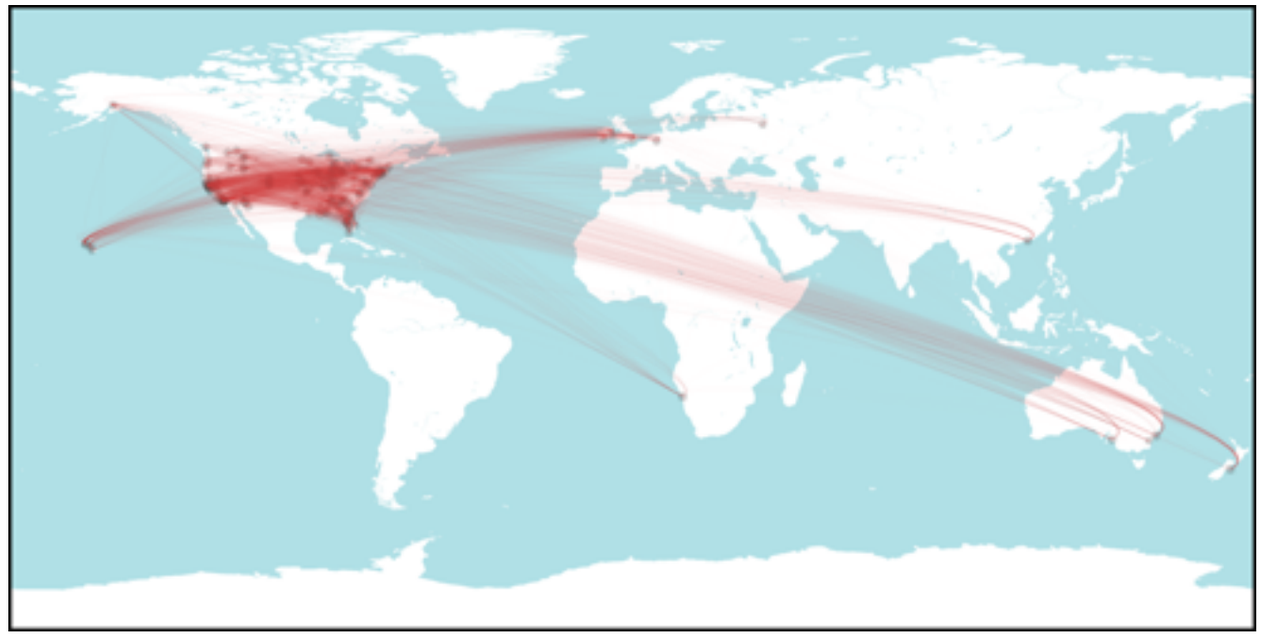
The dynamics of protest recruitment through an online network.
(S. González-Bailón et al" Sci rep 1 (2011).)



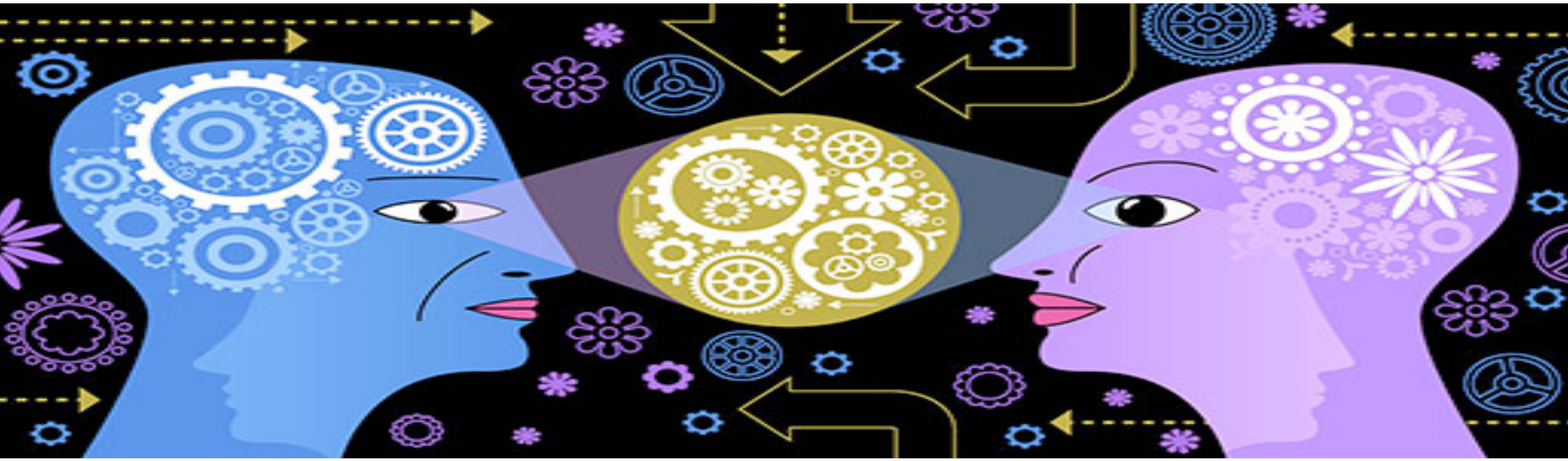
Sentiment of emojis
(P. Novak et al. PLoS One 2015)



Structural Patterns of the Occupy Movement on Facebook
(Del Vicario et al. submitted to SNAM)

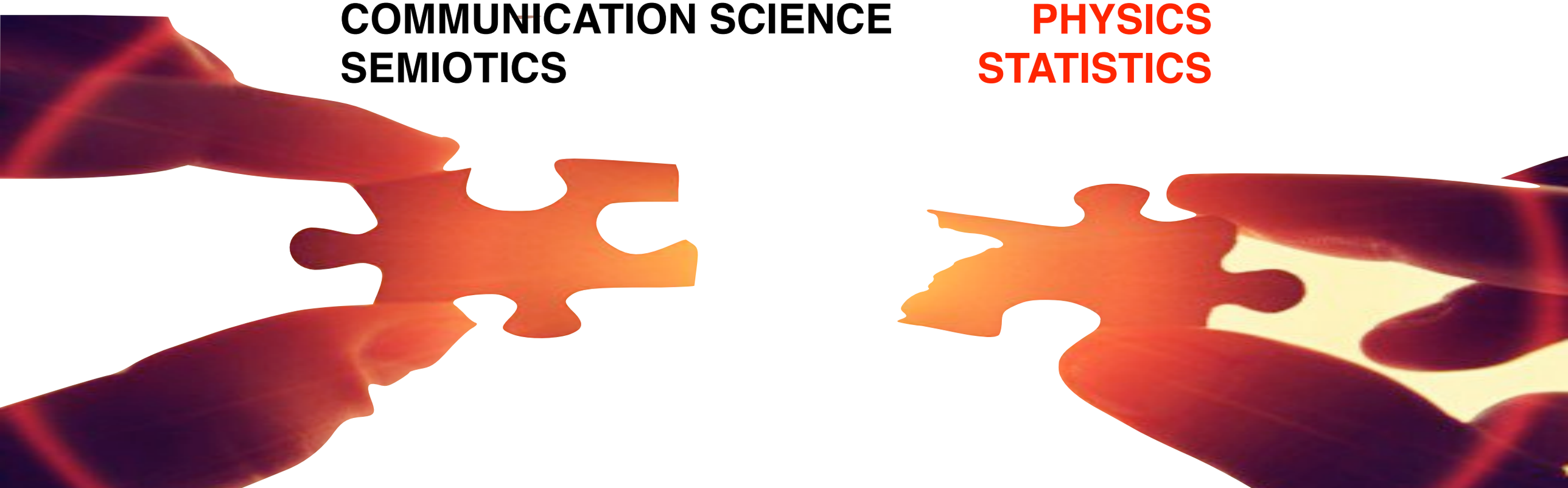


FAR AND BEYOND



SOCIAL SCIENCE
PSYCHOLOGY
COMMUNICATION SCIENCE
SEMIOTICS

COMPUTER SCIENCE
MATHEMATICS
PHYSICS
STATISTICS



SETTING UP EXPERIMENTS WITH DATA

FOCUS

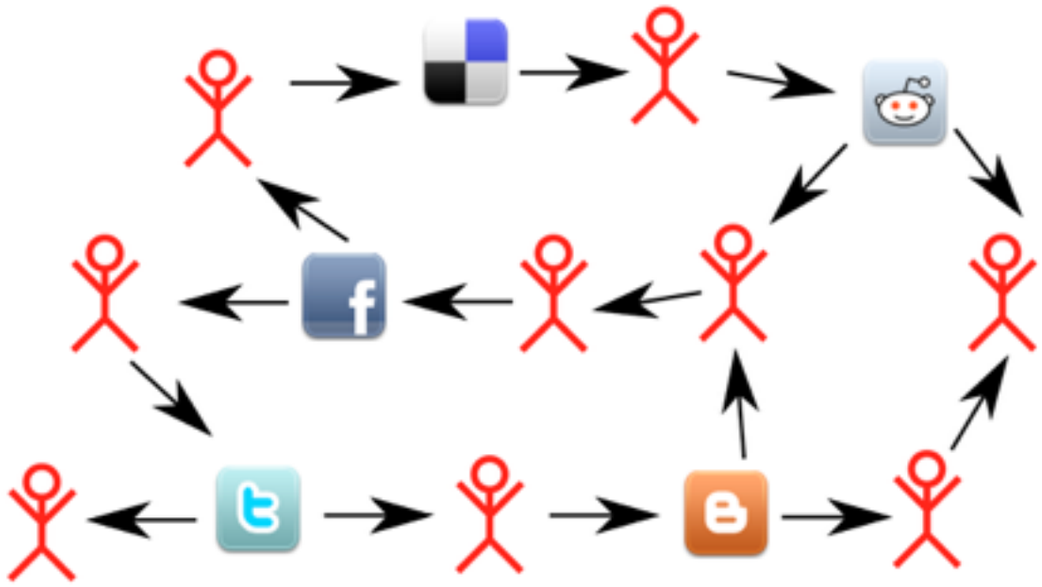
(MIS)INFORMATION SPREADING ONLINE

METHODOLOGY**:**

- **Questions framing** (Sociology, Comm., Psych., Semiotics, Anthropology)
- **Data Collection** (Algorithms, Database Eng.)
- **Quantitative Analysis** (Statistical mechanics, Net Sci, Machine Learning)
- **Modeling** (Statistical mechanics, Multi agent systems)

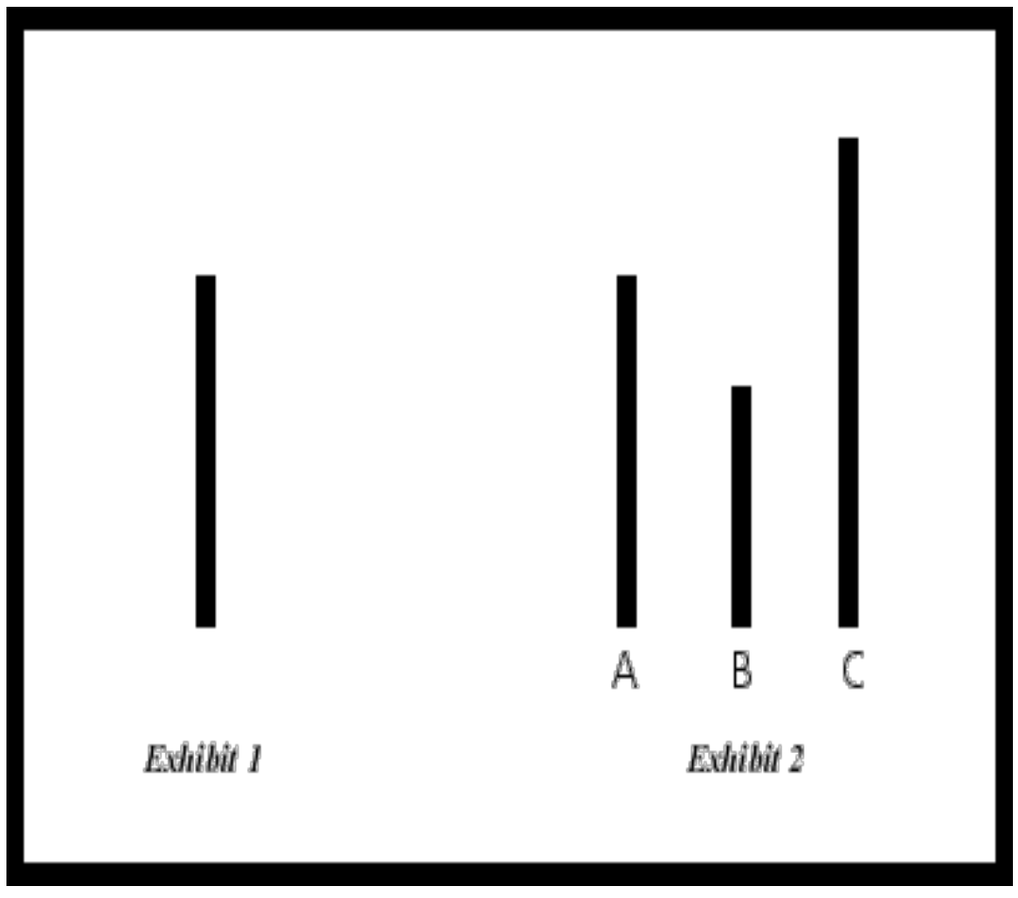
RELATED TOPICS:

- **Social Contagion**
- **Collective Framing of Narratives**
- **Content Consumption**
- **Opinion Dynamics**



THE ASCH DILEMMA (1951)

Which line of the right panel matches the one in the left panel?



