



Photo Illustration @21WIRE

Oxford Dictionaries' word of the year is

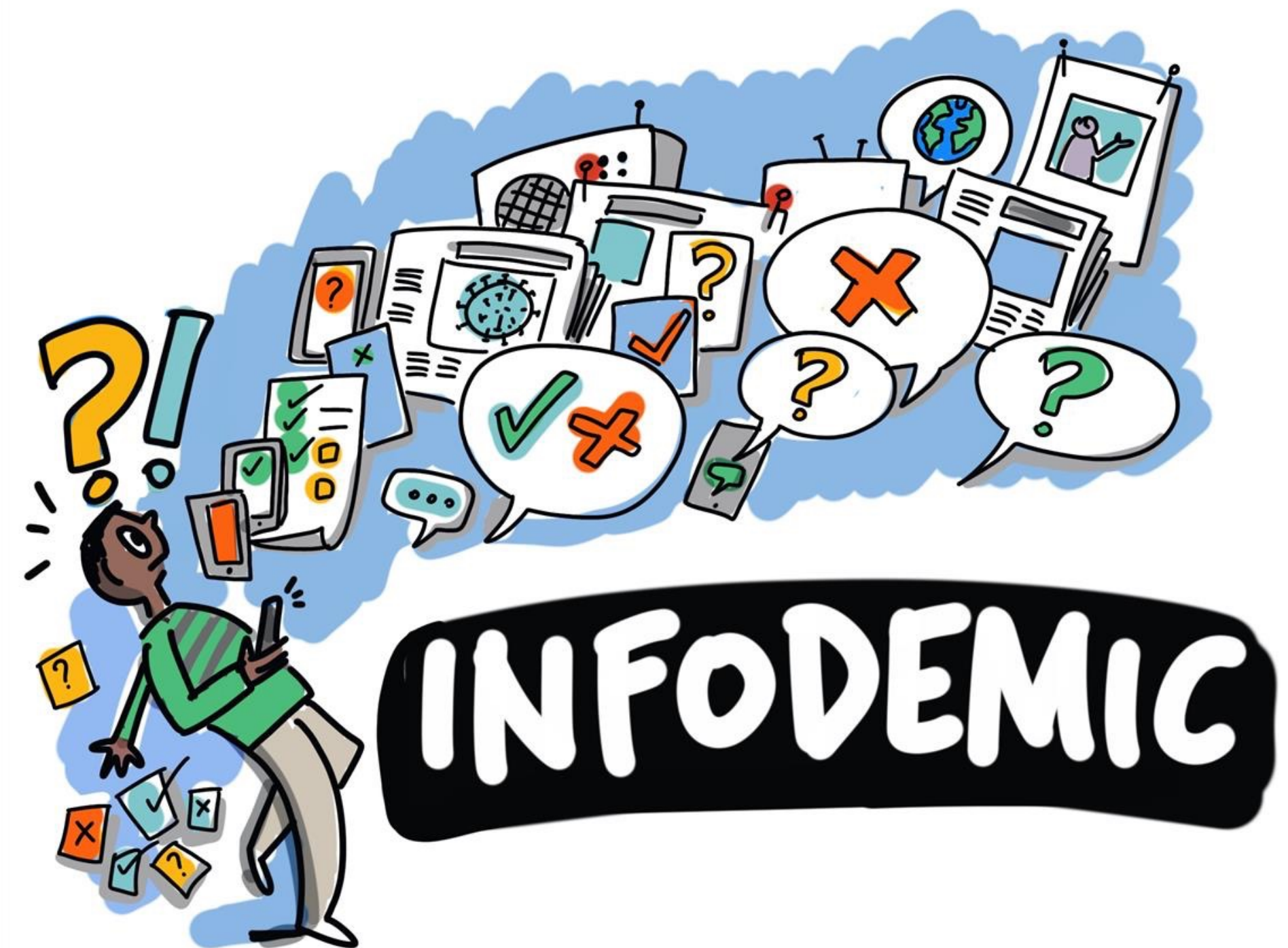
Post-truth

relating to or denoting circumstances in which objective facts are less influential in shaping public opinion than appeals to emotion and personal belief

INFODEMIC DEFINITION

An infodemic is too much information including false or misleading information in digital and physical environments during a disease outbreak. It causes confusion and risk-taking behaviours that can harm health. It also leads to mistrust in health authorities and undermines the public health response.

An infodemic can intensify or lengthen outbreaks when people are unsure about what they need to do to protect their health and the health of people around them. With growing digitization – an expansion of social media and internet use – information can spread more rapidly. This can help to more quickly fill information voids but can also amplify harmful messages.



THE ROLE OF THE MEDIA

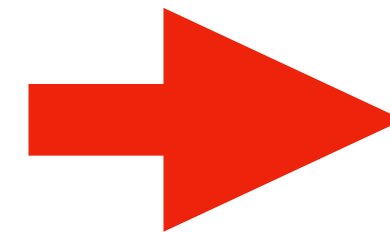
“The press may not be successful much of the time in telling people what to think, but it is stunningly successful in telling its readers what to think about”

(Bernard Cohen, 1963)



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)

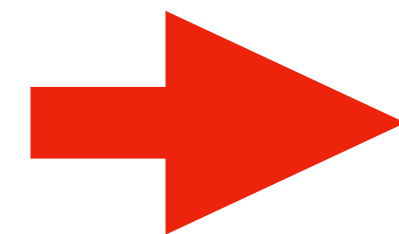
MEDIATED



NEW MEDIA

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

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.***

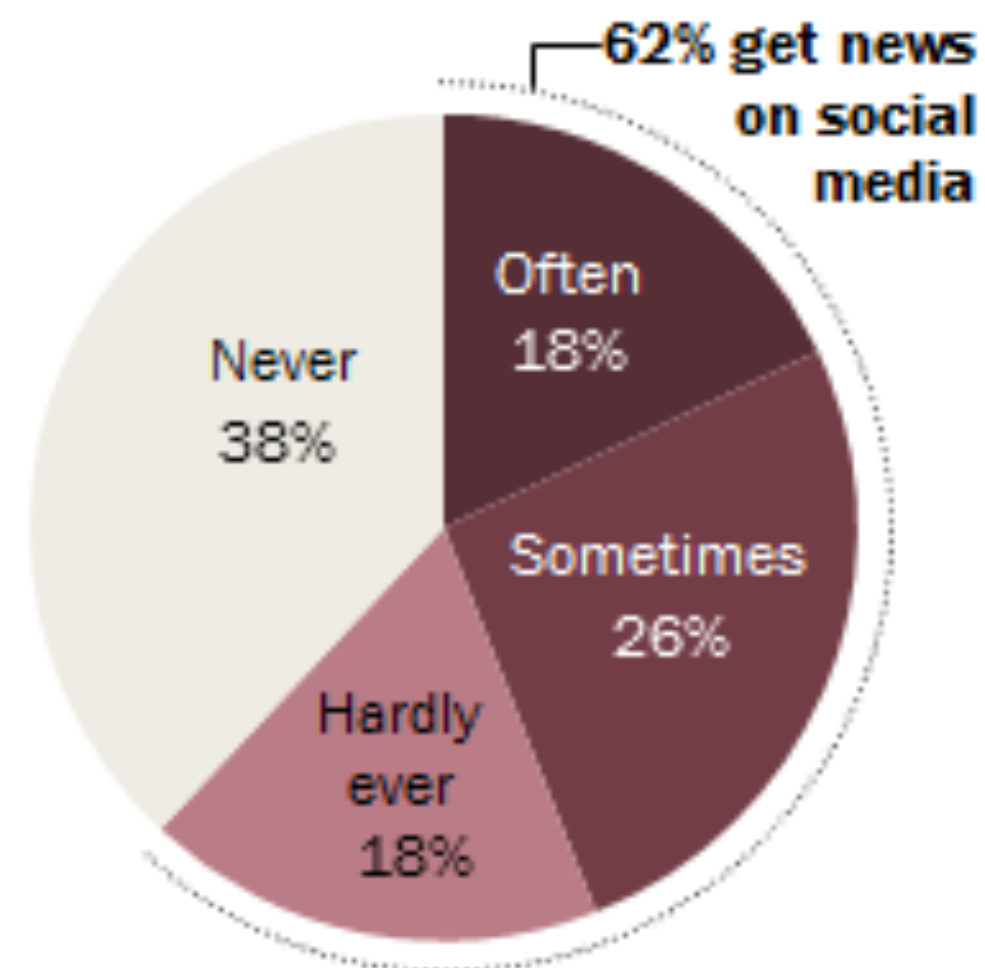
We always try to emphasize the utility component.”

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

**Poggia le dita sui gattini,
condividi l'immagine
scrivendo la parola EBOLA**

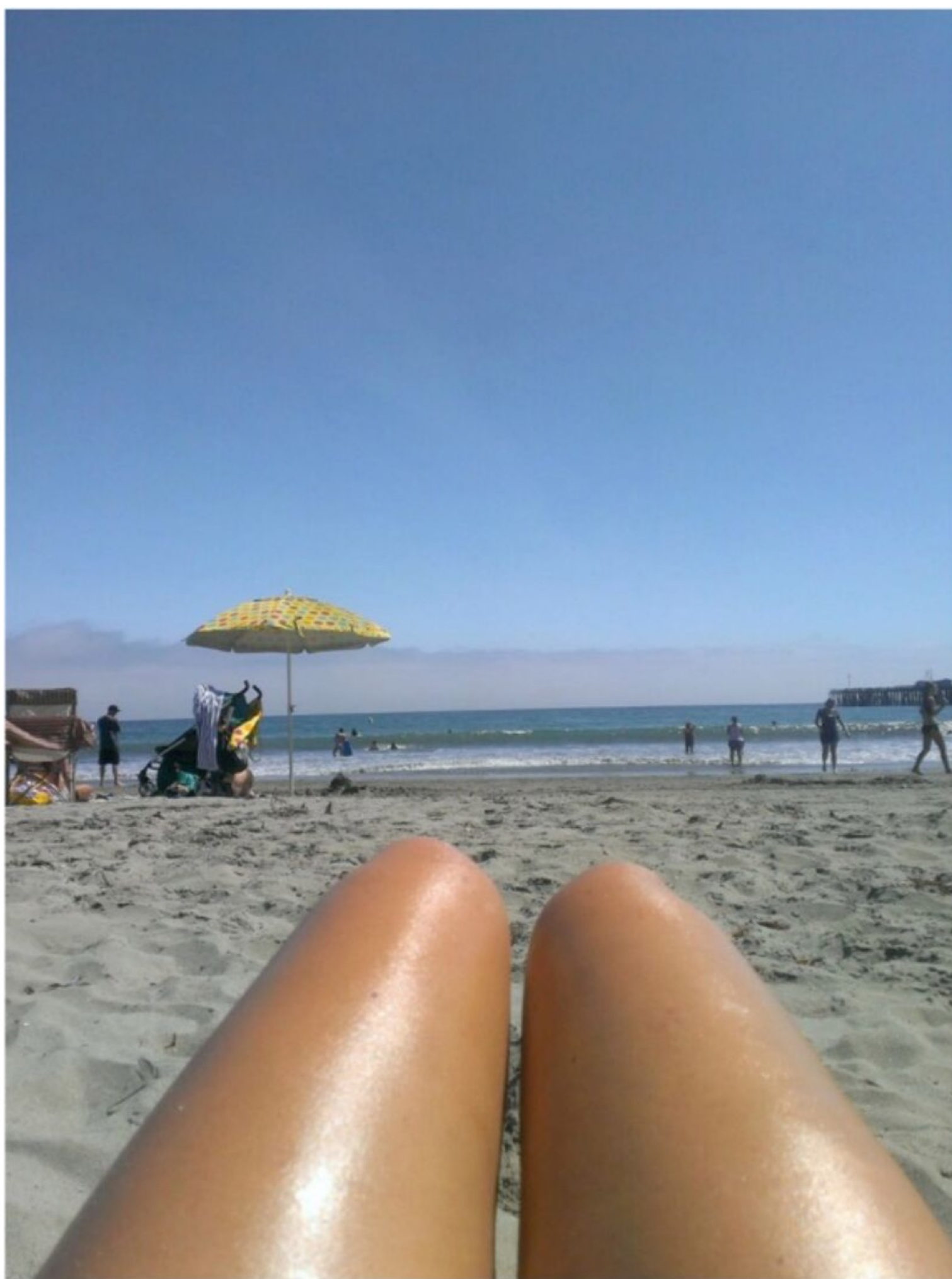


e guarda cosa

Spazzolino, dentifricio, ciabatte, accappatoio, sci
cappellino, preservativi, pinne, autan
il tuo paperastoro

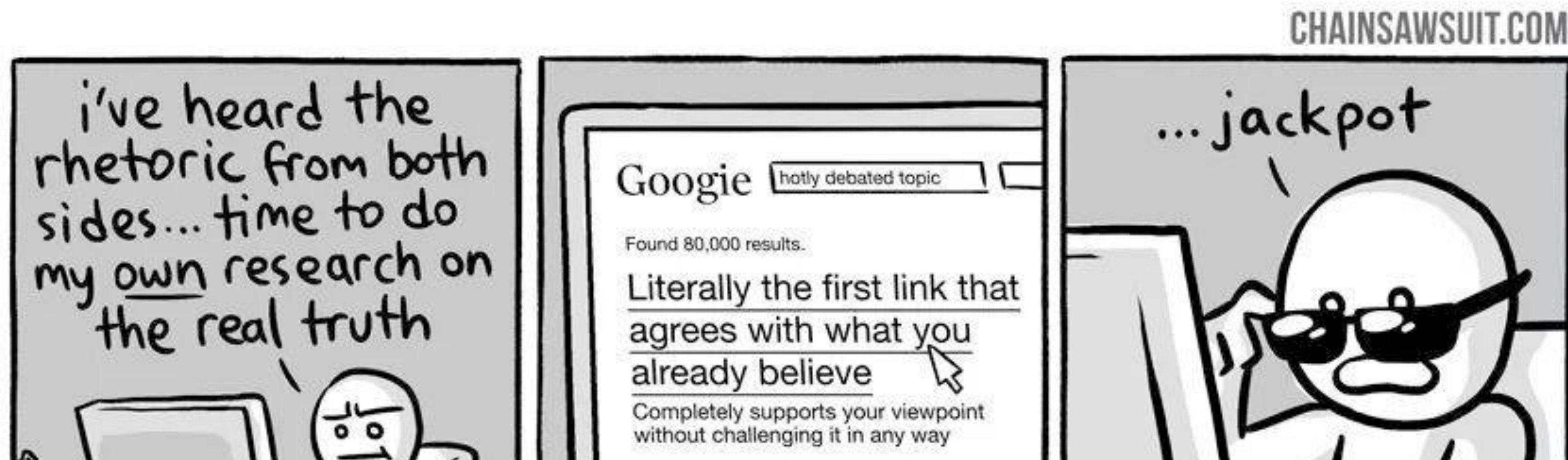


Cuando progetti le tue vacanze, non ti dimenticare di lui





CONFIRMATION BIAS AND INFORMATION CONSUMPTION



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

SCIENCE VS CONSPIRACY

C'è differenza nel modo in cui le due comunità fruiscono dei contenuti online?



