Polarization: Information, Opinions and other Monsters

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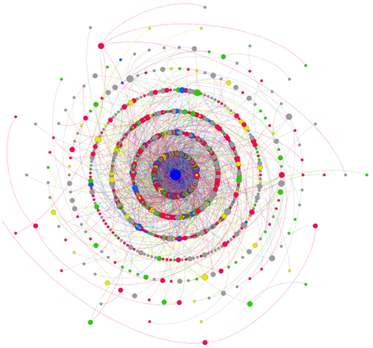


CDCS

Center of Data and Complexity for Society

The scientific message

Since 2014 and almost 90 scientific papers just to say that :

The idea that information spreads like a virus is almost inconsistent.

Online users, indeed, tend to seek information that is most aligned with their pre-existing beliefs, ignoring dissenting viewpoints and joining clusters of like-minded individuals, where shared narratives may be collectively shaped and reinforced.

This “echo chamber” effect and related heightened polarization may vary across different social media platforms according to their feed algorithms primarily designed to prioritize user engagement instead of accurate information dissemination.

Complex Systems
Physics
Percolation
Sandpiles
Climate
Energy systems
Turbulences
Social science
Social networks
Diffusion
Mathematics
Fractals
Chaotic systems
Economics
Markets
Organizations
Transportation
Traffic
Mobility systems
Biology
Colonies (ants, bees...)
Cells
Ecosystems
Organs
Populations
Organisms
Nervous systems

" ALL THE NEWS YOU NEED TO KNOW "
News·Today
FOUNDED 1851
SOCIAL MEDIA: TAKING OVER THE WORLD

FAKE NEWS
INVASION

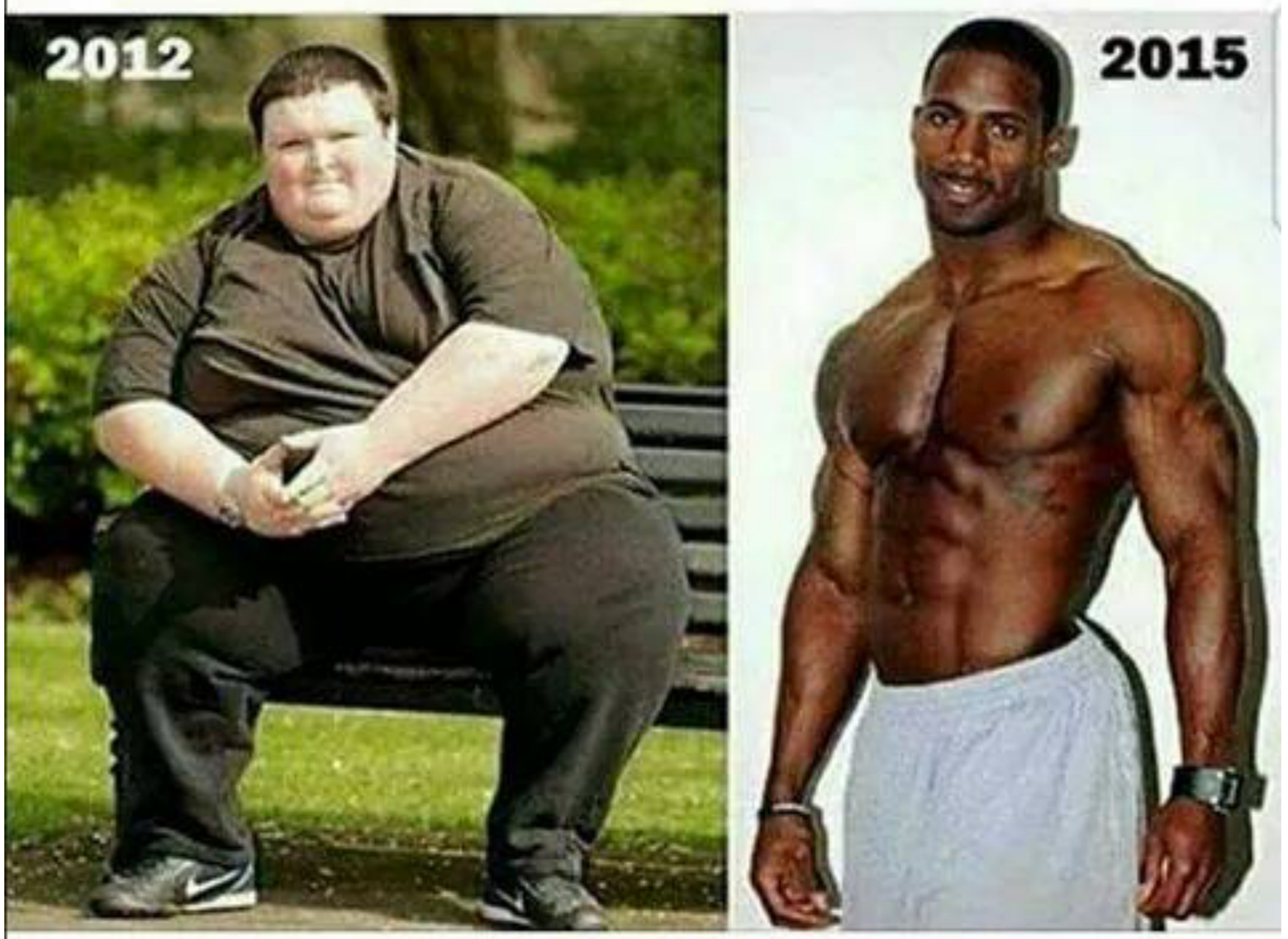
FOX NEWS
CNN
USA TODAY
NBC NEWS

FAKE NEWS
QUIET!
KNOW YOUR PLACE
SHUT YOUR FACE!
A MESSAGE FROM THE MINISTRY OF HOMELAND SECURITY
THE RED MENACE IS REAL!
The Washington Post
RT
Photo Illustration @21WIRE

Fake Gnus

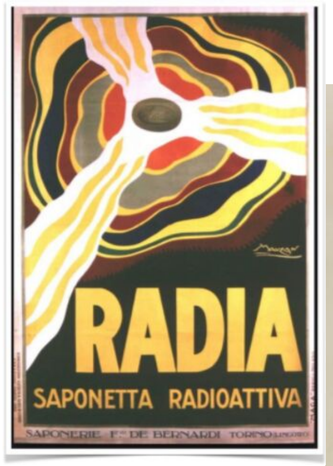
FAKE GNUS
makeameme.org

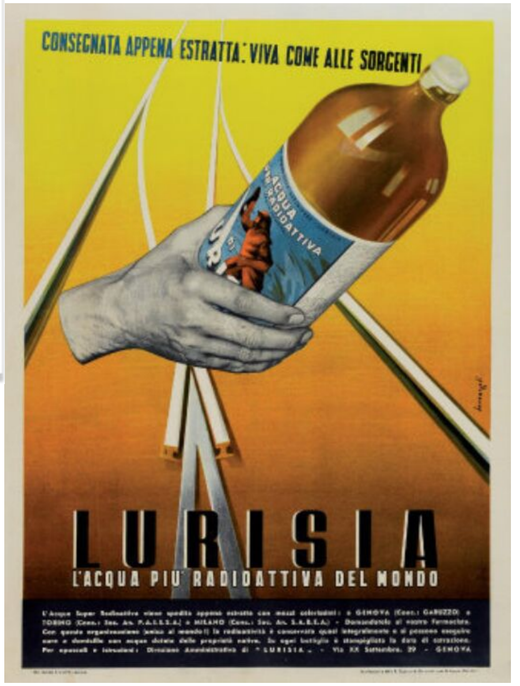
Never give up 💪 💯



Fake?

RADIUM:
SOSTANZE RADIOATTIVE PER IL BENESSERE DEL CORPO, LA PULIZIA E L'IDRATAZIONE DELLA PELLE





Fake?

CUSCINETTO IPNOTICO:
LUPPOLO E ALTRE SOSTANZE
AROMATICHE PER L'INSONNIA

.

CUSCINETTO IPNOTICO

- SASPUS. LUPPOLO ED ALTRE SOSTANZE AROMATICHE -

DI EFFETTO IMMEDIATO E SICURO NEI CASI D'INSONNIA PER NEVRASTENIA, SOVRECCITAZIONE CEREBRALE ec.

JAMES DIXON
FARMACISTA
CHICAGO
W. C.

Come si vince l'INSONNIA

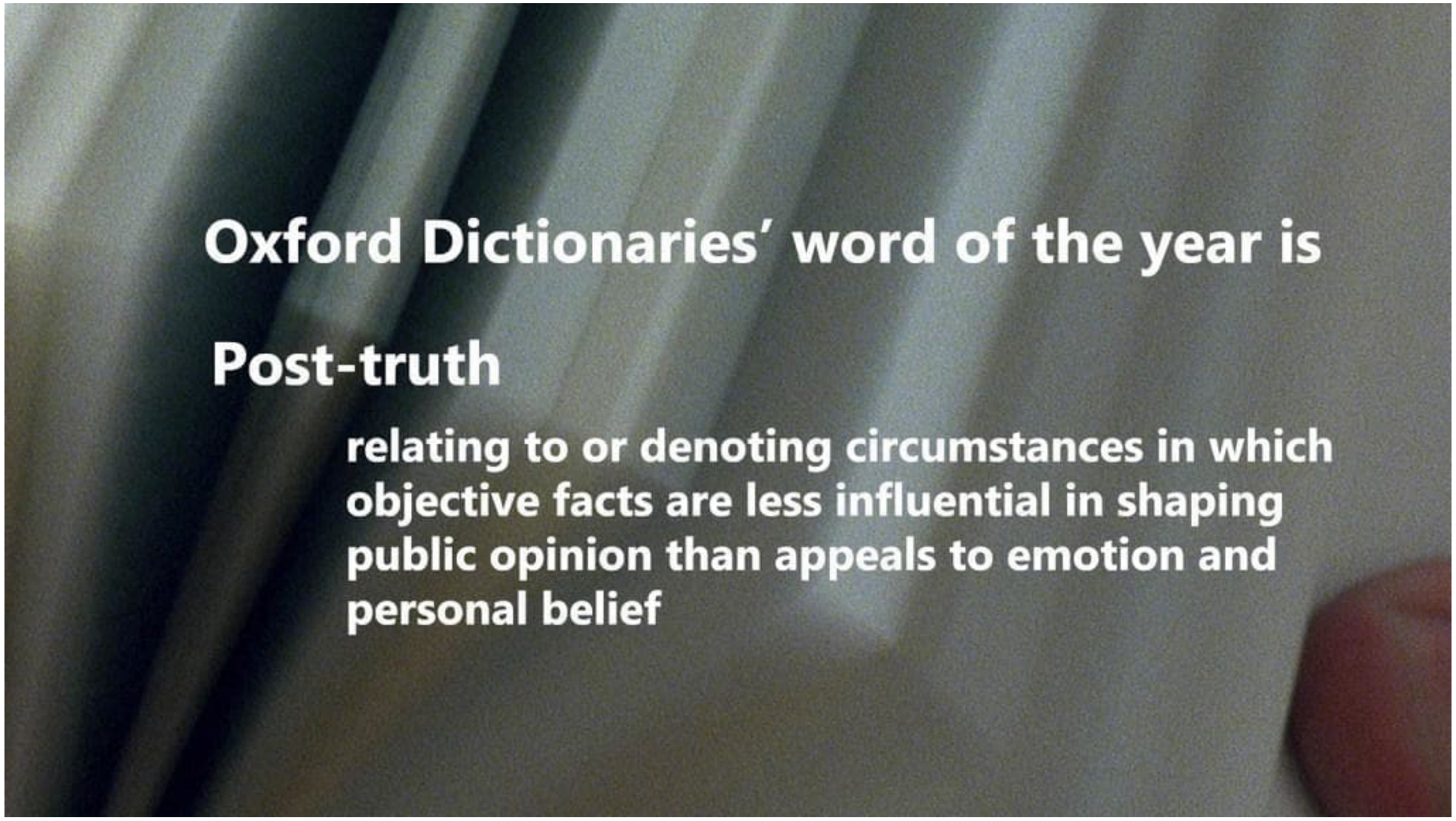
Non più bromuri, né ipnotici, né altri mezzi coercitivi, sempre dannosi alla salute!