8-10 participants
Only **one** is the really subject
Other participants are **actors**

Occasionally other participants intentionally give the wrong answer.

On 18 Trials **12** the answer was wrong

SOCIAL CONTAGION

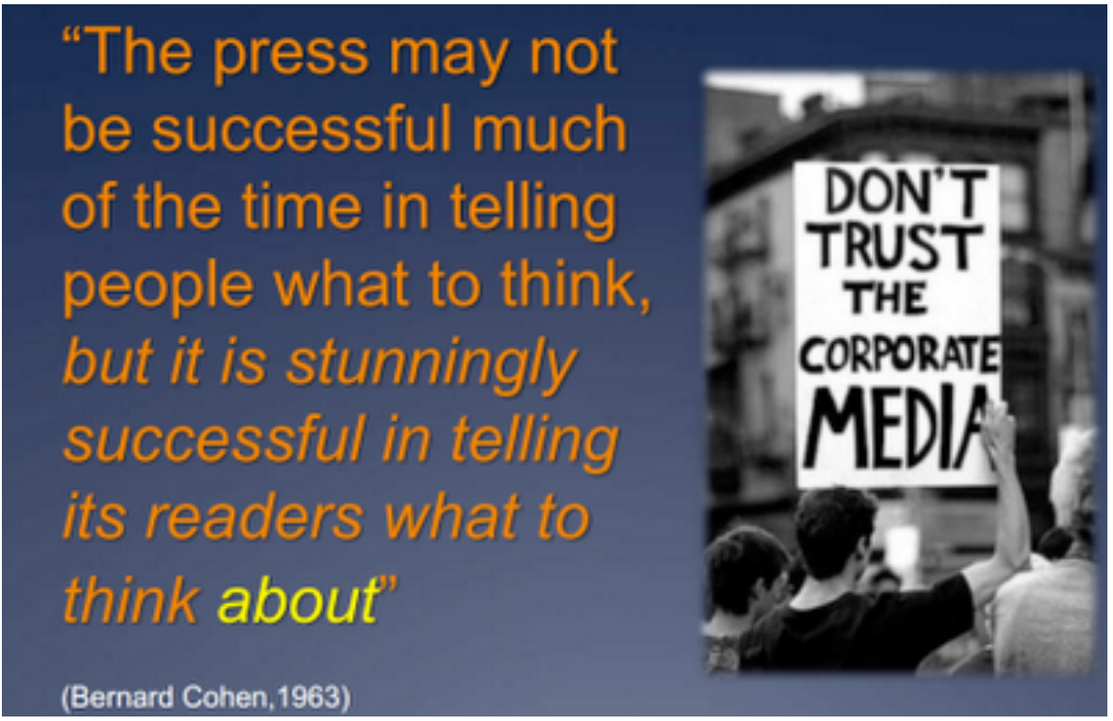
Epidemics:
Simple Contagion

Ideas and behaviors:
Complex Contagion

Under the Virus metaphor the receptor for an information is complex

Intentionality
Trust
Attitudes
Social Norms
Confirmation Bias

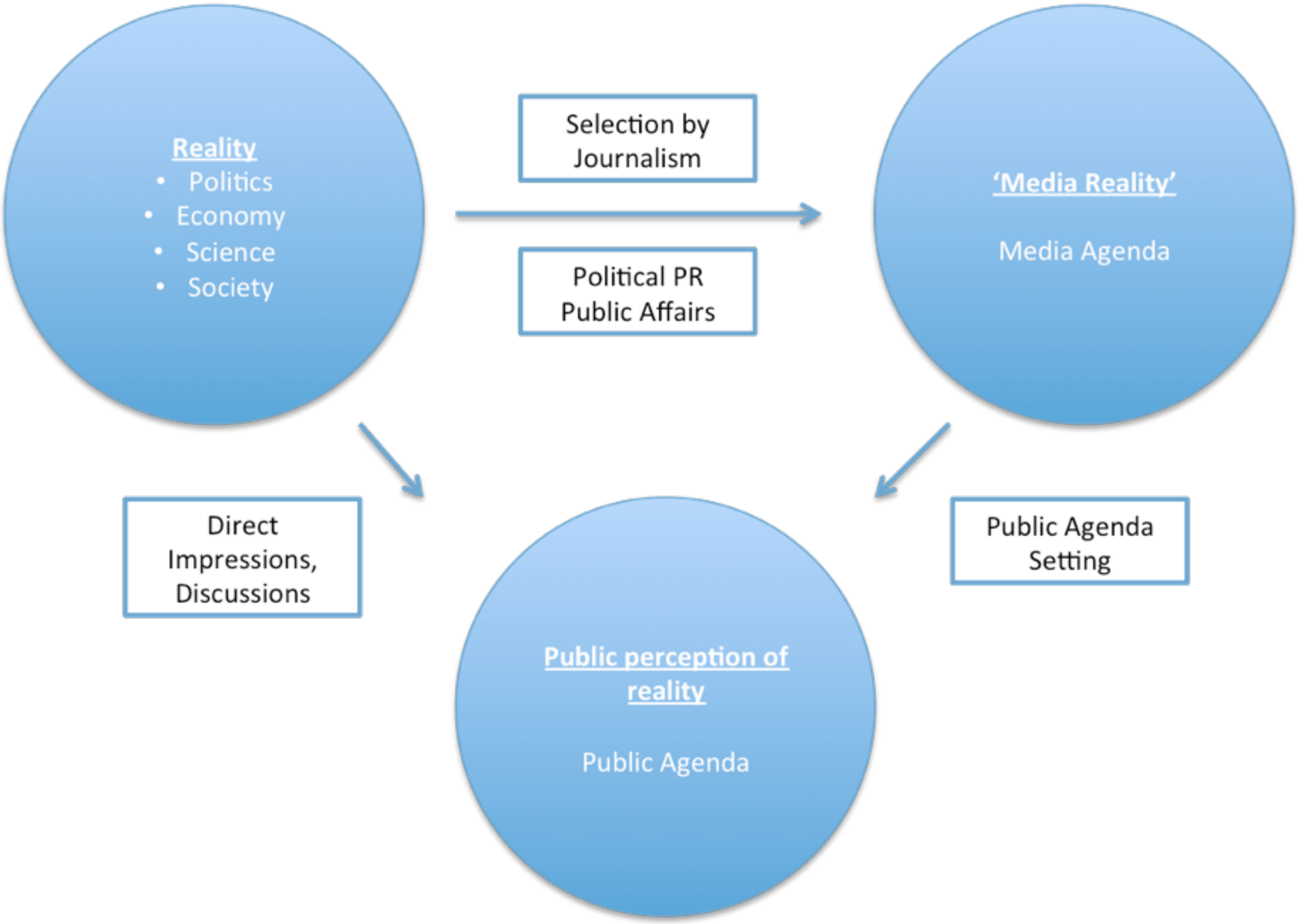
THE ROLE OF THE MEDIA



Agenda Setting is the process of the mass media presenting certain issues **frequently** and **prominently** with the result that large segments of the public perceive those issues as more important than others.

MORE COVERAGE —> MORE IMPORTANT

AGENDA SETTING CYCLE



A SHIFT OF PARADIGM

OLD MEDIA

- Follow the “Ritual of Objectivity”
- Publication patterns are driven by most followed sources (imitation) (Marlow 2005)

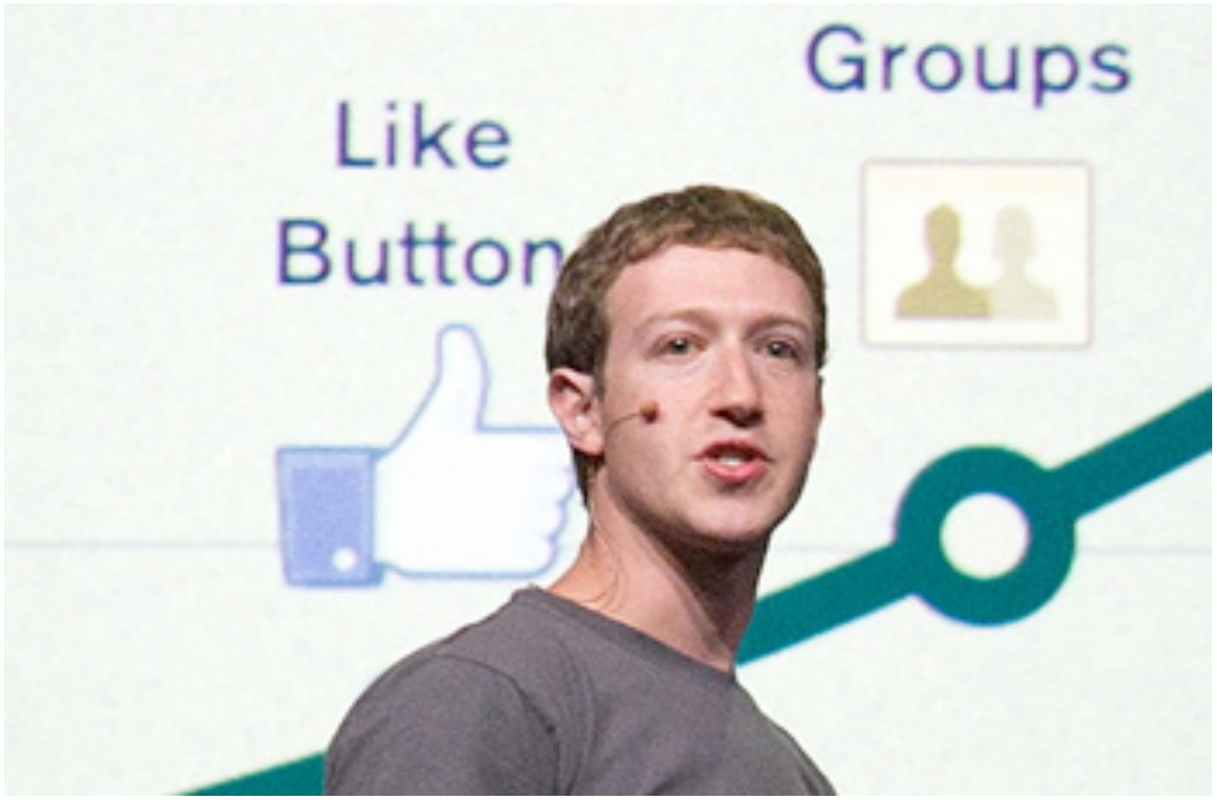
MEDIATED

NEW MEDIA

- Information production is the work of interconnected actors spanning over organizations, professional identity and geographical location

DISINTERMEDIATED

FACEBOOK AS A CROWD DRIVEN BROADCASTER



“We're not thinking about ourselves as a community
— we're not trying to build a community — we're not trying to make new connections. [...]
What we're trying to do is just make it really efficient for people to communicate, **get information and share information**.
We always try to emphasize the utility component.”

Mark Zuckerberg Jul. 2007

WHAT ABOUT THE QUALITY OF INFORMATION?

From the steady roll of theories on what happened to Malaysian Arlines Flight 370, to Sarah Palin's "death panels" panic, to Donald Trump's birther theories, misinformation spreads like wildfire in the age of Facebook.

In 2013, professor Walter Quattrociocchi of Northeastern University along with his team studied how more than 1 million Facebook users engaged with political information during the Italian election. During that election a post appeared titled: "Italian Senate voted and accepted (257 in favor and 165 abstentions) a law proposed by Senator Cirenga to provide policy makers with €134 billion Euros to find jobs in the event of electoral defeat."

