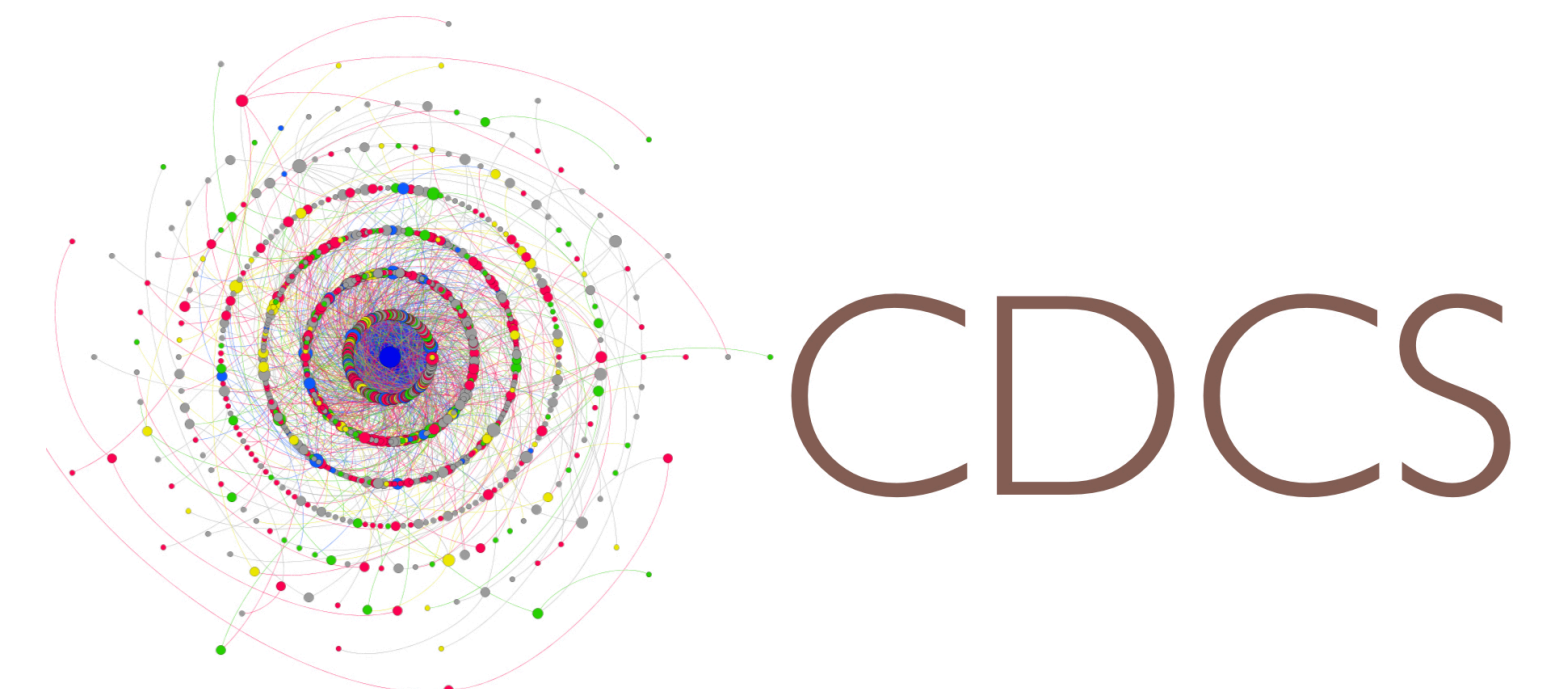




# Polarization: Information, Opinions and other Monsters

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Sapienza University of Rome  
walter.quattrociocchi@uniroma1.it



Center of Data and Complexity for Society

# The poem

**Since 2014 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.

However, users behavior in online conversation is persistent across platforms and over years.





# Fake Gnus





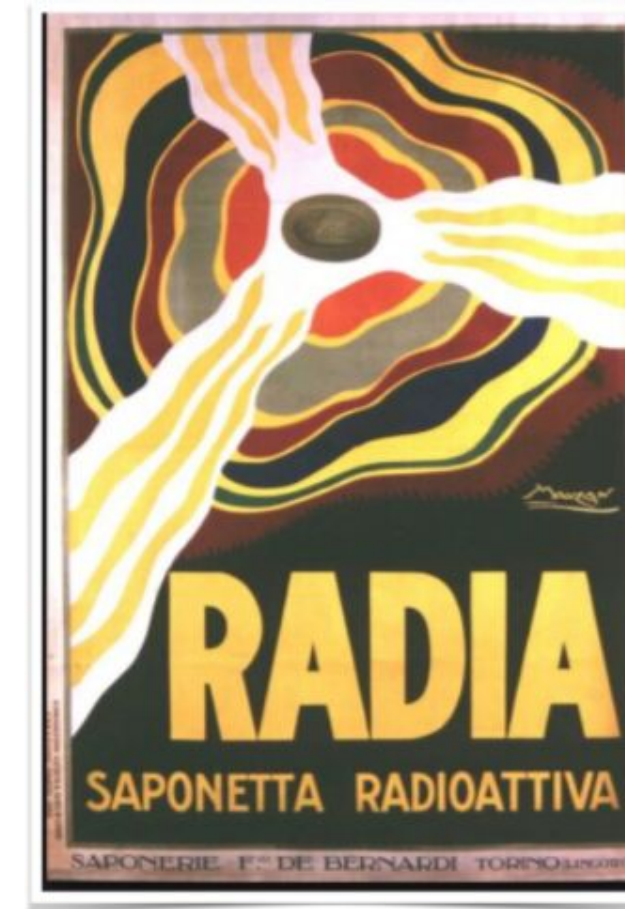
**FAKE GNUS**

Never give up 🏋️ 100



# 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



**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 distretti di Goalpara, il *Sassa*, che ha potenti proprietà ipnotiche. Unendo il succo condensato di tale pianta ad altre e col *Luppolo* (conosciuto, questo *ad antea* 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 *mezzo sicuro, infallibile*, nel maggior numero dei casi, per conciliare il sonno, senza disturbare lo stomaco coll'ingerimento di farmaci, i quali, se producono un torpore cerebrale conciliante il sonno finiscono coll'apportare gravi, irreparabili inconvenienti all'organismo.

Dal **CUSCINETTO IPNOTICO** sul quale il malato posa la testa a guisa di comodo origliere, emanano gli aromi gradevoli di dette piante sonnifere, e nello stesso tempo assolutamente innocue ai nevralgici più sensibili, come alle donne affette da isterismo 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

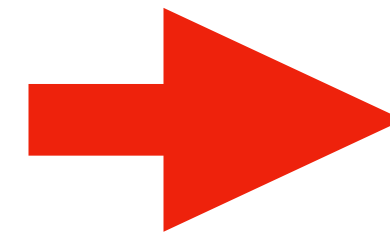
“The press may not be successful much of the time in telling people what to think, *but it is stunningly successful in telling its readers what to think about*”

(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)