Prezzo del **Cuscinetto ipnotico**, L. **9,50** franco di porto nel regno

Esclusiva depositaria per l' Italia: **Lega italiana,** via Fra Domenico n. 9, Firenze

L' insigne chimico e valentissimo botanico Dott. Dixon di Chicago, di fama mondiale nei suoi lunghi viaggi attraverso il globo, e specialmente nelle Indie orientali, ha scoperto una pianta che vegeta sulle sponde del Brahmaputra nei dintorni di Goalpara, il *Saspus*, che ha potenti proprietà ipnotiche. Unendo il succo condensato di tale pianta ad altre e col *Luppolo* (conosciuto, questo *ab antico* solo nelle nordiche regioni come facilitante il sonno se assorbito il suo olio volatile per le vie respiratorie). è riuscito, dopo lunghe ripetute ricerche e scientifiche esperienze, ad ottenere un *rezzo sicuro, infallibile*, nel maggior numero dei casi, per conciliare il sonno, senza disturbare lo stomaco coll' ingerimento di farmachi, i quali, se producono un torpore cerebrale conciliante il sonno finiscono coll'apportare gravi, irreparabili inconvenienti all'organismo.

Dal **CUSCINO IPNOTICO** sul quale il malato posa la testa a guisa di comodo origliere, emanano gli aftori gradevoli di dette piante sonnifere, e nello stesso tempo assolutamente innocue ai nevrastenici più sensibili, come alle donne affette da isteriemo il più acuto. A poco a poco, mediante l'azione calmante ed ipnotica degli oli volatili di questi benefici vegetali, l'eccitazione nervosa cessa, le cellule cerebrali dolcemente si assopiscono e il sonno calmo e ristoratore viene in breve ad esercitare la sua azione riparatrice sul malato nel cui animo ritorna la pace, l'amore alla vita che poco prima egli aveva detestata.


Oxford Dictionaries' word of the year is
Post-truth
relating to or denoting circumstances in which objective facts are less influential in shaping public opinion than appeals to emotion and personal belief

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**

A SHIFT OF PARADIGM

OLD MEDIA

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

NEW MEDIA

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

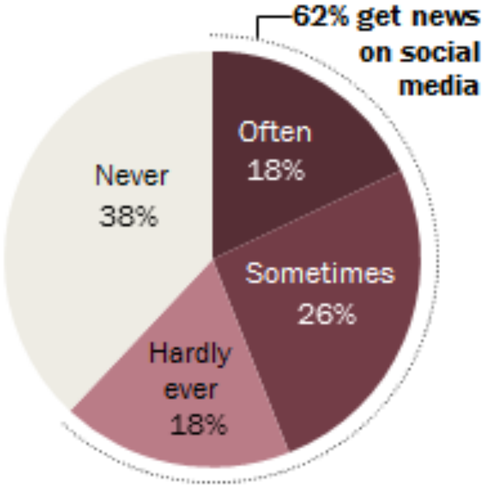
MEDIATED → **DISINTERMEDIATED**

facebook
“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?

About 6-in-10 Americans get news from social media

% of U.S. adults who get news on a social networking site ...



Source: Survey conducted Jan. 12-Feb. 8, 2016.
"News Use Across Social Media Platforms 2016"

PEW RESEARCH CENTER

JADE HELM 15

The Washington Post

+ More

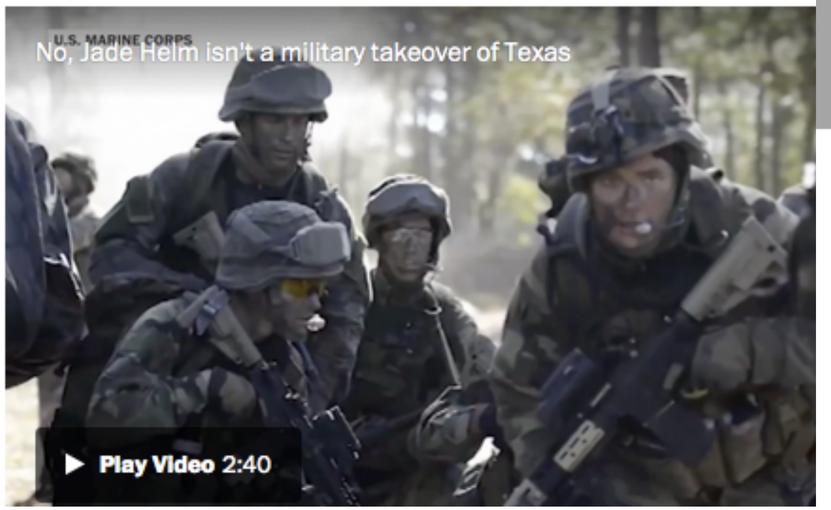
Save

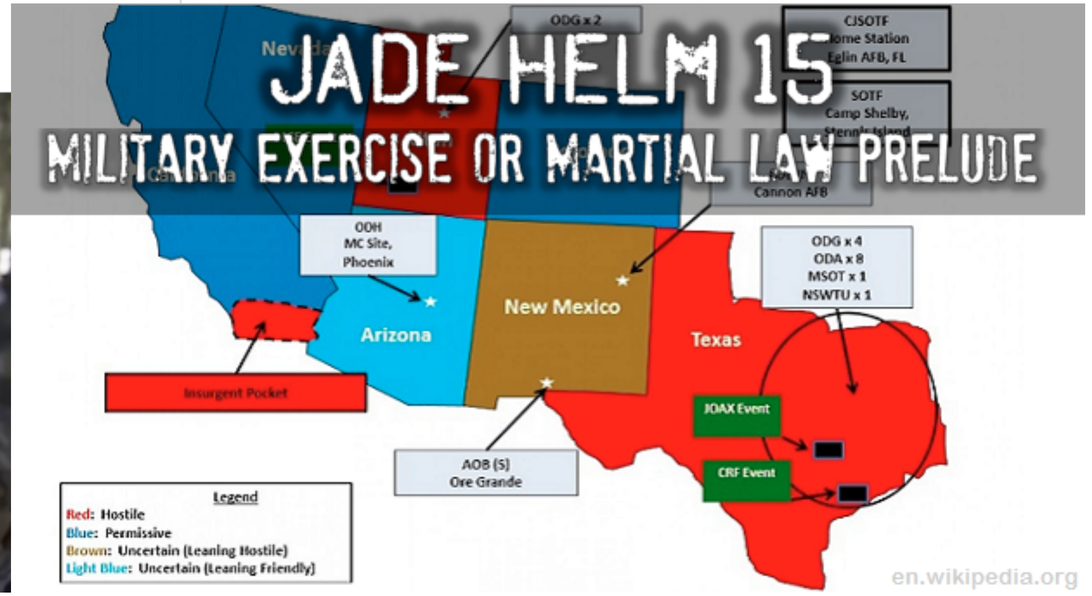
Checkpoint

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

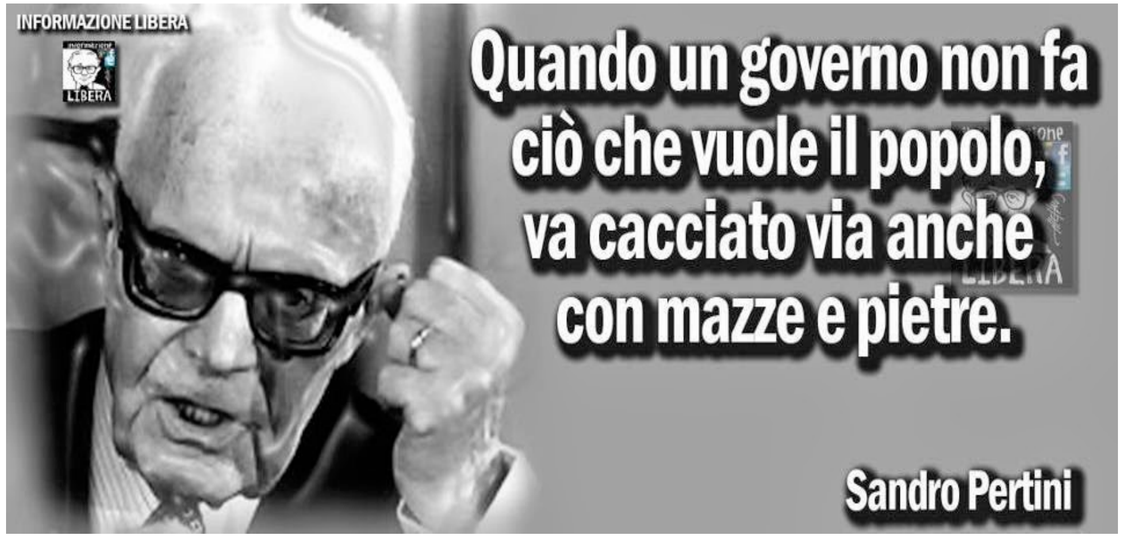
A | 57

By Dan Lamothe March 31 Follow @danlamothe





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…”

Wired Italia
22 aprile 2015 ·

Le dinamiche sono sempre le stesse.

Bufale, i complottisti sono tutti uguali - Wired

Uno studio italiano svela il comportamento degli utenti che seguono pagine che diffondono bufale su Facebook: seguono tutti le stesse dinamiche

WIRED.IT I DI SANDRO JANNACCONE

Mi piace · Commenta · Condividi

[redacted] è un fake!!!!!!

Mi piace · Rispondi · 1 · 22 aprile 2015 alle ore 12:18

[redacted]a Risalta benissimo come l'utente che si crede informato e illuminato sia la persona meno aperta mentalmente,chiusa com'e nel suo loop di auto(dis)informazione.Patetici.

Mi piace · Rispondi · 25 · 22 aprile 2015 alle ore 12:11

Nascondi 83 risposte

Walter Quattrociocchi perche meglio invece chi si informa sulle fonti ufficiali come cicap o quark? svegliatevi.

Mi piace · Rispondi · 22 aprile 2015 alle ore 12:19

[redacted]la Eccallá.Hai letto l'articolo?Mi pare evidente che leggere notizie su pagine che si autocitano e si autorimandano non sia una buonissima cosa.Serve una visione d'insieme, il WEBBE non ha la risposta definitiva. E tranquillo che sono sveglio ed attento A TUTTO, anche alle bufalate deliranti.

Mi piace · Rispondi · 8 · 22 aprile 2015 alle ore 12:22

[redacted] Eccolo è arrivato puntuale il fenomeno che dice sveglia al resto del mondo .Le scie chimiche fanno brutti effetti 🙂

Mi piace · Rispondi · 1 · 22 aprile 2015 alle ore 12:25

Walter Quattrociocchi E la risposta di insieme te la da piero angela (o il figlio)? Non lo sai che da sempre la storia la scrivono i vincitori e i potenti?