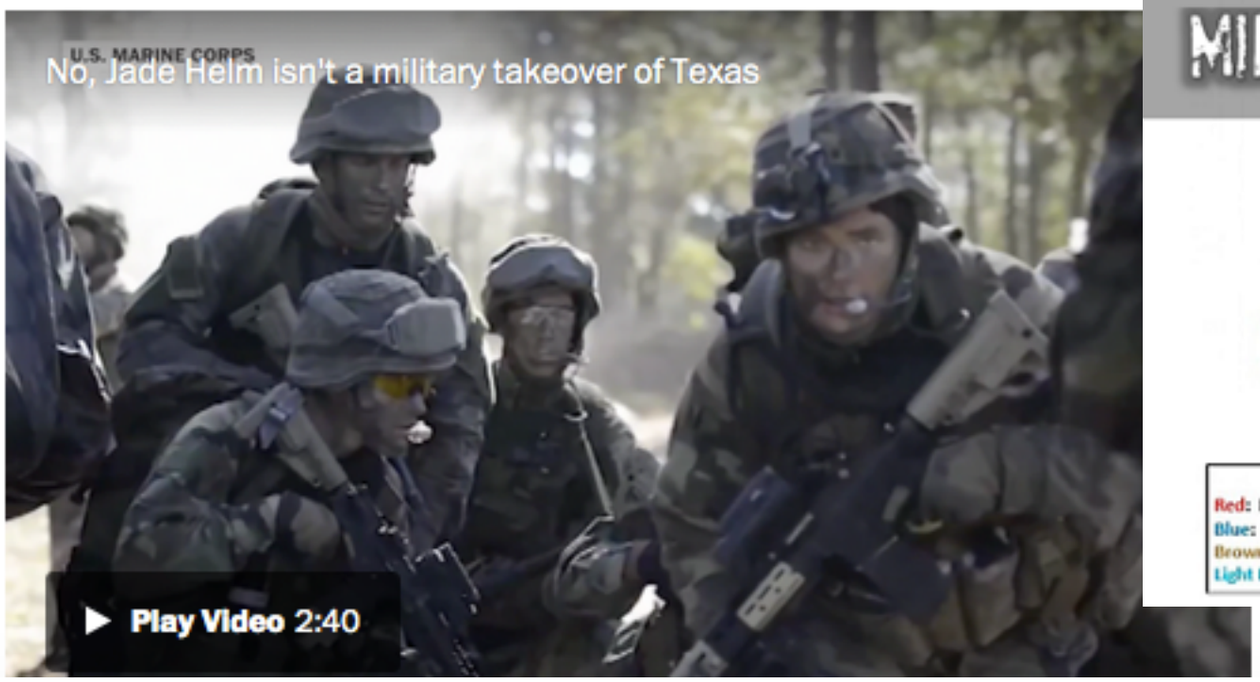
JADE HELM 15

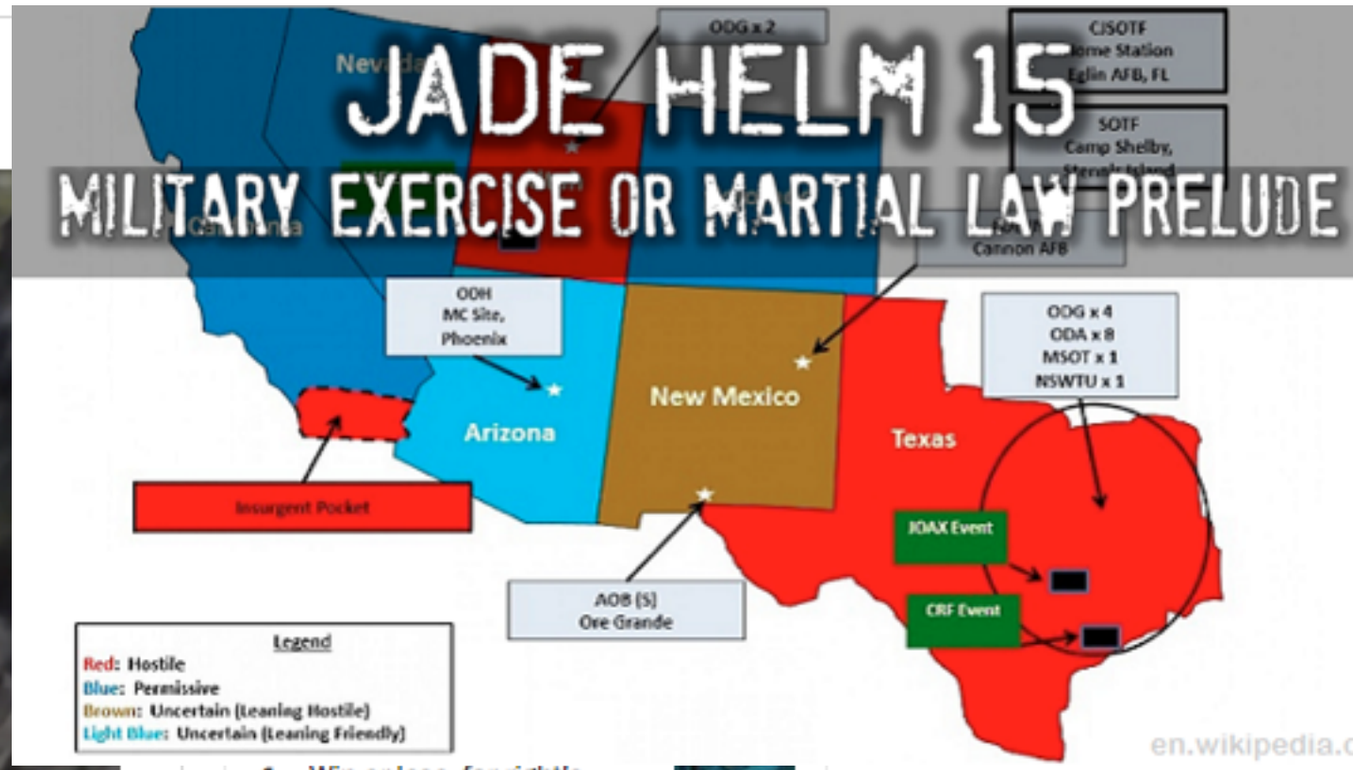
The Washington Post

Checkpoint

Why Operation Jade Helm 15 is freaking out the Internet — and why it shouldn't be

By Dan Lamothe March 31





1 Win or lose, far right's tough rhetoric against

TROLLING: MOCKING COLLECTIVE “INTELLIGENCE”

TROLLS

Their activities range from controversial comments and posting satirical content mimicking alternative news sources, to the fabrication of purely fictitious statements, heavily unrealistic and sarcastic.

POE’S LAW

Without a blatant display of humor, it is impossible to create a parody of extremism or fundamentalism that someone won't mistake for the real thing. (Nathan Poe 2005)

THE EFFECT OF FALSE RUMORS

Sandro Pertini never said
"*when the government does not do what people want must be fired with stones and sledgehammers.*"
He has been President of the Republic (1978-1985).

INSIGHTS OF THE PROCESS

A GLIMPSE OF CONFIRMATION BIAS

<< Ci piace, ma non sappiamo >>

<< We like it, but we don’t know…>>

“Italian Senate voted and accepted (257 in favor and 165 abstentions) a law proposed by Senator Cirenga aimed at funding with 134 billion Euros the policy-makers to find a job in case of defeat in the political competition.”

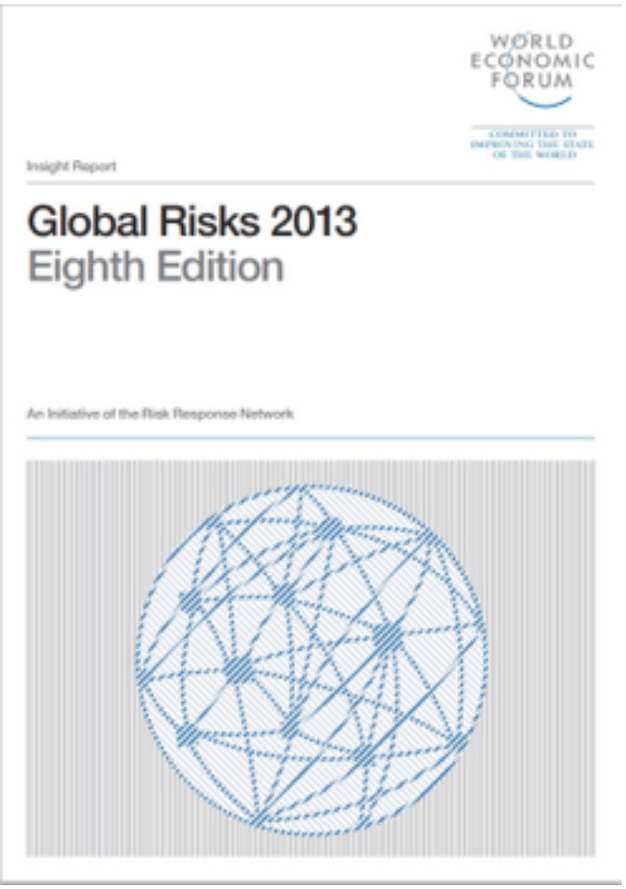
CLAPPING……..

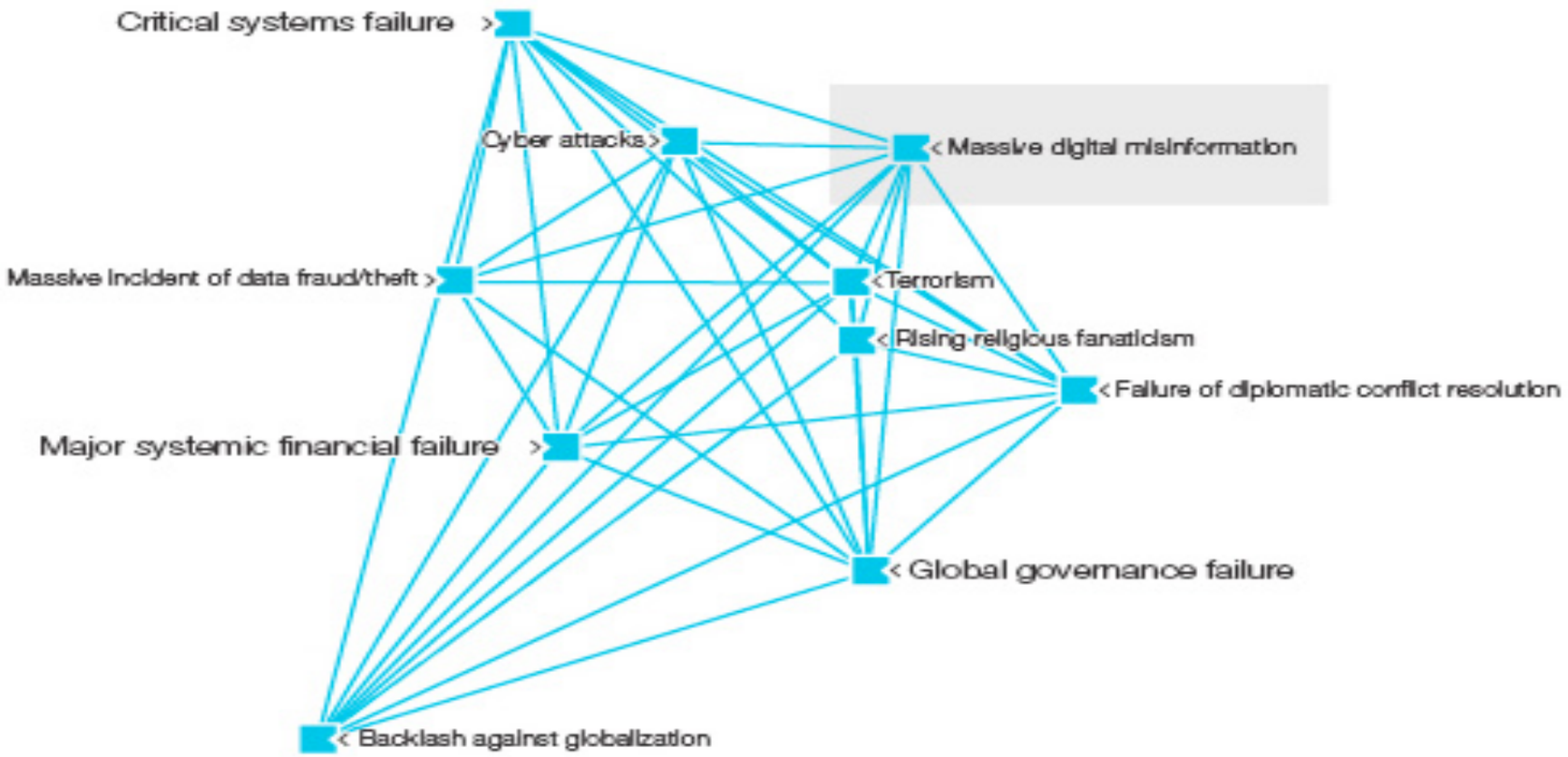
TROLLING FOR UNDERSTANDING OLINE MISINFORMATION

CONFIRMATION BIAS

The cognitive attitude to search for, interpret, favor, and recall information in a way that confirms one's beliefs

MISINFORMATION ONLINE



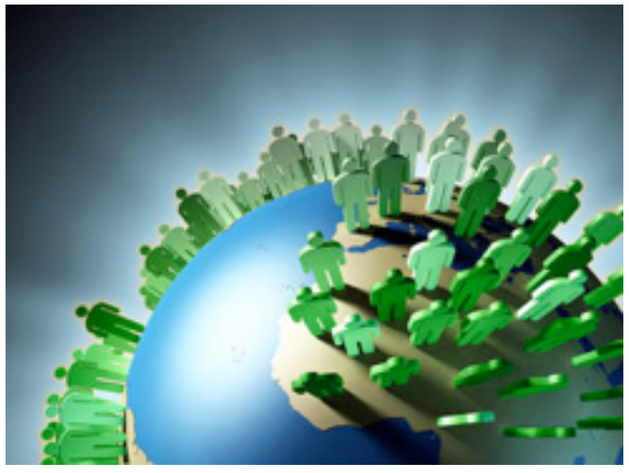


THE WORLD ECONOMIC FORUM HAS POINTED OUT
MASSIVE DIGITAL MISINFORMATION
AS ONE OF THE MAIN RISKS FOR OUR SOCIETY

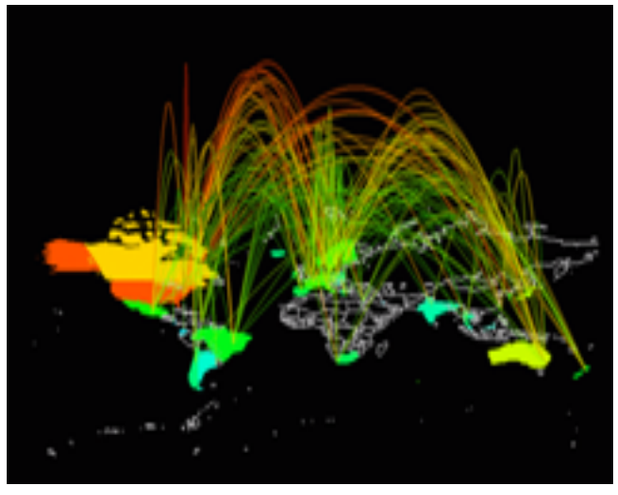
WHY?