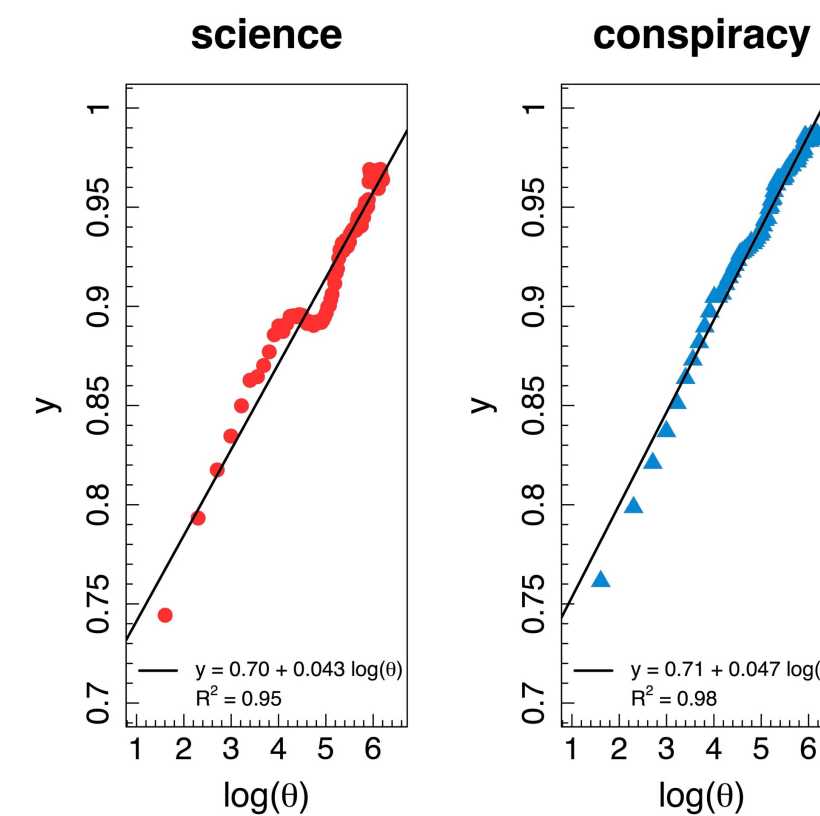
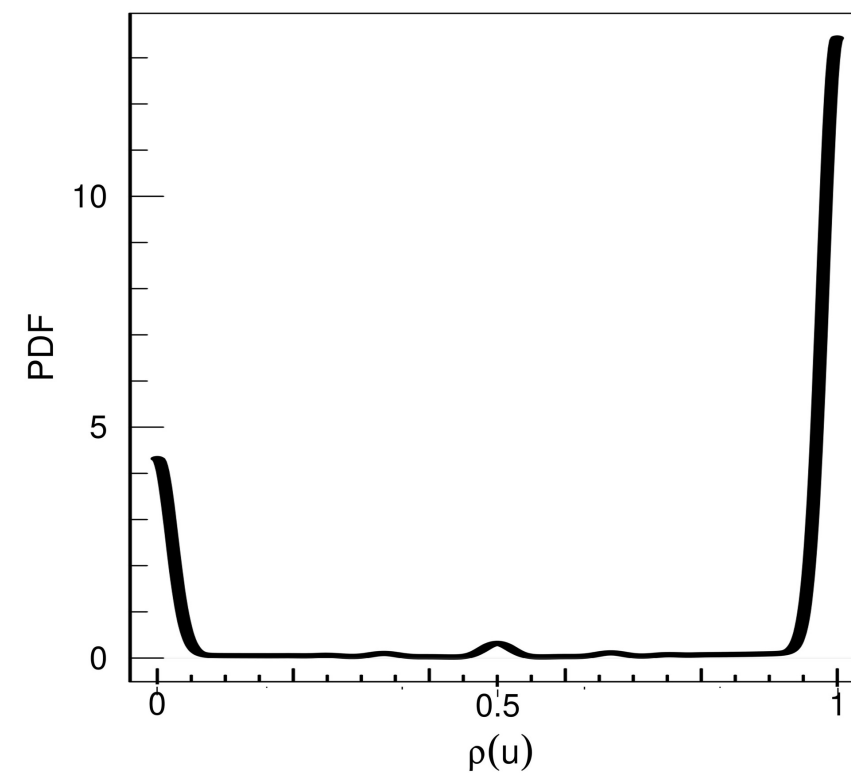
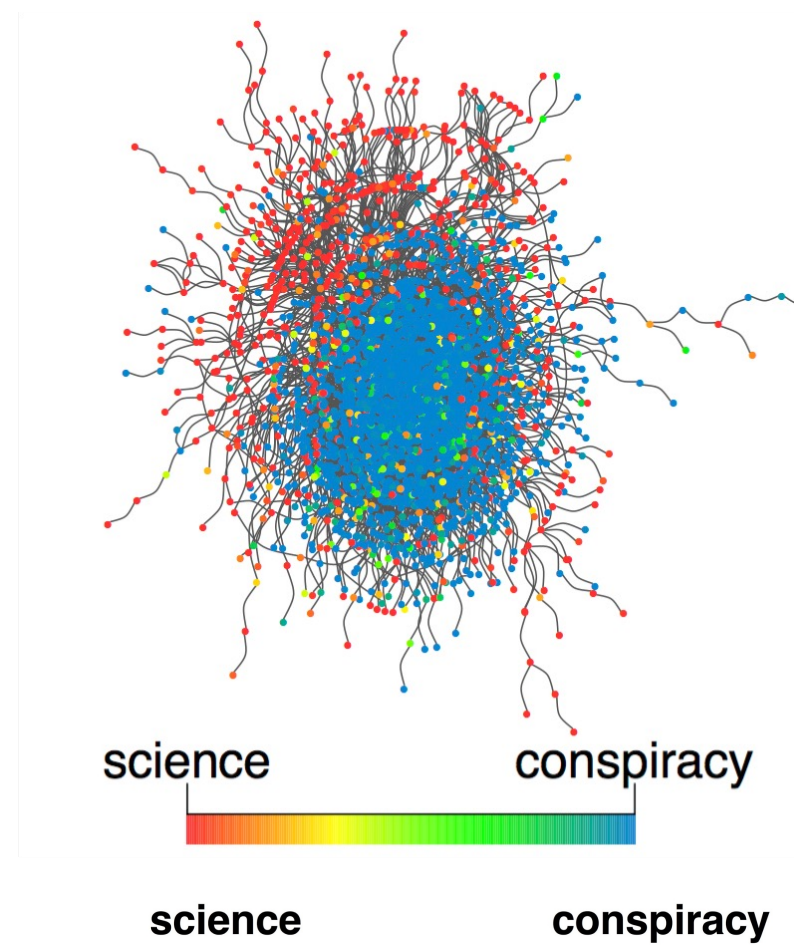
THE DATASET(s)

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



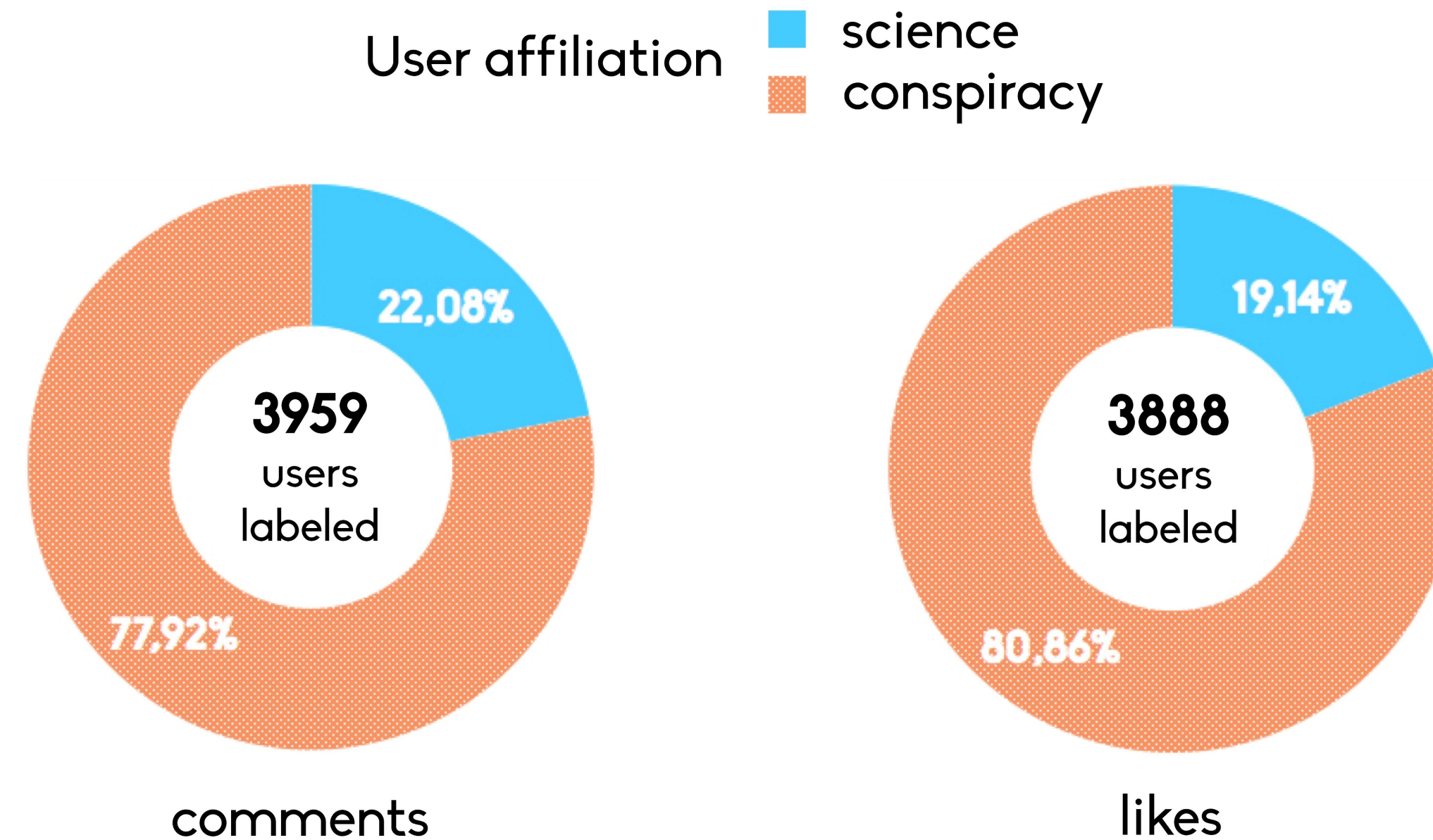
Polarization on contents. Probability density function (PDF) of users' polarization. Notice the strong bimodality of the distribution, with two sharp peaks localized at $0 < \rho < 0.005$ (science users) and at $0.95 < \rho < 1$ (conspiracy users).

Homophily. Fraction of polarized friends with the same polarization respect to the number of likes $\log(\theta(u))$ 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.

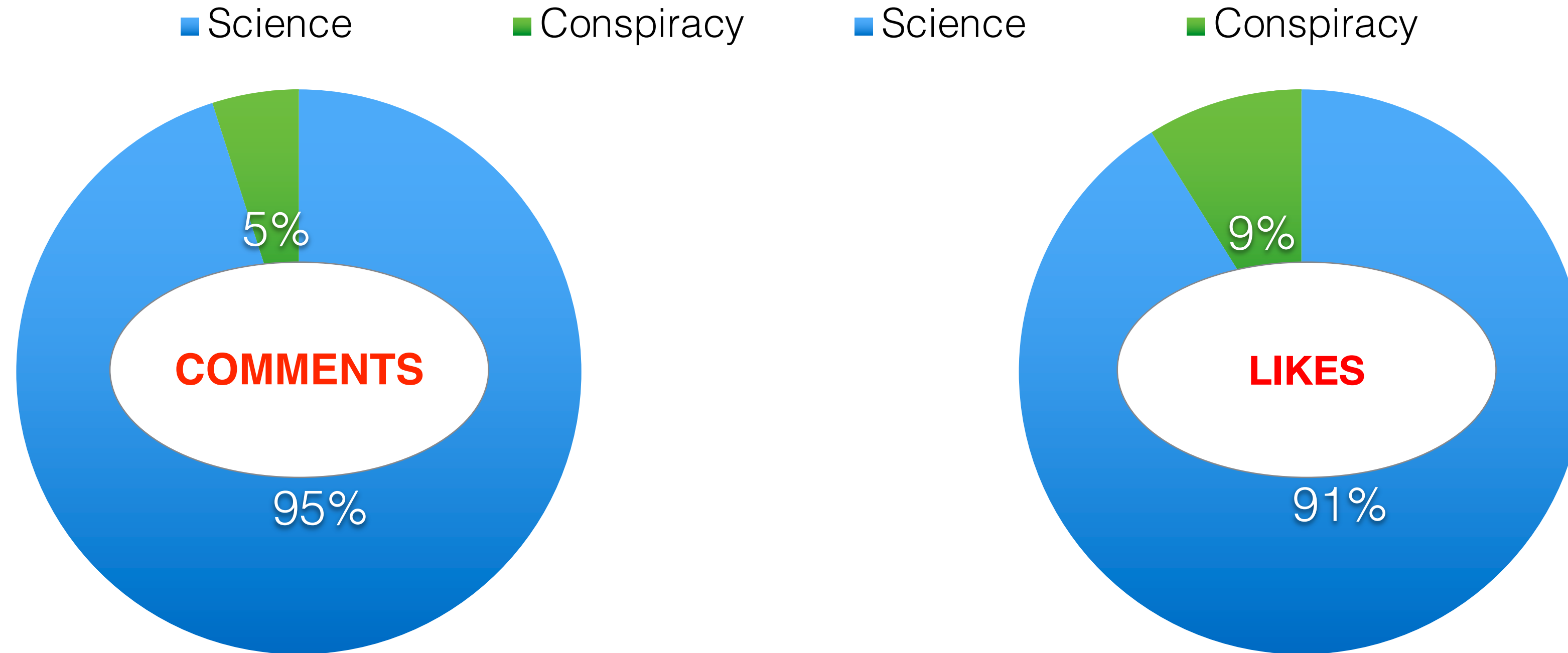
Mocanu, D., Rossi, L., Zhang, Q., Karsai, M., & Quattrociocchi, W. (2015). Collective attention in the age of (mis) information. *Computers in Human Behavior*, 51, 1198-1204.

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.

DEBUNKING
E
FACT-CHECKING



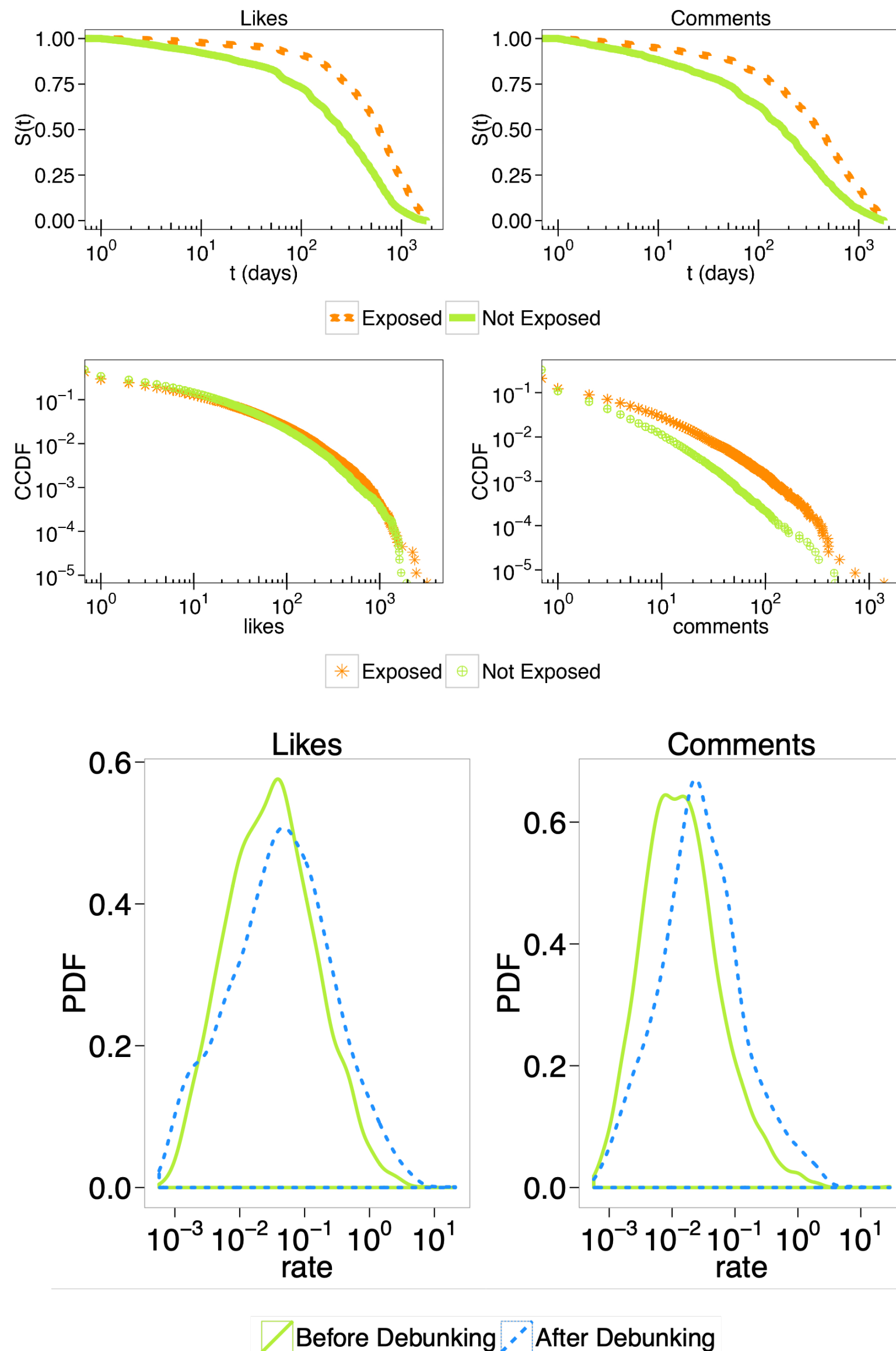
RESPONSE TO 47,780 DEBUNKING POSTS (1)



Debunking information are ignored by users in the conspiracy echo-chamber

(out of 9,790,906 polarized conspiracy users only 5,831 interact)

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.