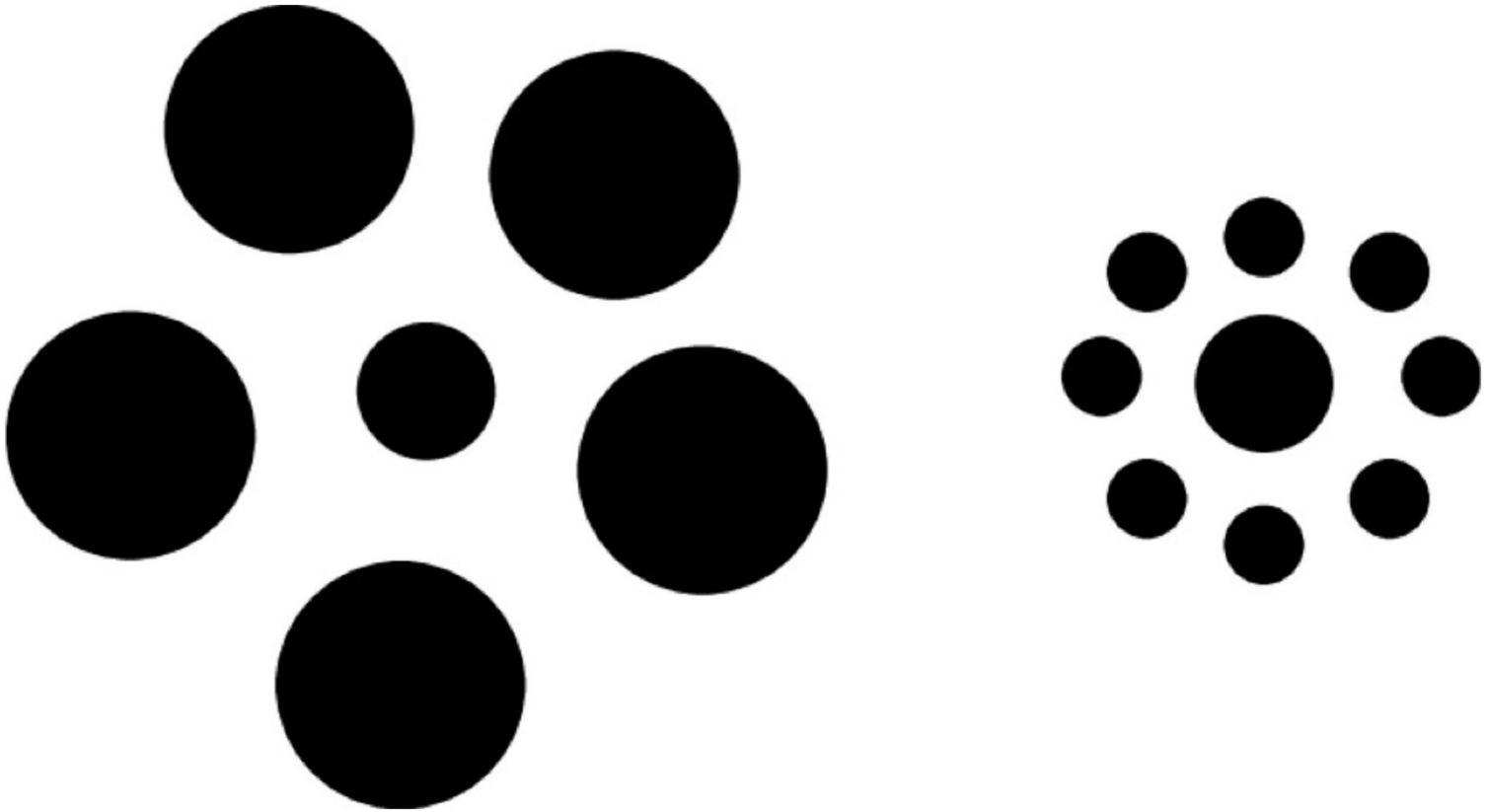
Mi piace · Rispondi · 22 aprile 2015 alle ore 12:30

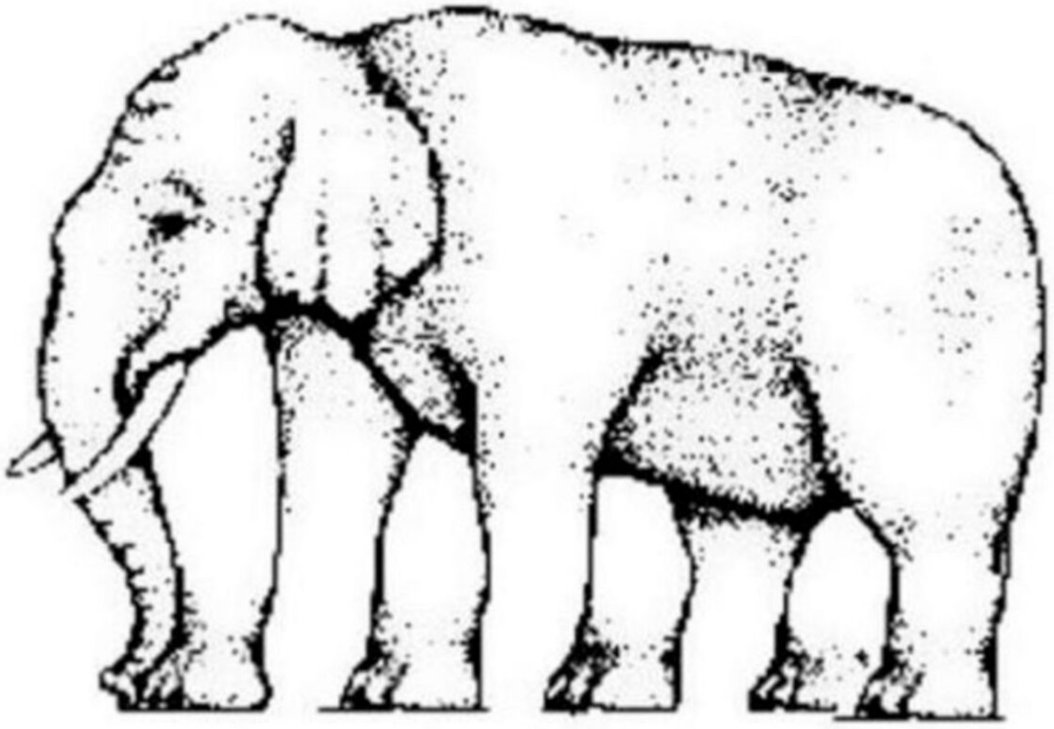
[redacted]i Se la "storia" è scritta dai vincitori, lo è anche la "storia" narrata su internet.

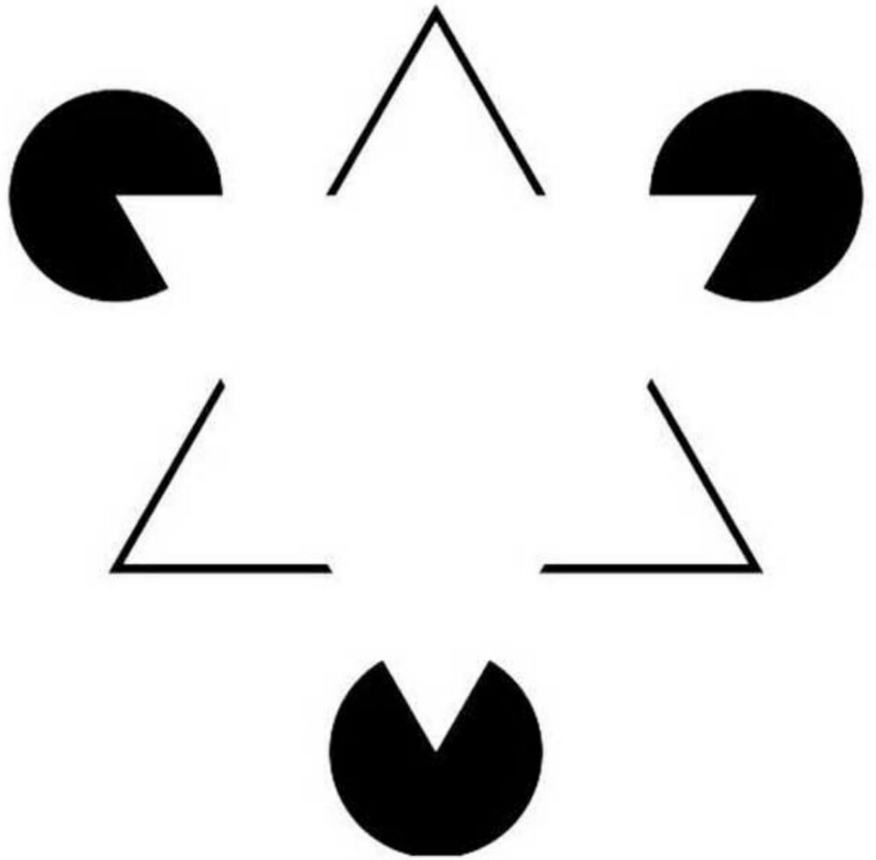
Mi piace · Rispondi · 1 · 22 aprile 2015 alle ore 12:33 · Modificato

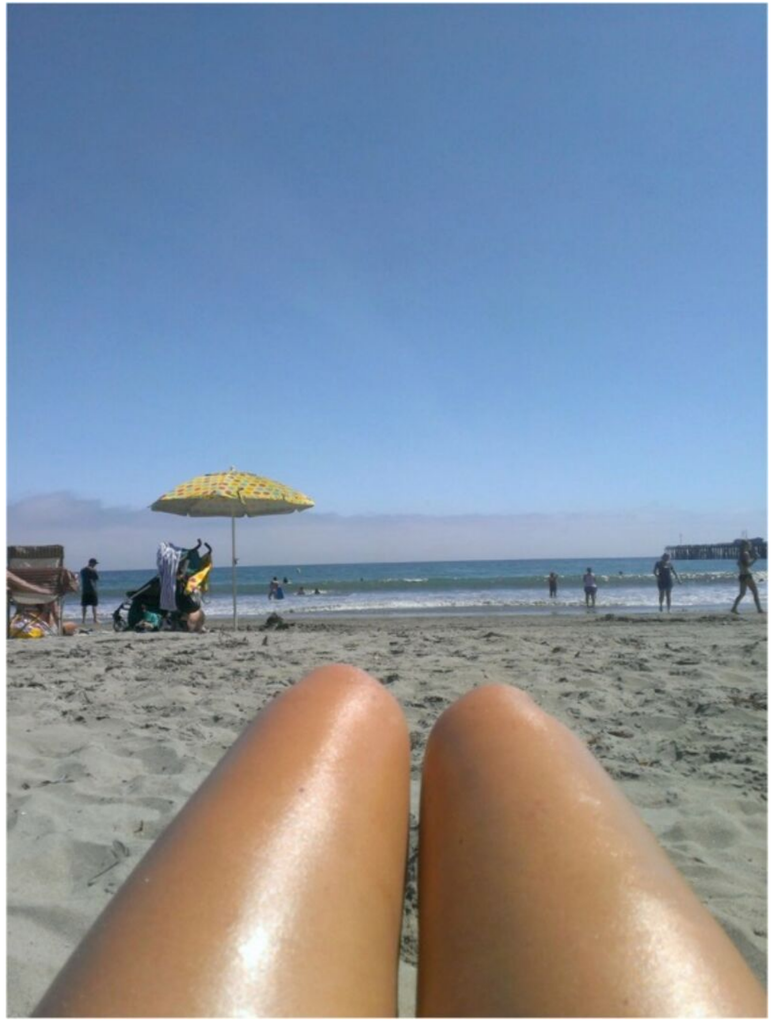
[redacted]la Quello che mi fa piu ridere della gente come te è che rinnegate il confronto, siete un disco rotto, provo più piacere a conversare con un muro

Mi piace · Rispondi · 5 · 22 aprile 2015 alle ore 12:32









CONFIRMATION BIAS AND INFORMATION CONSUMPTION

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

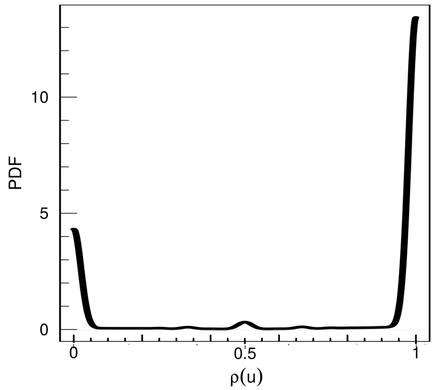
THE DATASET(s)

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

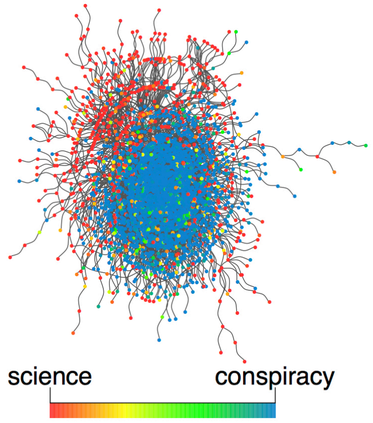
FB ITALY	TOTAL	SCIENCE	CONSPIRACY	**TROLL**
Pages	73	34	39	**2**
Posts	271,296	62,705	208,591	**4,709**
Likes	9,164,781	2,505,399	6,659,382	**40,341**
Comments	1,017,509	180,918	836,591	**58,686**
Likers	1,196,404	332,357	864,047	**15,209**
Commentsers	279,972	53,438	226,534	**43,102**

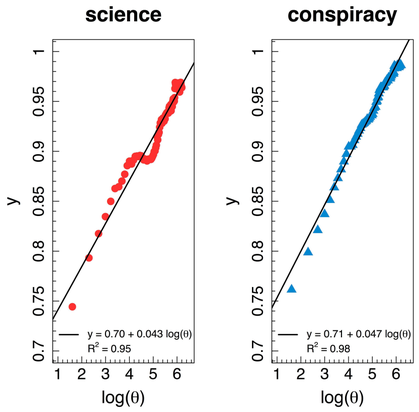
FB USA	TOTAL	SCIENCE	CONSPIRACY	**DEBUNKING**
Pages	478	83	330	**66**
Posts	679,948	262,815	369,420	**47,780**
Likes	603,332,826	453,966,494	145,388,117	**3,986,922**
Comments	30,828,705	22,093,692	8,304,644	**429,204**
Likers	52,172,855	39,854,663	19,386,131	**702,122**
Commentsers	9,790,906	7,223,473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

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 <? ρ <? 0.005 (science users) and at 0.95 ?< ρ < ? 1 (conspiracy users).