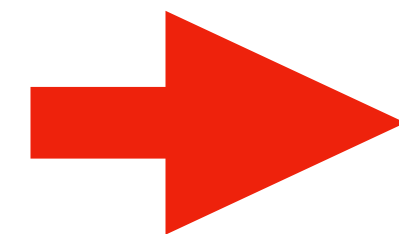
**MEDIATED**



## **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.”*

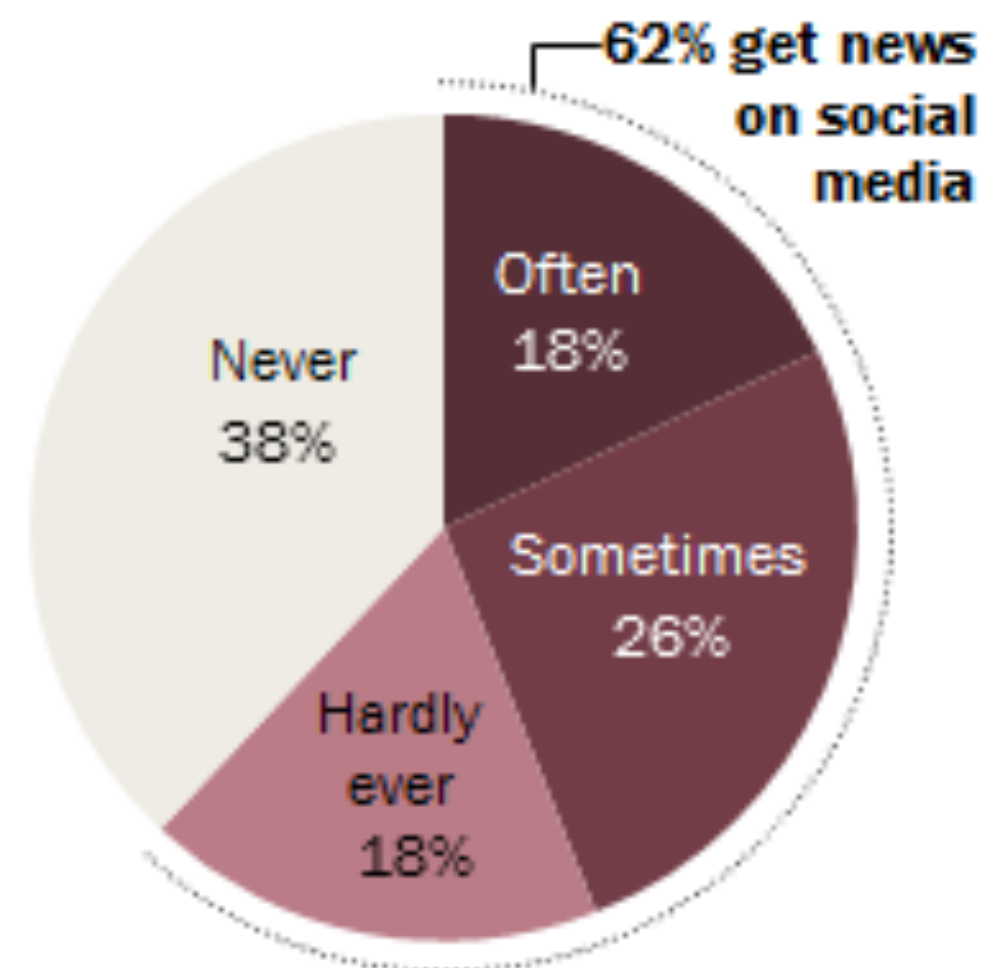
*Mark Zuckerberg Jul. 2007*

# 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**

# JADE HELM 15

The Washington Post

+ More

Save

Checkpoint

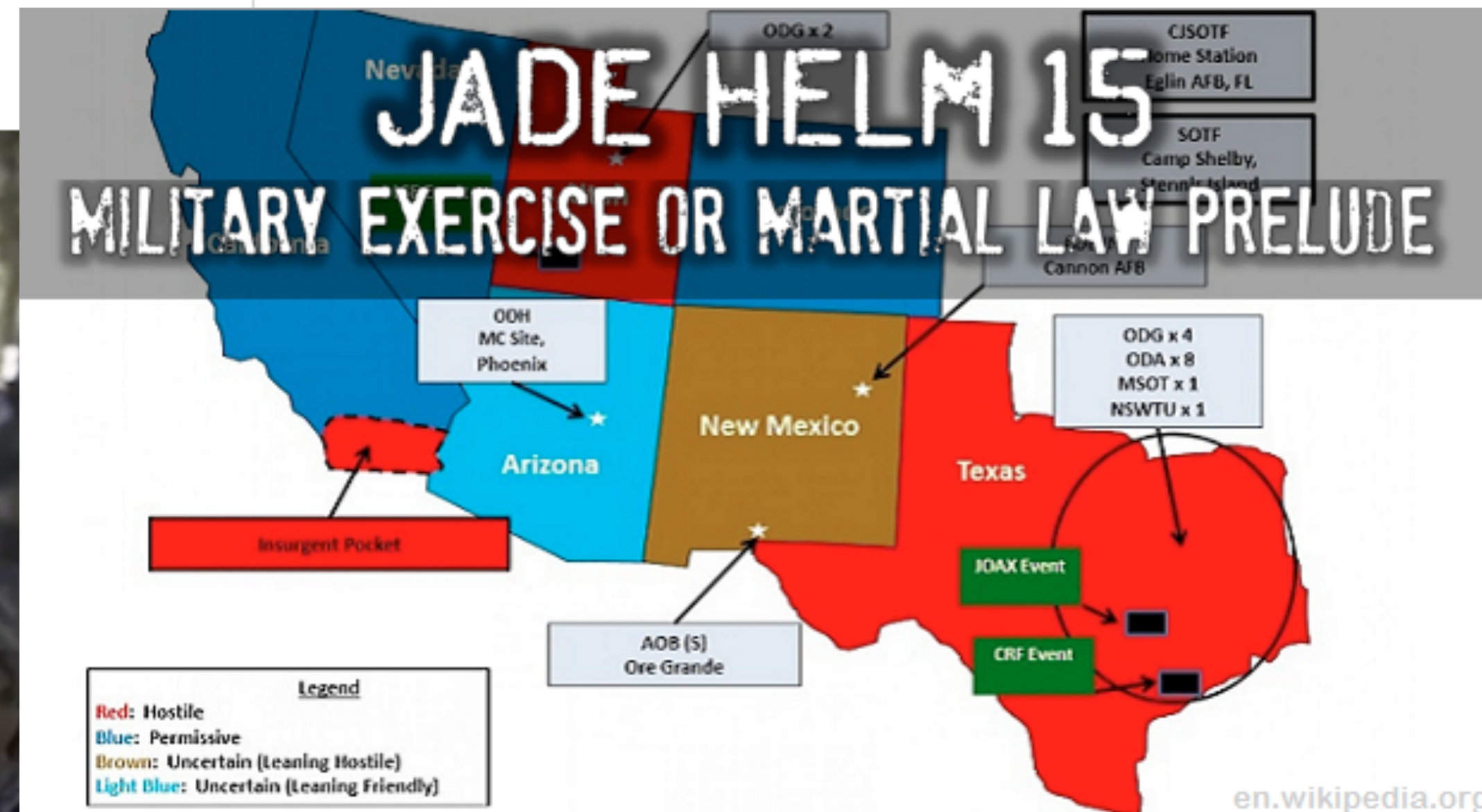
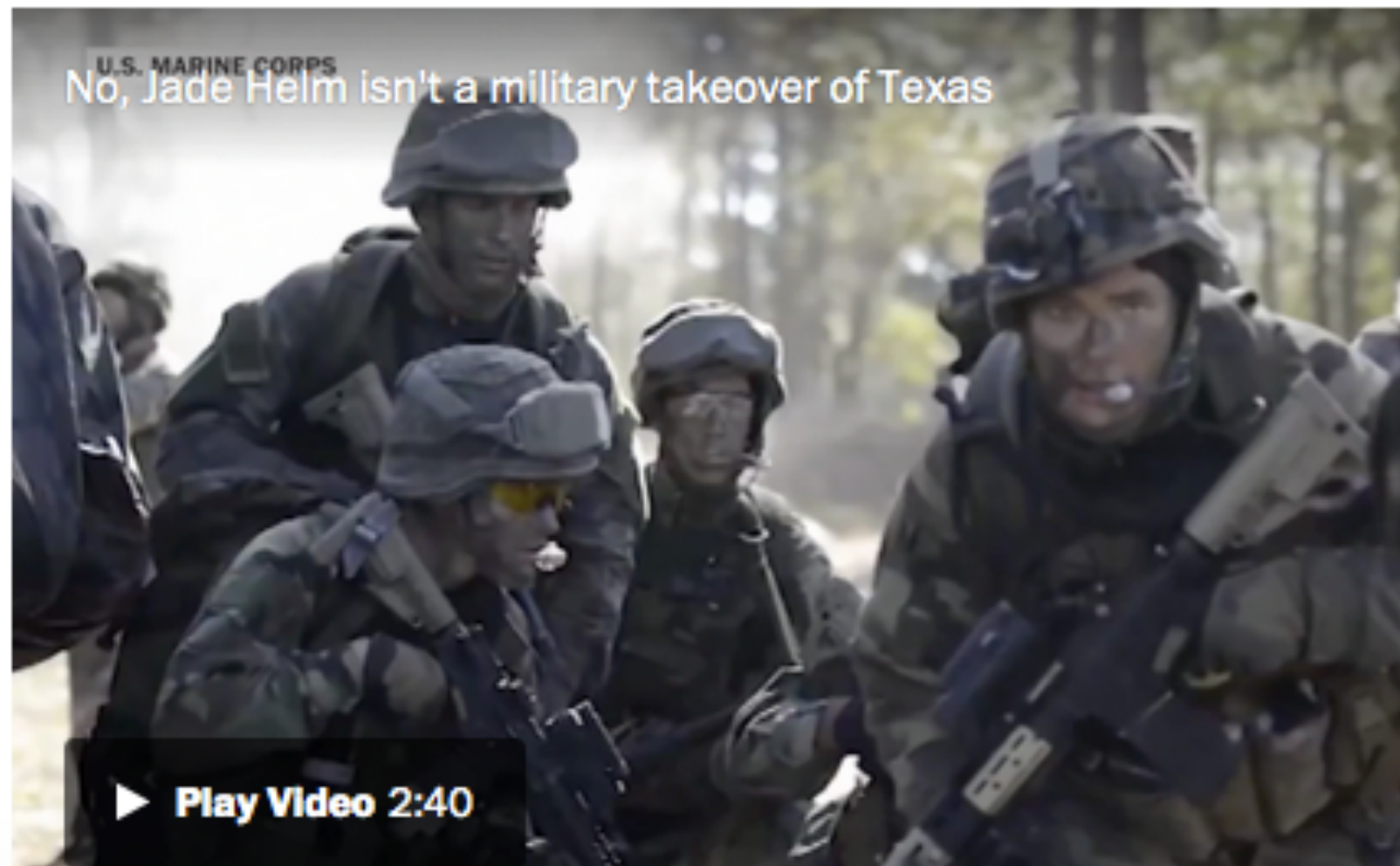
## Why Operation Jade Helm 15 is freaking out the Internet – and why it shouldn't be

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 | DI SANDRO JANNACCONE

Mi piace

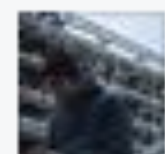
Commenta

Condividi



Walter Quattrococchi e un take!!!!!!

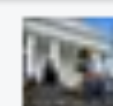
Mi piace · Rispondi · 1 · 22 aprile 2015 alle ore 12:18



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

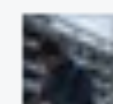
Mi piace · Rispondi · 25 · 22 aprile 2015 alle ore 12:11

Nascondi 83 risposte



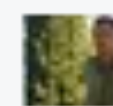
Walter Quattrococchi perche meglio invece chi si informa sulle fonti ufficiali come cicap o quark? svegliatevi.

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



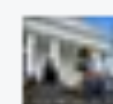
la Eccallá. Hai letto l'articolo? Mi pare evidente che leggere notizie su pagine che si autocitano e si autorimandano non sia una buonissima cosa. Serve una visione d'insieme, il WEBBE non ha la risposta definitiva. E tranquillo che sono sveglio ed attento A TUTTO, anche alle bufalate deliranti.

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



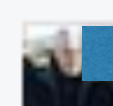
Eccolo è arrivato puntuale il fenomeno che dice sveglia al resto del mondo .Le scie chimiche fanno brutti effetti 😊

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



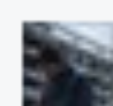
Walter Quattrococchi E la risposta di insieme te la da piero angela (o il figlio)? Non lo sai che da sempre la storia la scrivono i vincitori e i potenti?