VIRAL PROCESSES AND THE SIZE OF ECHO-CHAMBERS



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}

^aLaboratory of Computational Social Science, Networks Department, IMT Alti Studi Lucca, 55100 Lucca, Italy; ^bIUSS Institute for Advanced Study, 27100 Pavia, Italy; ^cSapienza University, 00185 Rome, Italy; ^dISC-CNR Uos "Sapienza," 00185 Rome, Italy; and ^eBoston 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

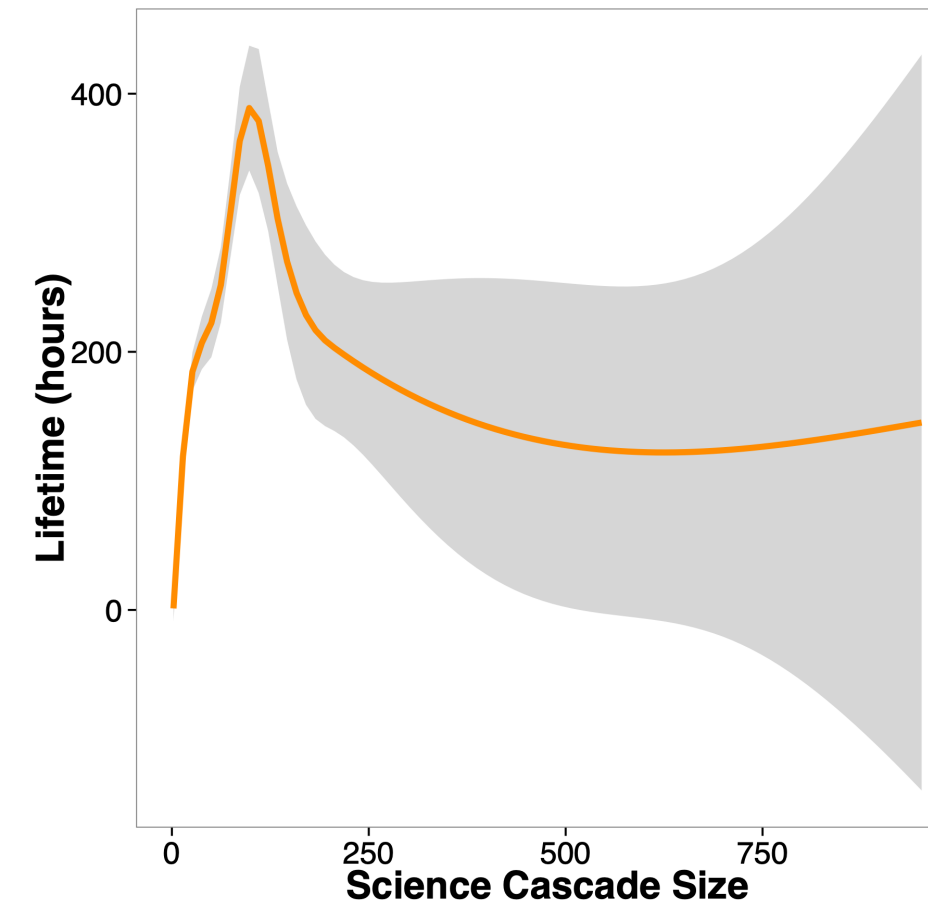
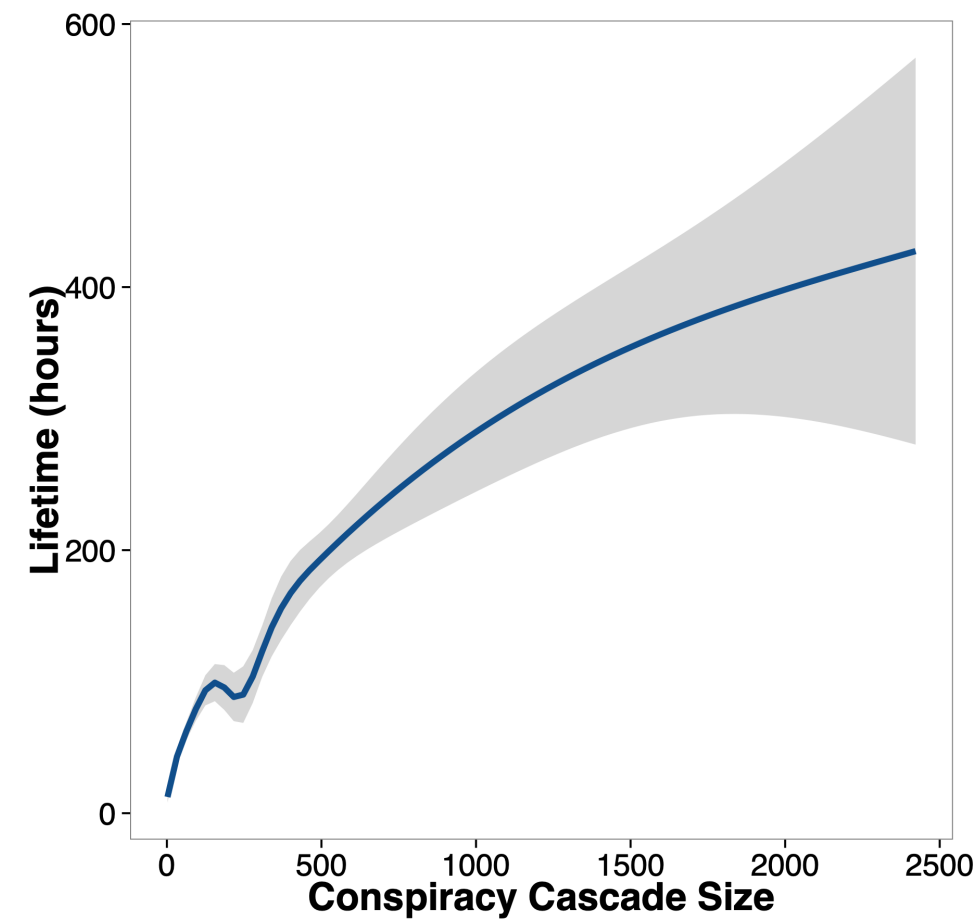
The massive diffusion of sociotechnical systems and micro-blogging platforms on the World Wide Web (WWW) creates

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).

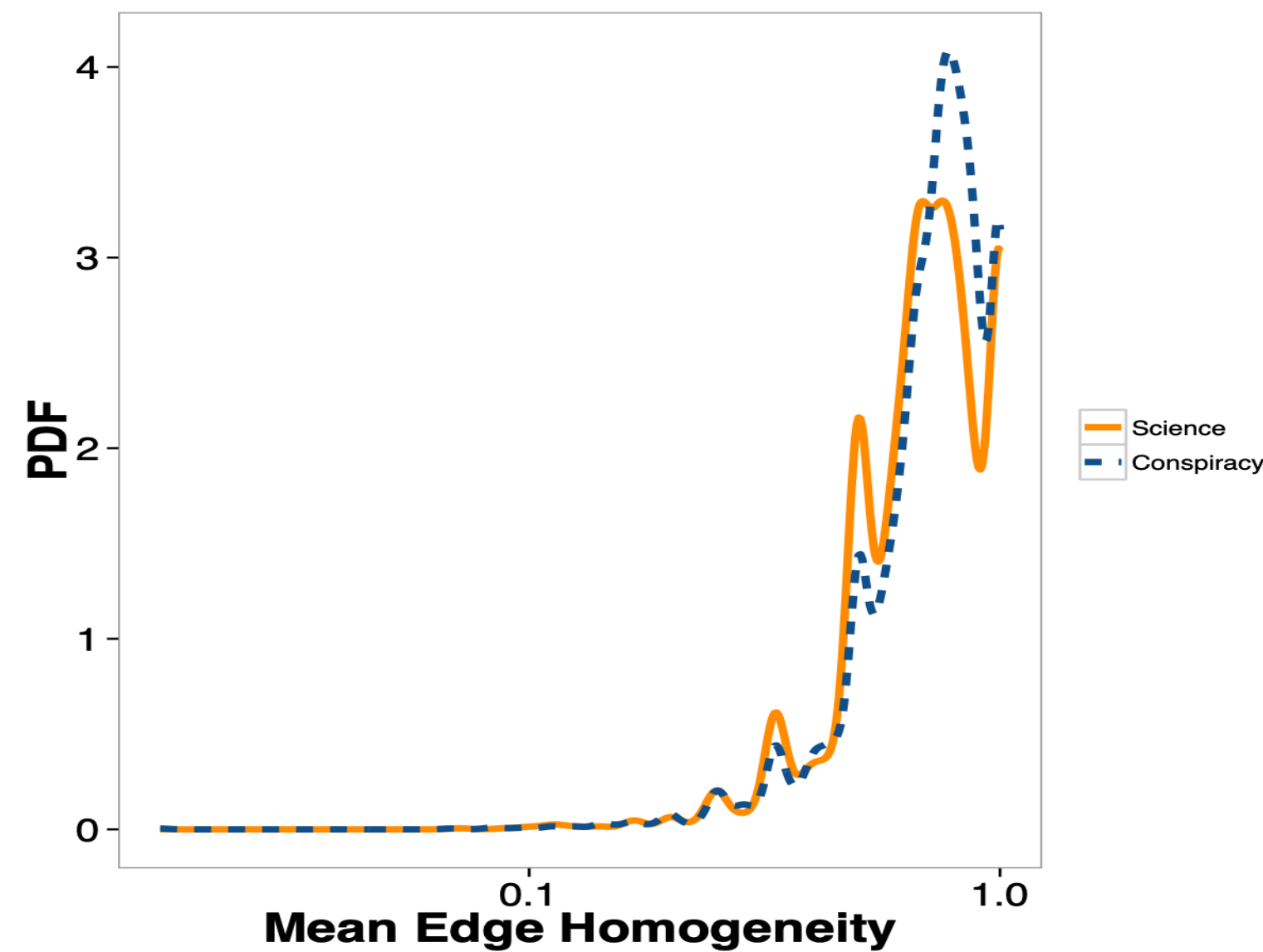
VIRAL PROCESSES AND ECHO CHAMBERS



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.



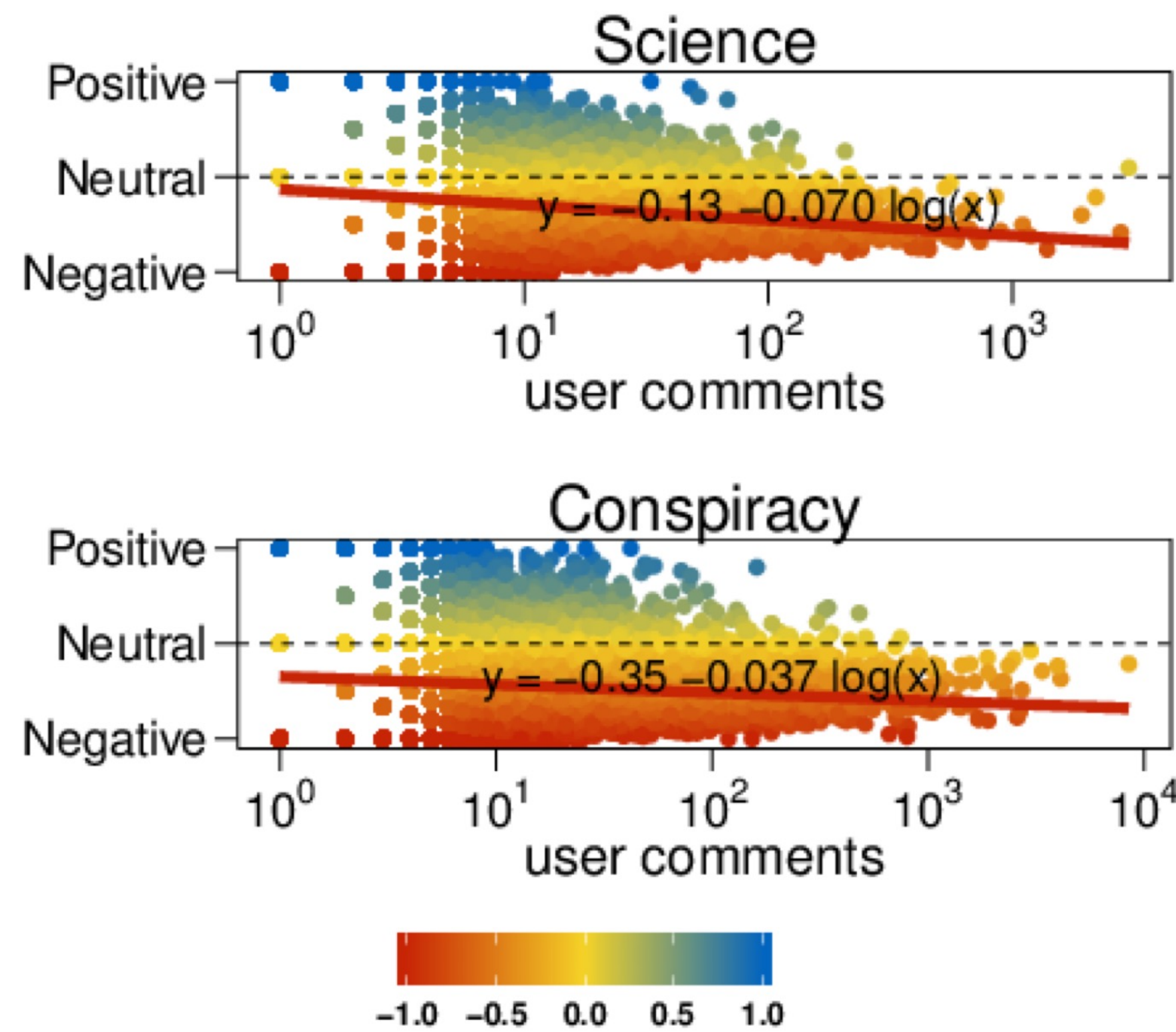
Probability density function (PDF) of edge homogeneity for science (orange) and conspiracy (blue) news.

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

EMOTIONAL DYNAMICS AND ECHO-CHAMBERS

DISCUSSION AND GROUP POLARIZATION

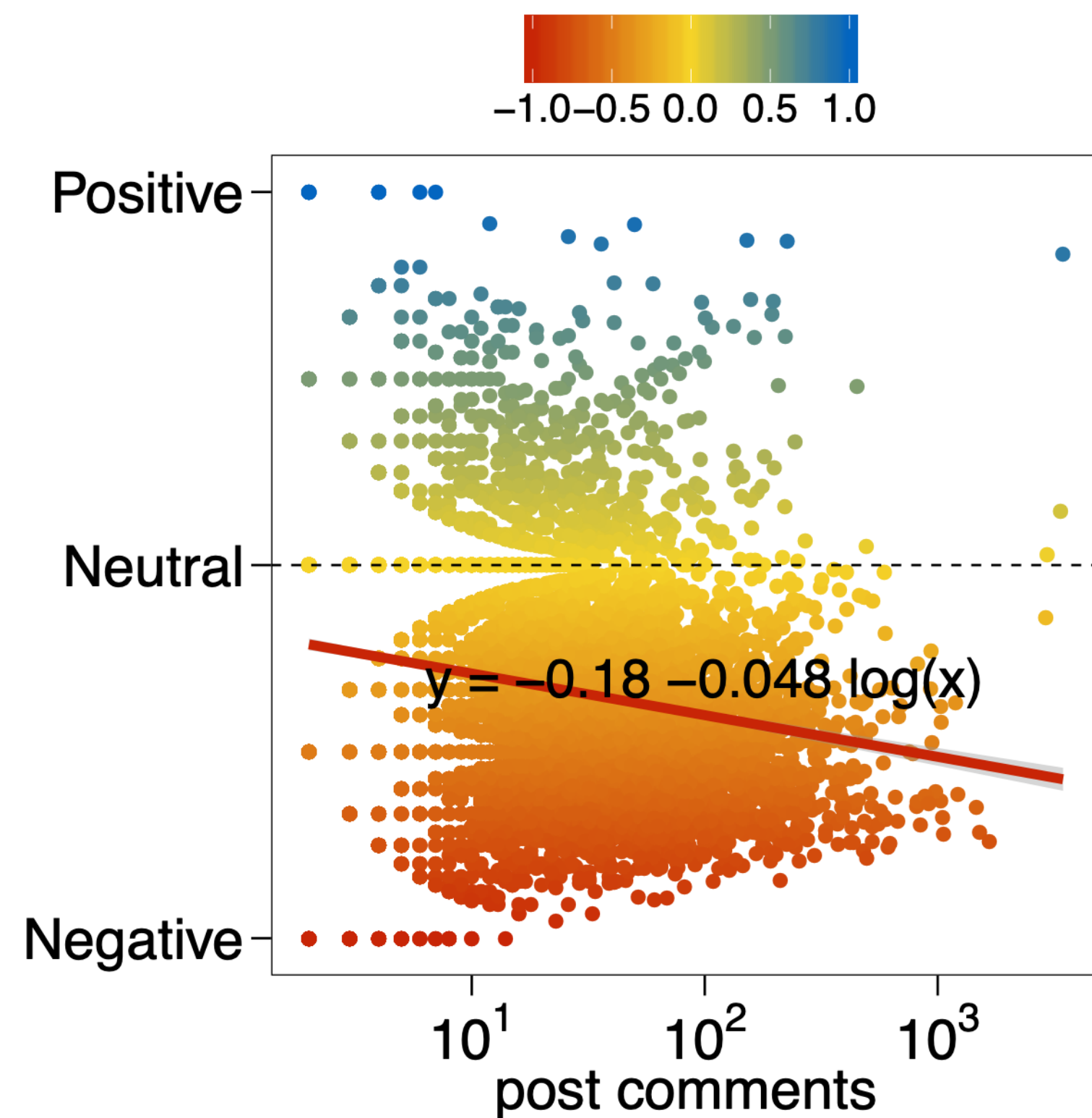
“It is well known that when like-minded groups deliberate, they tend to polarize, in the sense that they generally end up in a more extreme position in line with their predeliberation tendencies” **(Sunstein, 2008)** *Going to extremes: how like minds unite and divide. Oxford University Press*



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.

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.