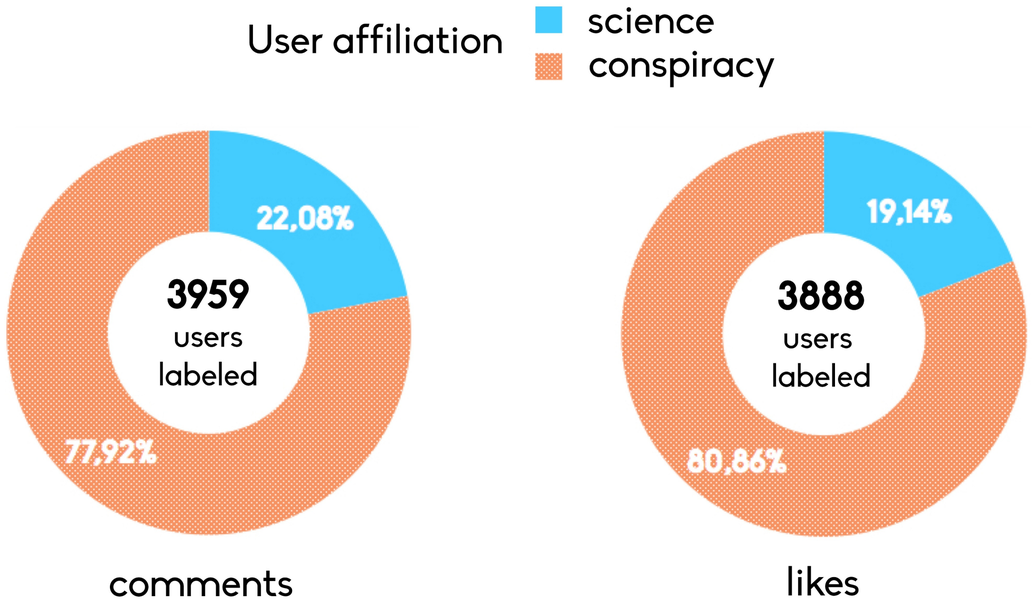


Homophily. Fraction of polarized friends with the same polarization respect to the number of likes log(θ(u)) of user u.

Bessi, A., Petroni, F., Del Vicario, M., Zollo, F., Anagnostopoulos, A., Scala, A., ... & Quattrociocchi, W. (2015, May). Viral misinformation: The role of homophily and polarization. In *Proceedings of the 24th International Conference on World Wide Web* (pp. 355-356). ACM. webSci@WWW (Bessi *et al. 2015*)

Bessi, A., Petroni, F., Del Vicario, M., Zollo, F., Anagnostopoulos, A., Scala, A., ... & Quattrociocchi, W. (2016). Homophily and polarization in the age of misinformation. *The European Physical Journal Special Topics*, *225*(10), 2047-2059.

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



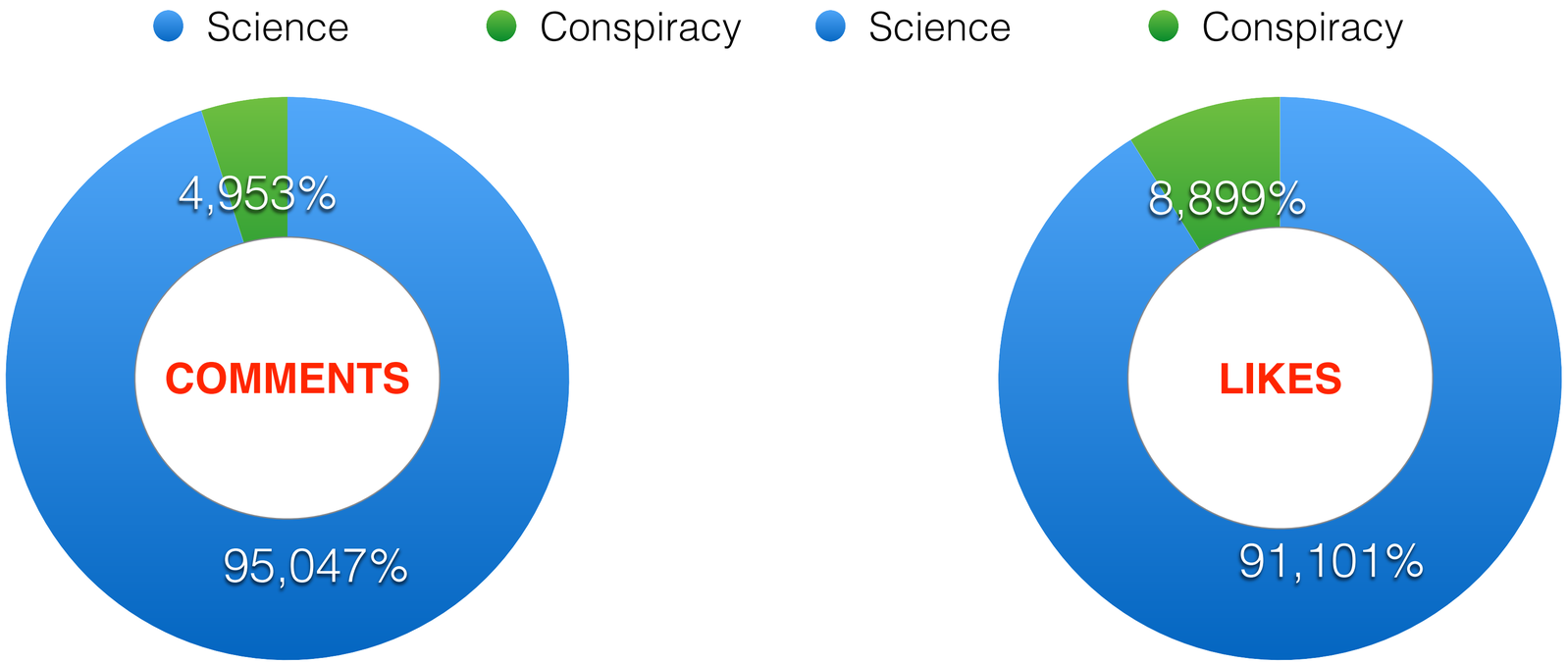
Polarized users on false information.

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

Mocanu, D., Rossi, L., Zhang, Q., Karsai, M., & Quattrociocchi, W. (2015). Collective attention in the age of (mis) information. *Computers in Human Behavior*, *51*, 1198-1204.

Bessi, A., Coletto, M., Davidescu, G. A., Scala, A., Caldarelli, G., & Quattrociocchi, W. (2015). Science vs conspiracy: Collective narratives in the age of misinformation. *PloS one*, *10*(2), e0118093.

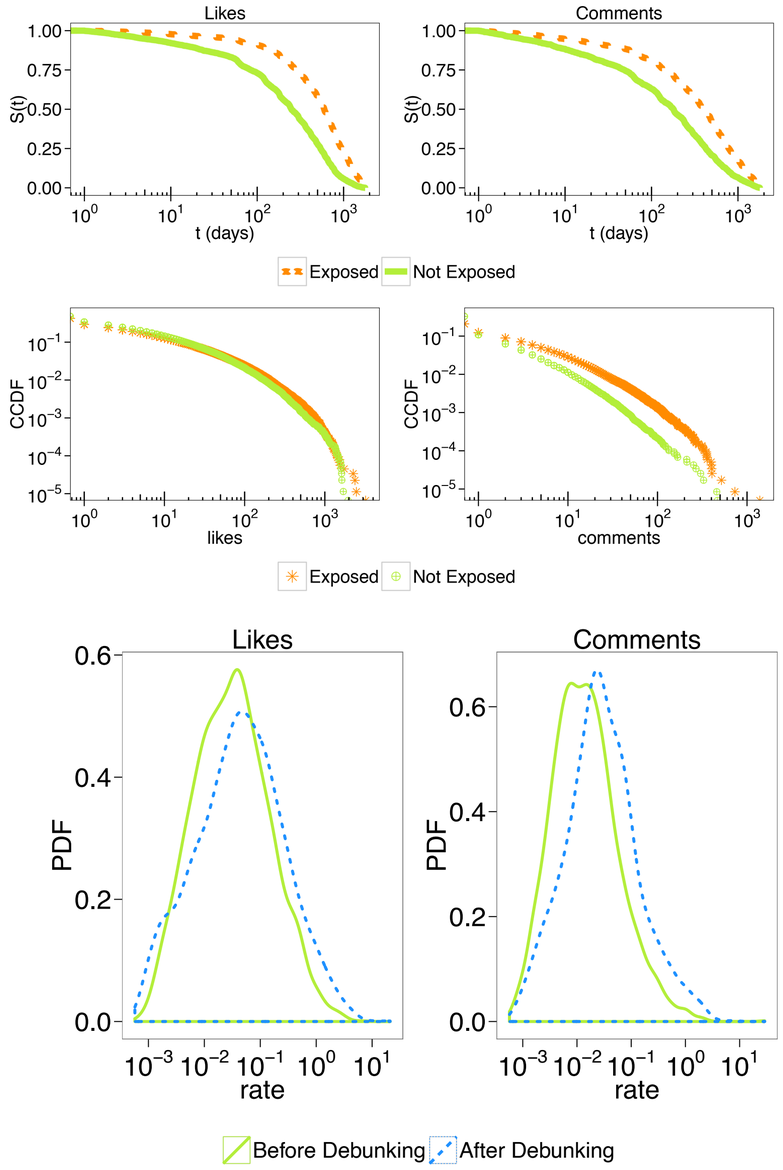
RESPONSE TO **47,780** DEBUNKING POSTS (1)



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

Zollo, F., Bessi, A., Del Vicario, M., Scala, A., Caldarelli, G., Shekhtman, L., ... & Quattrociocchi, W. (2017). Debunking in a world of tribes. *PloS one*, *12*(7), e0181821.

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.

Zollo, F., Bessi, A., Del Vicario, M., Scala, A., Caldarelli, G., Shekhtman, L., ... & Quattrociocchi, W. (2017). Debunking in a world of tribes. *PloS one*, *12*(7), e0181821.