Complexity of the world exploded

GLOBALIZATION



INTERCONNECTIVITY



SCIENTIFIC PROGRESS

FUNCTIONAL ILLITERACY

Nazione	Persone funzionalmente analfabete (% con età 16–65) 2003-2008[7]
Italia	47,0
Messico	43,2
Stati Uniti	20,0
Ungheria	17,0
Svizzera	15,9
Canada	14,6
Australia	13,9
Nuova Zelanda	13,4

INFORMATION OVERLOAD

SETTING UP THE (DATA) EXPERIMENT

Focus:

Understand the role of confirmation bias in the diffusion of (mis)information

Methodology:

a) Analyze users' behavior on specific contents Conspiracy and Science News (cont)
b) Response to intentional false claims (Trolls)
c) Response to contrasting information (Debunking)

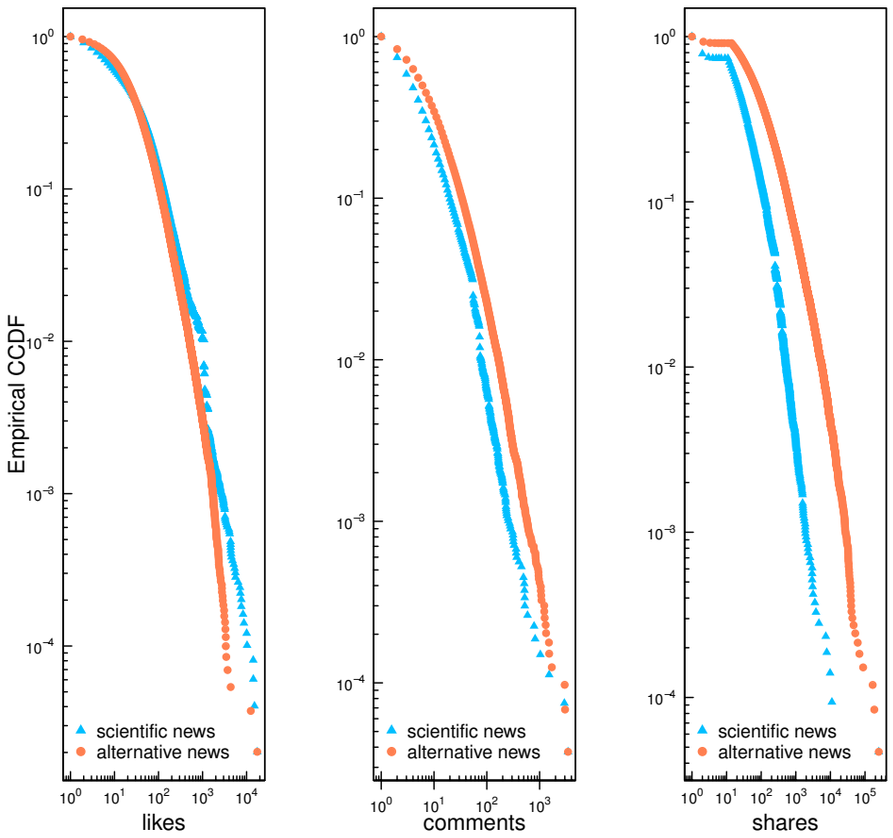
THE DATASET(s)

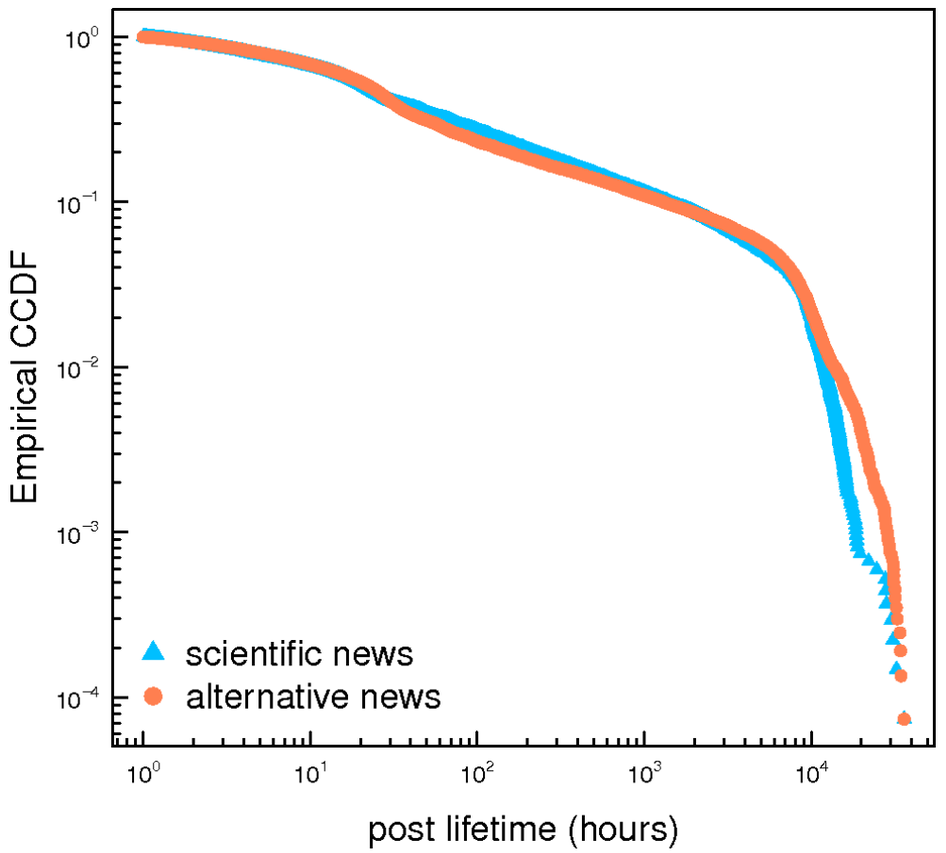
Facebook ITALY and **USA** from Jan 2010 to Dec 2014

FB ITALY	TOTAL	SCIENCE	CONSPIRACY	**TROLL**
Pages	73	34	39	**2**
Posts	271,296	62,705	208,591	**4,709**
Likes	9,164,781	2,505,399	6,659,382	**40,341**
Comments	1,017,509	180,918	836,591	**58,686**
Likers	1,196,404	332,357	864,047	**15,209**
Commentsers	279,972	53,438	226,534	**43,102**

FB USA	TOTAL	SCIENCE	CONSPIRACY	**DEBUNKING**
Pages	478	83	330	**66**
Posts	679,948	262,815	369,420	**47,780**
Likes	603,332,826	453,966,494	145,388,117	**3,986,922**
Comments	30,828,705	22,093,692	8,304,644	**429,204**
Likers	52,172,855	39,854,663	19,386,131	**702,122**
Commentsers	9,790,906	7,223,473	3,166,726	**118,996**

POSTS CONSUMPTION PATTERNS (FB ITA)





Users Activity. Empirical complementary cumulative distribution function (CCDF) of users' activity (like, comment and share) for post grouped by page category.

Post lifetime. Empirical complementary cumulative distribution function (CCDF), grouped by page category, of the temporal distance between the first and last comment to each post.

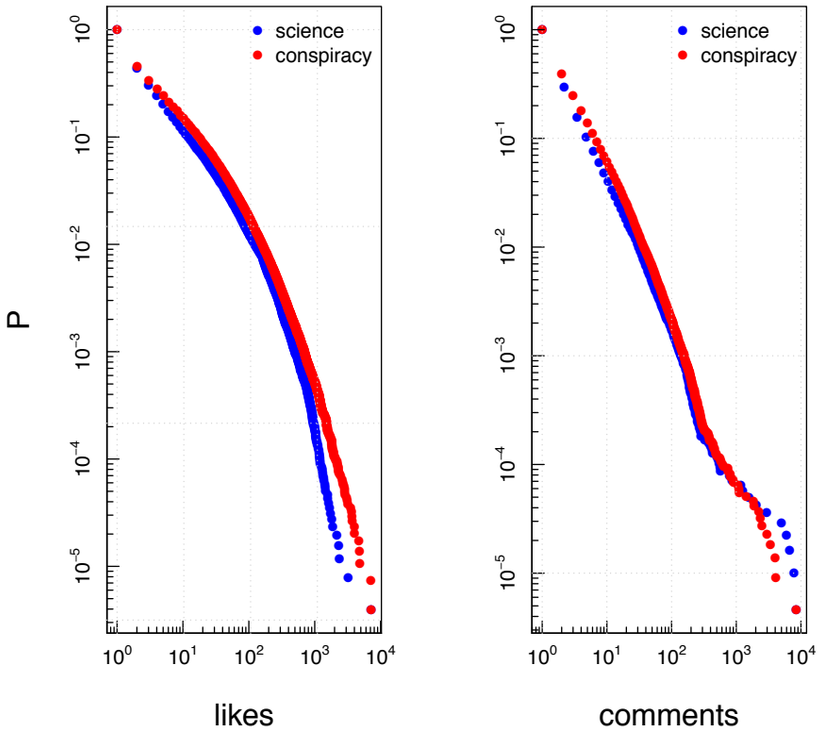
	Like/ Comments	Like/Shares	Comments/ Shares
Science	0.52	0.21	0.52
Conspiracy	0.63	**0.81**	0.65

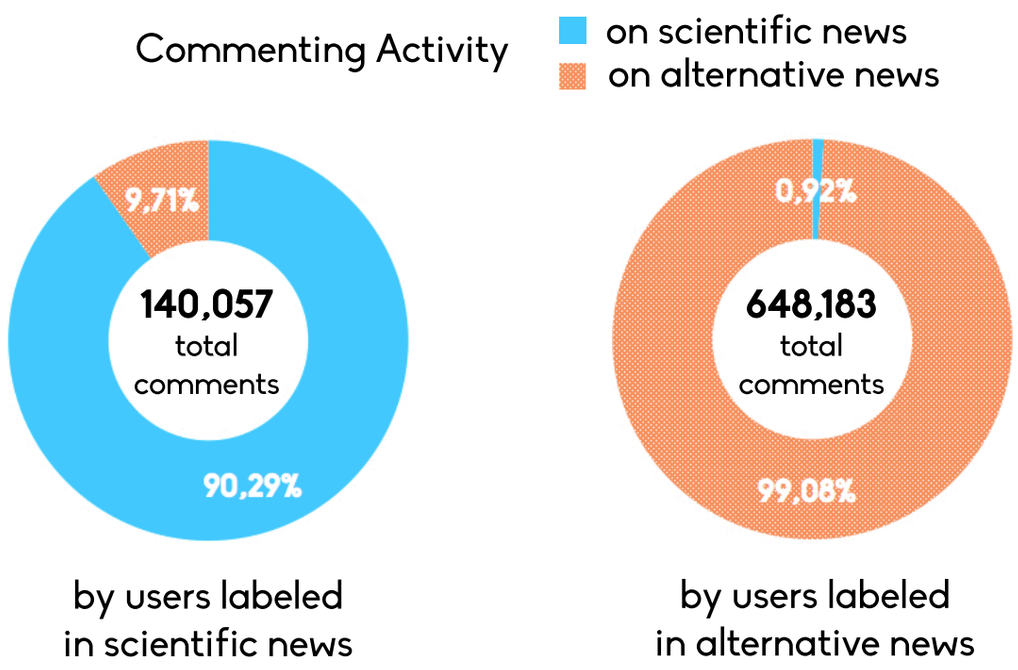
Correlation (Pearson coefficient) between couple of actions to each post in scientific and conspiracy news. Posts from conspiracy pages are more likely to be liked and shared by users, indicating a major commitment in the diffusion.