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



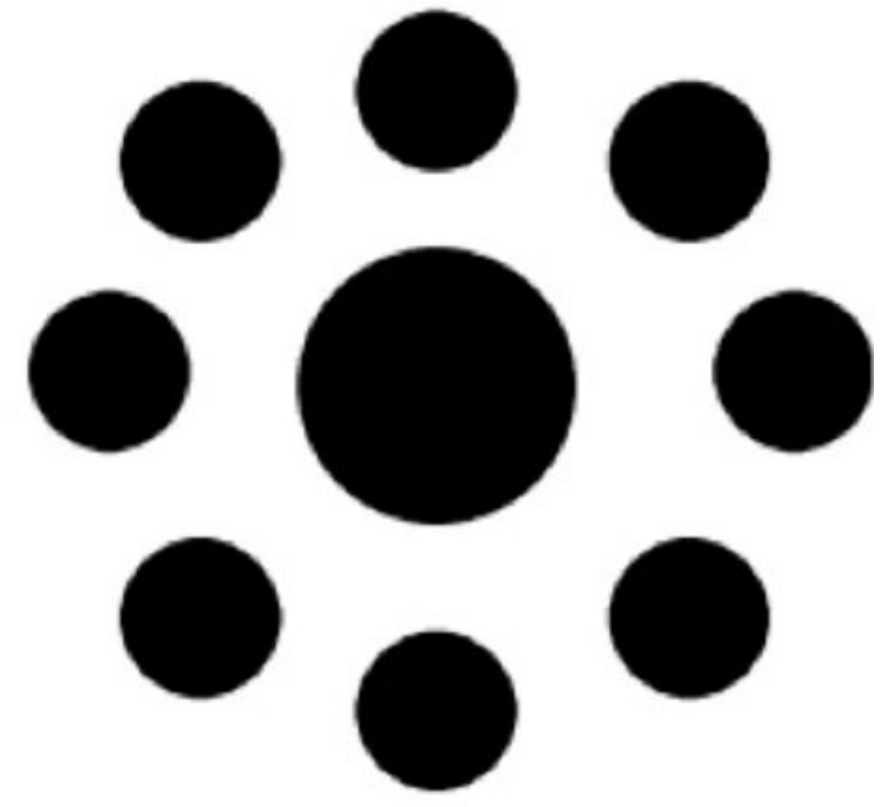
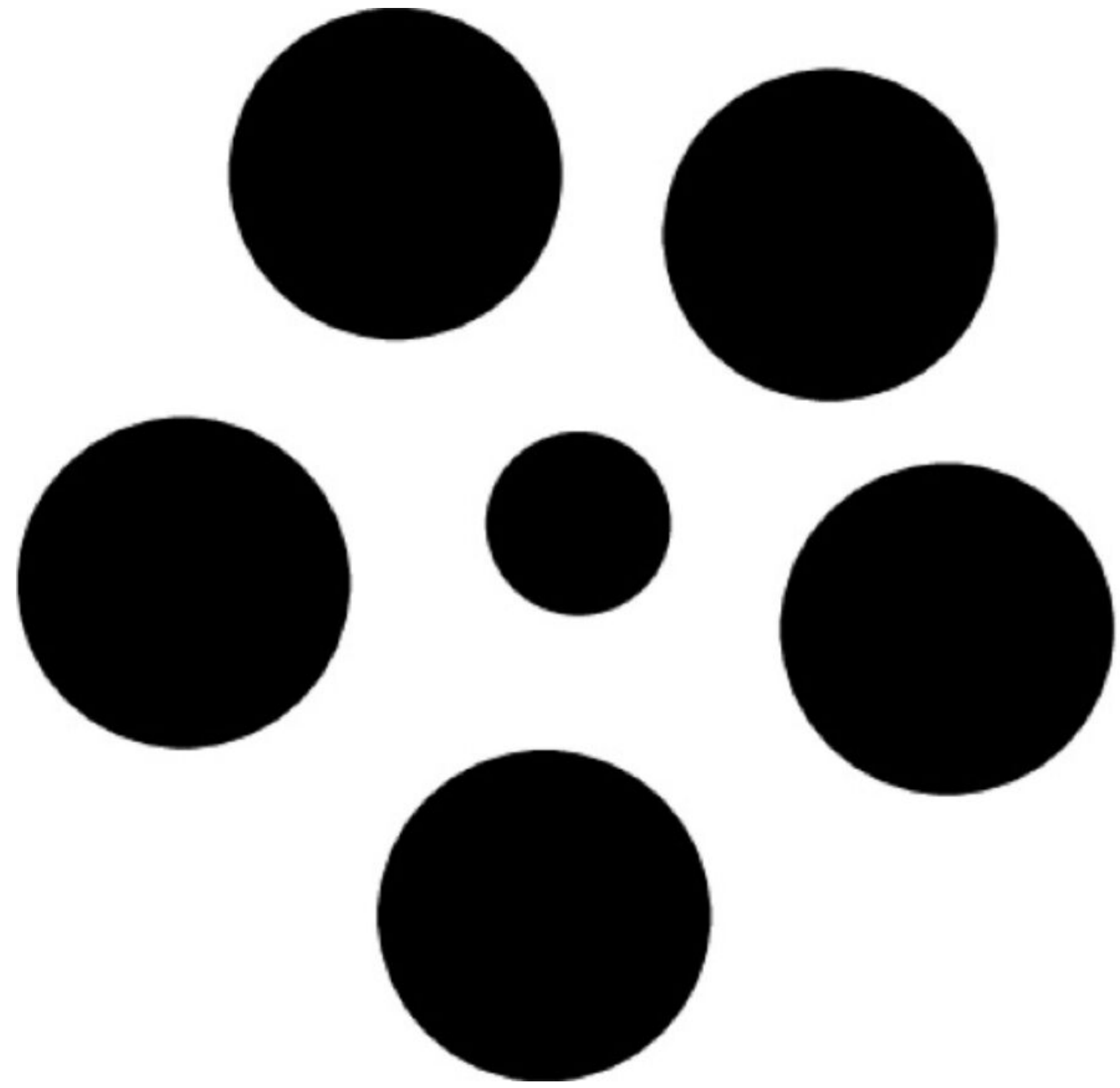
Se la "storia" è scritta dai vincitori, lo è anche la "storia" narrata su internet.

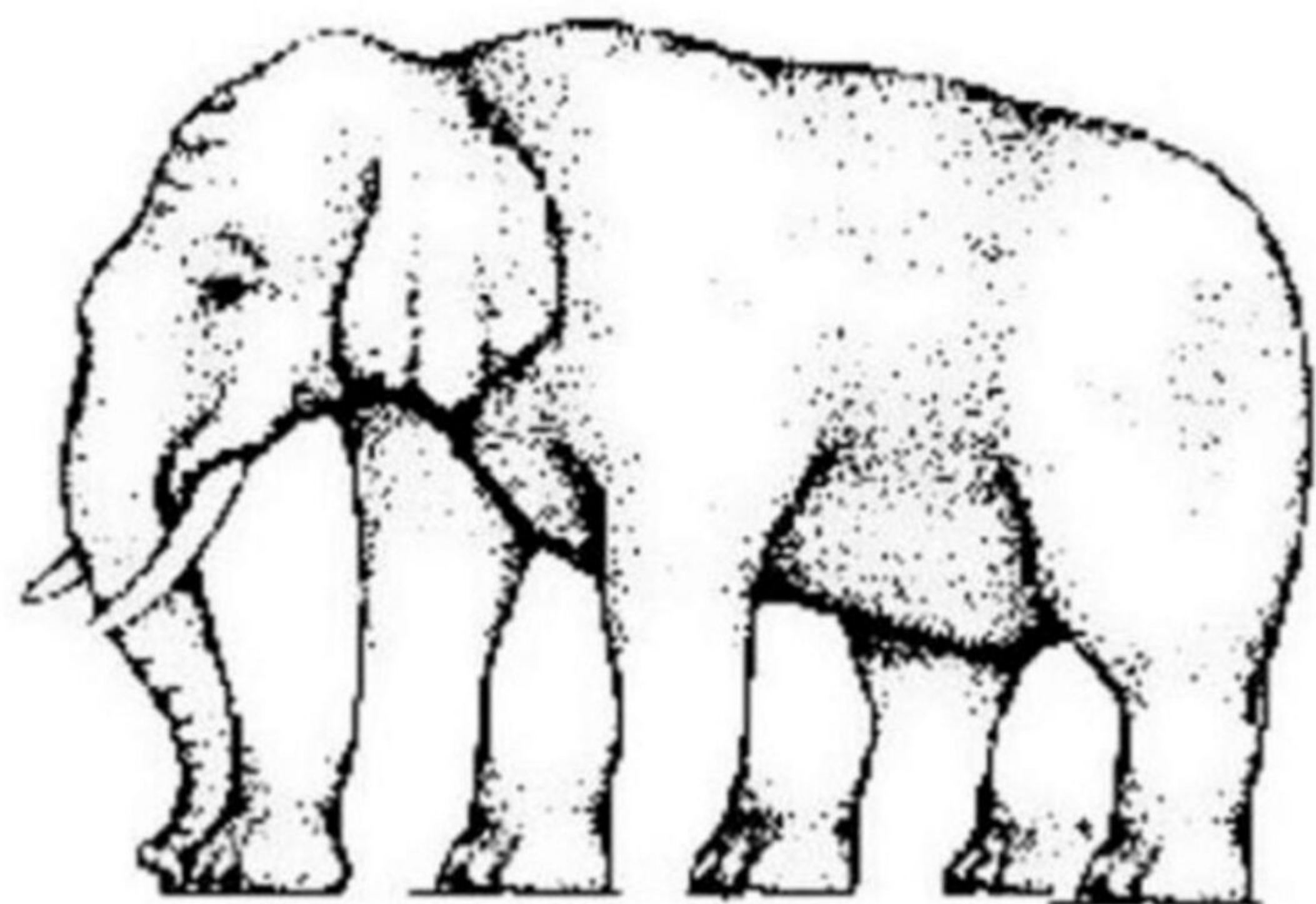
Mi piace · Rispondi · 1 · 22 aprile 2015 alle ore 12:33 · Modificato