VIRAL PROCESSES AND THE SIZE OF ECHO-CHAMBERS

PNAS

The spreading of misinformation online

Michela Del Vicario[a], Alessandro Bessi[b], Fabiana Zollo[a], Fabio Petroni[c], Antonio Scala[a,d], Guido Caldarelli[a,d], H. Eugene Stanley[e], and Walter Quattrociocchi[a,1]

[a]Laboratory of Computational Social Science, Networks Department, IMT Alti Studi Lucca, 55100 Lucca, Italy; [b]IUSS Institute for Advanced Study, 27100 Pavia, Italy; [c]Sapienza University, 00185 Rome, Italy; [d]ISC-CNR Uos "Sapienza," 00185 Rome, Italy; and [e]Boston University, Boston, MA 02115

Edited by Matjaz Perc, University of Maribor, Maribor, Slovenia, and accepted by the Editorial Board December 4, 2015 (received for review September 1, 2015)

The wide availability of user-provided content in online social media facilitates the aggregation of people around common interests, worldviews, and narratives. However, the World Wide Web (WWW) also allows for the rapid dissemination of unsubstantiated rumors and conspiracy theories that often elicit rapid, large, but naive social responses such as the recent case of Jade Helm 15—where a simple military exercise turned out to be perceived as the beginning of a new civil war in the United States. In this work, we address the determinants governing misinformation spreading through a thorough quantitative analysis. In particular, we focus on how Facebook users consume information related to two distinct narratives: scientific and conspiracy news. We find that, although consumers of scientific and conspiracy stories present similar consumption patterns with respect to content, cascade dynamics differ. Selective exposure to content is the primary driver of content diffusion and generates the formation of homogeneous clusters, i.e., "echo chambers." Indeed, homogeneity appears to be the primary driver for the diffusion of contents and each echo chamber has its own cascade dynamics. Finally, we introduce a data-driven percolation model mimicking rumor spreading and we show that homogeneity and polarization are the main determinants for predicting cascades' size.

misinformation | virality | Facebook | rumor spreading | cascades

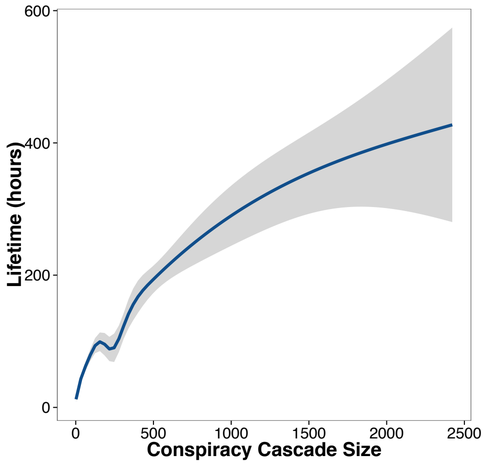
The massive diffusion of sociotechnical systems and micro-blogging platforms on the World Wide Web (WWW) creates a

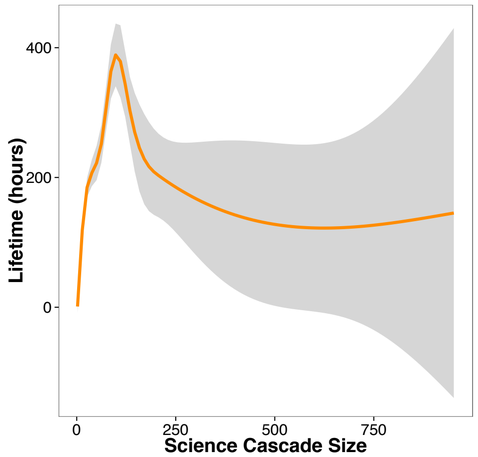
the main difference between the two is content verifiability. The generators of scientific information and their data, methods, and outcomes are readily identifiable and available. The origins of conspiracy theories are often unknown and their content is strongly disengaged from mainstream society and sharply divergent from recommended practices (22), e.g., the belief that vaccines cause autism.

Massive digital misinformation is becoming pervasive in online social media to the extent that it has been listed by the World Economic Forum (WEF) as one of the main threats to our society (23). To counteract this trend, algorithmic-driven solutions have been proposed (24–29), e.g., Google (30) is developing a trustworthiness score to rank the results of queries. Similarly, Facebook has proposed a community-driven approach where users can flag false content to correct the newsfeed algorithm. This issue is controversial, however, because it raises fears that the free circulation of content may be threatened and that the proposed algorithms may not be accurate or effective (10, 11, 31). Often conspiracists will denounce attempts to debunk false information as acts of misinformation.

Whether a claim (either substantiated or not) is accepted by an individual is strongly influenced by social norms and by the claim's coherence with the individual's belief system—i.e., confirmation bias (32, 33). Many mechanisms animate the flow of false information that generates false beliefs in an individual, which, once adopted, are rarely corrected (34–37).

VIRAL PROCESSES AND ECHO CHAMBERS

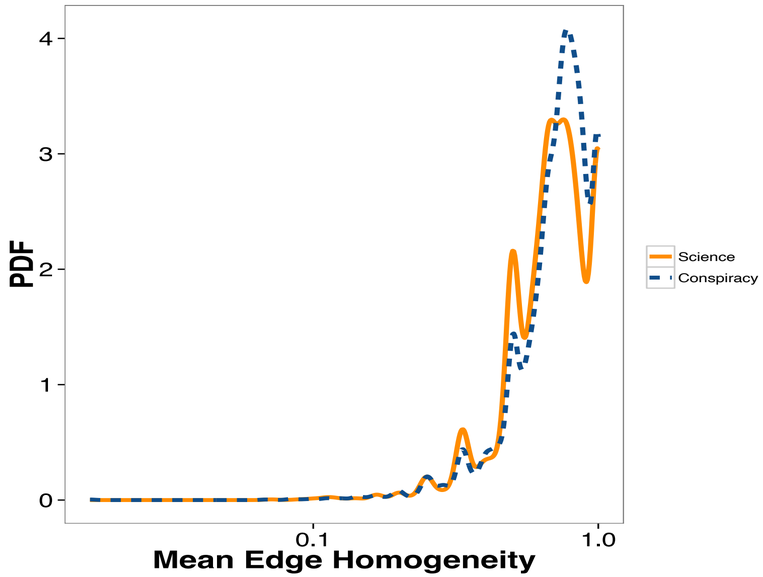




Lifetime as a function of the cascade size for conspiracy news (left) and science news (right).

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.

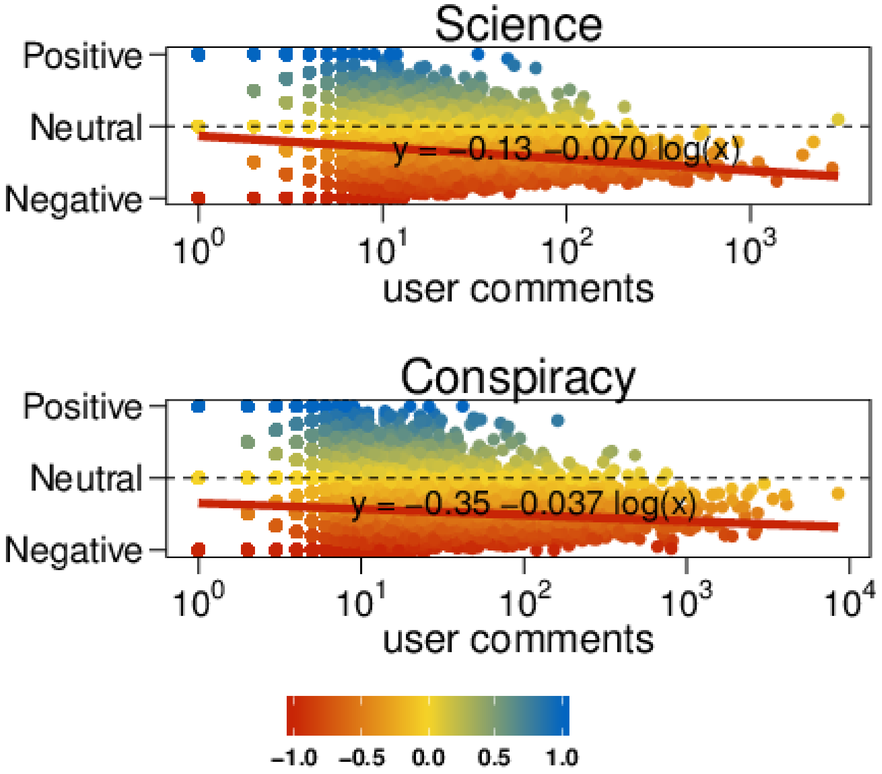
Homophilic paths are dominant on the whole cascades for both scientific and conspiracy news.

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*, *113*(3), 554-559.

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*

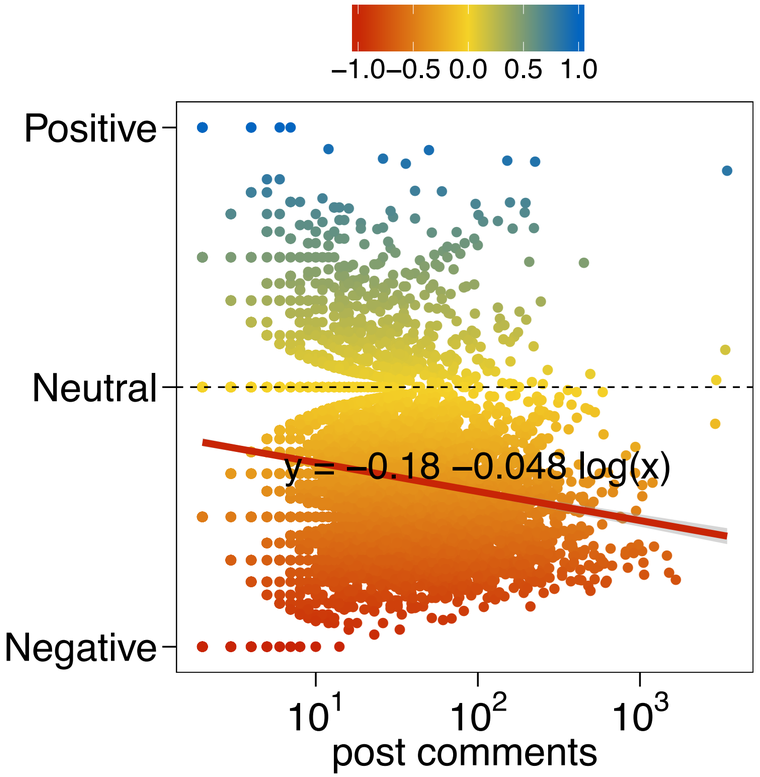


Sentiment and commenting activity.

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.

Zollo, F., Novak, P. K., Del Vicario, M., Bessi, A., Mozetič, I., Scala, A., ... & Quattrociocchi, W. (2015). Emotional dynamics in the age of misinformation. *PloS one*, *10*(9), e0138740.