Science vs Conspiracy: Collective Narratives in the age of Misinformation
PLOS ONE (*Bessi et al. 2015*)

POLARIZED USERS

	Users Classified	% Users Classified	Comm on their category	Comments on the opposite category
Science	225,225	76,79	126,454	13,603
Conspiracy	790,899	91.53	642,229	5,954



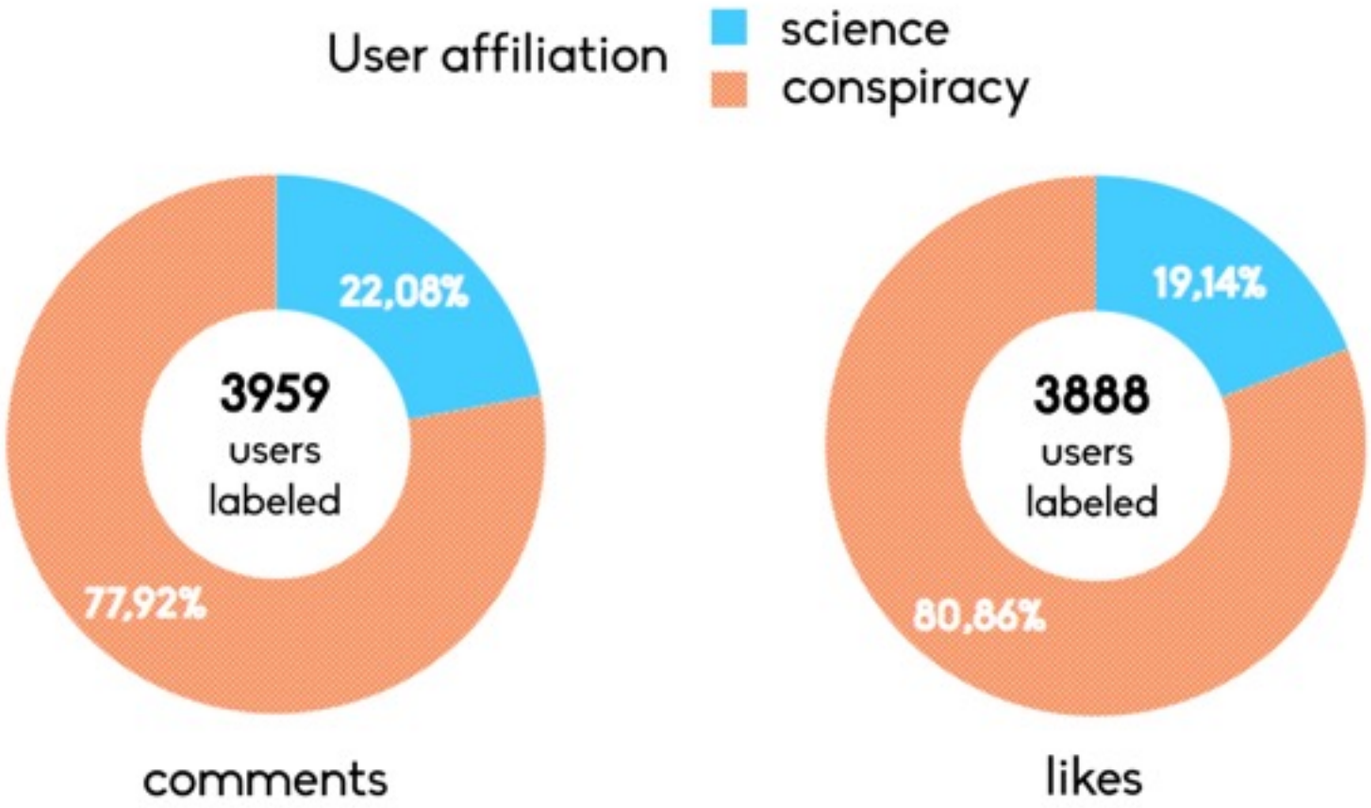


Consumption patterns for polarized users.
Cumulative Distribution Function for likes (panel a) and comments (panel b) of polarized users. Also the analysis on polarized users show some similarities in consumption patterns.

Commenting activity of polarized users.
7551 posts (**1991** in Science and **5790** in Conspiracy) polarized users on the opposite category in terms of comments.

Science vs Conspiracy: Collective Narratives in the age of Misinformation
PLOS ONE (*Bessi et al. 2015*)

RESPONSE TO **4,709** INTENTIONAL FALSE CLAIMS (TROLLS)

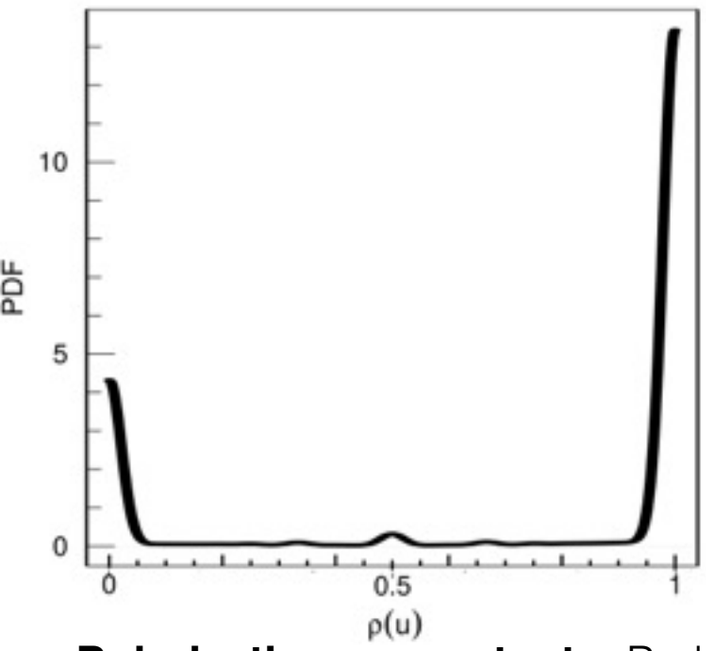


Polarized users on false information.

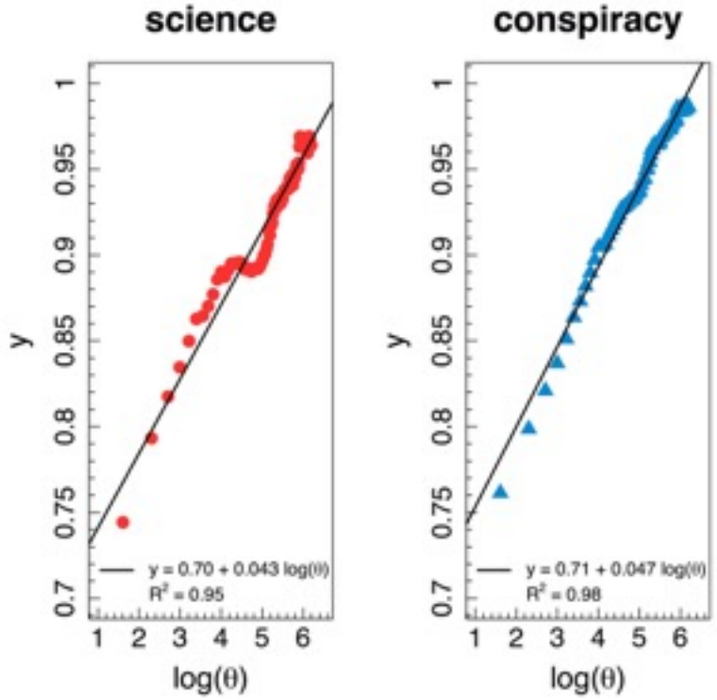
Percentage of likes and comments on intentional false information posted by a satirical page from polarized users of the two categories.

Science vs Conspiracy: Collective Narratives in the age of Misinformation
PLOS ONE (*Bessi et al. 2015*)

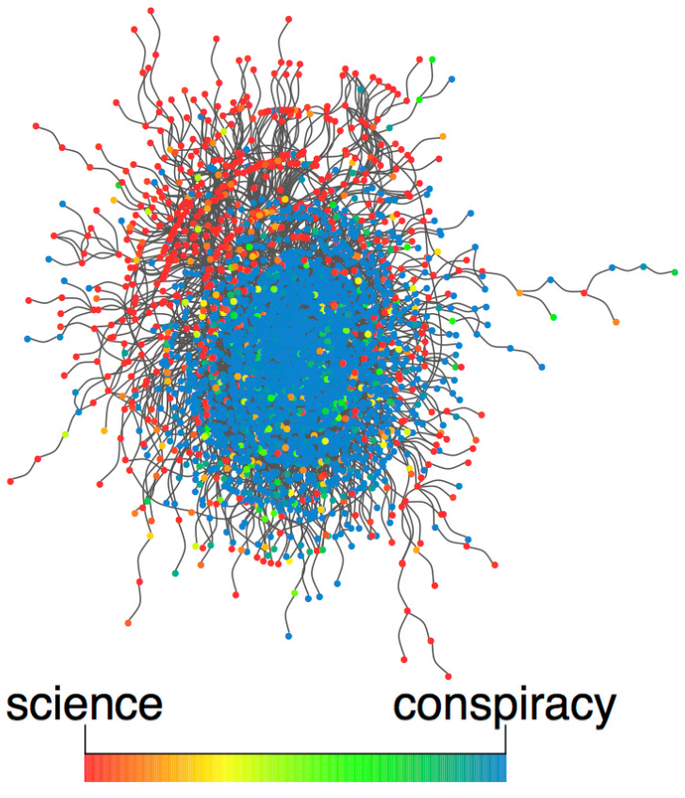
CONTENT CONSUMPTIONS AND FRIENDS



Polarization on contents. Probability density function (PDF) of users' polarization. Notice the strong bimodality of the distribution, with two sharp peaks localized at $0 < \rho < 0.005$ (science users) and at $0.95 < \rho < 1$ (conspiracy users).



Homophily. Fraction of polarized friends with the same polarization respect to the number of likes log(θ(u)) of user u.

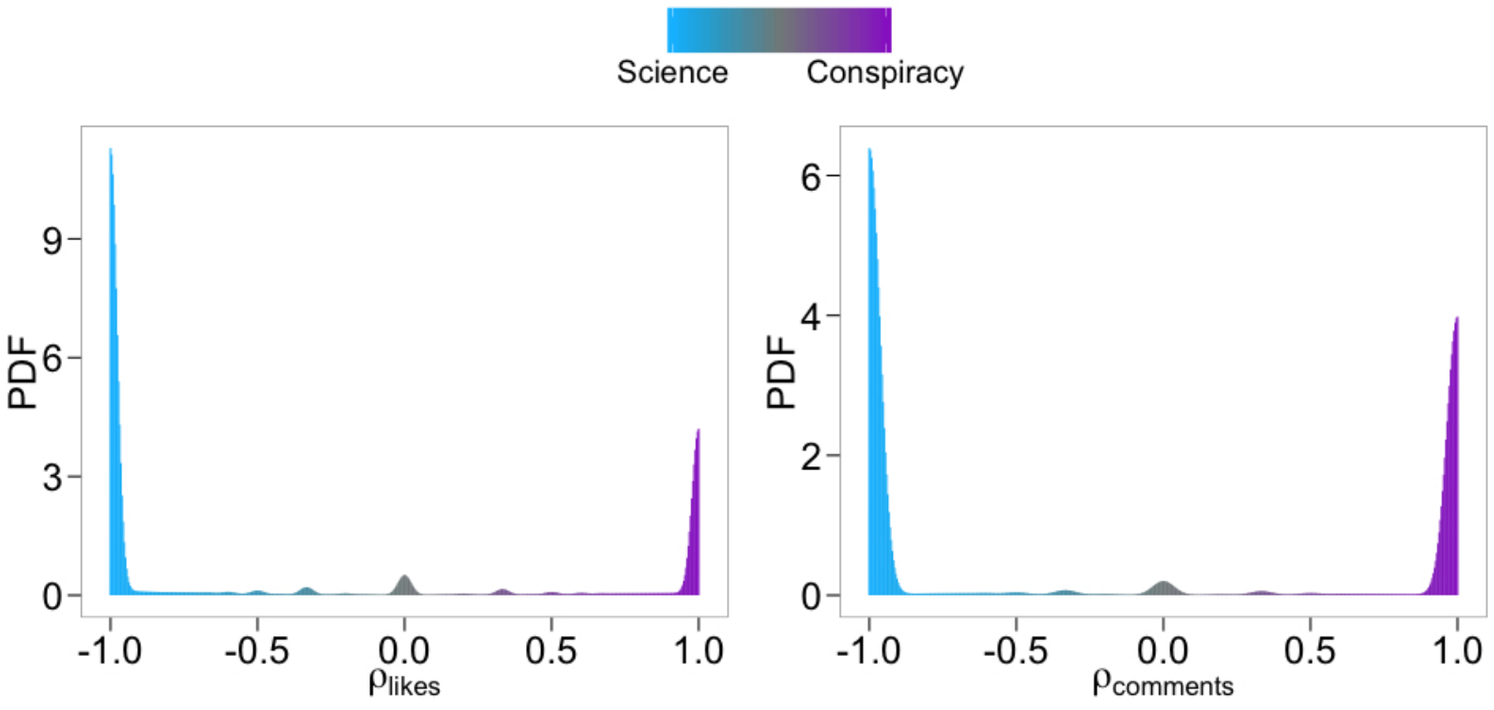


ECHO-CHAMBERS

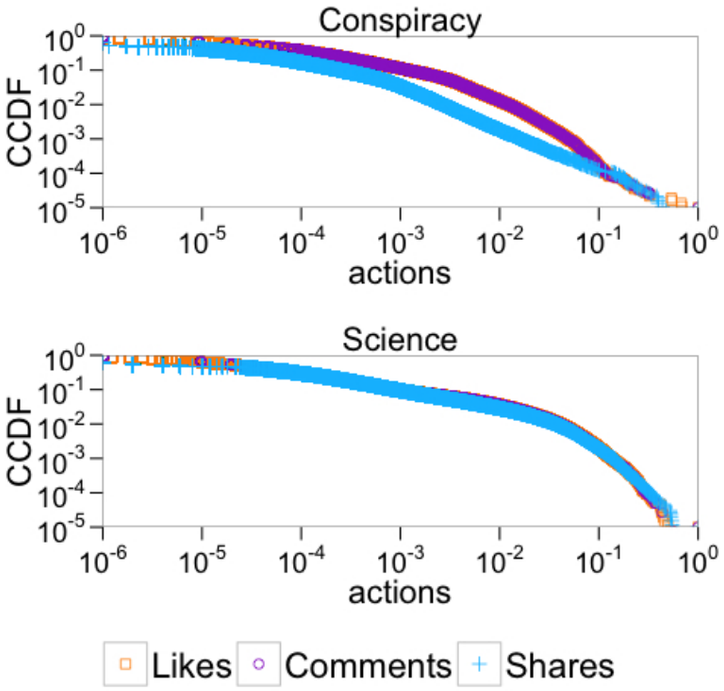
- Highly separated activity on the 2 categories
- The more the liking activity the higher the probability to have friends with the same attitude
- The more the activity on the narrative, the more the exposure to it