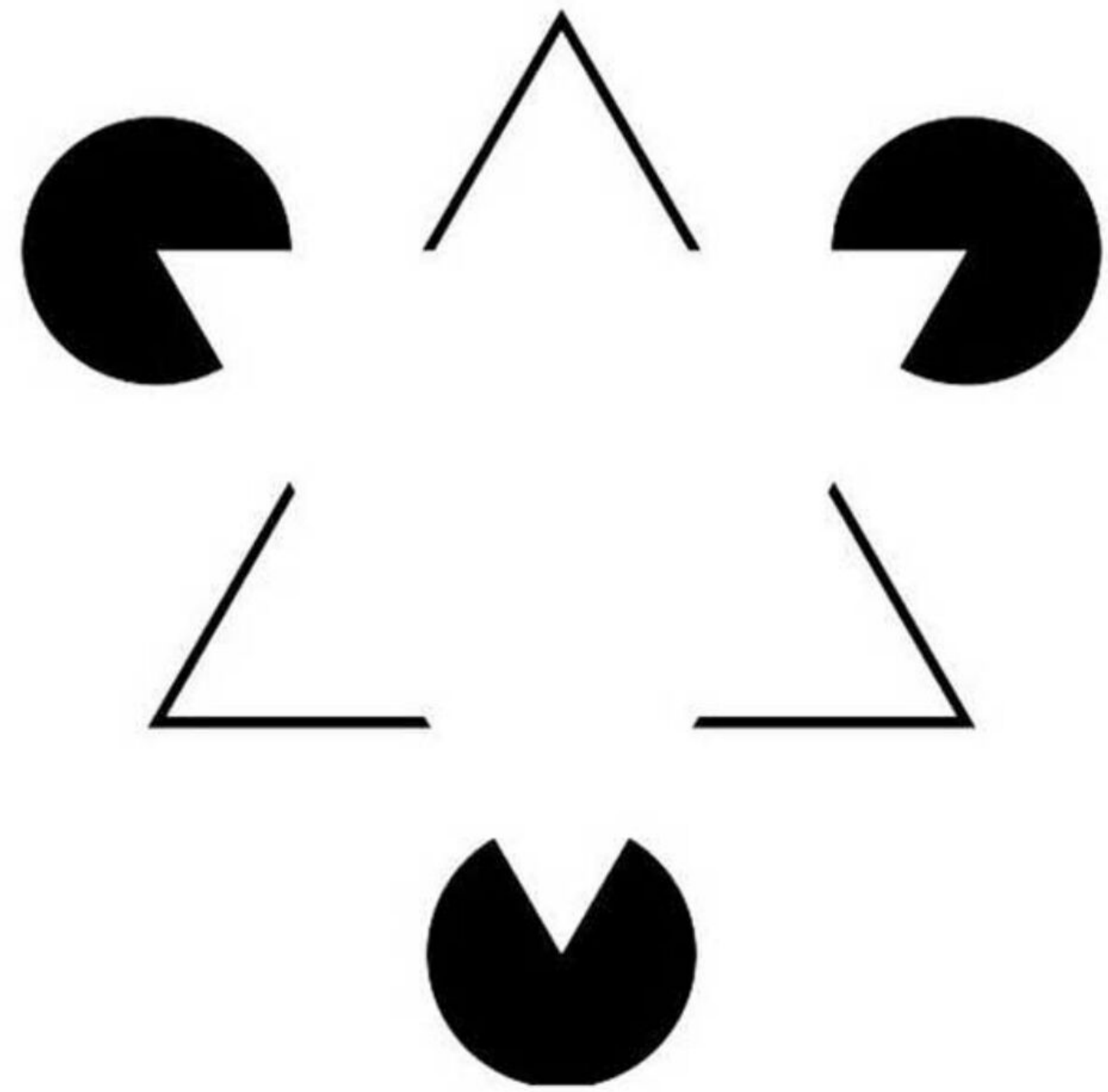


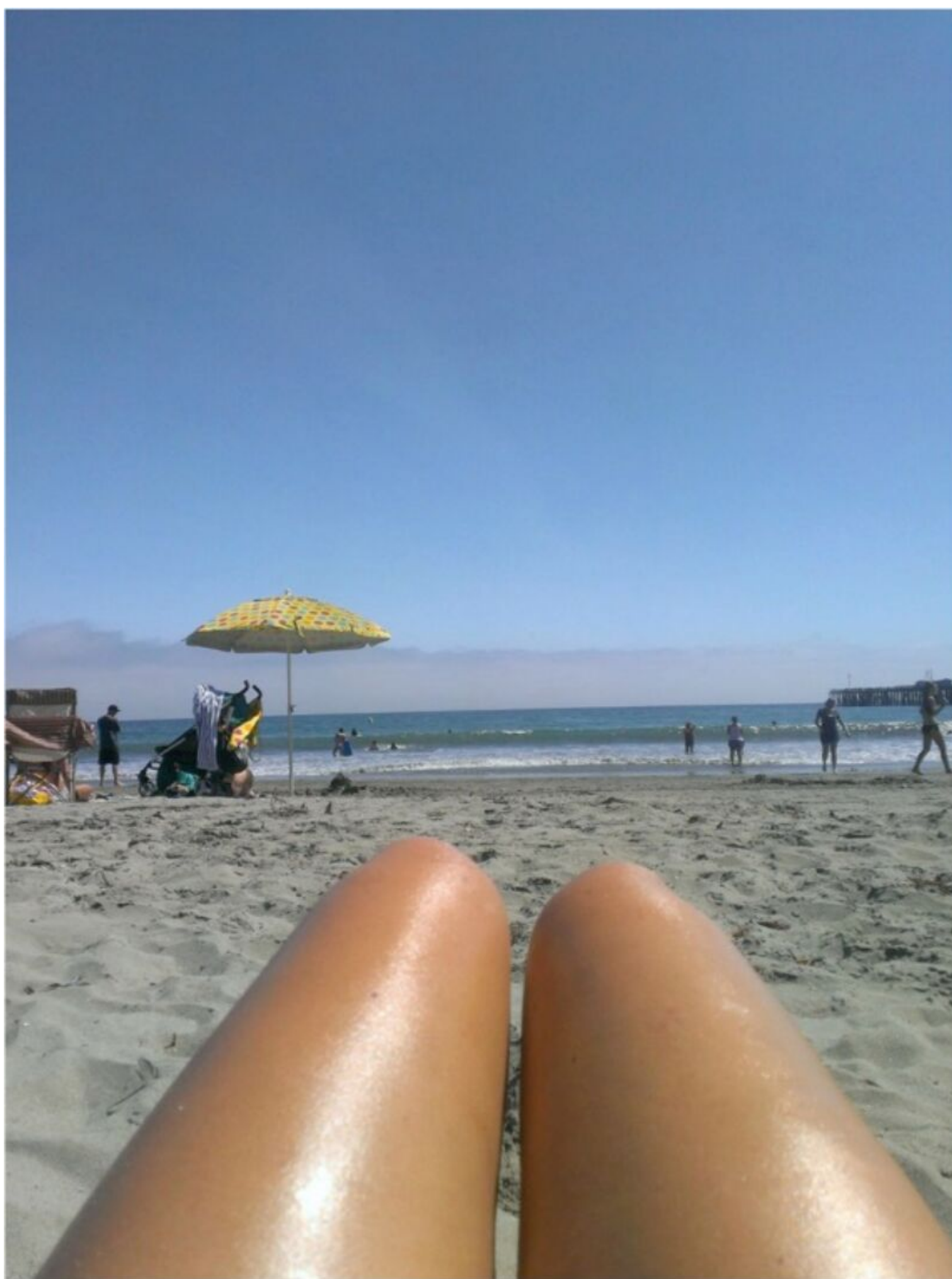
la Quello che mi fa piu ridere della gente come te è che rinnegate il confronto, siete un disco rotto, provo più piacere a conversare con un muro