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}

^aLaboratory of Computational Social Science, Networks Department, IMT Alti Studi Lucca, 55100 Lucca, Italy; ^bIUSS Institute for Advanced Study, 27100 Pavia, Italy; ^cISC-CNR Uos "Sapienza," 00185 Rome, Italy; and ^dDepartment of Physics, Boston University, Boston, MA 02115

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

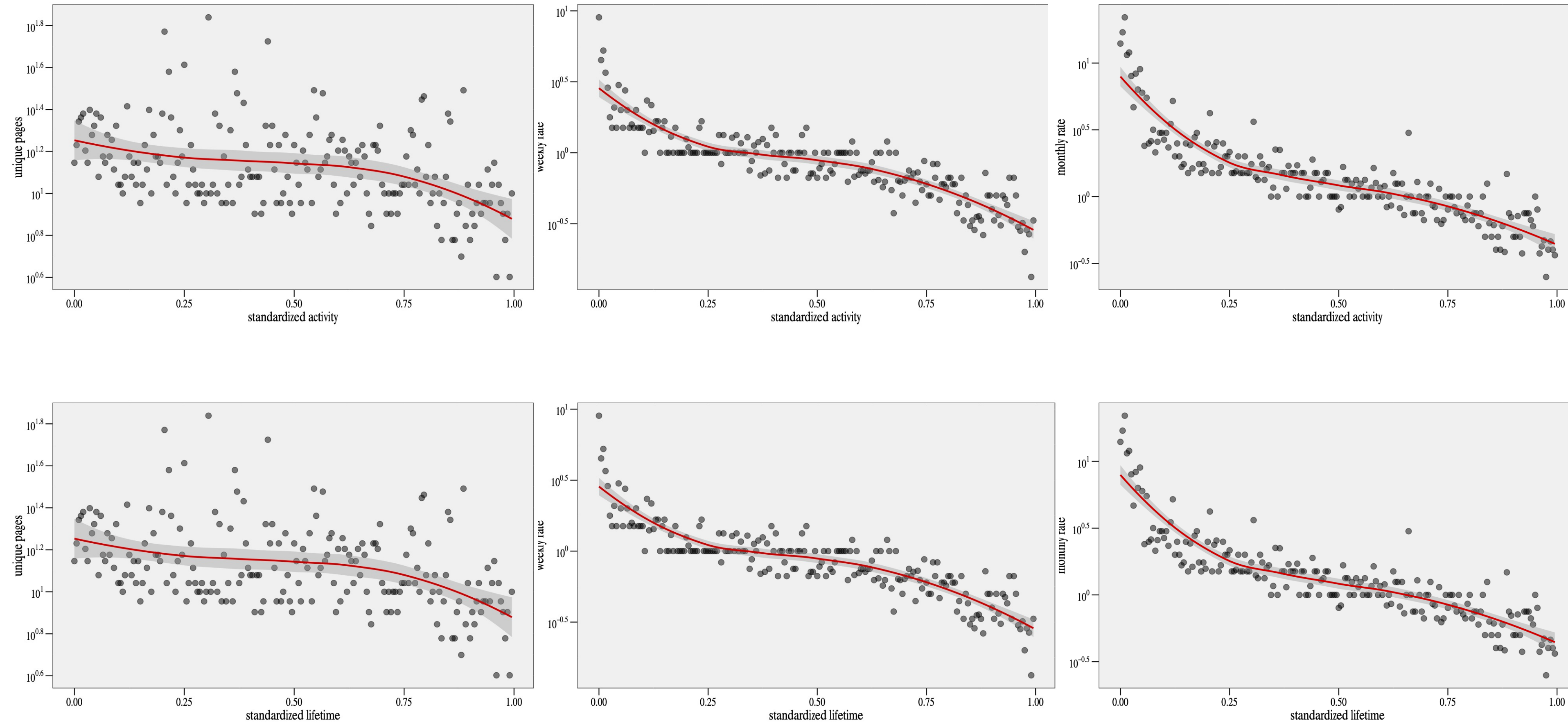
The advent of social media and microblogging platforms has radically changed the way we consume information and form opinion. Information diffusion is the polarization of users on specific narratives rather than the lack of fact-checked certifications.

PNAS

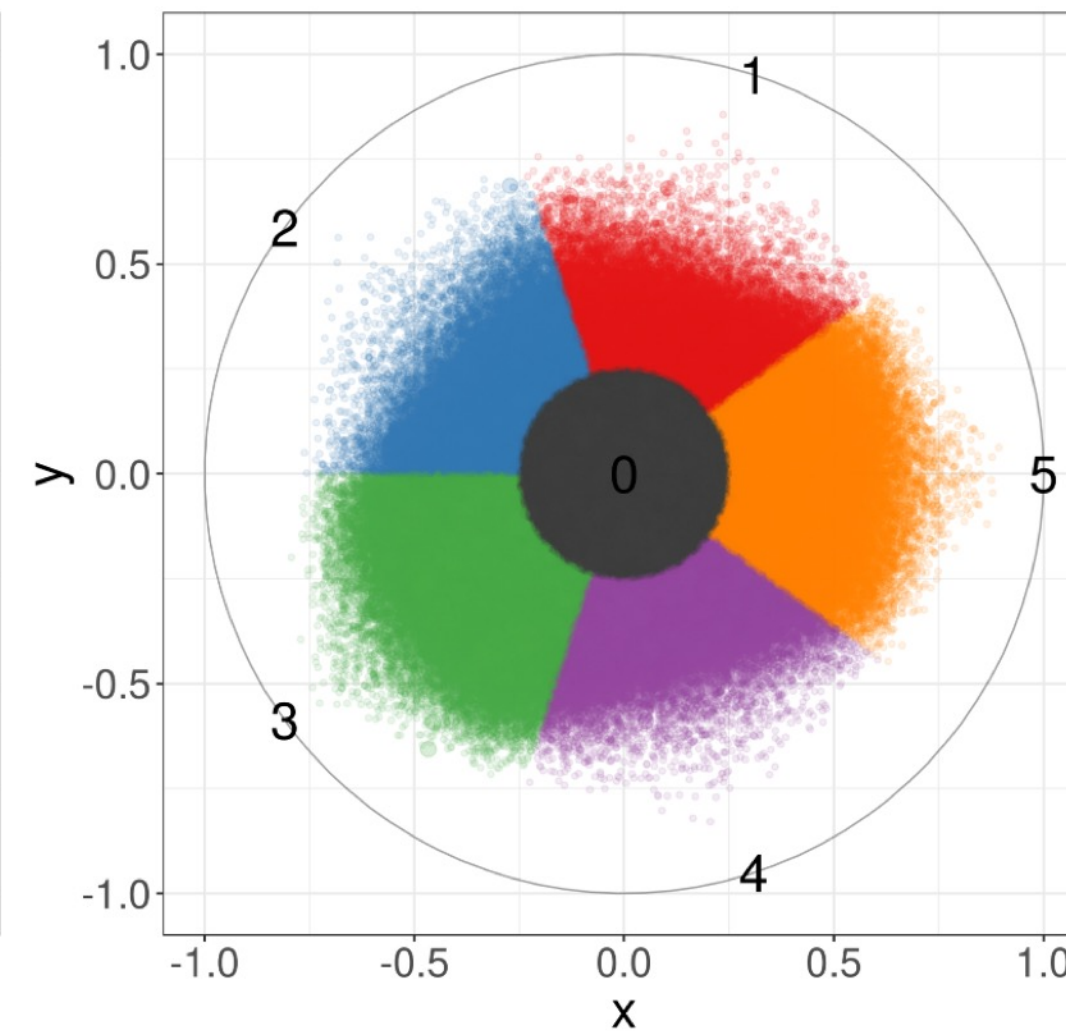
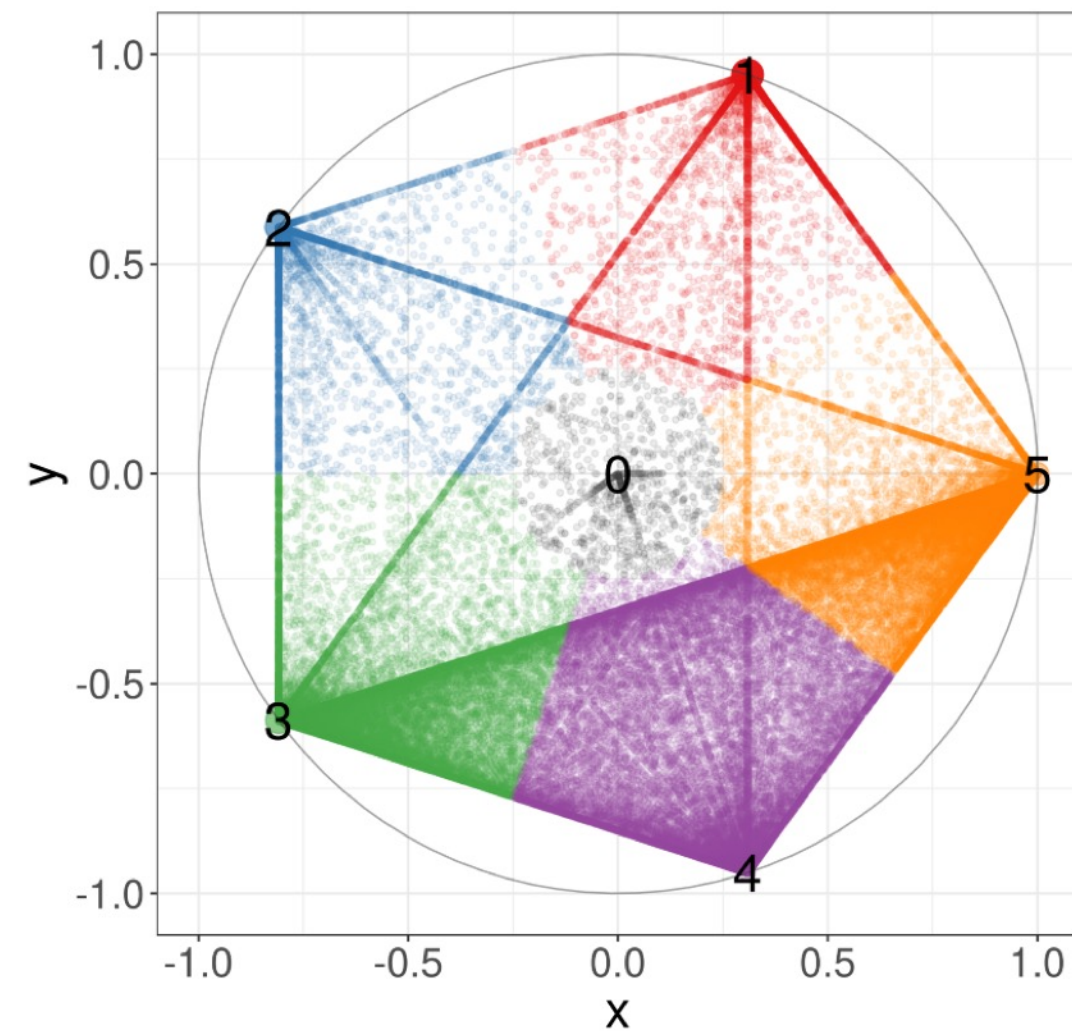
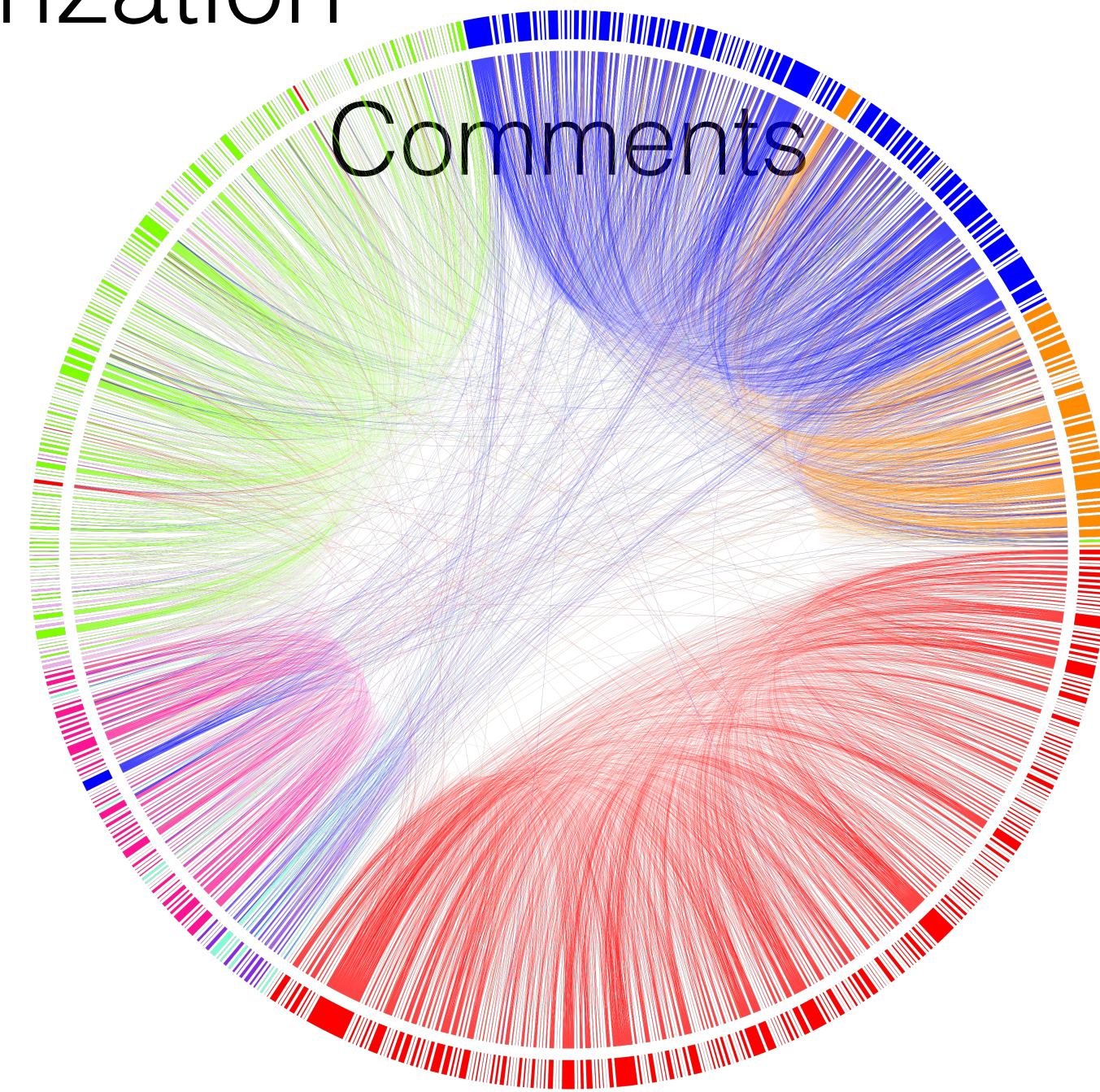
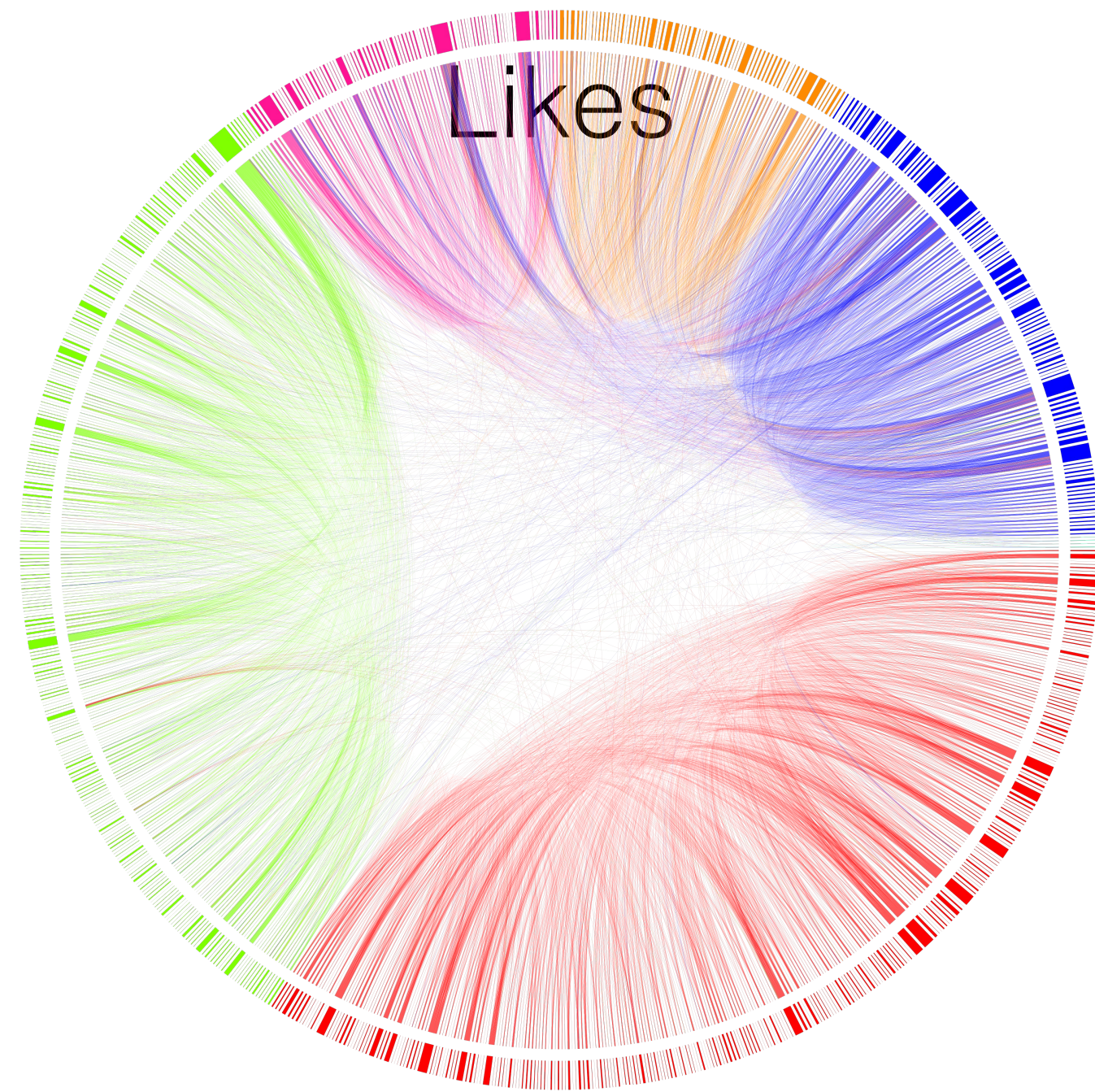
376 Million of Facebook Users (Jan 2010- Dec 2015)