WHEN THE ECHO CHAMBERS MEET

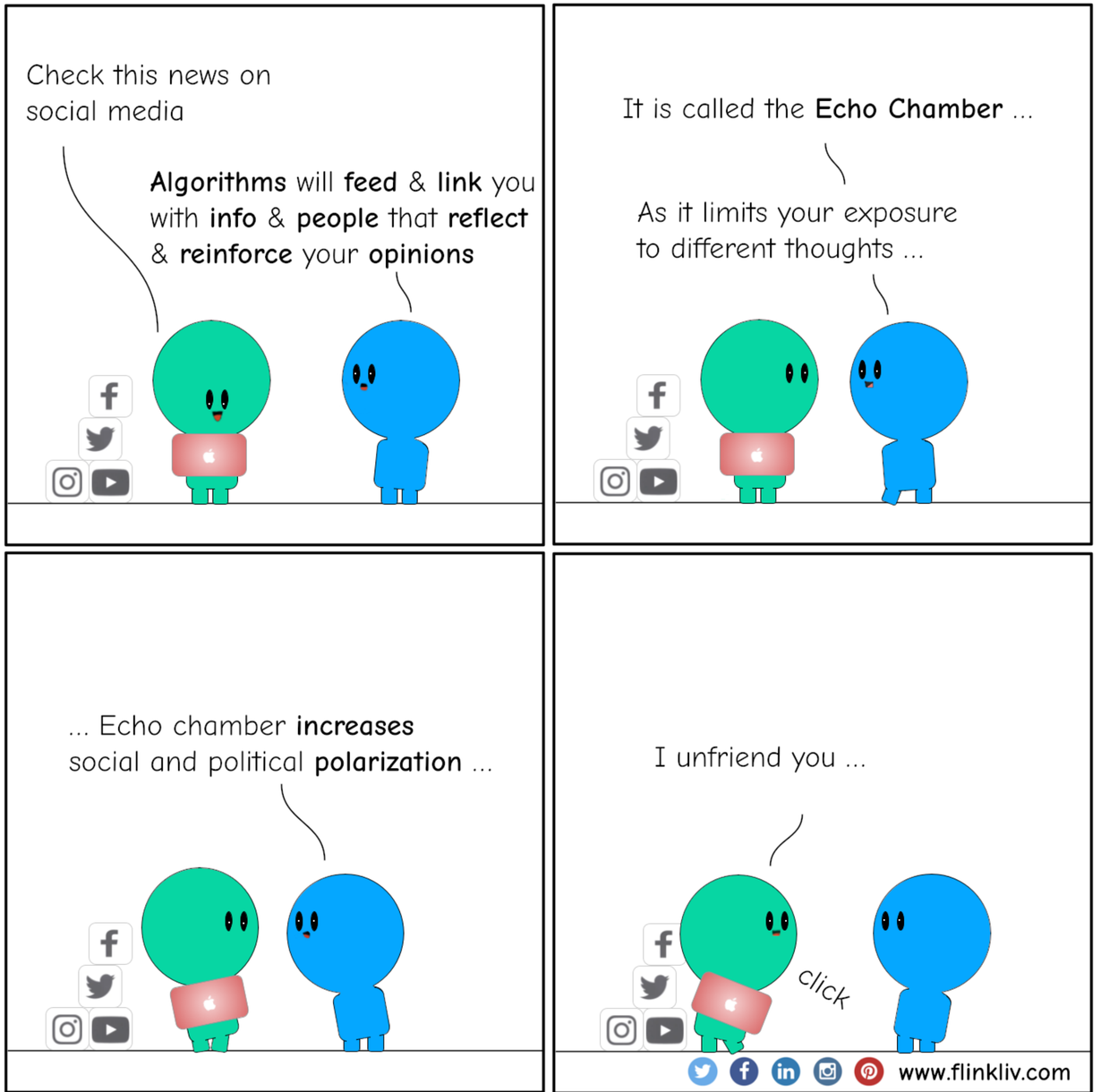


Sentiment and discussion.

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.

Zollo, F., Novak, P. K., Del Vicario, M., Bessi, A., Mozetič, I., Scala, A., ... & Quattrociocchi, W. (2015). Emotional dynamics in the age of misinformation. *PloS one*, *10*(9), e0138740.

THE BIG PICTURE



PNAS

Anatomy of news consumption on Facebook

Ana Lucía Schmidt[a], Fabiana Zollo[a,1], Michela Del Vicario[a], Alessandro Bessi[b], Antonio Scala[a,c], Guido Caldarelli[a,c], H. Eugene Stanley[d], and Walter Quattrociocchi[a,2]

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Edited by Susan T. Fiske, Princeton University, Princeton, NJ, and approved January 31, 2017 (received for review October 14, 2016)

The advent of social media and microblogging platforms has radically changed the way we consume information and form opinions. In this paper, we explore the anatomy of the information space on Facebook by characterizing on a global scale the news

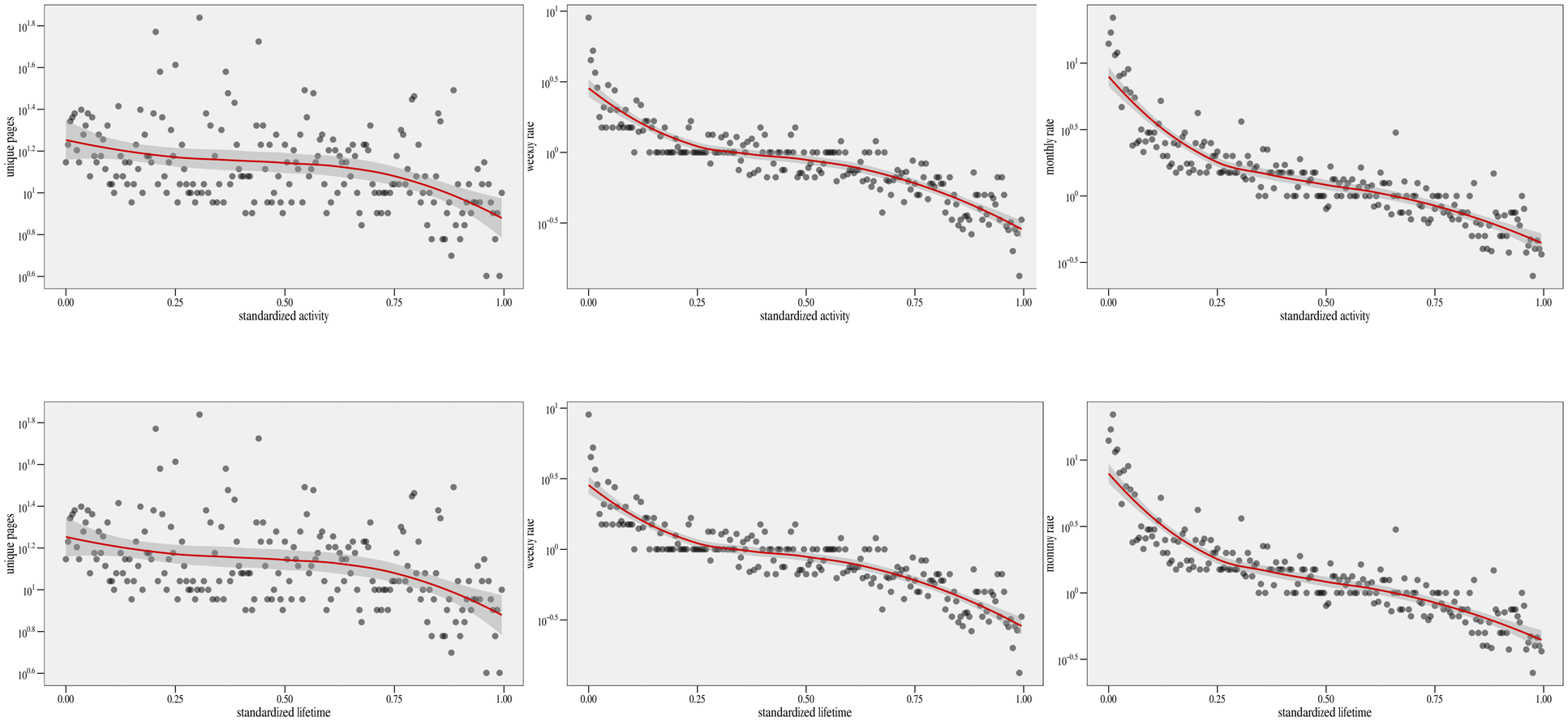
mation diffusion is the polarization of users on specific narratives rather than the lack of fact-checked certifications.

Results and Discussion

Users' Attention. News items on Facebook appear in posts that

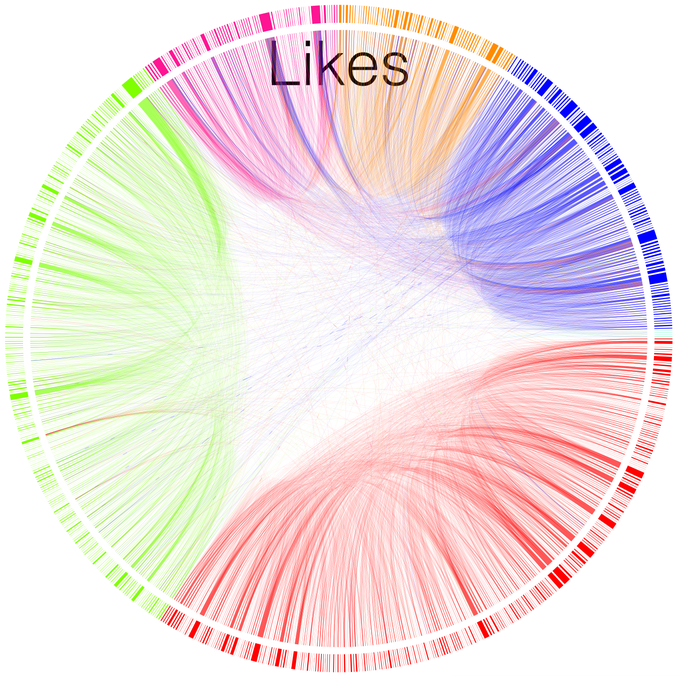
376 Million of Facebook Users (Jan 2010- Dec 2015)

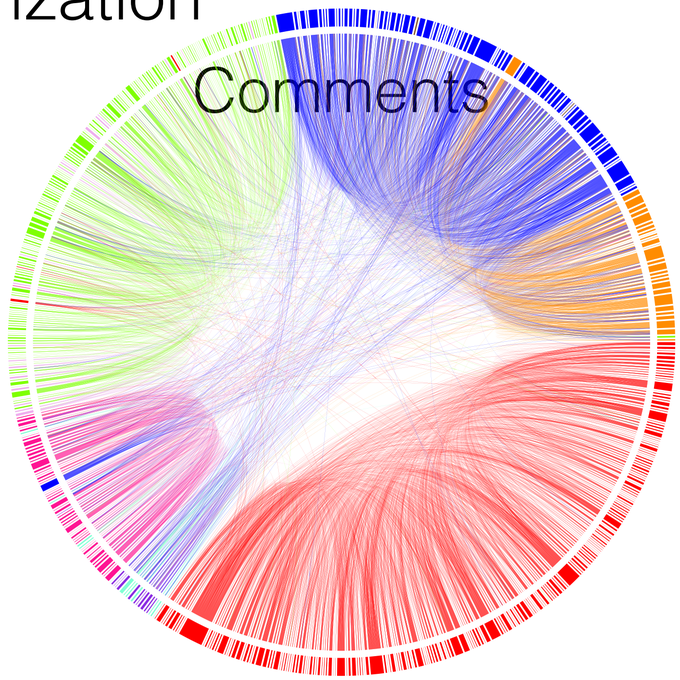
Users tend to focus on a limited set of information sources

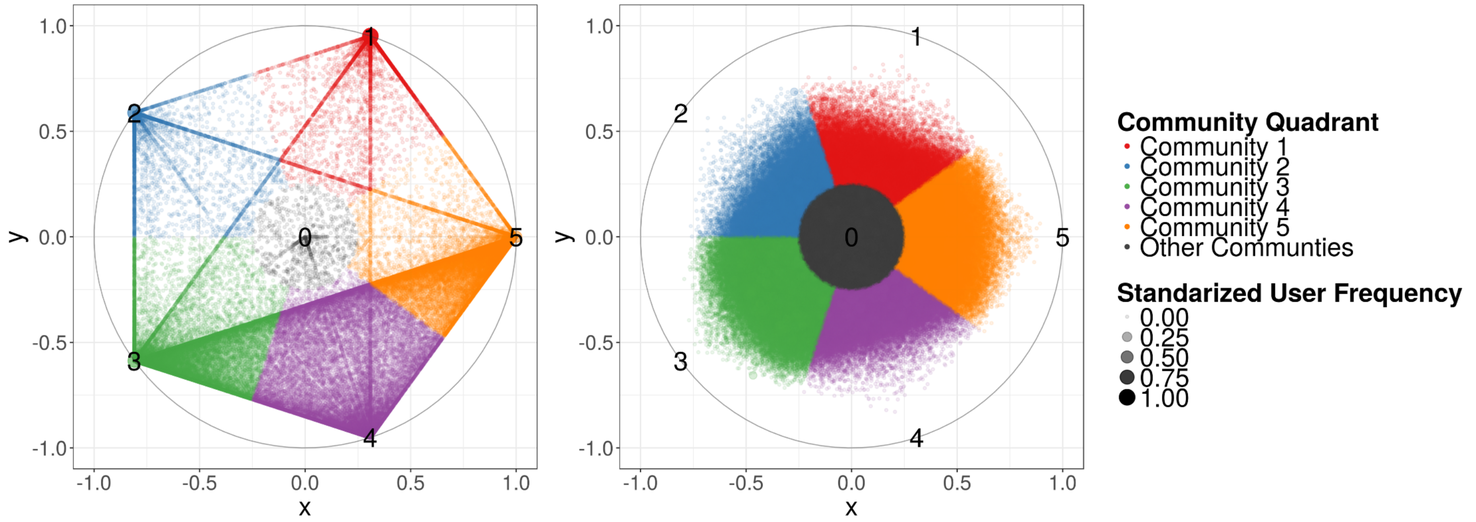


Schmidt, A. L., Zollo, F., Del Vicario, M., Bessi, A., Scala, A., Caldarelli, G., ... & Quattrociocchi, W. (2017). Anatomy of news consumption on Facebook. Proceedings of the National Academy of Sciences, 114(12), 3035-3039.