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



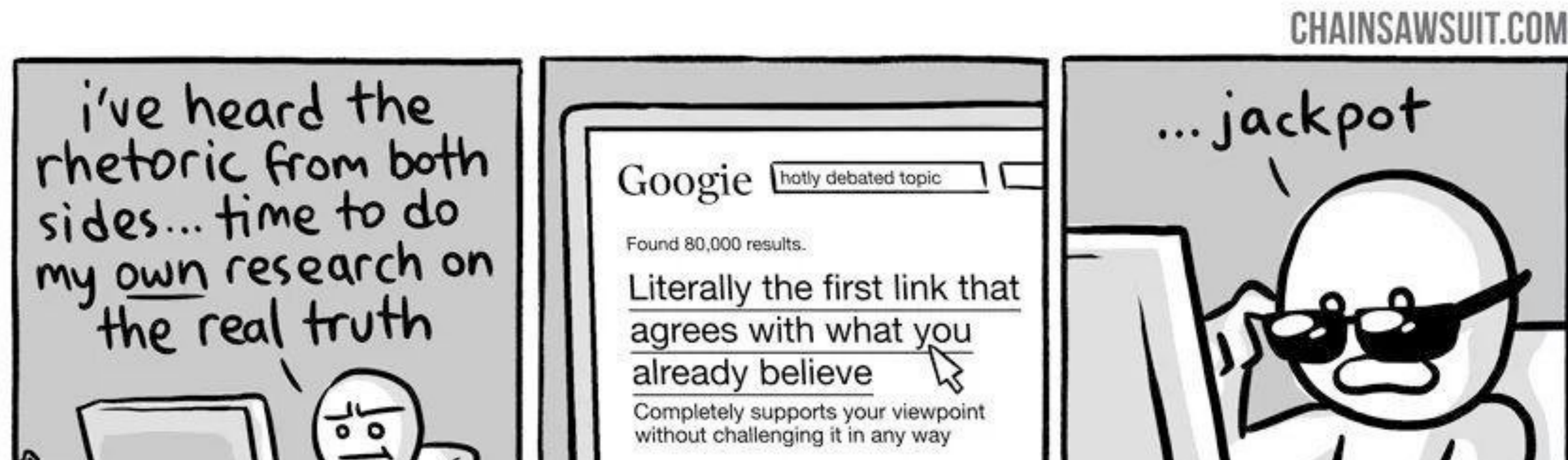








# CONFIRMATION BIAS AND INFORMATION CONSUMPTION



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



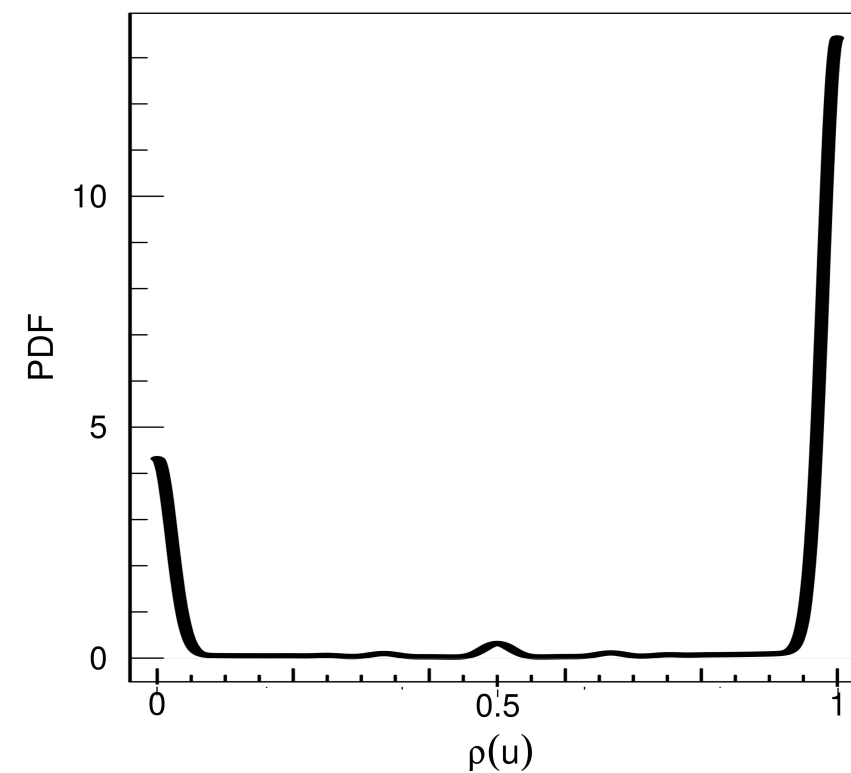
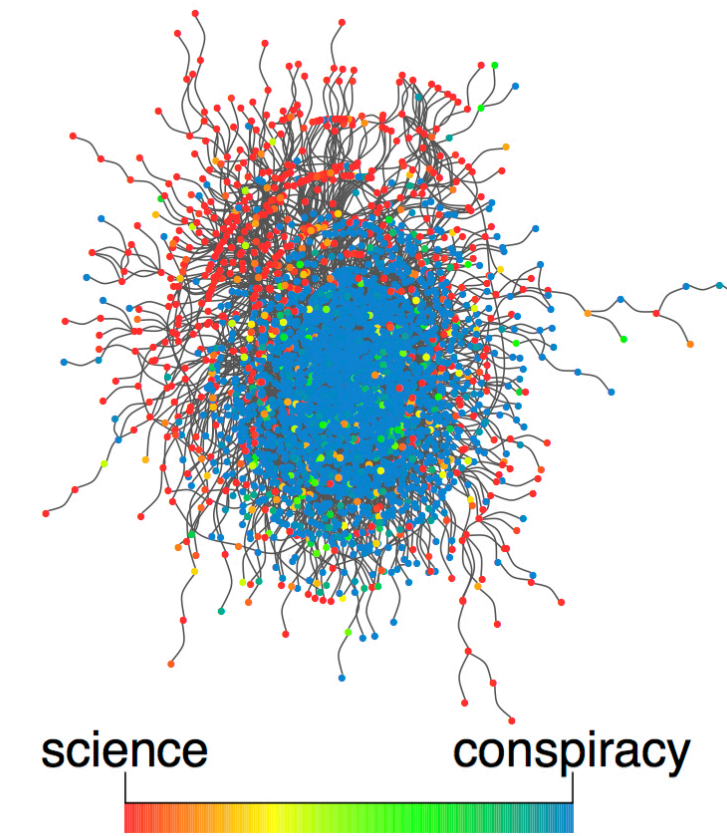
# THE DATASET(s)

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

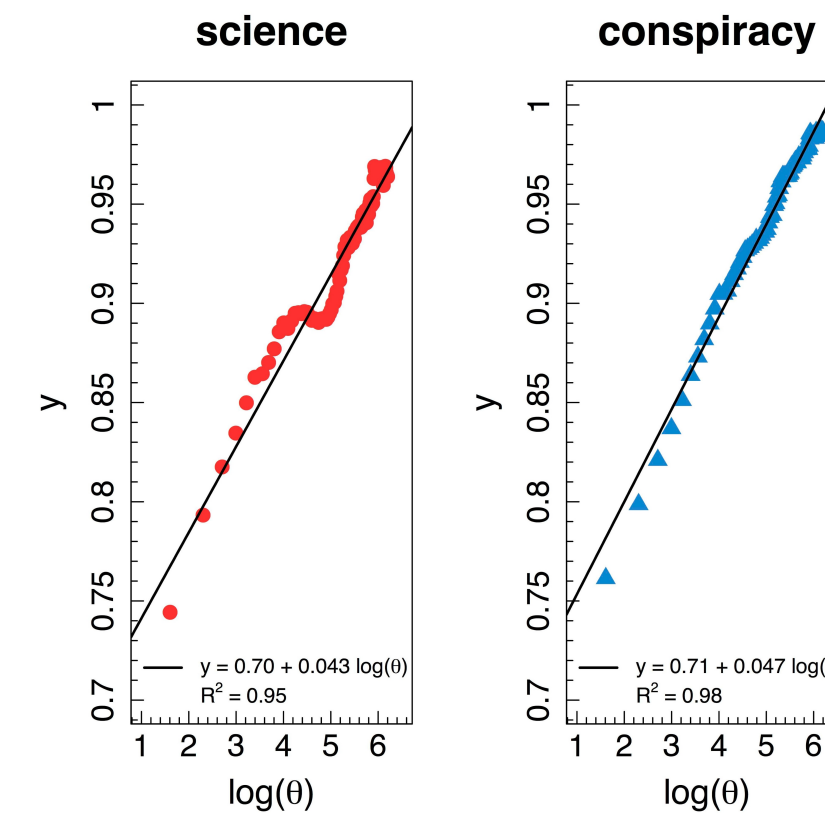
<b>FB ITALY</b>	TOTAL	SCIENCE	CONSPIRACY	<b>TROLL</b>
Pages	73	34	39	<b>2</b>
Posts	271,296	62,705	208,591	<b>4,709</b>
Likes	9,164,781	2,505,399	6,659,382	<b>40,341</b>
Comments	1,017,509	180,918	836,591	<b>58,686</b>
Likers	1,196,404	332,357	864,047	<b>15,209</b>
Commentsers	279,972	53,438	226,534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

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

# 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).

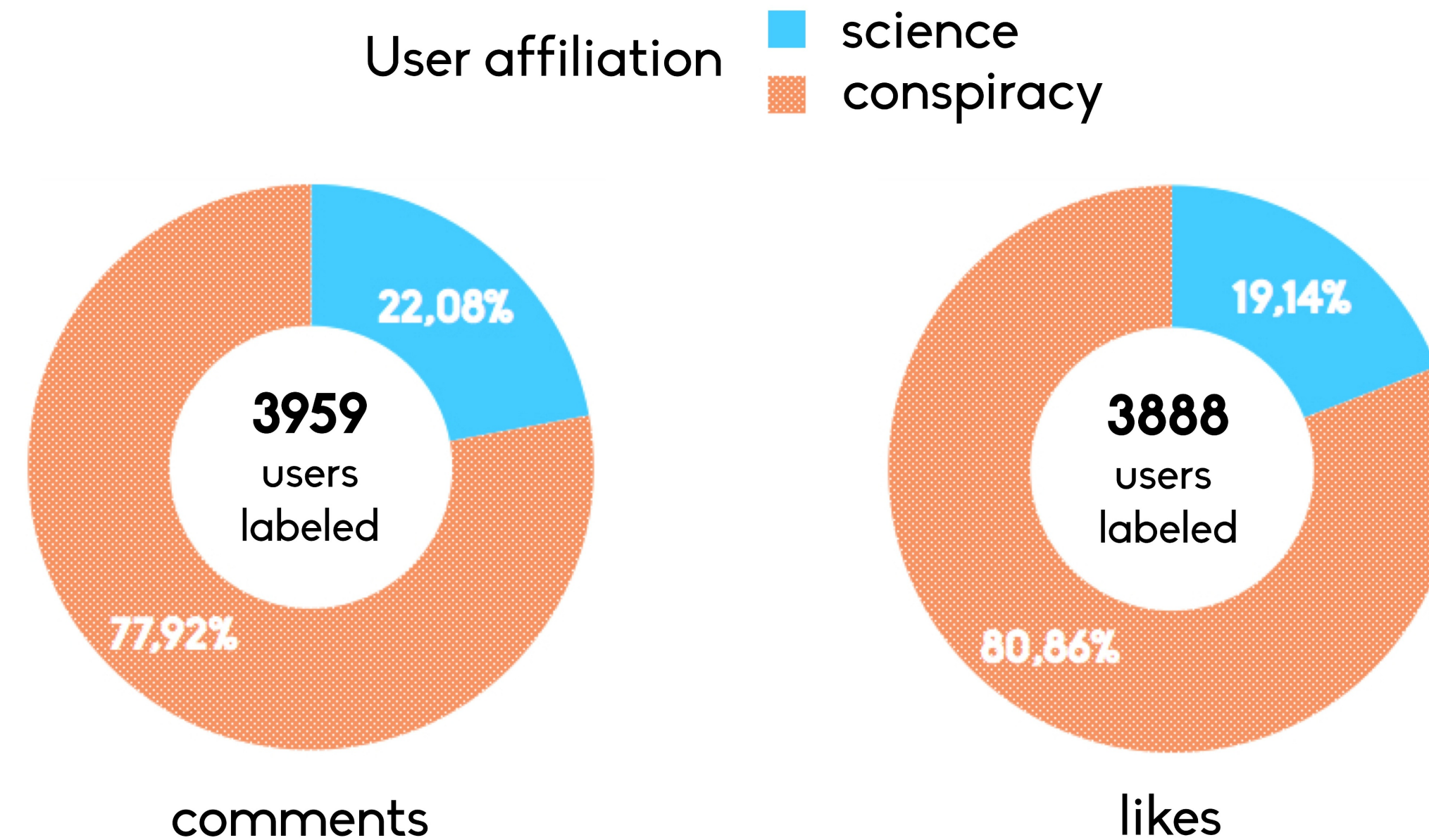


**Homophily.** Fraction of polarized friends with the same polarization respect to the number of likes  $\log(\theta(u))$  of user  $u$ .