Users tend to focus on a limited set of information sources



Clusters and Users Polarization



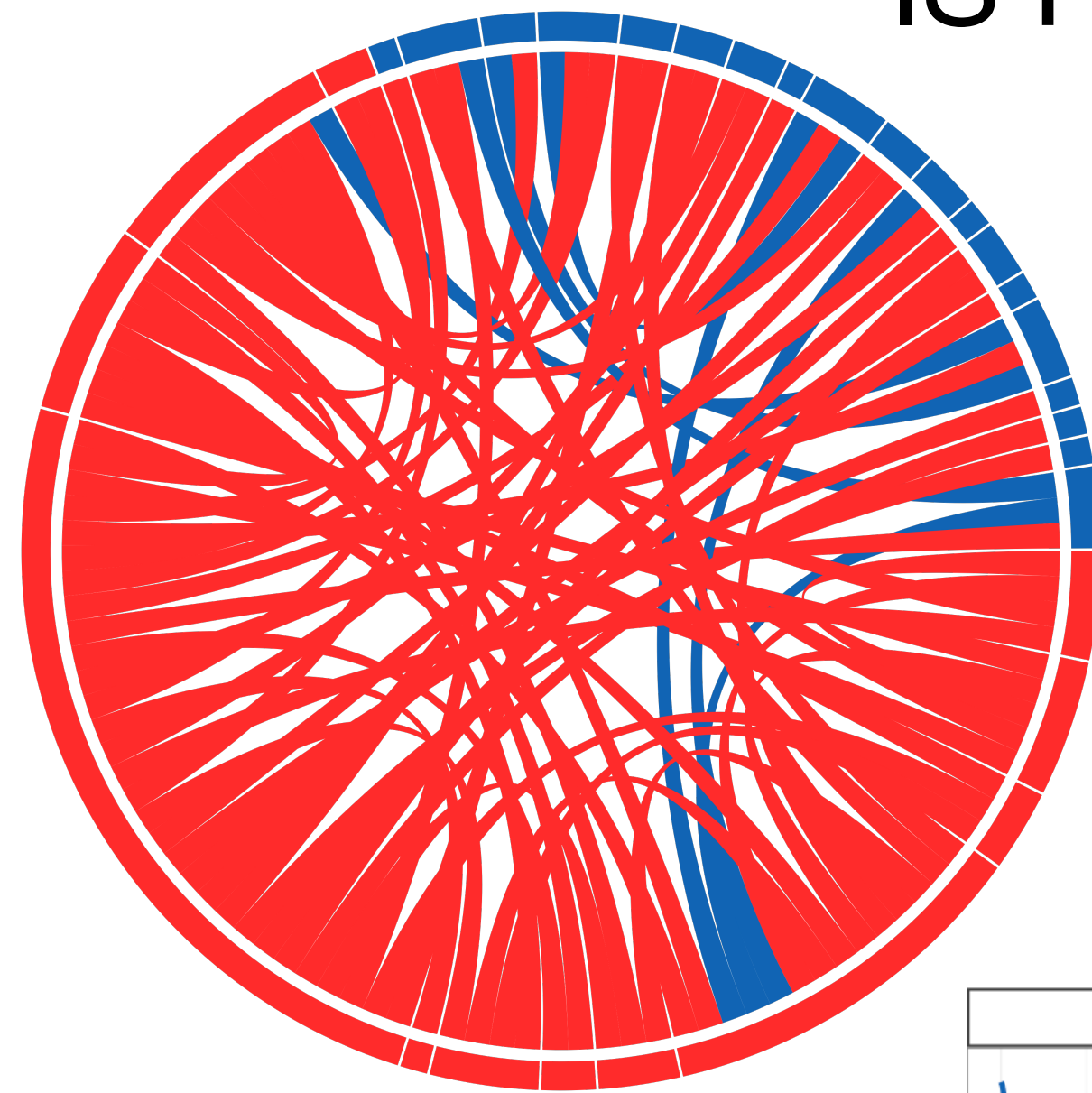
Community Quadrant

- Community 1
- Community 2
- Community 3
- Community 4
- Community 5
- Other Communities

Standardized User Frequency

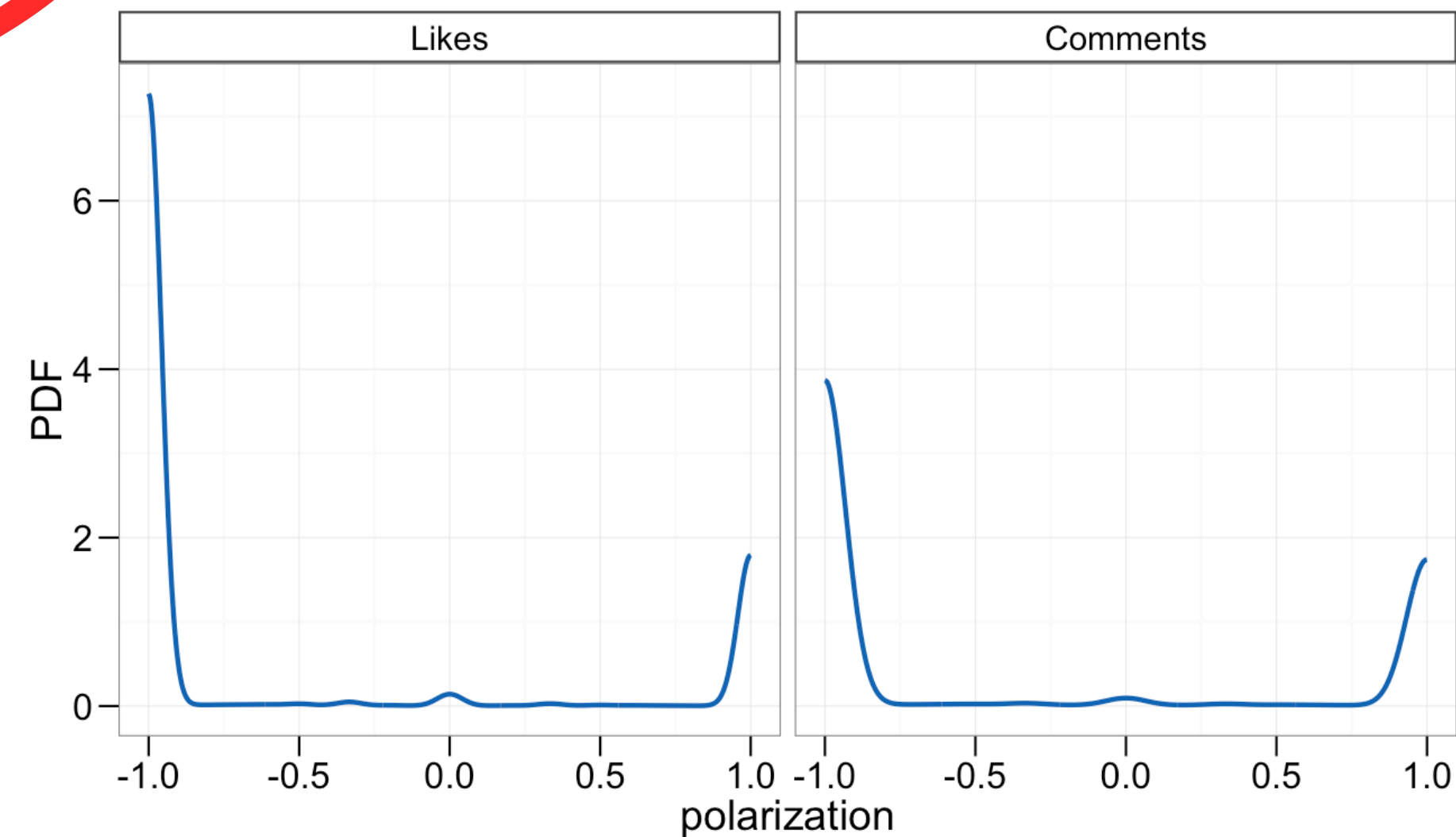
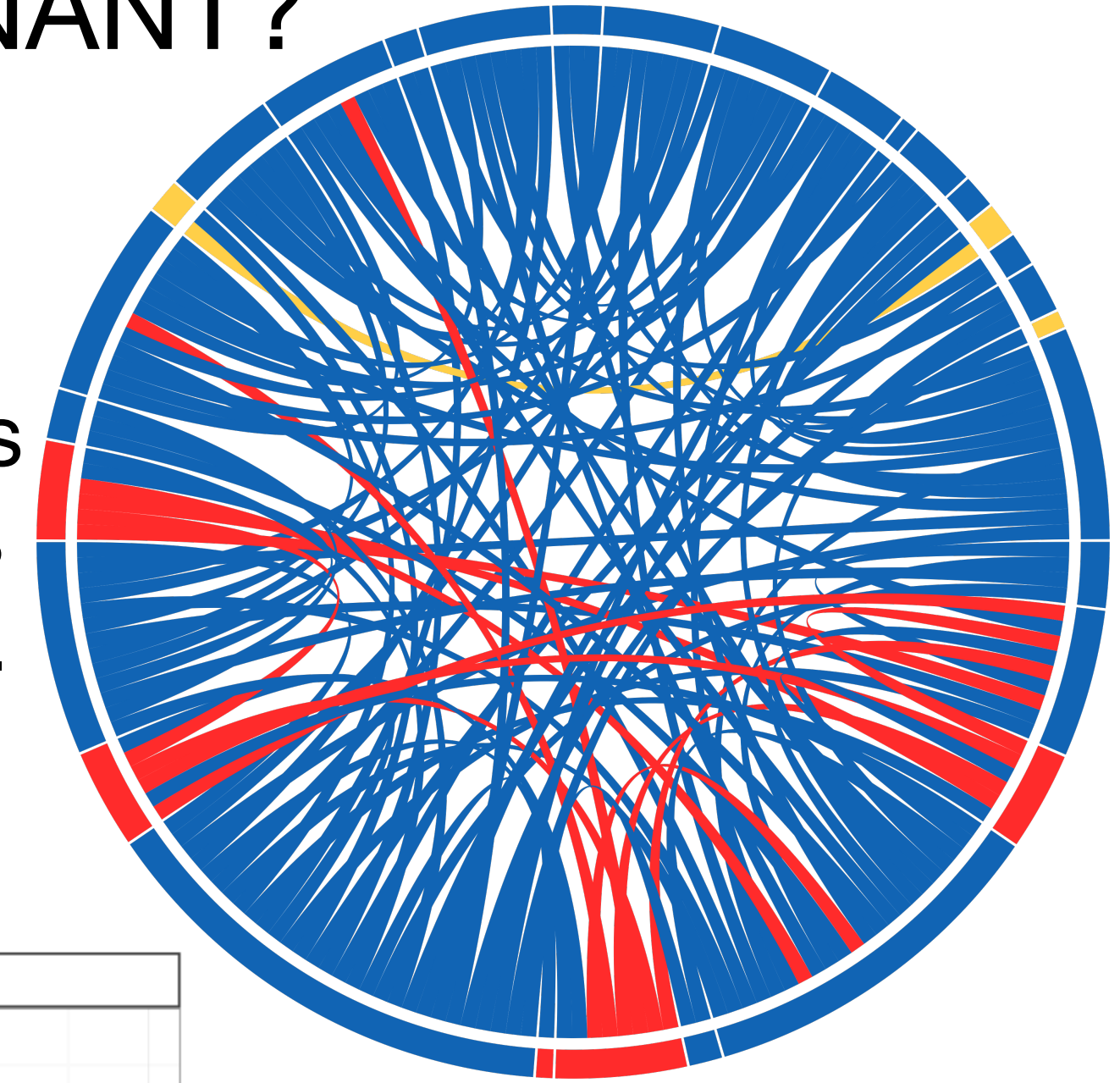
- 0.00
- 0.25
- 0.50
- 0.75
- 1.00

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

WHAT ABOUT VACCINES?



Contents lists available at [ScienceDirect](#)

Vaccine

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



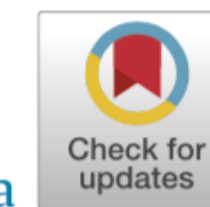
Polarization of the vaccination debate on Facebook

Ana Lucía Schmidt ^{a,*}, Fabiana Zollo ^a, Antonio Scala ^b, Cornelia Betsch ^c, Walter Quattrocioni ^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



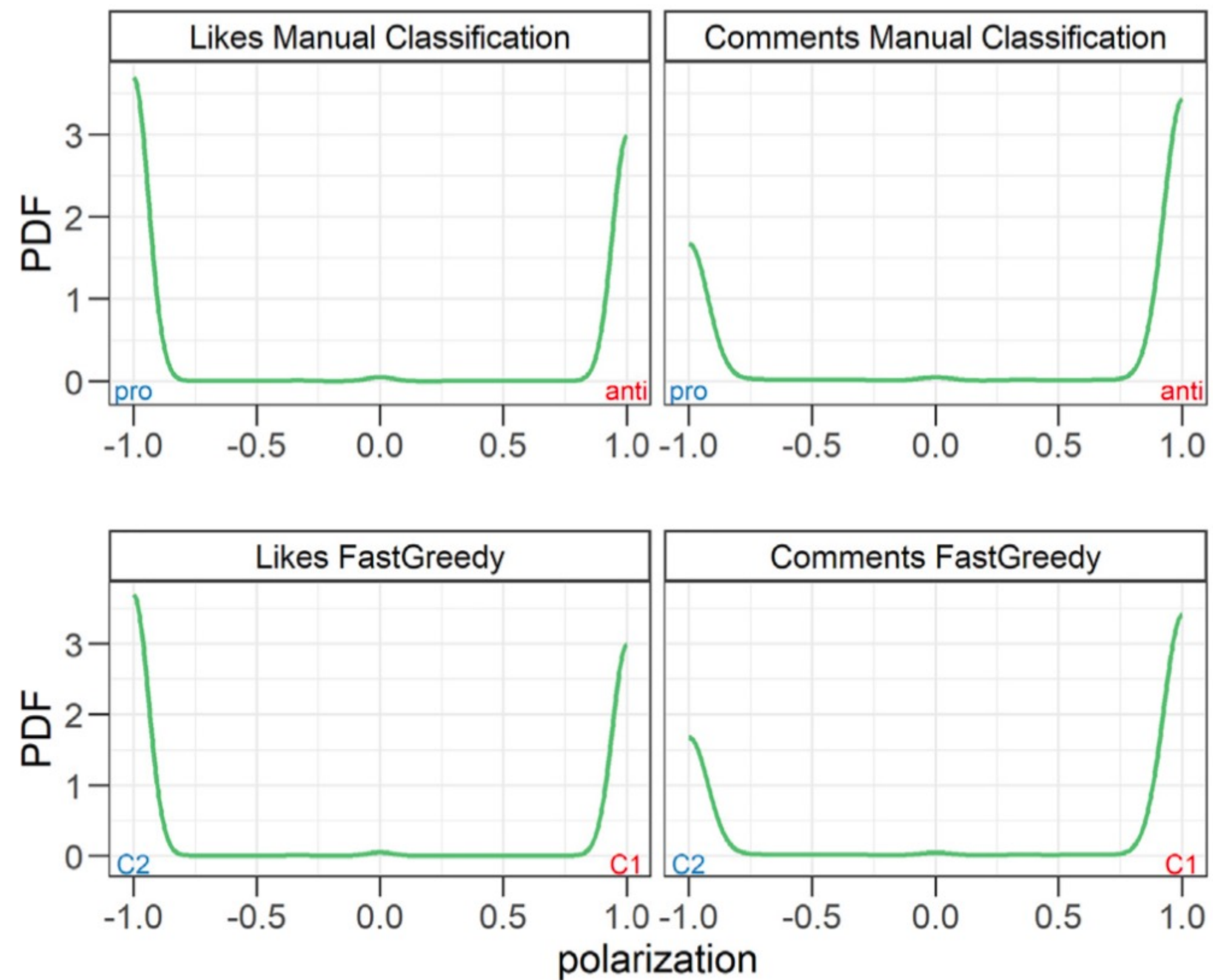


Fig. 2. Probability Density Function (PDF) of the users' liking (left) and commenting (right) behavior in the manual communities (top) and the 2 largest communities detected with FastGreedy (bottom). The distribution of the users is bimodal for all cases, which indicates a strong polarization among the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

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 

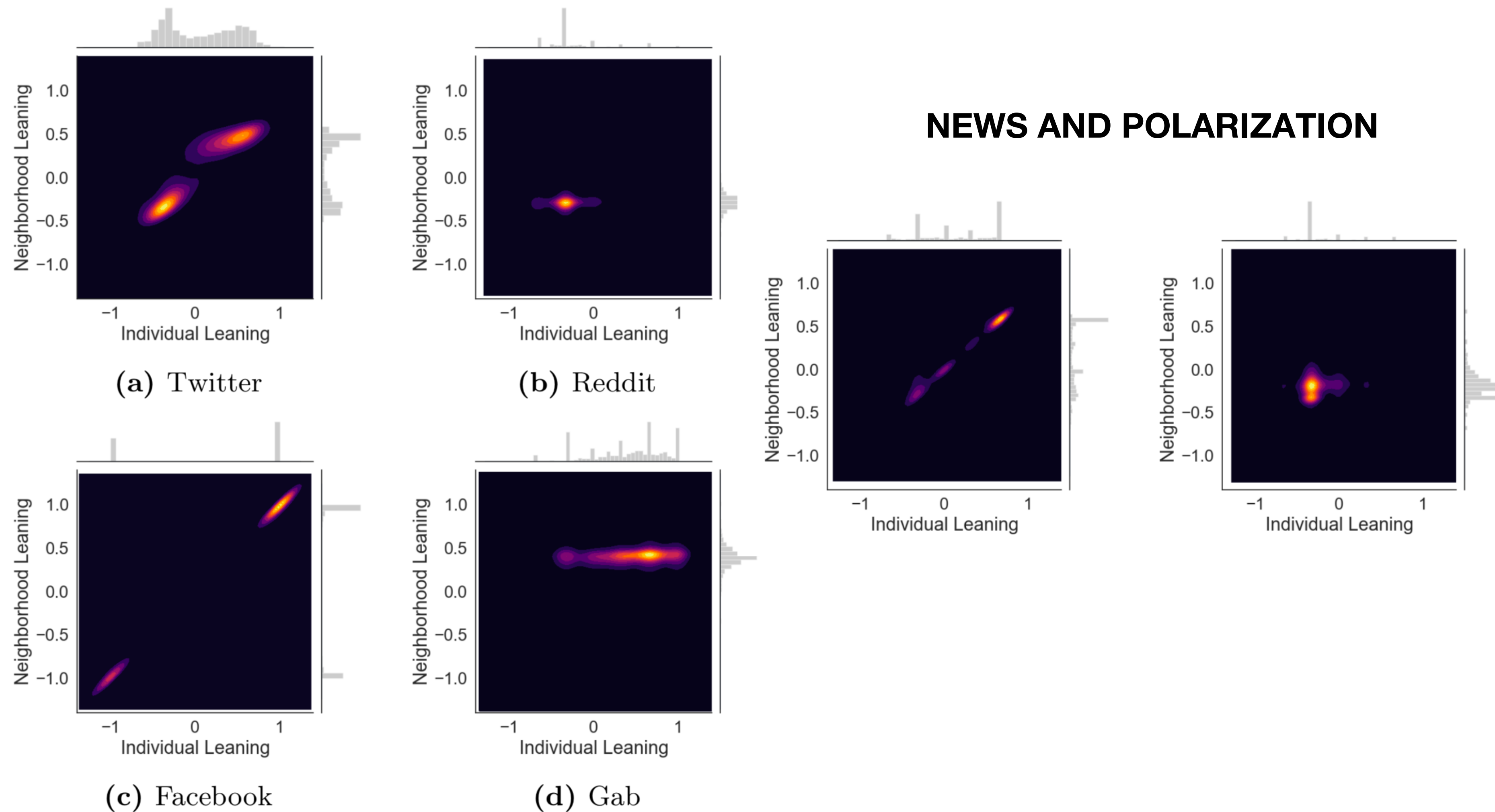
^aDepartment of Environmental Sciences, Informatics and Statistics, Ca'Foscari University of Venice, 30172 Venice, Italy; ^bInstitute for Scientific Interchange (ISI) Foundation, 10126 Torino, Italy; ^cDepartment of Information Engineering, University of Brescia, 25123 Brescia, Italy; and ^dDepartment of Computer Science, Sapienza University of Rome, 00185 Rome, Italy