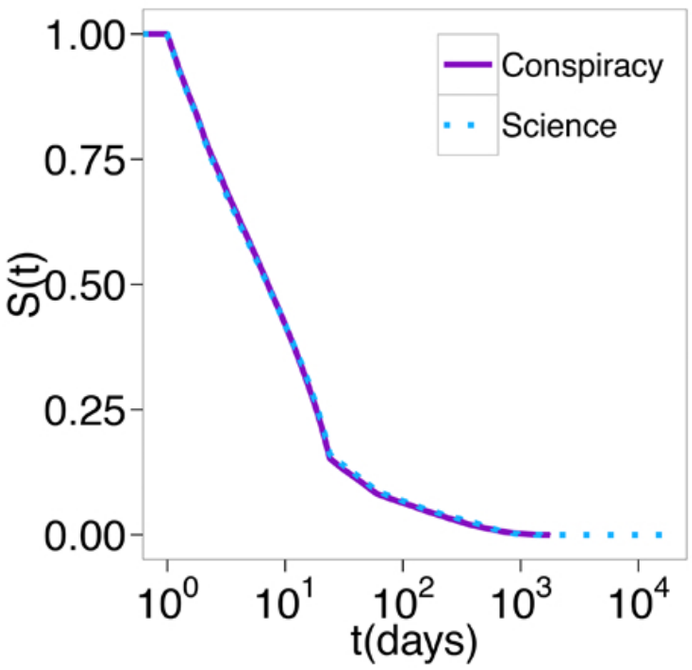
Viral Misinformation: The Role of Homophily and Polarization
webSci@WWW (Bessi *et al. 2015*)
Homophily and Polarization in the age of misinformation
EPJ Special Topics (*Bessi et al. to appear*)

CONSUMPTION PATTERNS (FB USA)



Users polarization. Probability density functions (PDFs) of the polarization of all users computed both on likes (left) and on comments (right).



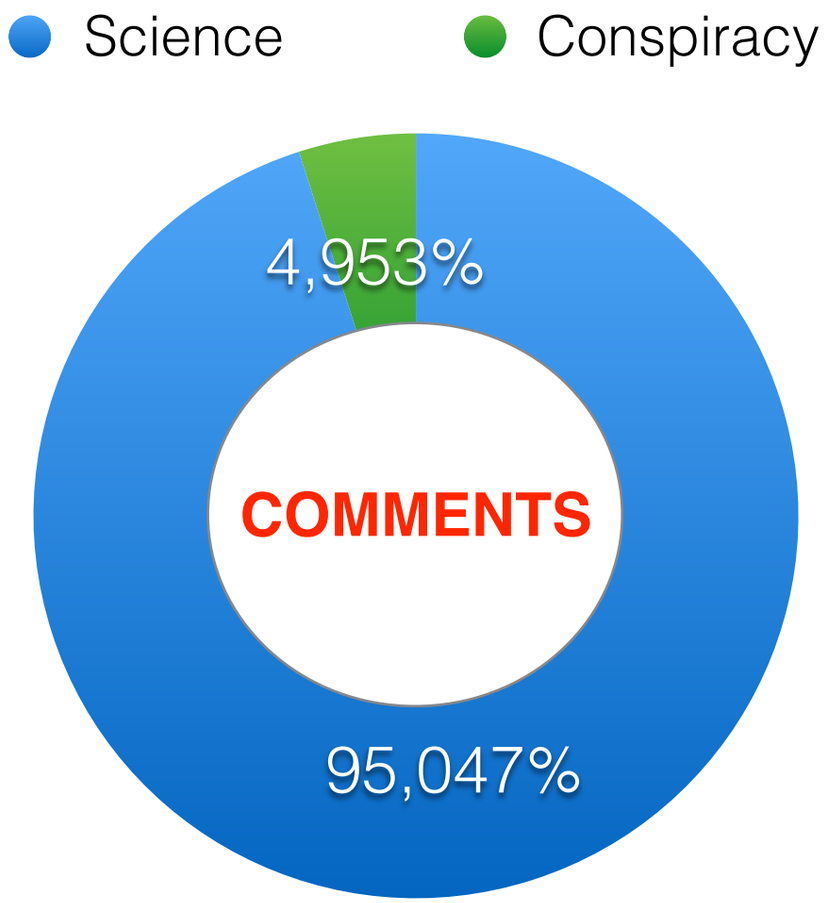


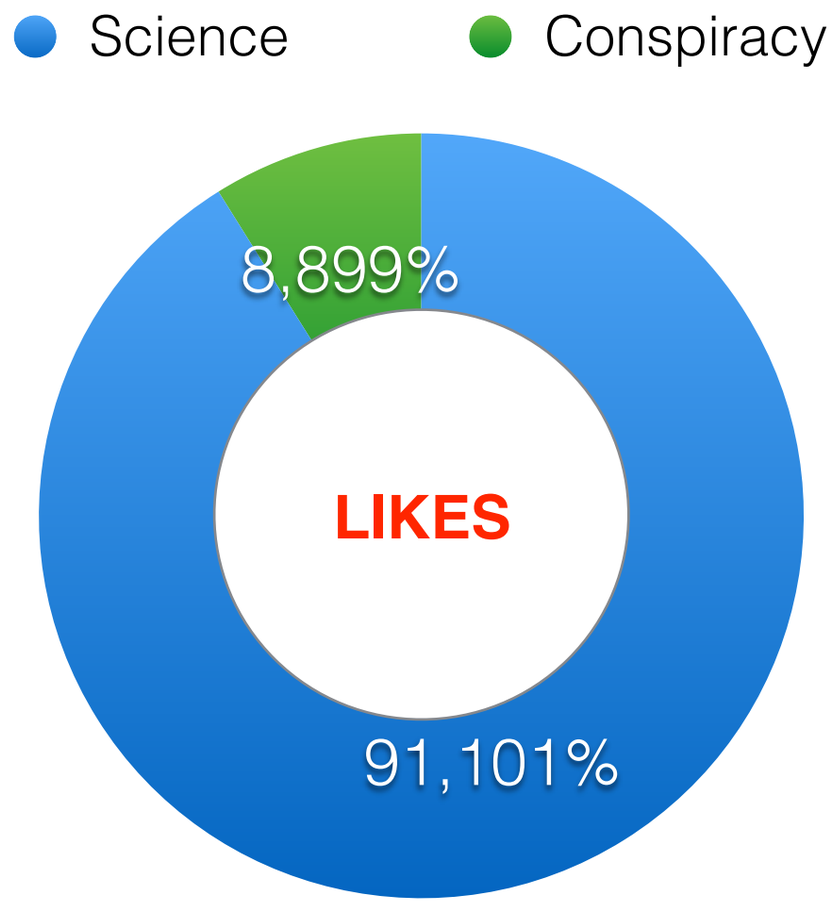
Consumption patterns and lifetime. Left panel: Complementary cumulative distribution functions (CCDFs) of the number of likes, comments, and shares received by posts belonging to conspiracy (top) and scientific (bottom) news.

Right panel: Kaplan-Meier estimates of survival functions of posts belonging to conspiracy and scientific news.

Debunking in a World of Tribes
submitted (*Zollo et al. 2016*)

RESPONSE TO **47,780** DEBUNKING POSTS (1)

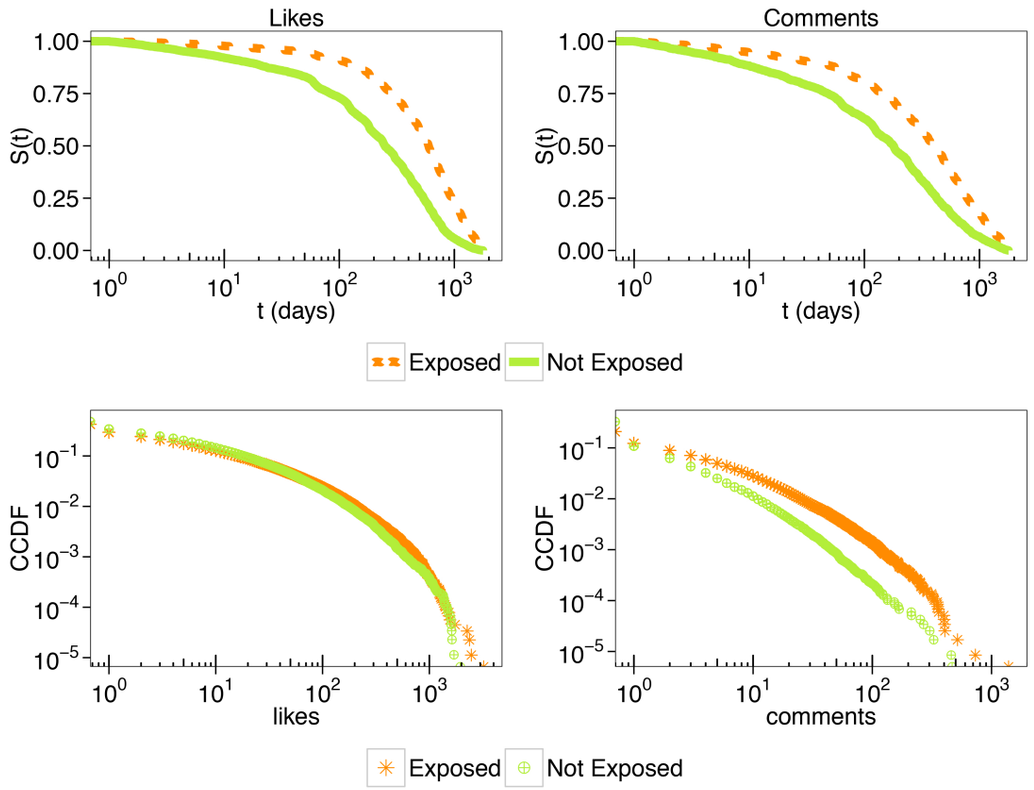




Debunking information are ignored by users in the conspiracy echo-chamber
(out of 9,790,906 polarized conspiracy users only 5, 831 interact)

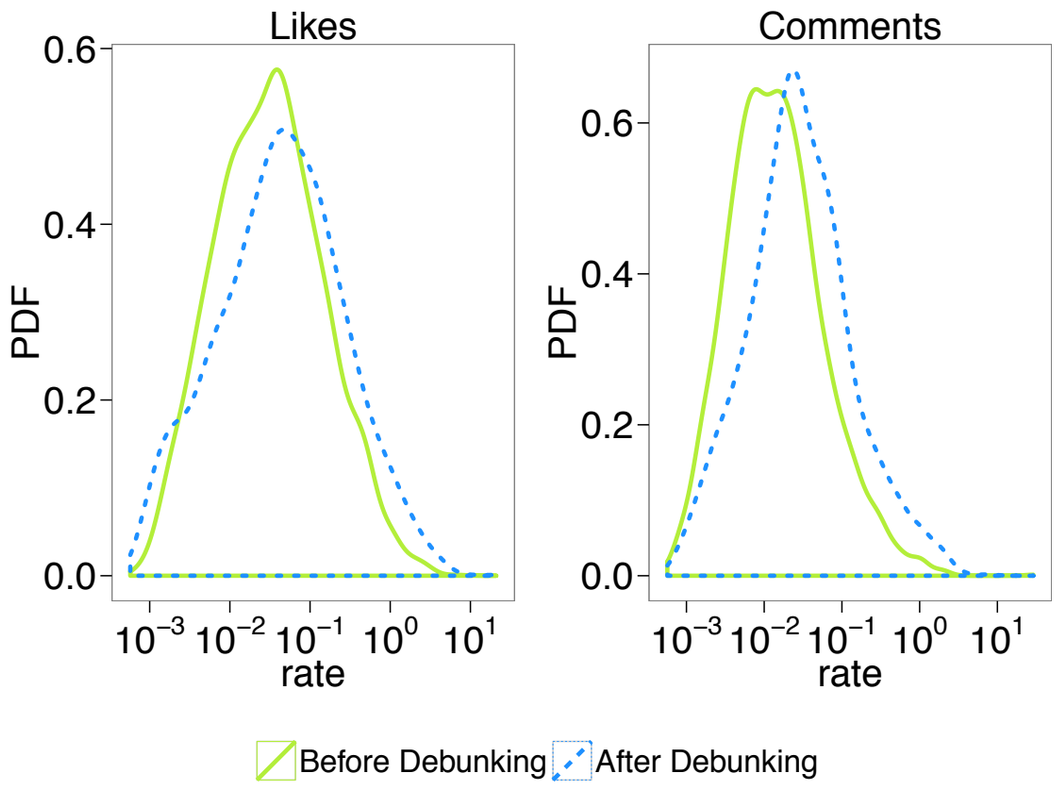
Debunking in a World of Tribes
submitted (*Zollo et al. 2016*)

RESPONSE TO **47,780** DEBUNKING POSTS (1)



Exposure to debunking: survival functions and attention patterns. Top panel: Kaplan-Meier estimates of survival functions of users exposed and not exposed to debunking. Users lifetime is computed both on their likes (left) and comments (right).