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.

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)



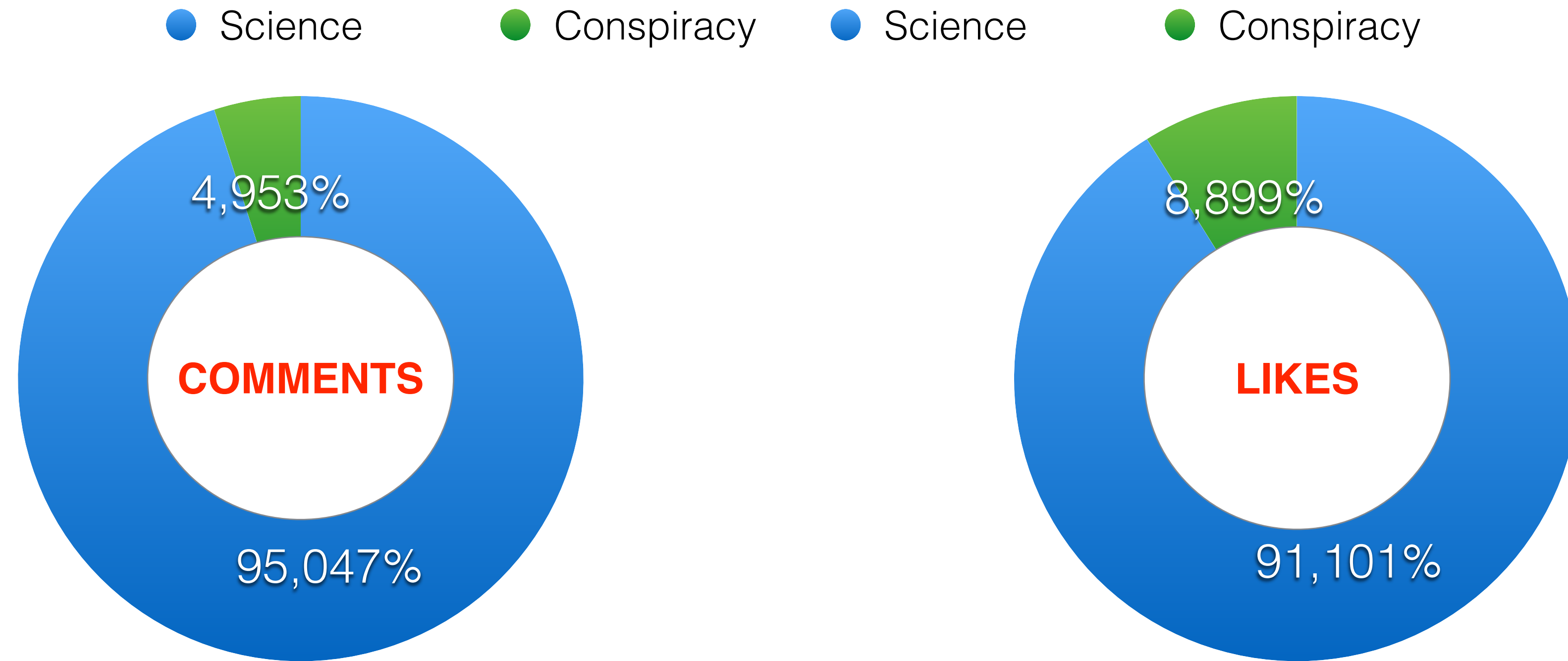
## Polarized users on false information.

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.

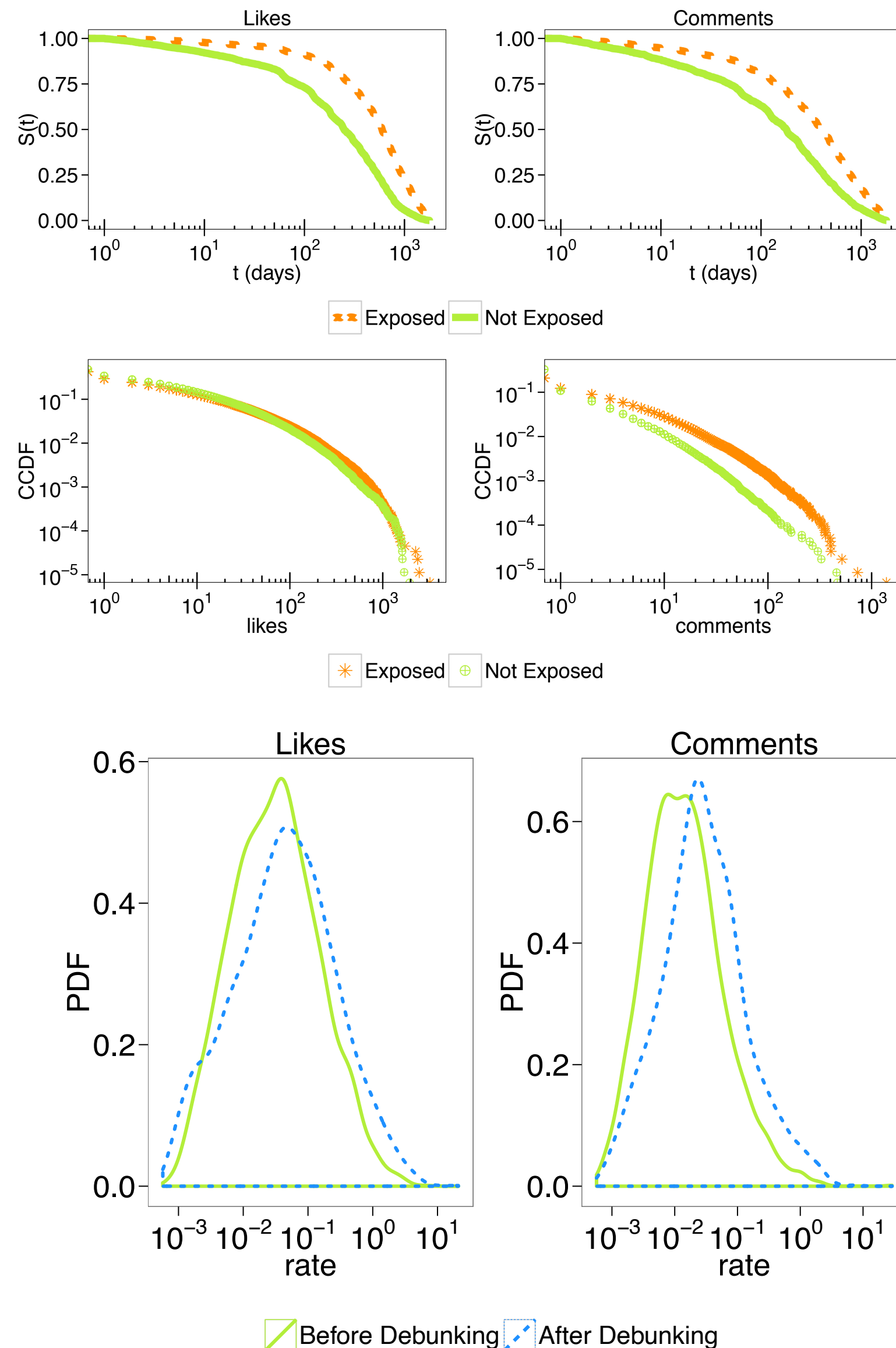
Bessi, A., Coletto, M., Davidescu, G. A., Scala, A., Caldarelli, G., & Quattrociocchi, W. (2015). Science vs conspiracy: Collective narratives in the age of misinformation. *PloS one*, 10(2), e0118093.

# 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 )

# 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<sup>a</sup>, Alessandro Bessi<sup>b</sup>, Fabiana Zollo<sup>a</sup>, Fabio Petroni<sup>c</sup>, Antonio Scala<sup>a,d</sup>, Guido Caldarelli<sup>a,d</sup>, H. Eugene Stanley<sup>e</sup>, and Walter Quattrociocchi<sup>a,1</sup>