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

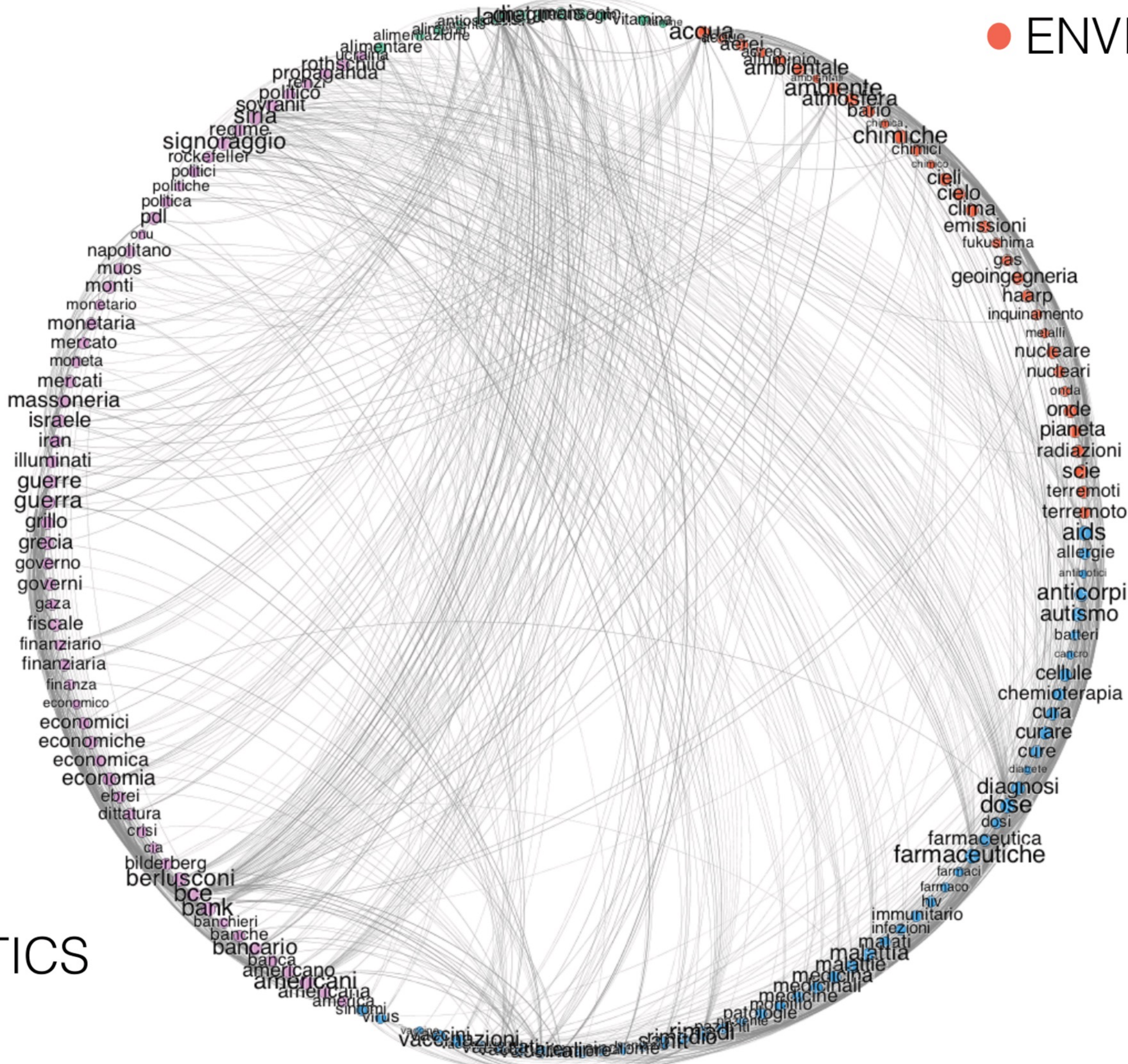
POLARIZATION ON DIFFERENT PLATFORMS



THE TOPICS OF THE CONSPIRACY NARRATIVE

● DIET

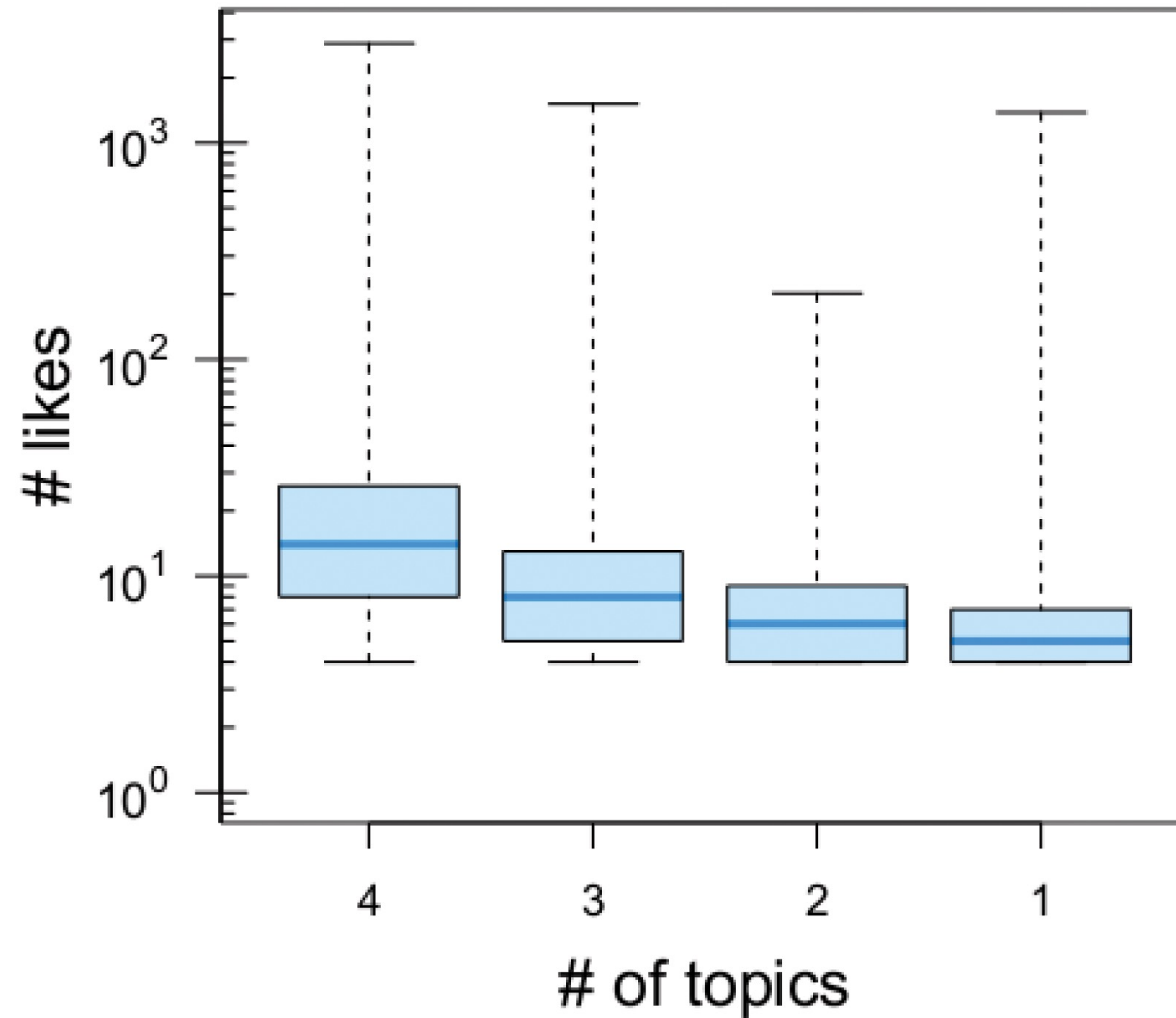
● ENVIRONMENT



● GEOPOLITICS

● HEALTH

THE MORE THE USER INTERACT ONLINE
THE MORE HE TEND TO INTERACT WITH THE OVERALL CORPUS



REGULATED VS UNREGULATED ENVIRONMENT: TWITTER VS GAB



← Thread

Elon Musk @elonmusk · 4h

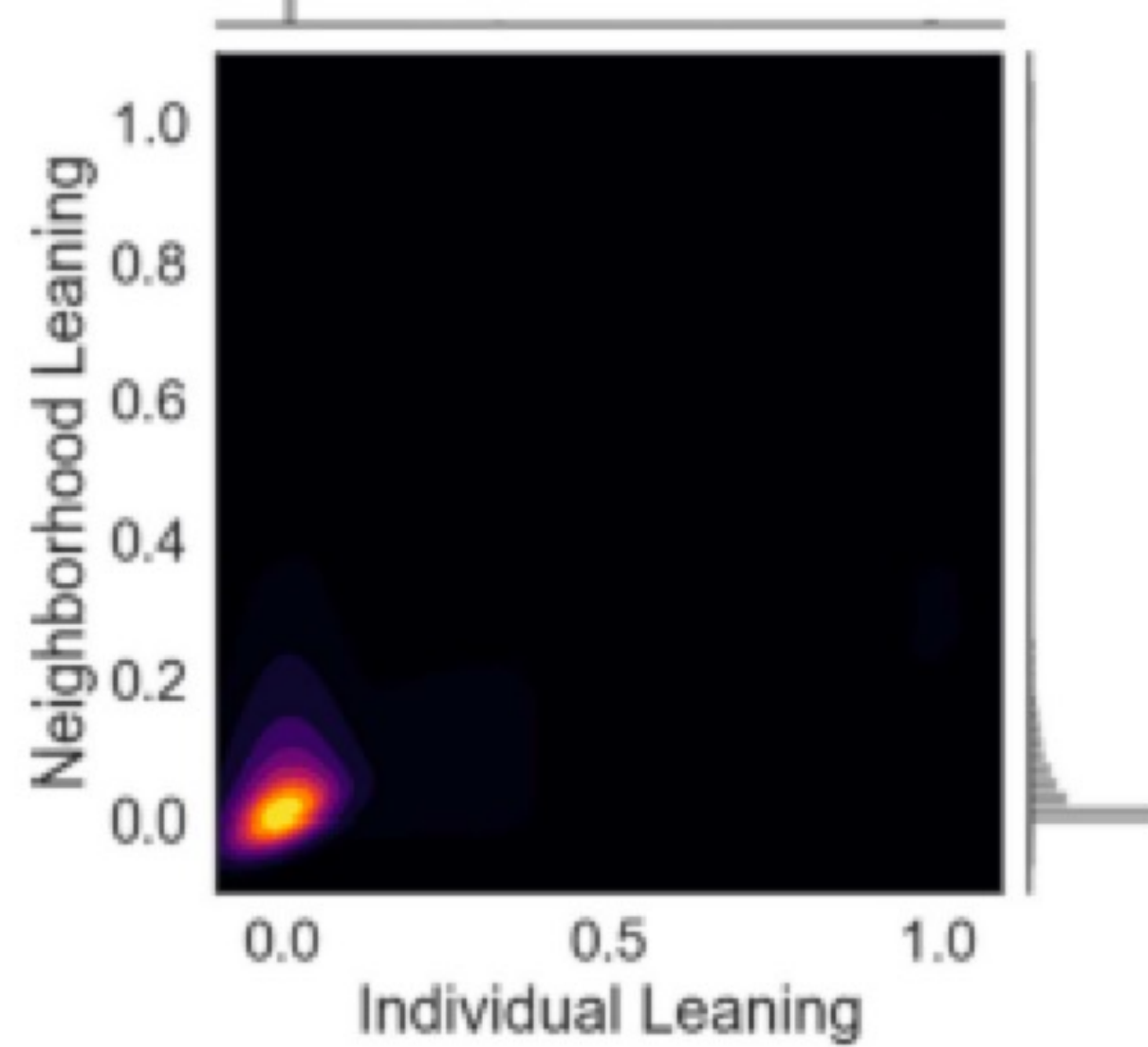
Free speech is essential to a functioning democracy.

Do you believe Twitter rigorously adheres to this principle?

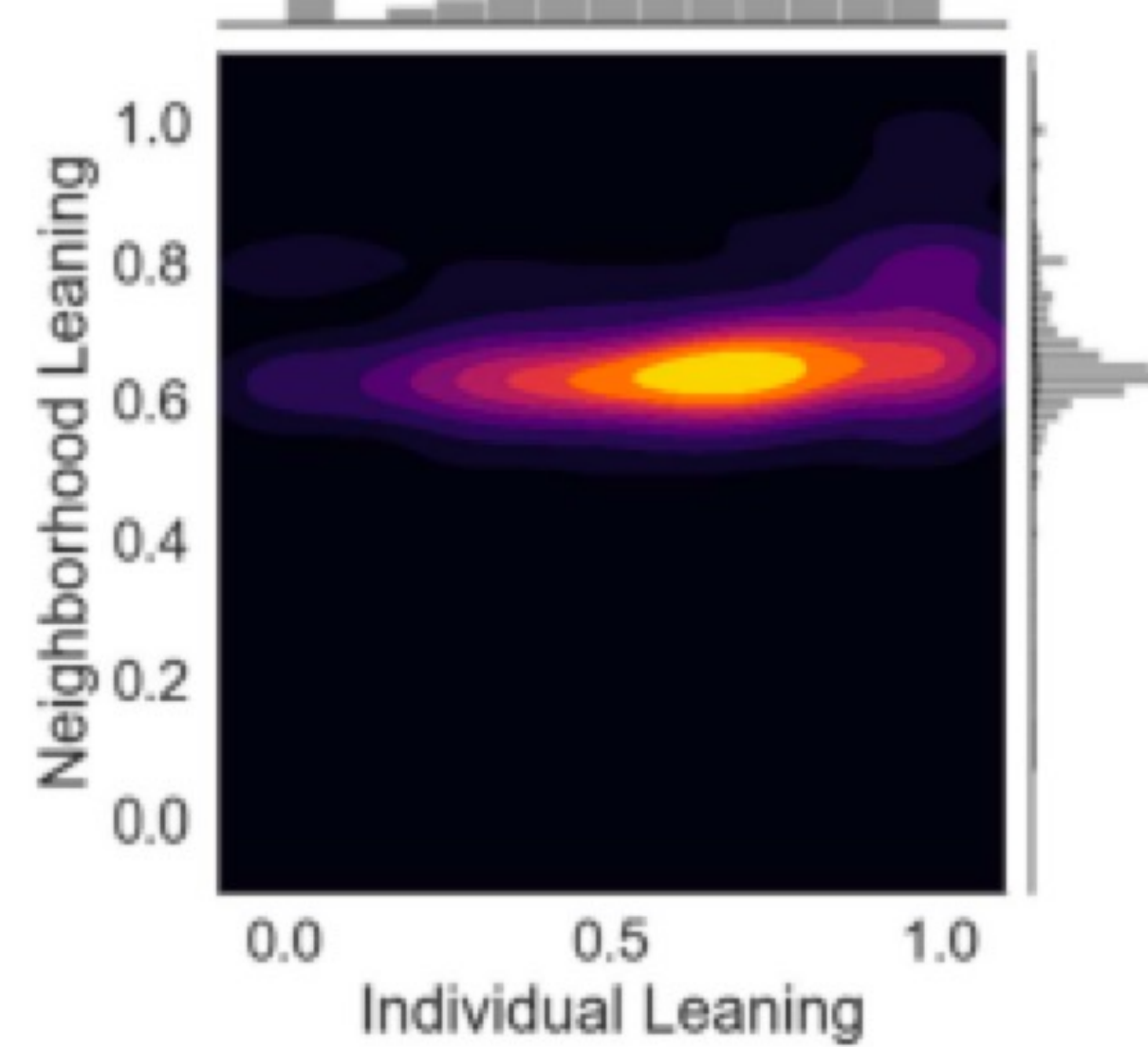
Yes	33%
No 🗳️	67%

665,011 votes · 19 hours 52 minutes left

8,969 10.8K 36.3K



(a)