Bottom panel: Complementary cumulative distribution functions (CCDFs) of the number of likes (left) and comments (right), per each user exposed and not exposed to debunking.



Exposure to debunking: comments and likes rate. Rate –i.e.,average number of likes (left) (resp., comments (right)) on conspiracy posts over time of users exposed to debunking posts.

BACKFIRE EFFECT

"An especially useful account suggests that what makes (unjustified) conspiracy theories unjustified is that those who accept them must also accept a kind of spreading distrust of all knowledge-producing institutions, in a way **that makes it difficult to believe anything at all**."

Prof. Cass Sunstein "Conspiracy Theories"

Acquiring information coherent with your system of beliefs
even if those contains intentional false claims

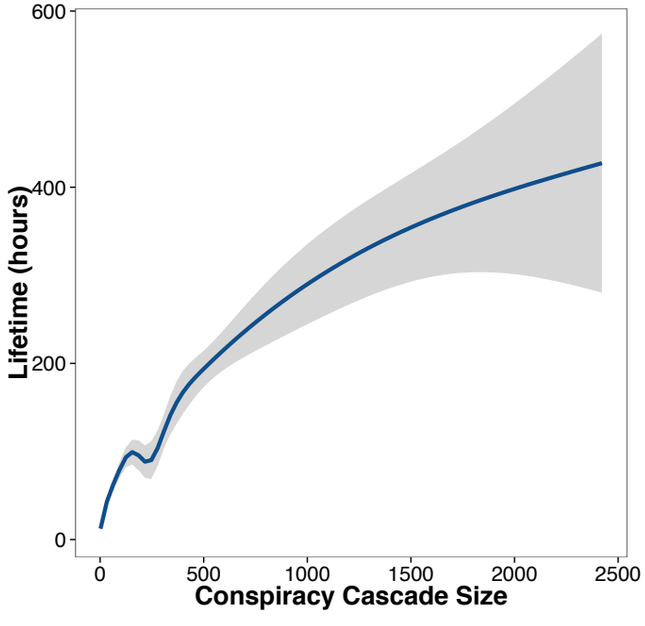
Rejecting information from oppositions

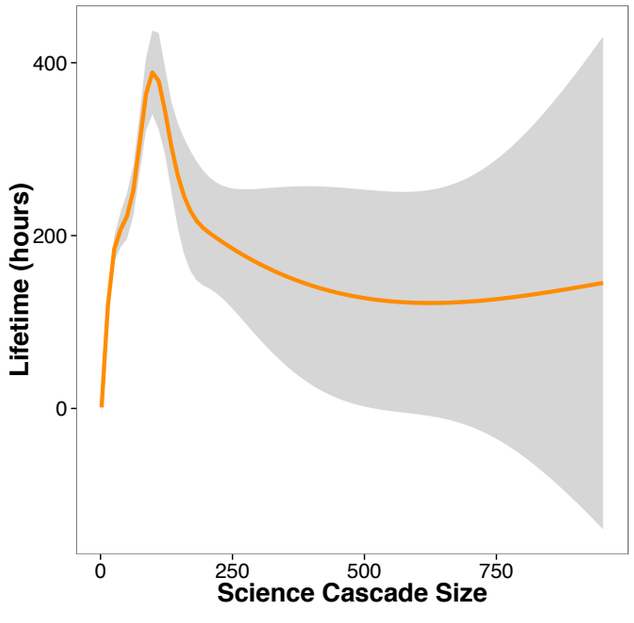
Debunking reinforce the beliefs of people already in the science echo chamber rather than convince people in the conspiracy echo chamber to change their views. only a small fraction of usual consumers of unsubstantiated information interact with the posts.

Those few are often the most committed conspiracy users and rather than internalizing debunking information, they often react to it negatively. After interacting with debunking posts, users retain, or even increase, their engagement within the conspiracy echo chamber.

Debunking in a World of Tribes
submitted (*Zollo et al. 2016*)

VIRAL PROCESSES AND ECHO CHAMBERS

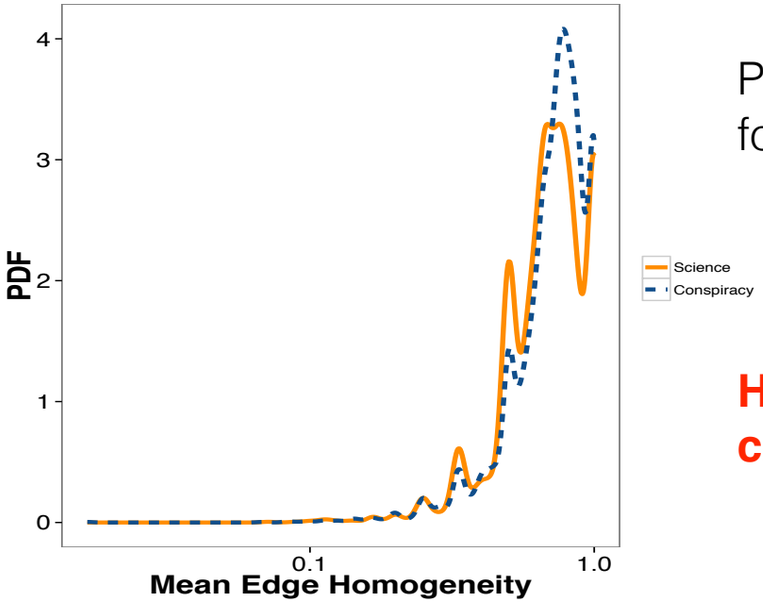




Lifetime as a function of the cascade size for conspiracy news (left) and science news (right).

Science news quickly reach a higher diffusion, a longer lifetime does not correspond to a higher level of interest.

Conspiracy rumors are assimilated more slowly and show a positive relation between lifetime and size.



Probability density function (PDF) of edge homogeneity for science (orange) and conspiracy (blue) news.

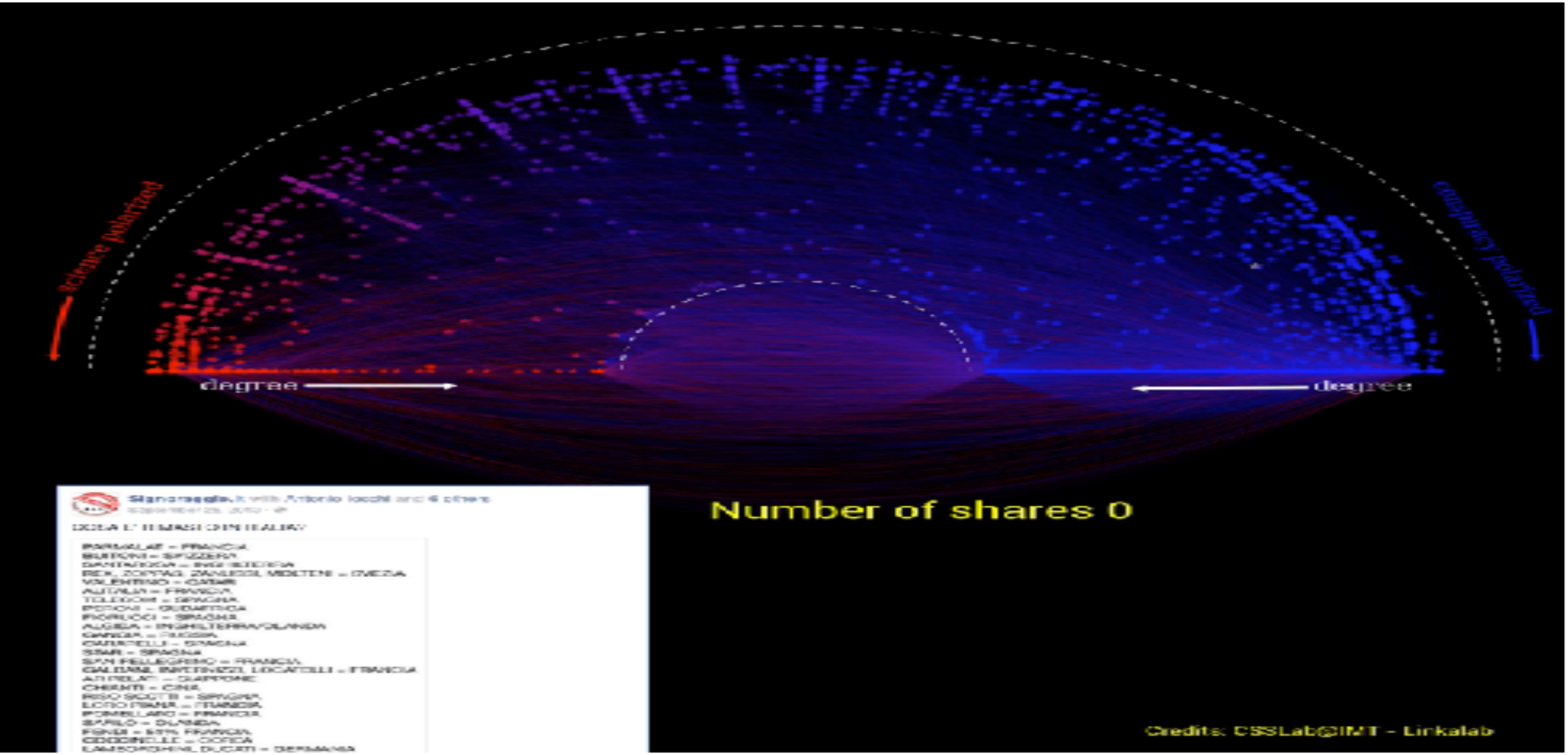
Homophilic paths are dominant on the whole cascades for both scientific and conspiracy news.

The spreading of misinformation online
PNAS (*Del Vicario et al. 2016*)

CASCADES

MODELING RUMOR SPREADING

- Predicting where certain kind of rumors are more likely to spread
- Cascades' size is bounded to the size of the echo-chamber

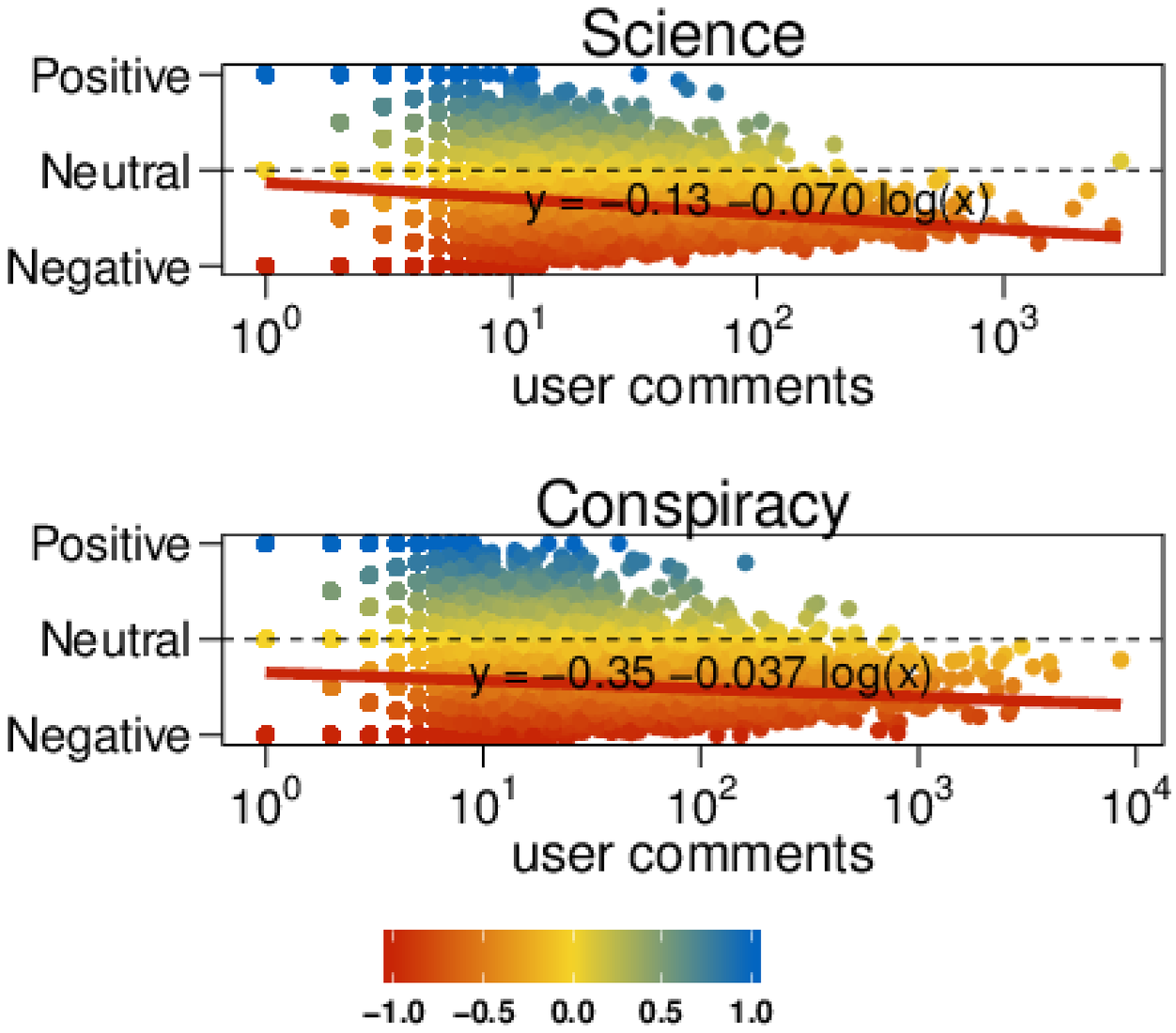


The spreading of misinformation online
PNAS (*Del Vicario et al. 2016*)