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

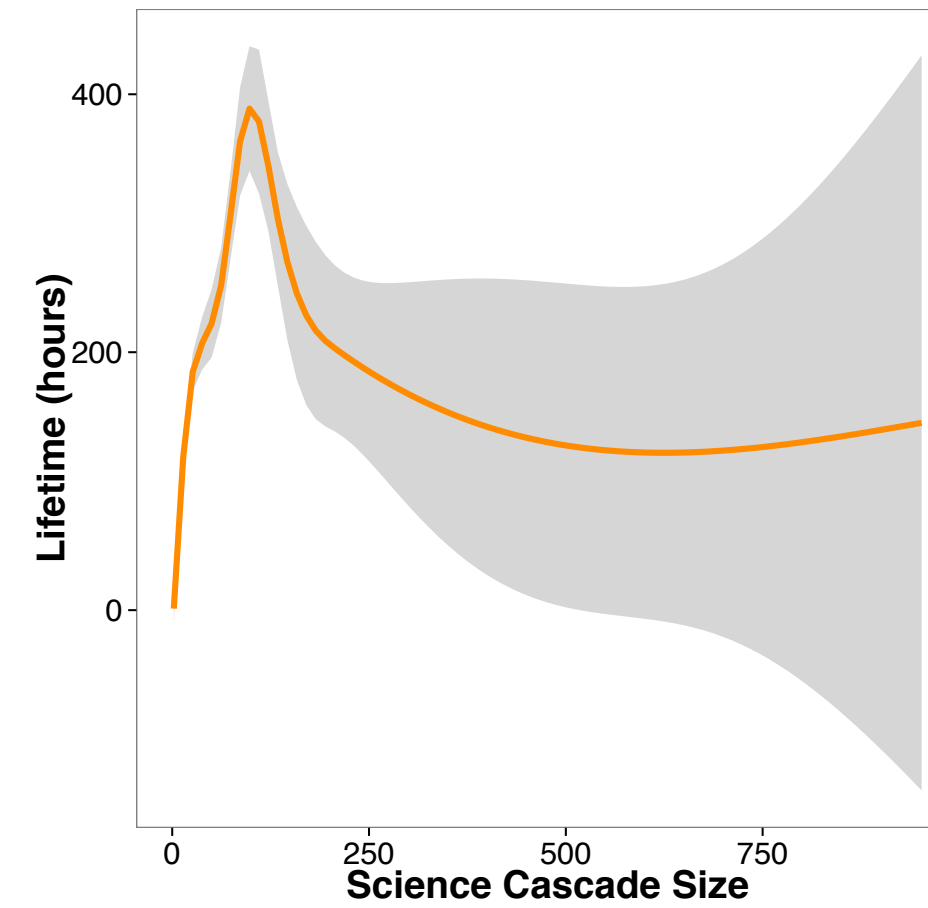
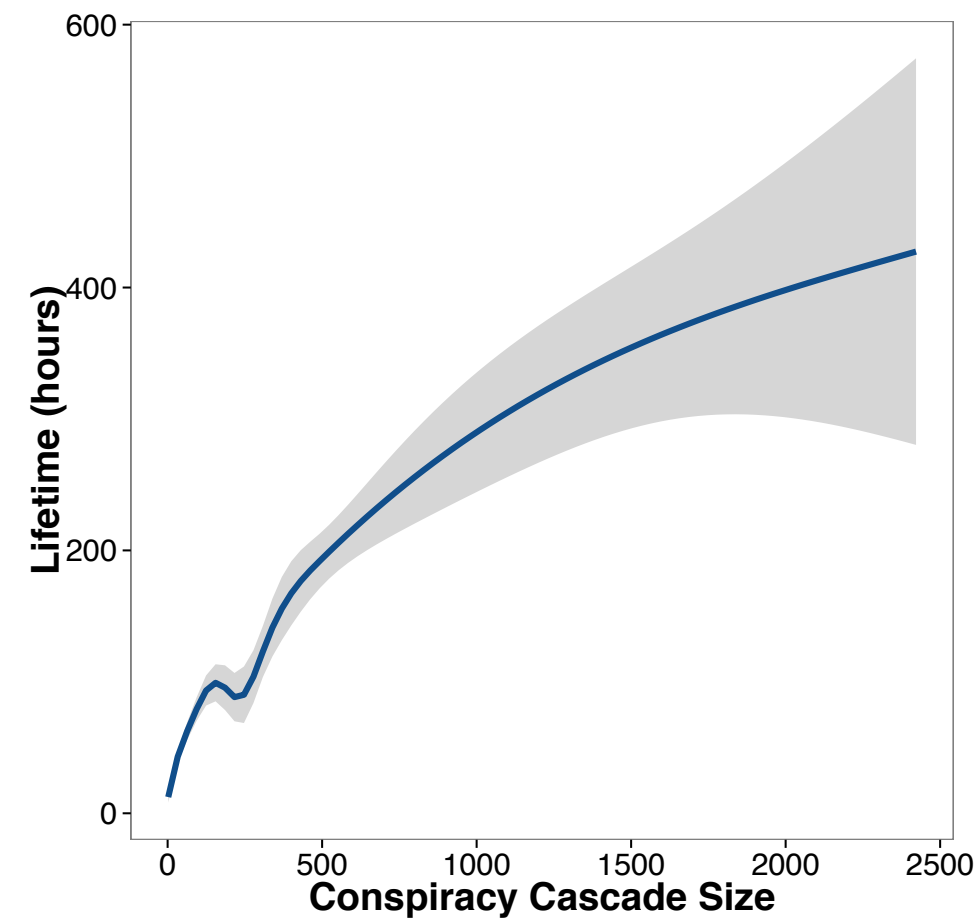
The massive diffusion of sociotechnical systems and micro-blogging platforms on the World Wide Web (WWW) creates

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).

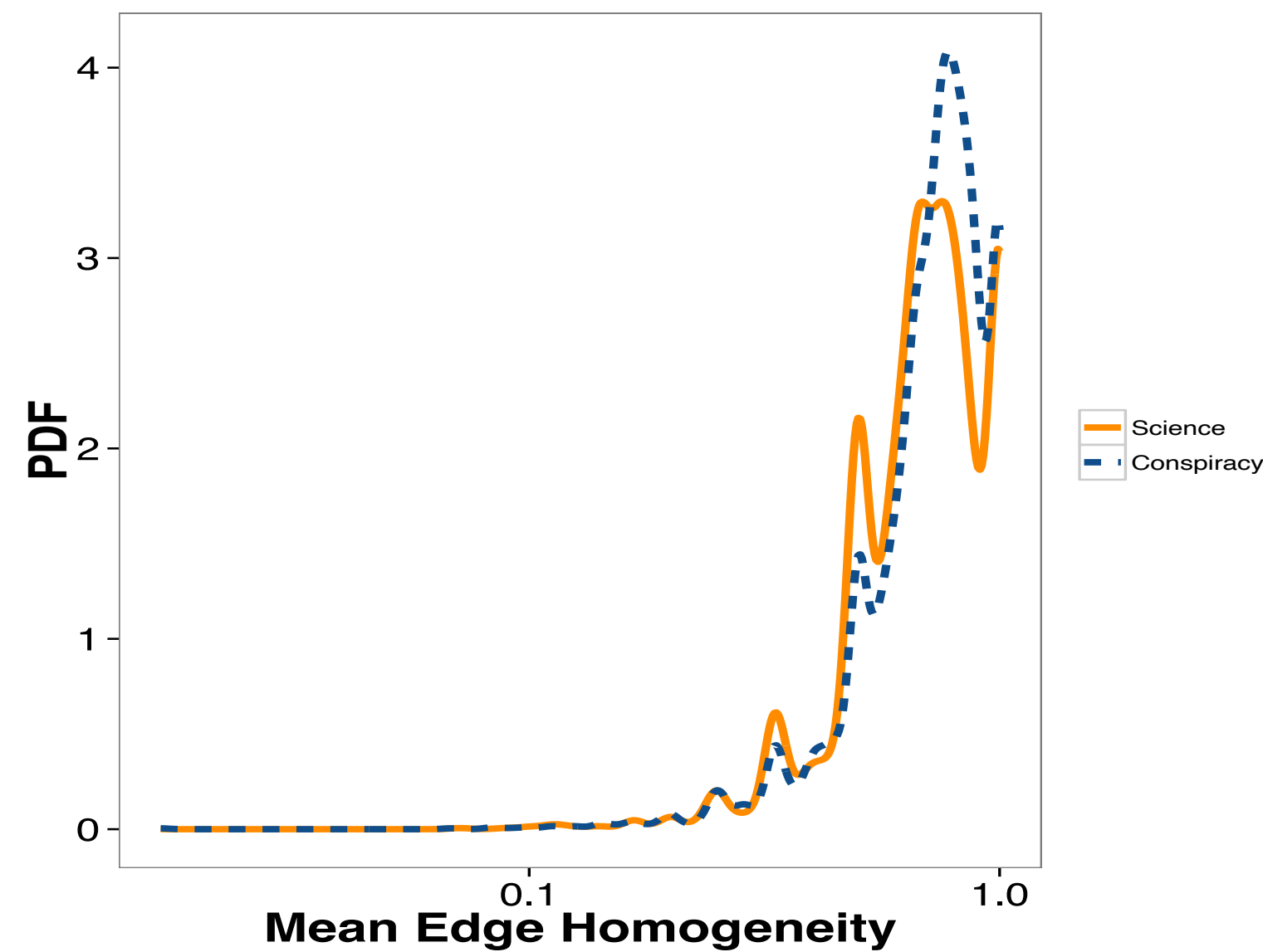
# VIRAL PROCESSES AND ECHO CHAMBERS



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.



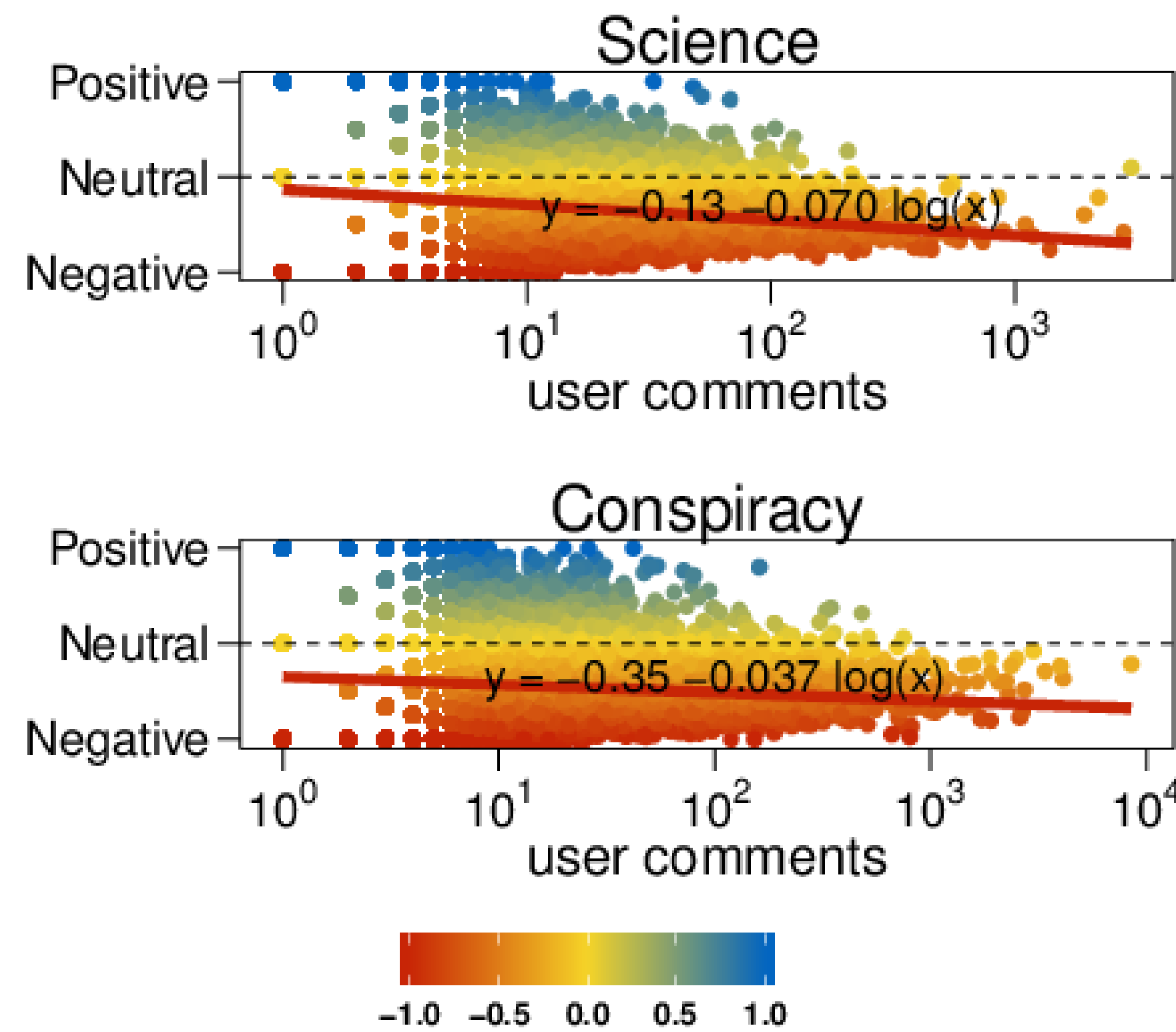
Probability density function (PDF) of edge homogeneity for science (orange) and conspiracy (blue) news.