(b)

The COVID-19 Social Media Infodemic

<https://arxiv.org/abs/2003.05004>



5 social media platforms: Instagram, Youtube, Twitter, Reddit, Gab



More than 3.7M users



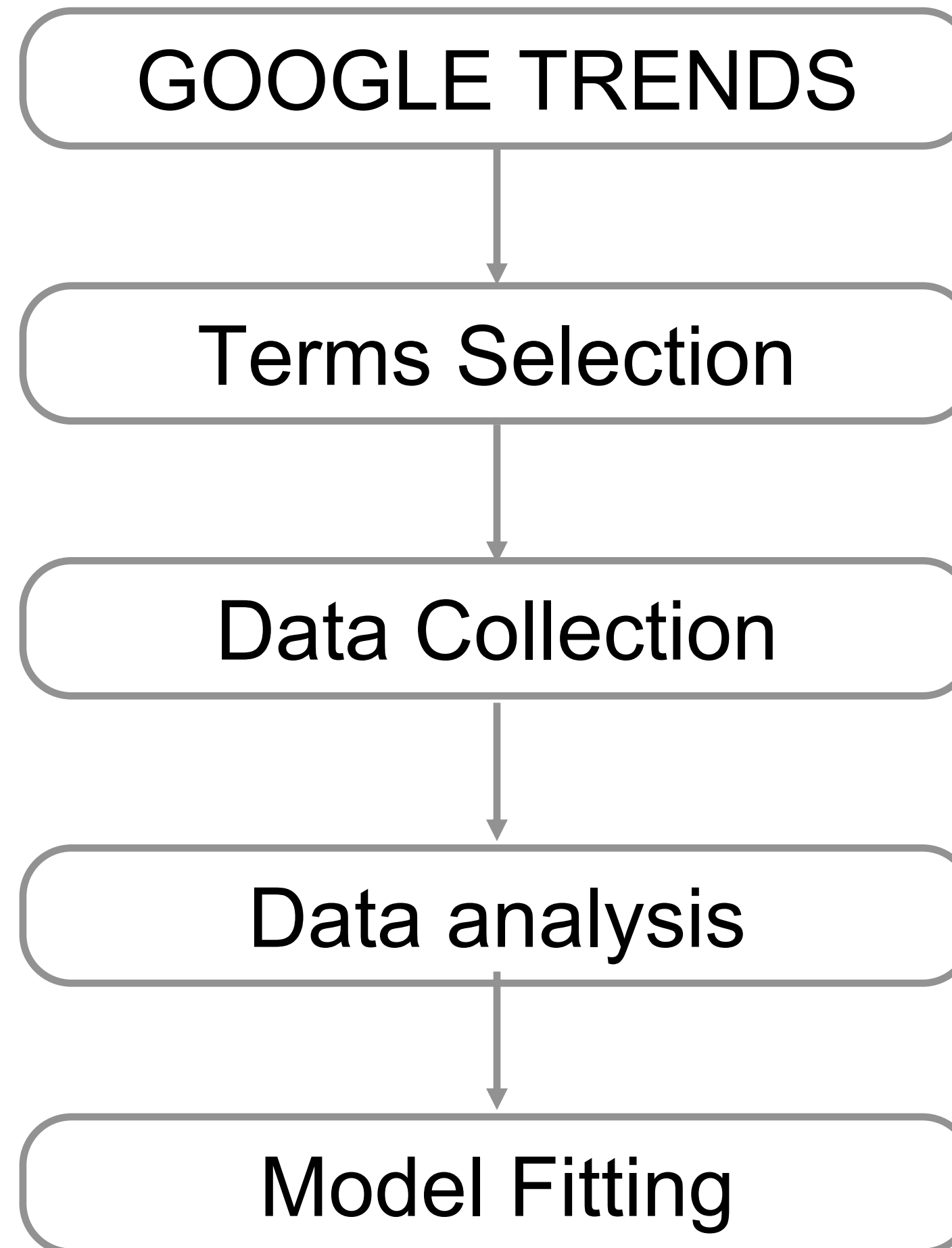
More than 8M of unique contents



Target: study the diffusion of information about the COVID-19 and characterize information spreading from questionable sources

The COVID-19 Social Media Infodemic

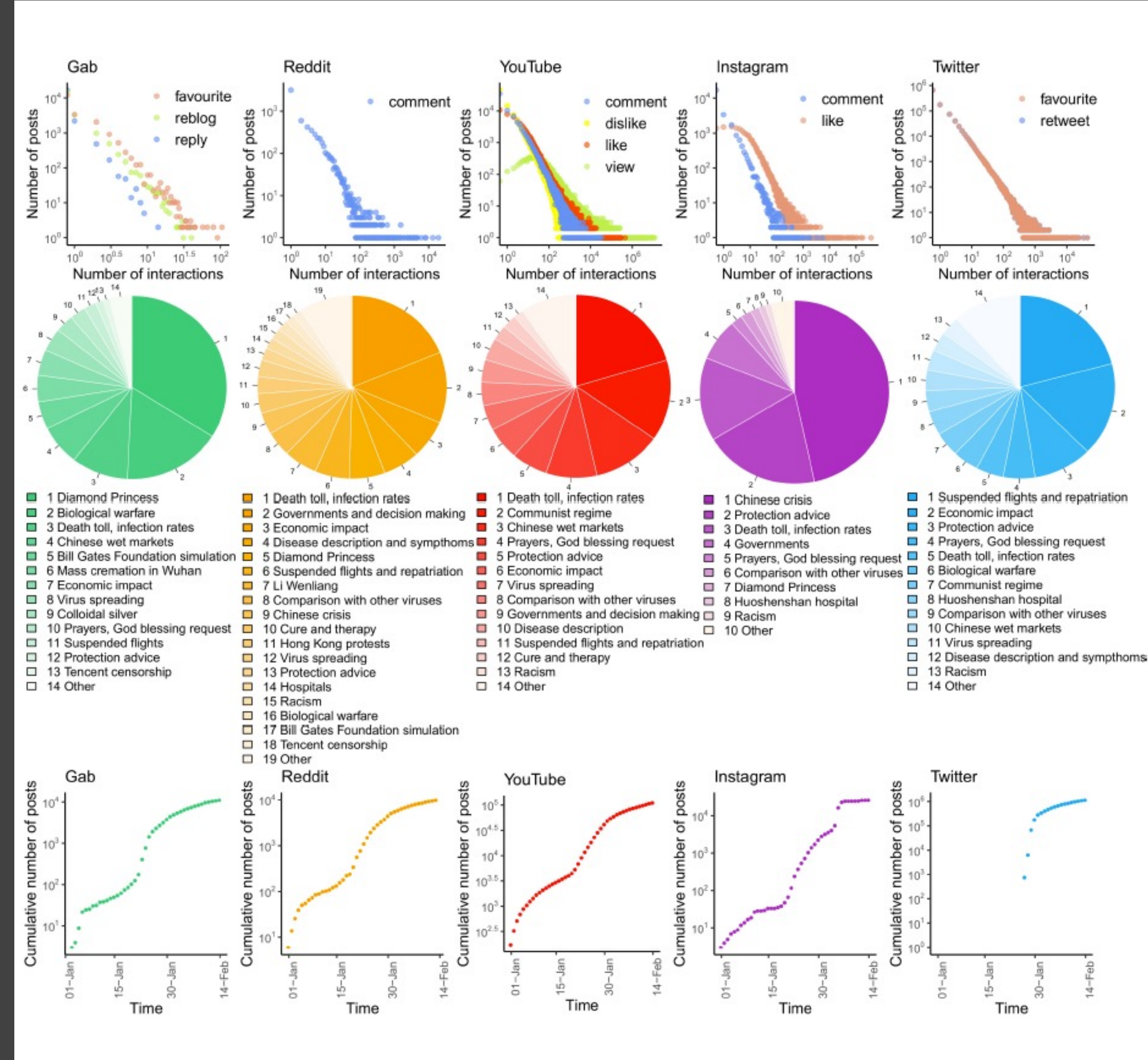
Workflow



The COVID-19 Social Media Infodemic

Results

- Users behave similarly for what concern the dynamics of reactions and content consumption
- Users' interactions patterns with the COVID-19 content are similar to any other topic
- Change of behavior around the 20th of January but with different delays: social media platforms seem to have specific timings for content consumption



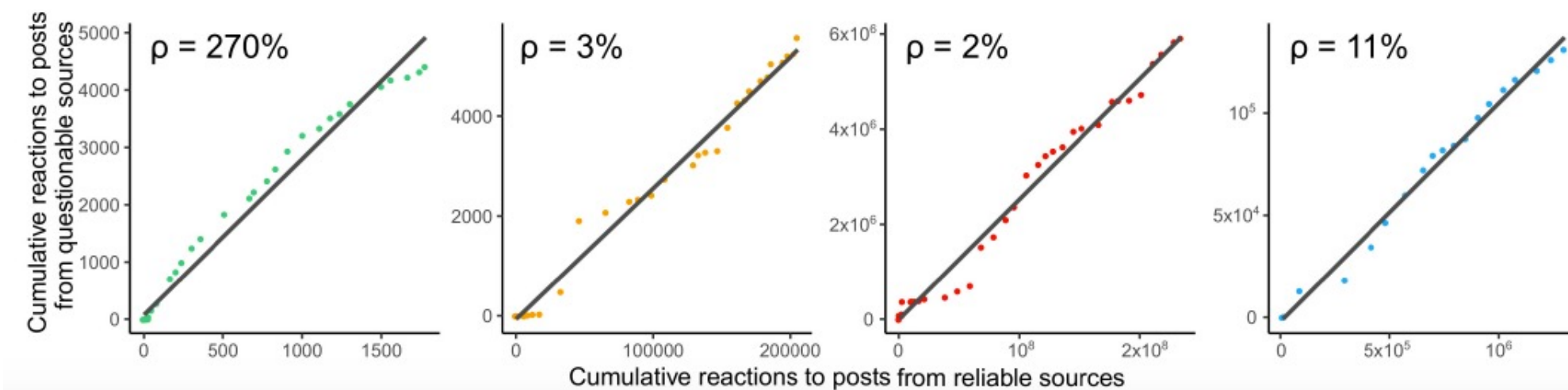
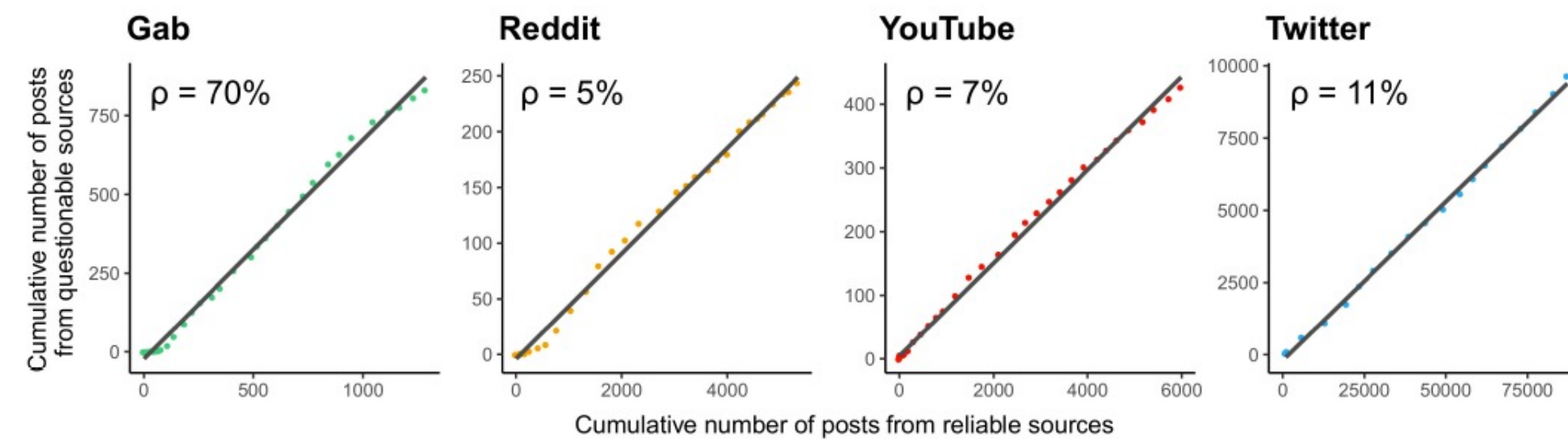
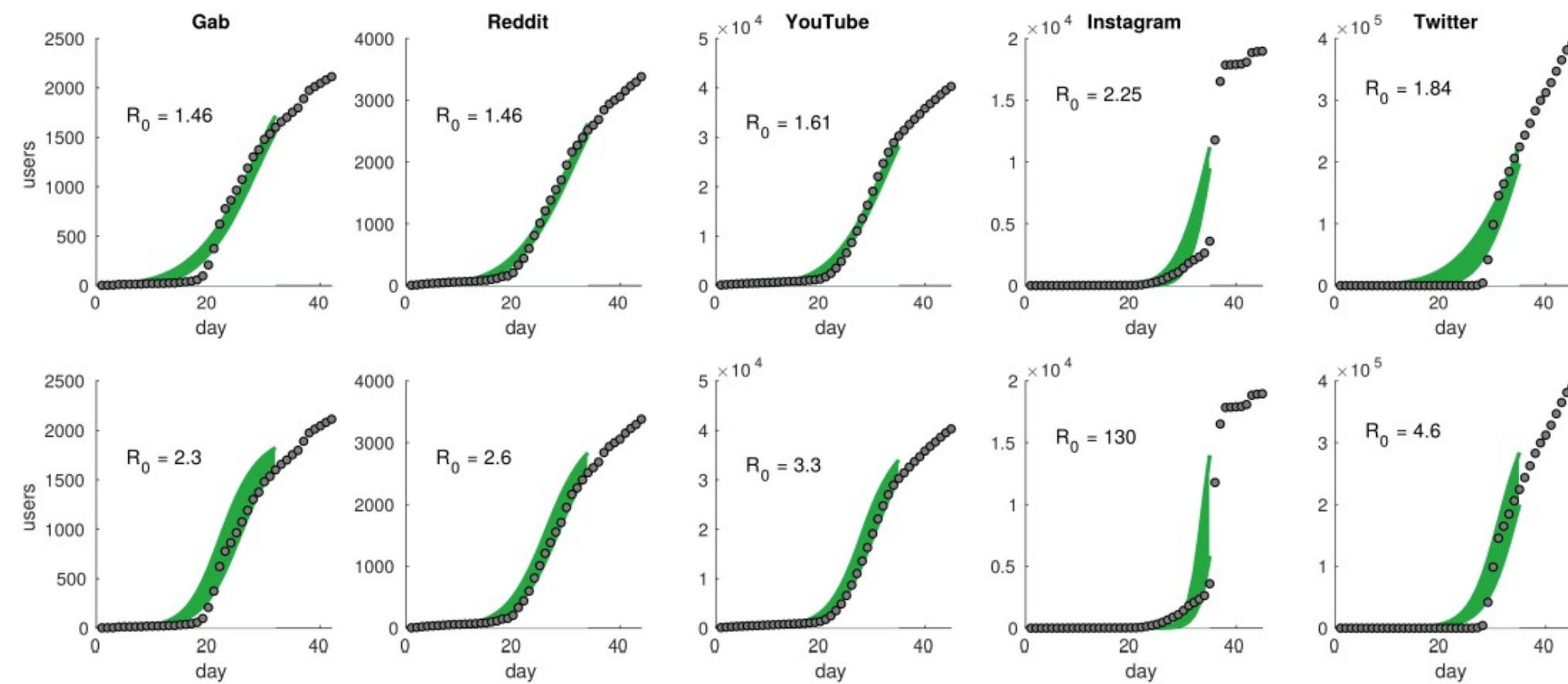
The COVID-19 Social Media Infodemic

Results

- R_0 depends on different platforms
- Questionable and Reliable source spread with the same dynamic, but differ in terms of volume.
- The ratio questionable/reliable changes from social media to social media.
- Notably, Gab is very prone to disinformation diffusion.

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Cell

Volume 184, Issue 25, 9 December 2021, Pages 6010-6014



Commentary

Infodemics: A new challenge for public health

Sylvie C. Briand¹, Matteo Cinelli², Tim Nguyen³, Rosamund Lewis⁴, Dimitri Prybylski⁵, Carlo M. Valensise⁶, Vittoria Colizza⁷, Alberto Eugenio Tozzi⁸, Nicola Perra⁹, Andrea Baronchelli¹⁰, Michele Tizzoni¹¹, Fabiana Zollo², Antonio Scala^{12, 13}, Tina Purnat³, Christine Czerniak¹, Adam J. Kucharski¹⁴, Akhona Tshangela¹⁵, Lei Zhou¹⁶, Walter Quattrocchi¹⁷  

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<https://doi.org/10.1016/j.cell.2021.10.031>

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The COVID-19 information epidemic, or “infodemic,” demonstrates how unlimited access to information may confuse and influence behaviors during a health emergency. However, the study of infodemics is relatively new, and little is known about their relationship with epidemics management. Here, we discuss unresolved issues and propose research directions to enhance preparedness for future health crises.