EMOTIONAL DYNAMICS AND ECHO-CHAMBERS

DISCUSSION AND GROUP POLARIZATION

"It is well known that when like-minded groups deliberate, they tend to polarize, in the sense that they generally end up in a more extreme position in line with their predeliberation tendencies" **(Sunstein, 2008)** *Going to extremes: how like minds unite and divide. Oxford University Press*

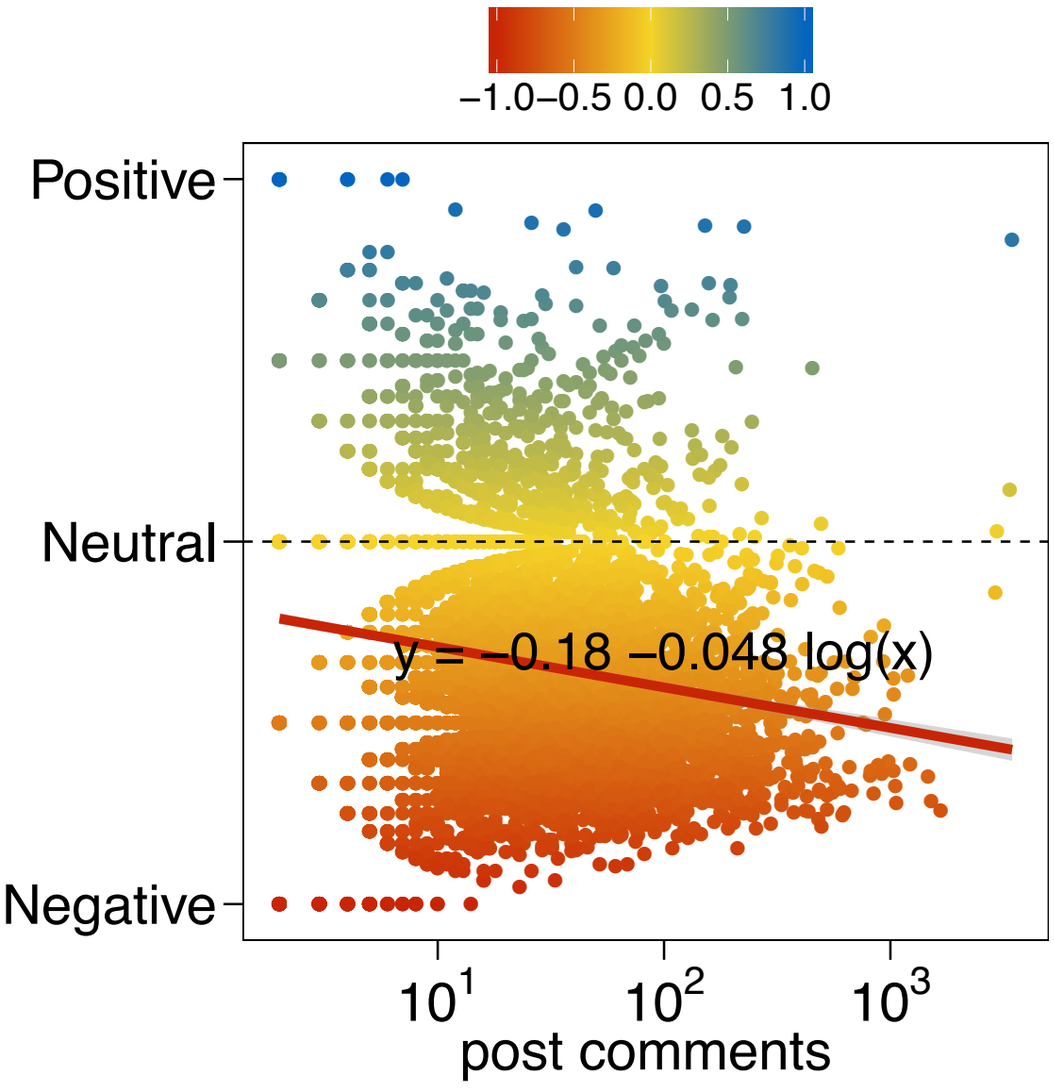


Sentiment and commenting activity.

Average sentiment of polarized users as a function of their number of comments. Negative (respectively, neutral, positive) sentiment is denoted by red (respectively, yellow, blue) color. The sentiment has been regressed w.r.t. the logarithm of the number of comments.

Emotional Dynamics in the age of Misinformation
PLOS ONE (*Zollo et al. 2015*)

WHEN THE ECHO CHAMBERS MEET



Sentiment and discussion.

Aggregated sentiment of posts as a function of their number of comments. Negative (respectively, neutral, positive) sentiment is denoted by red (respectively, yellow, blue) color.

Emotional Dynamics in the age of Misinformation
PLOS ONE (*Zollo et al. 2015*)

PAPERS

- Quattrociocchi, W., Caldarelli, G., & Scala, A. (2014). Opinion dynamics on interacting networks: media competition and social influence. **Scientific reports**, 4.

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- Del Vicario, M., Bessi, A., Zollo, F., Petroni, F., Scala, A., Caldarelli, G., ... & Quattrociocchi, W. (2016). The spreading of misinformation online. **Proceedings of the National Academy of Sciences (PNAS)**, 113(3), 554-559.

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The Washington Post

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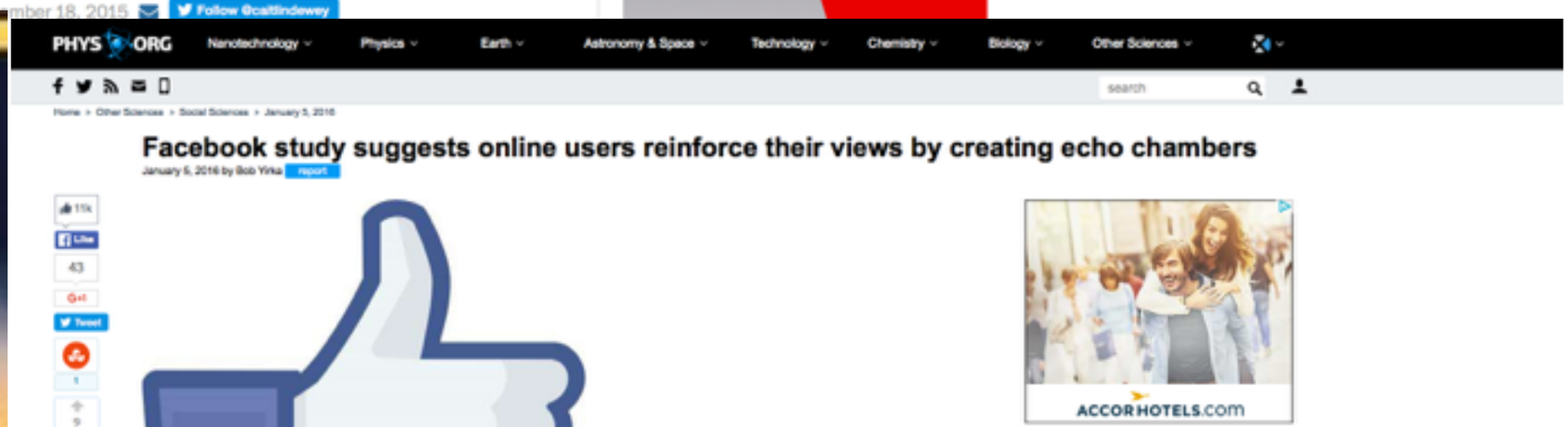

W.R.T INTERDISCIPLINARITY: FEEDBACKS FROM OTHER FIELDS

A FAN LETTER…

Greetings from the USA - just discovered your papers on polarization, misinformation, debunking etc. - they are amazing and fabulous! Pathbreaking, I think. All best wishes.

Prof. Cass Sunstein, Harvard University

BloombergView

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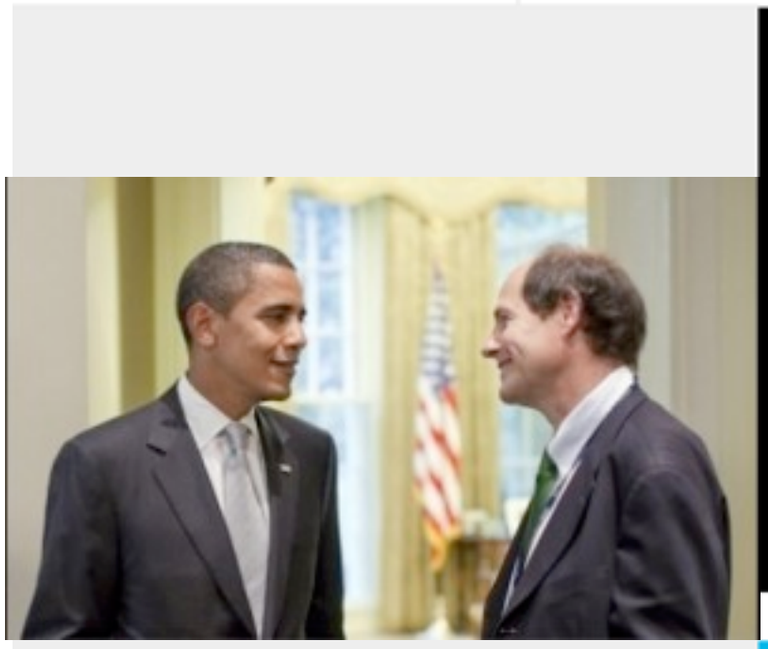

EARLY-STAGE SOCIAL MEDIA. PHOTOGRAPH: HULTON ARCHIVE/GETTY IMAGES

SOCIAL MEDIA

How Facebook Makes Us Dumber

149 JAN 8, 2016 9:51 AM EST

By Cass R. Sunstein

Why does misinformation spread so quickly on the social media? Why doesn't it get corrected? When the truth is so easy to find, why do people accept falsehoods?

Cass R. Sunstein, the former administrator of the White House Office of Information and Regulatory Affairs, is the Robert Walmsley university professor at Harvard Law School and a Bloomberg View columnist. Read more.

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Insight Report

The Global Risks Report 2016

11th Edition

The Risks-Trends Interconnection Map 2016

How does misinformation spread online?

Image: A man poses with his iPad tablet as he sits in a bar, in this photo illustration taken in Rome September 20, 2012. REUTERS/Tony Gentile

Written by

Walter Quattrociocchi, Head of the Laboratory of Computational Social Science, IMT Lucca in Italy

Published

Thursday 14 January 2016

In the run up to the 2013 Italian elections, a social media post exposing the corruption of parliament went viral. Italian politicians were quietly certain that, win or lose, they would be financially secure by taking money from the taxpayer. Parliament had quietly passed a special welfare bill specially designed to protect policy-makers by ensuring them an incredible unemployment package should they lose their seat in the upcoming election. The bill, proposed by Senator

(some) WORKS IN PROGRESS

ESSAY ON MISINFORMATION DYNAMICS

- Interdisciplinary perspective of our findings about misinformation and confirmation bias

in collaboration with **Prof. Cass Sunstein,** Harvard University

NEWS SPREADING ONLINE

- The network of influence of media on a global scale

in collaboration with **Dr. Igor Mozetic**, Jozef Stefan Institute

COLLECTIVE FRAMING AROUND CLIMATE CHANGE

- Spreading patterns about climate change deniers and supporters

in collaboration with **Prof. Riley Dunlap** Oklahoma State University

K-COMMUNITIES BOOTSTRAP PERCOLATION

- Models for rumor spreading accounting for polarization and overlapping communities

in collaboration with **Prof. Bela Bollobas** Trinity College, Cambridge University UK

MODEL VIRALITY UNDER POLARIZATION CONSTRAINTS

- Data-driven models mimicking information spreading and confirmation bias

in collaboration with **Prof. H. Gene Stanley**, Boston University

A PSYCHOMETRIC ANALYSIS OF CONTENT CONSUMPTION

- Metrics and Models to predict virality of contents

in collaboration with **Dott. David Stillwell** Psychometric Center, Cambridge University UK

THAT'S JUST THE BEGINNING…

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