Clusters and Users Polarization

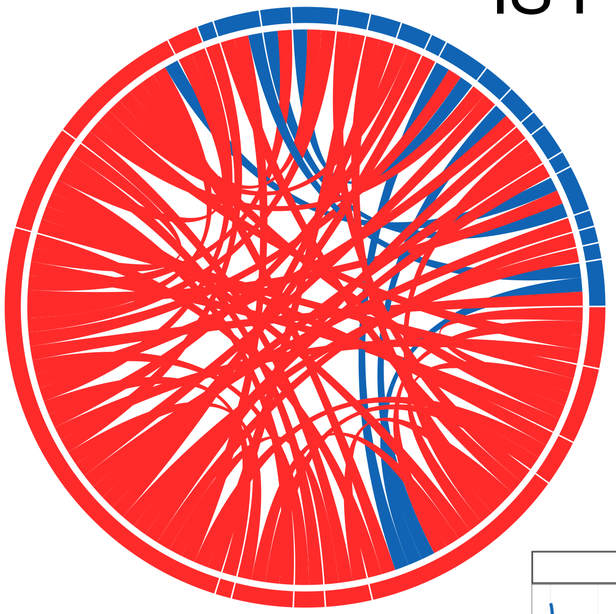






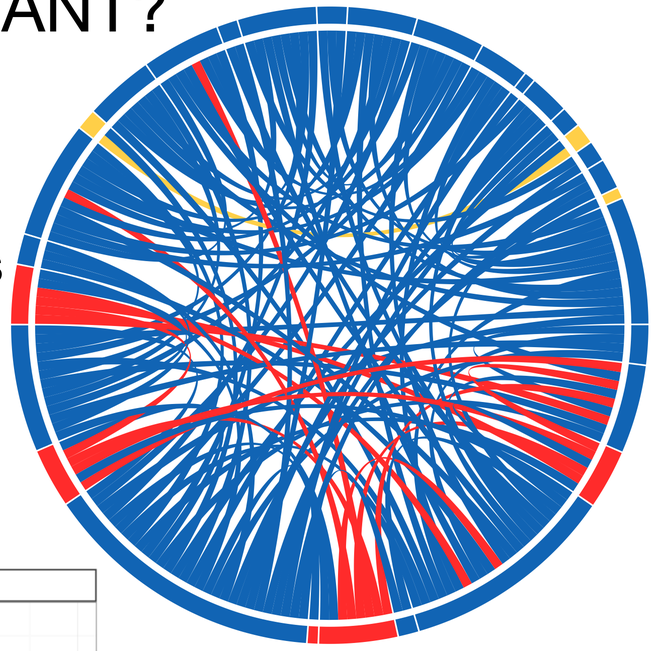
Schmidt, A. L., Zollo, F., Del Vicario, M., Bessi, A., Scala, A., Caldarelli, G., ... & Quattrociocchi, W. (2017). Anatomy of news consumption on Facebook. Proceedings of the National Academy of Sciences, 114(12), 3035-3039.

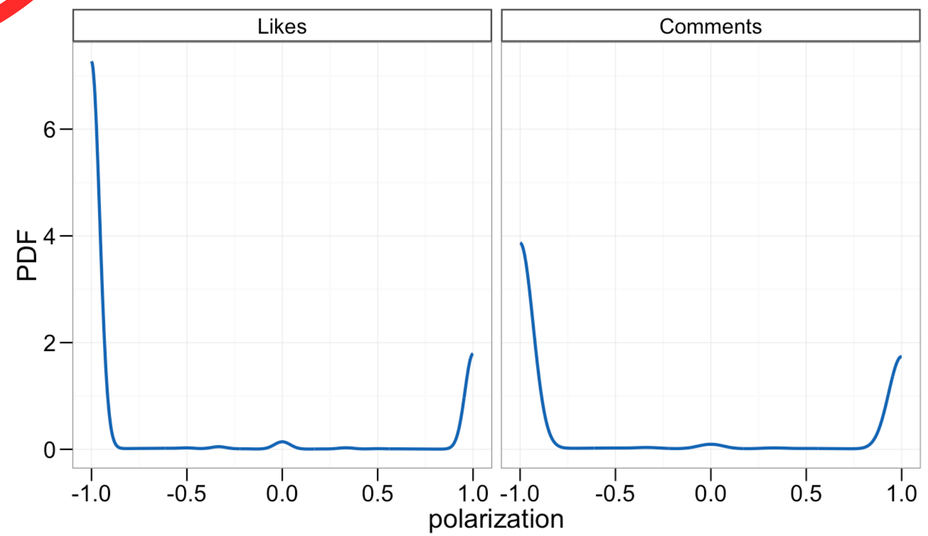
IS POLARIZATION DOMINANT?



Community Structure

Backbone of the projections on pages of the users likes (left) and comments (right).





Polarization: Distribution of Users likes and comments on the 2 communities

Del Vicario, M., Zollo, F., Caldarelli, G., Scala, A., & Quattrociocchi, W. (2017). Mapping social dynamics on Facebook: The Brexit debate. Social Networks, 50, 6-16.

WHAT ABOUT VACCINES?

Contents lists available at ScienceDirect

Vaccine

journal homepage: www.elsevier.com/locate/vaccine

Polarization of the vaccination debate on Facebook

Ana Lucía Schmidt [a,*], Fabiana Zollo [a], Antonio Scala [b], Cornelia Betsch [c], Walter Quattrociocchi [a]

[a] Ca' Foscari University of Venice, Via Torino 155, 30172 Venice, Italy
[b] ISC-CNR, SC-CNR, Sapienza University of Rome, Via dei Taurini 19, 00185 Rome, Italy
[c] University of Erfurt, Nordhäuserstr, 63, 9089 Erfurt, Germany

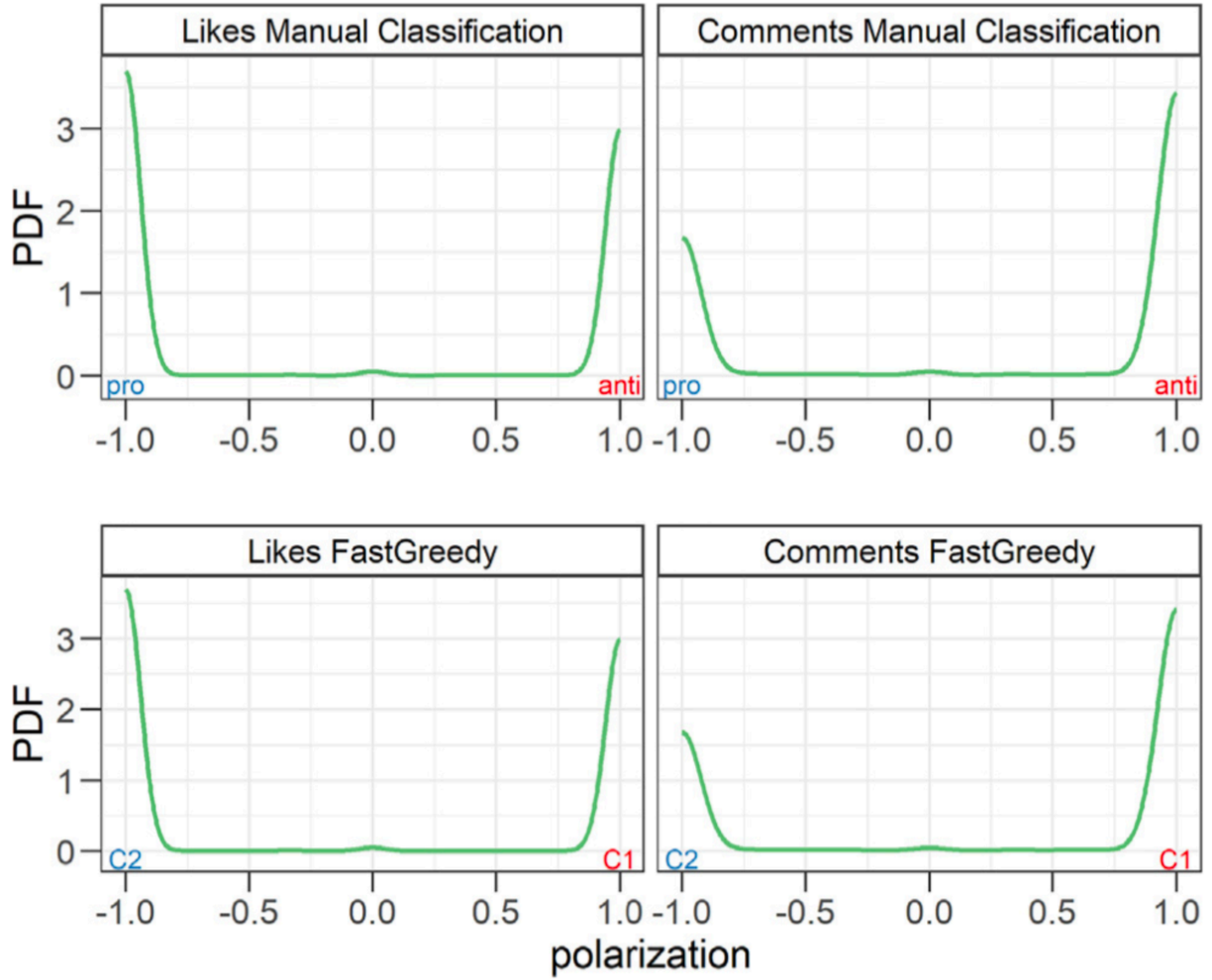


Fig. 2. Probability Density Function (PDF) of the users' liking (left) and commenting (right) behavior in the manual communities (top) and the 2 largest communities detected with FastGreedy (bottom). The distribution of the users is bimodal for all cases, which indicates a strong polarization among the communities, that is, the majority of the users are active in only one community.

Schmidt, A. L., Zollo, F., Scala, A., Betsch, C., & Quattrociocchi, W. (2018). Polarization of the vaccination debate on Facebook. Vaccine, 36(25), 3606-3612.

THE EFFECT OF ALGORITHMS

Check for updates

The echo chamber effect on social media

Matteo Cinelli[a], Gianmarco De Francisci Morales[b], Alessandro Galeazzi[c], Walter Quattrociocchi[d,1], and Michele Starnini[b]