Delivery-focused multilateralism



Addressing vaccine hesitancy and tackling misinformation through delivery-focused multilateralism



COMMITTED PARTNERS

Coordinated, collaborative, well-funded support from partners



GLOBAL INSIGHT

Deep, data-led, evidence-based understanding of the problem and what is needed



MULTILATERAL COMMS DELIVERY

Government partners & multilateral institutions are enabled to deliver impact to address the issue

Delivery-focused multilateralism: committed partners delivering insight-led, evidence-based communications at speed

Principles



- 50+ country OECD Expert Group on Public Communications established
- Best-practice international principles and models to build vaccine confidence and address misinformation.
- Guide a holistic and evidence-based response to misinformation to achieve meaningful impact
- OECD Best Practice Principles:
 - Draft Principles will be shared with G7 by April, 2021
 - Launch at G7 Health Ministerial in June, 2021
 - Endorsed at OECD Working Party on Open Government and by the OECD Expert Group on Public Communication in June, 2021

Partnering

Deliver **joint research initiatives** to understand vaccine hesitancy and misinformation:

- A global research coalition has been established called '**VIDERE**' ('see' in Latin) involving 6 research institutes from three G7 nations
- The focus: vaccine hesitancy drivers, spread of misinformation, susceptibility to and inoculation from misinformation, fact-based communications, government systemic capabilities
- **With G7 partner support:** expand funding and expand the network



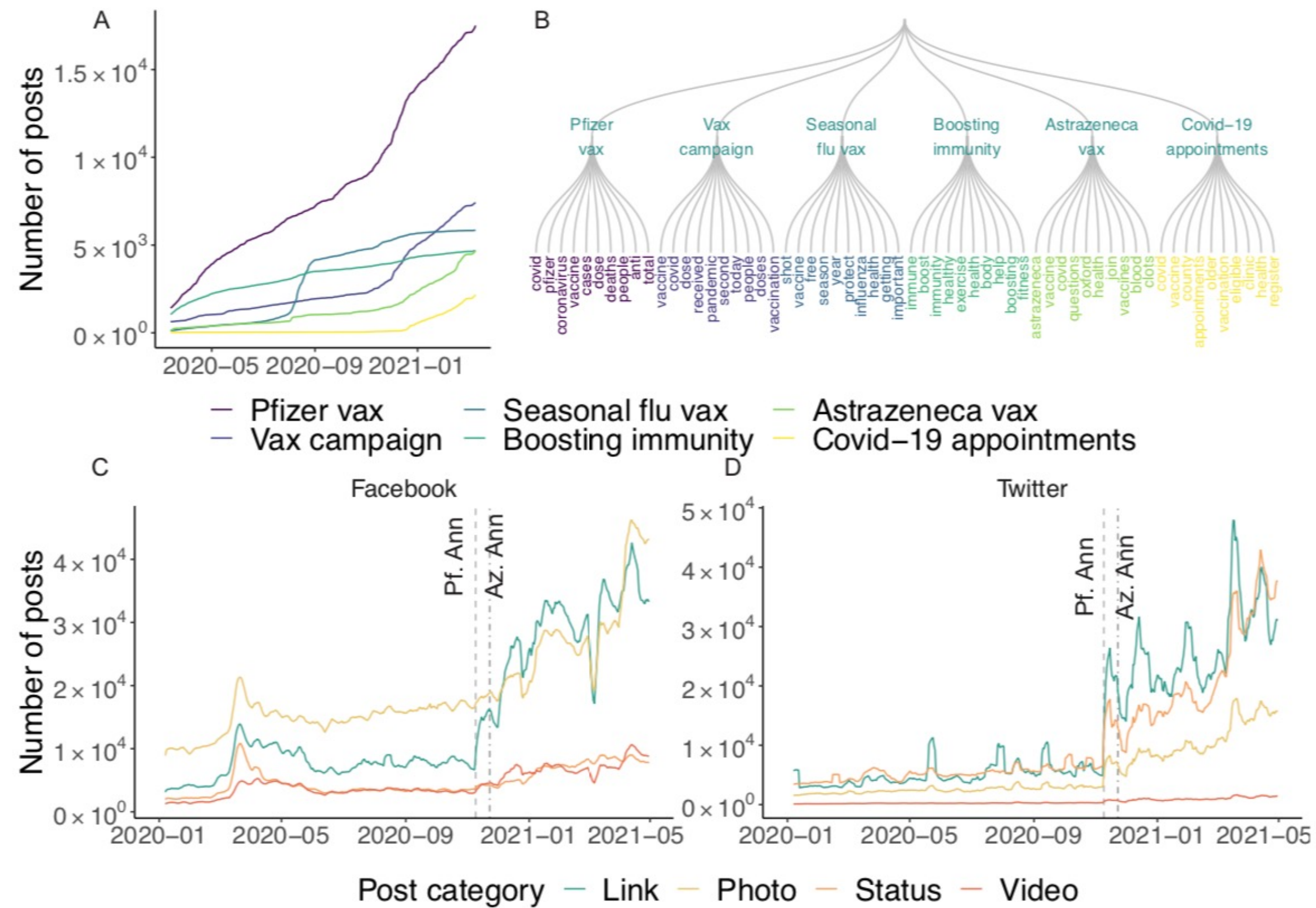


Figure 1: **Vaccine debate on social media platforms.** Panel A: evolution of debated topics over time. Panel B: Keywords representing the main topics. Panel C and D: seven days moving average of posts divided by category for Facebook and Twitter respectively. Dashed lines represent the announcement of Pfizer and AstraZeneca COVID-19 vaccine effectiveness occurred on 18 November and 23 November 2020, respectively.

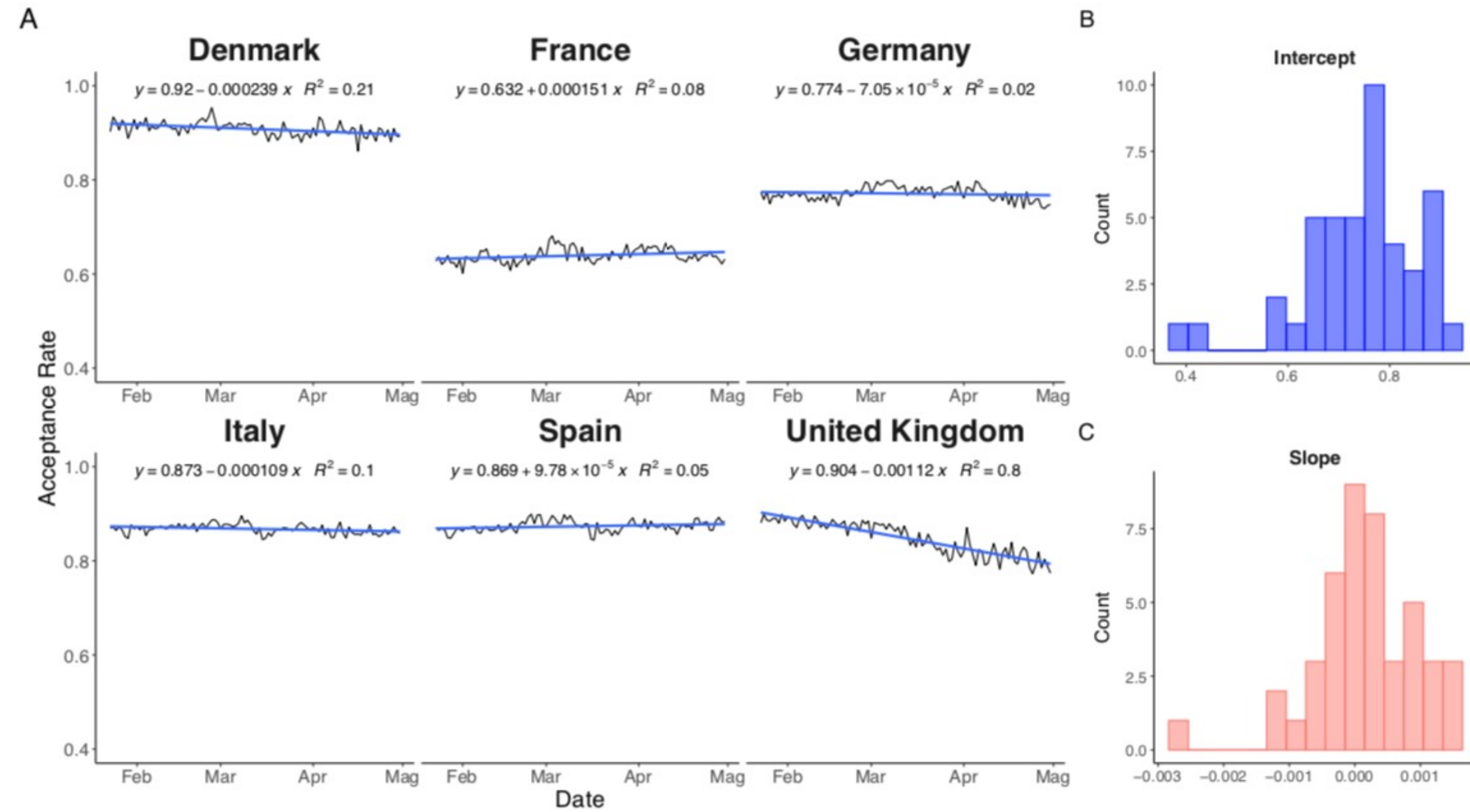


Figure 3: **Steady acceptance of COVID-19 vaccines.** Panel A: Black lines represent three days moving average of vaccine acceptance rate for Denmark, France, Germany, Italy, Spain, and United Kingdom from 23 January to 30 April 2021 according to Facebook COVID-19 Trends and Impact Survey. The blue lines are the linear fit on the trend. Panel B (C): Histogram of regression intercepts (slopes) for countries with more than 500 average daily respondents.

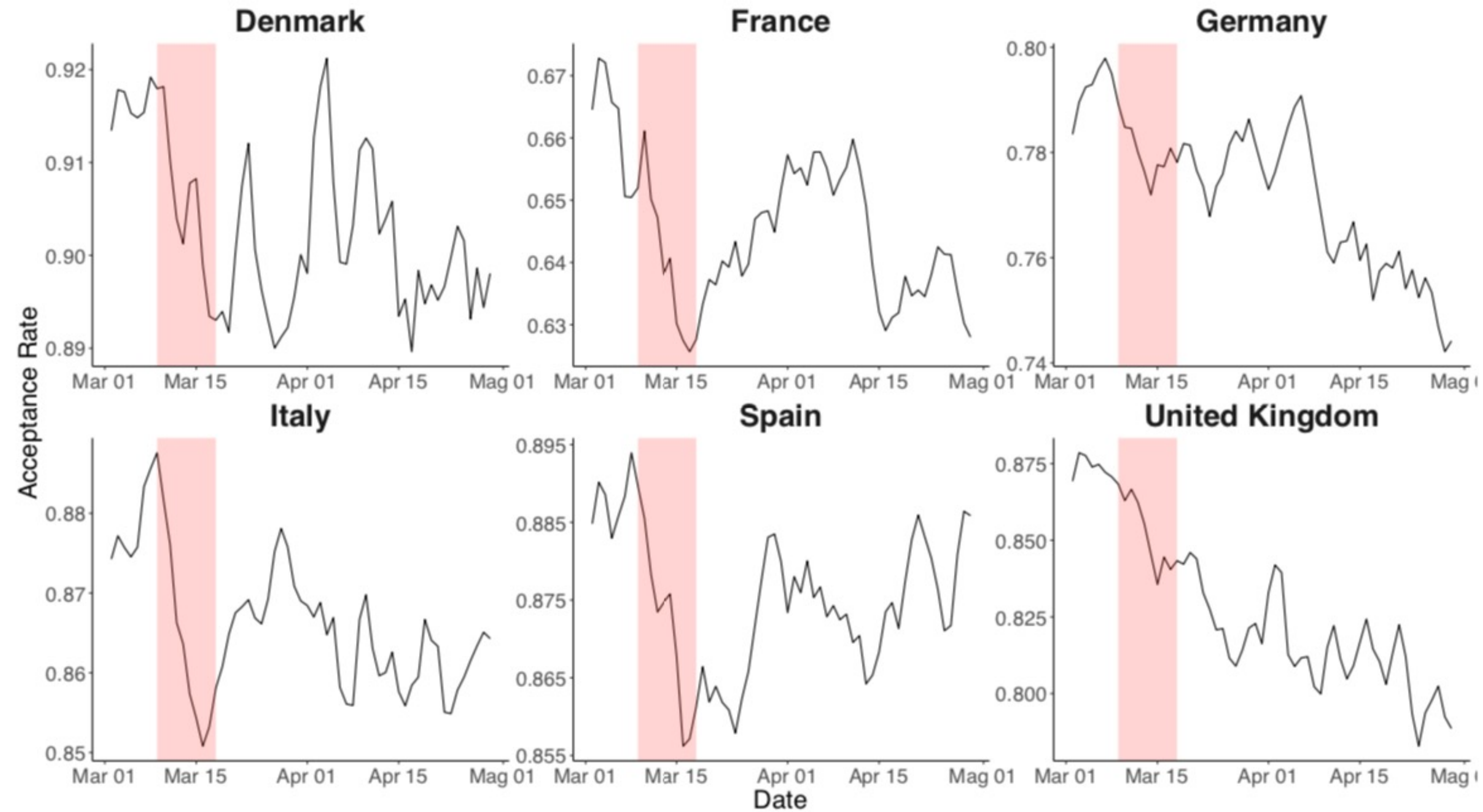
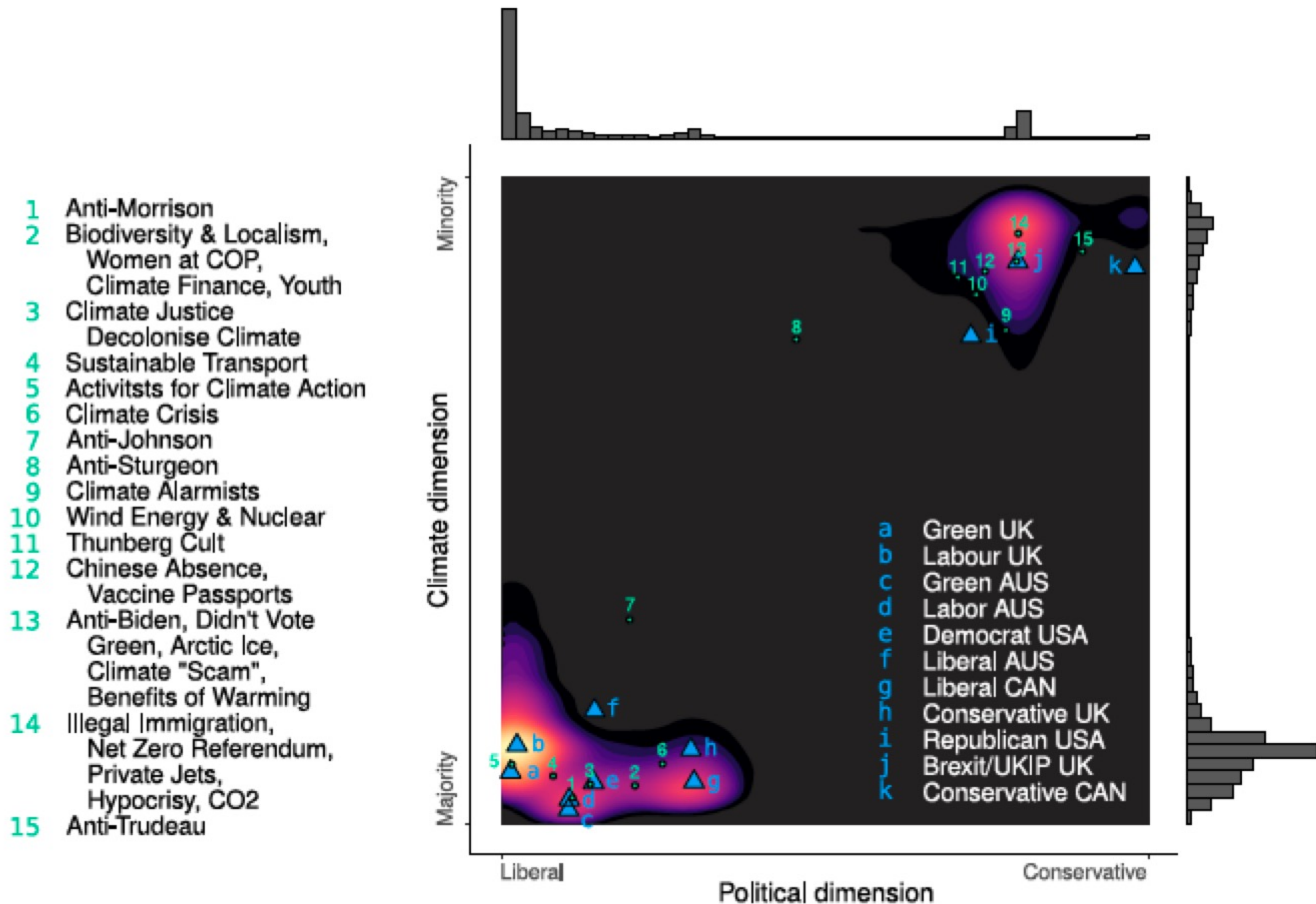


Figure 4: **Impact of AstraZeneca concerns on vaccine acceptance rate.** Black curve: three days moving average of vaccine acceptance rate for Denmark, France, Germany, Italy, Spain, and United Kingdom from 23 January to 30 April 2021 according to Facebook COVID-19 Trends and Impact Survey. Red area: from the early cases of blood clots (9 March 2021) to the end of EMA investigation (18 March 2021).

INFODEMICS AND CLIMATE CHANGE



A two-dimensional representation of the latent ideology, split according to political and non-political influencers. Triangular points label the median ideological position of accounts affiliated with specific political parties. Circular points indicate the median position of users who tweeted a particular topic, as derived using BERTopic. In Fig. 2, the latent ideology is calculated using the top 300 most retweeted accounts. Here, we calculate the latent ideology twice using (1) the top 300 most retweeted accounts affiliated with individual elected politicians (x-axis), and (2) using the top 300 most retweeted accounts excluding politicians (y-axis). The non-political axis can be thought of as the general climate dimension, whereas the political axis can be thought of as capturing the specific political groupings of the COP discussion. Note, some topics are merged into a single point for visual clarity.

PREBUNKING



E il conflitto in Ucraina?

Io che cerco di informarmi
sul conflitto in Ucraina



datasciencelab_sapienza