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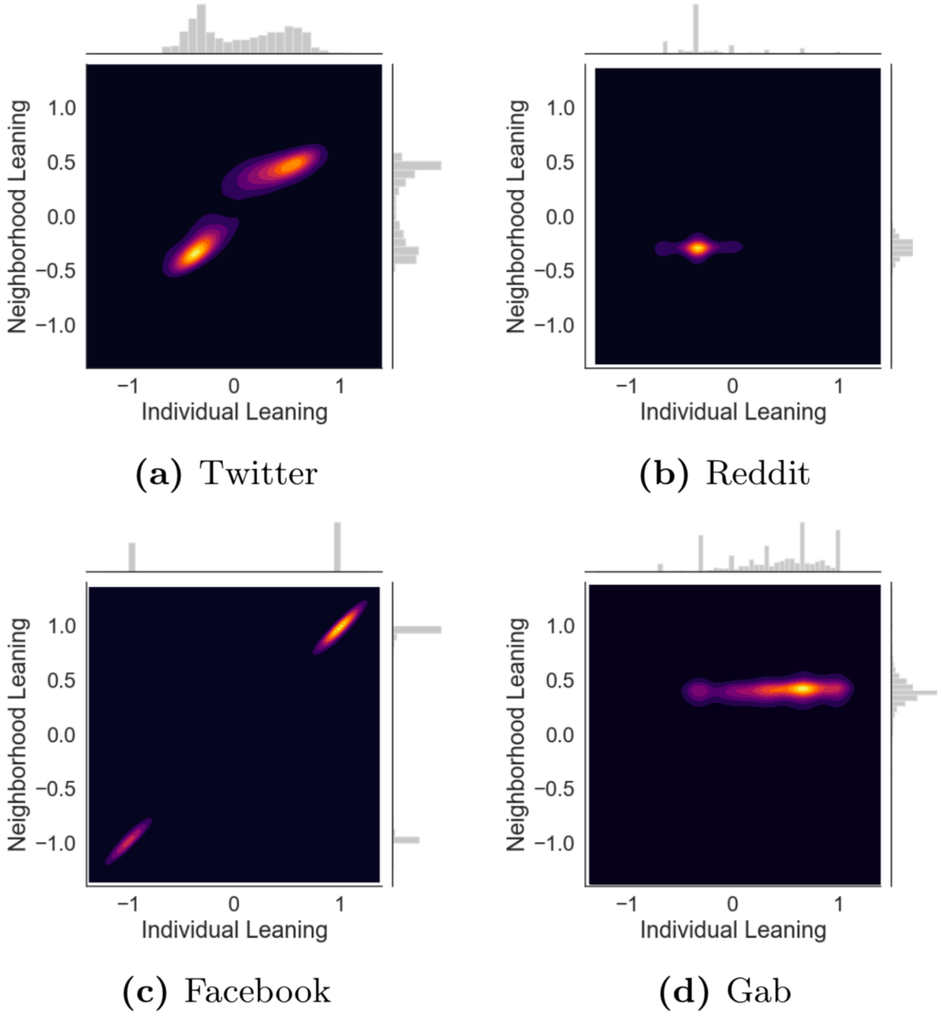
Edited by Arild Underdal, University of Oslo, Oslo, Norway, and approved January 14, 2021 (received for review November 15, 2020)

Social media may limit the exposure to diverse perspectives and favor the formation of groups of like-minded users framing and reinforcing a shared narrative, that is, echo chambers. However, the interaction paradigms among users and feed algorithms greatly vary across social media platforms. This paper explores the key differences between the main social media platforms and how they are likely to influence information spreading and echo chambers' formation. We perform a comparative analysis of more than 100 million pieces of content concerning several controversial topics (e.g., gun control, vaccination, abortion) from Gab, Facebook, Reddit, and Twitter. We quantify echo chambers over social media by two main ingredients: 1) homophily in the interaction networks and 2) bias in the information diffusion toward like-minded peers. Our results show that the aggregation of users in homophilic clusters dominate online interactions on Facebook and Twitter. We conclude the paper by directly comparing news consumption on Facebook and Reddit, finding higher segregation on Facebook.

tion and public opinion formation. In this paper, we explore the key differences between social media platforms and how they are likely to influence the formation of echo chambers or not. As recently shown in the case of selective exposure to news outlets, studies considering multiple platforms can offer a fresh view on long-debated problems (34). Different platforms offer different interaction paradigms to users, ranging from retweets and mentions on Twitter to likes and comments in groups on Facebook, thus triggering very different social dynamics (35). We introduce an operational definition of echo chambers to provide a common methodological ground to explore how different platforms influence their formation. In particular, we operationalize the two common elements that characterize echo chambers into observables that can be quantified and empirically measured, namely, 1) the inference of the user's leaning for a specific topic (e.g., politics, vaccines) and 2) the structure of their social interactions on the platform. Then, we use these elements to assess echo chambers' presence by looking

POLARIZATION ON DIFFERENT PLATFORMS



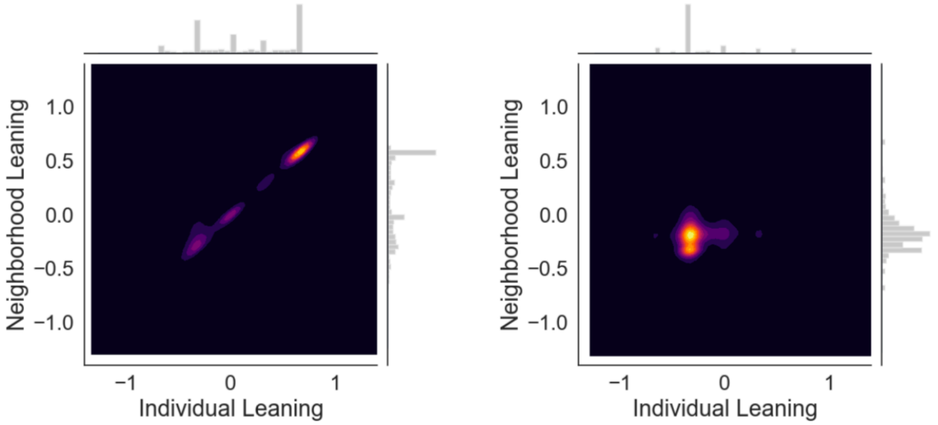
(a) Twitter

(b) Reddit

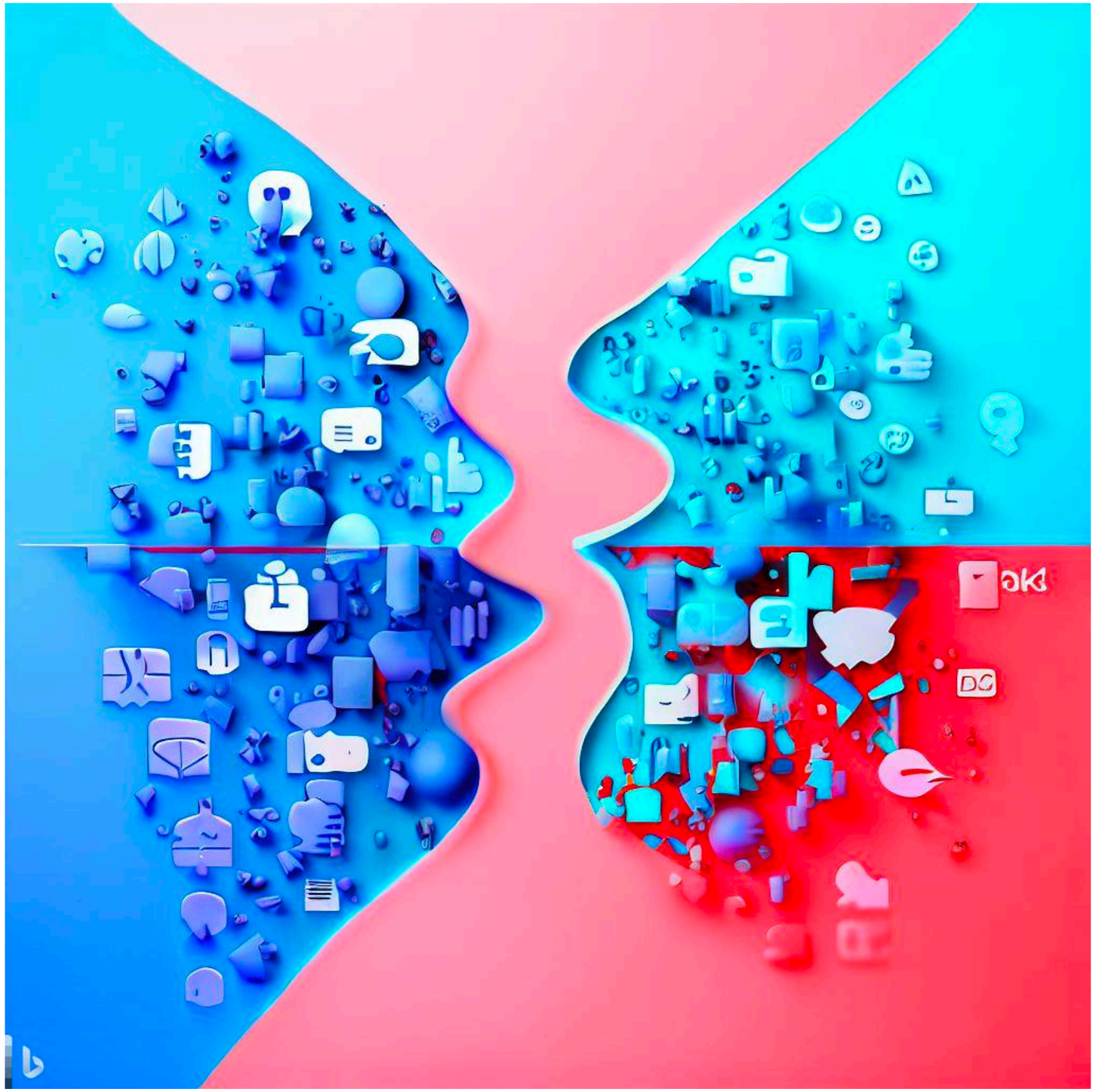
(c) Facebook

(d) Gab

NEWS AND POLARIZATION



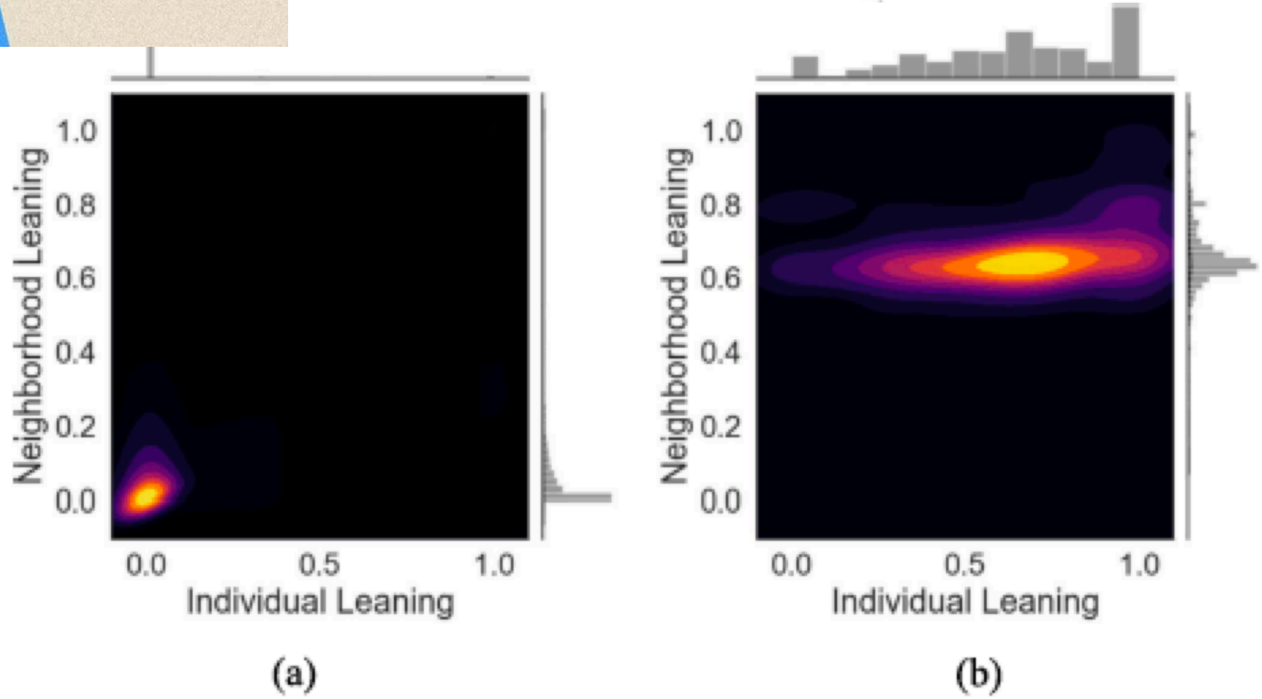
s, G. D. F., Galeazzi, A., Quattrociocchi, W., & Starnini, M. (2020). Echo chambers on social media: A comparative analysis. *arXiv preprint arXiv:2004.09603*. under revision to Science Advances



Fake news vs. real news is not the issue.

The issue is too much information driven by entertainment-oriented platforms.

FROM ECHO CHAMBERS TO ECHO-PLATFORMS: TWITTER VS GAB



OTHER WORKS

The evolution of memes over years

News Spreading Patterns

News Language Similarity

Agenda Setting in a Polarized Environment

Mixing Qualitative and Quantitative analysis

Does deplatforming users help?

ChatGPT and philosophy of language

……..

THANK YOU