**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*

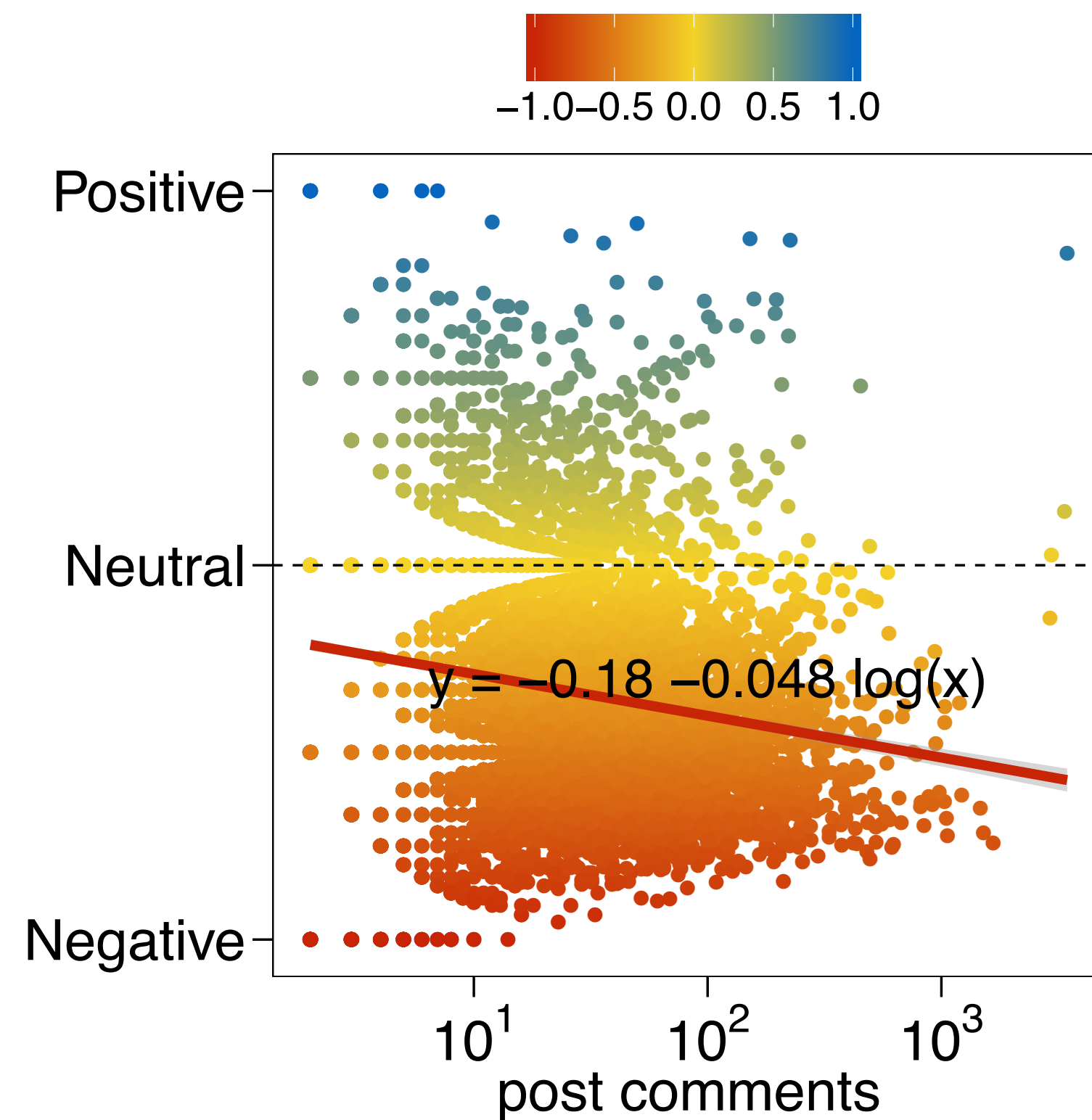


### Sentiment and commenting activity.

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



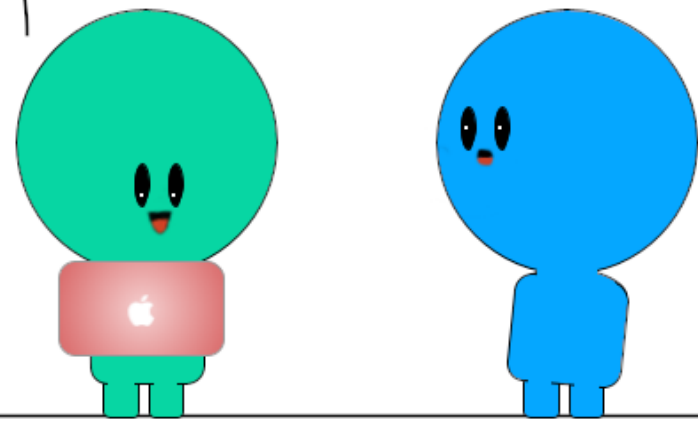
## Sentiment and discussion.

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.

# THE BIG PICTURE

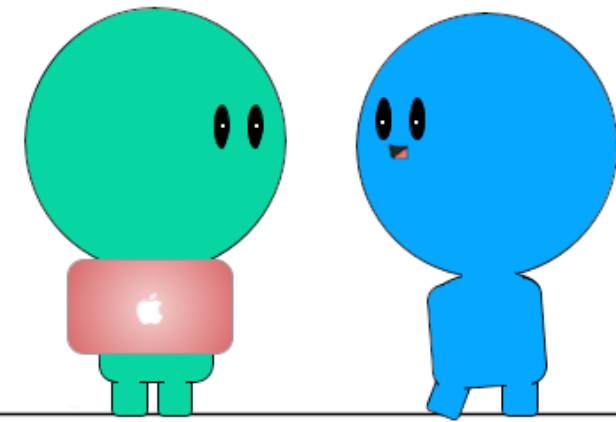
Check this news on social media

Algorithms will feed & link you with info & people that reflect & reinforce your opinions

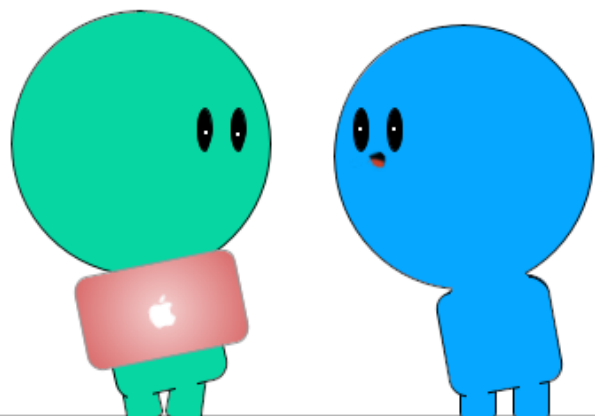


It is called the **Echo Chamber** ...

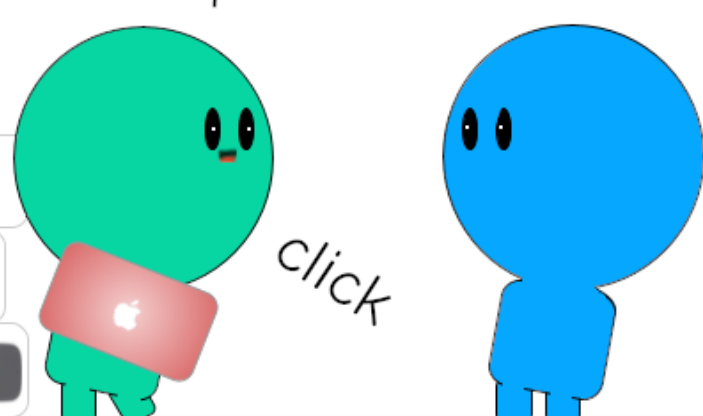
As it limits your exposure to different thoughts ...



... Echo chamber **increases** social and political **polarization** ...



I unfriend you ...



# Anatomy of news consumption on Facebook

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

<sup>a</sup>Laboratory of Computational Social Science, Networks Department, IMT Alti Studi Lucca, 55100 Lucca, Italy; <sup>b</sup>IUSS Institute for Advanced Study, 27100 Pavia, Italy; <sup>c</sup>ISC-CNR Uos "Sapienza," 00185 Rome, Italy; and <sup>d</sup>Department 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 opinions. In this paper, we explore the anatomy of the information space on Facebook by characterizing on a global scale the news consumption patterns of 376 million users over a time span of

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

## Results and Discussion

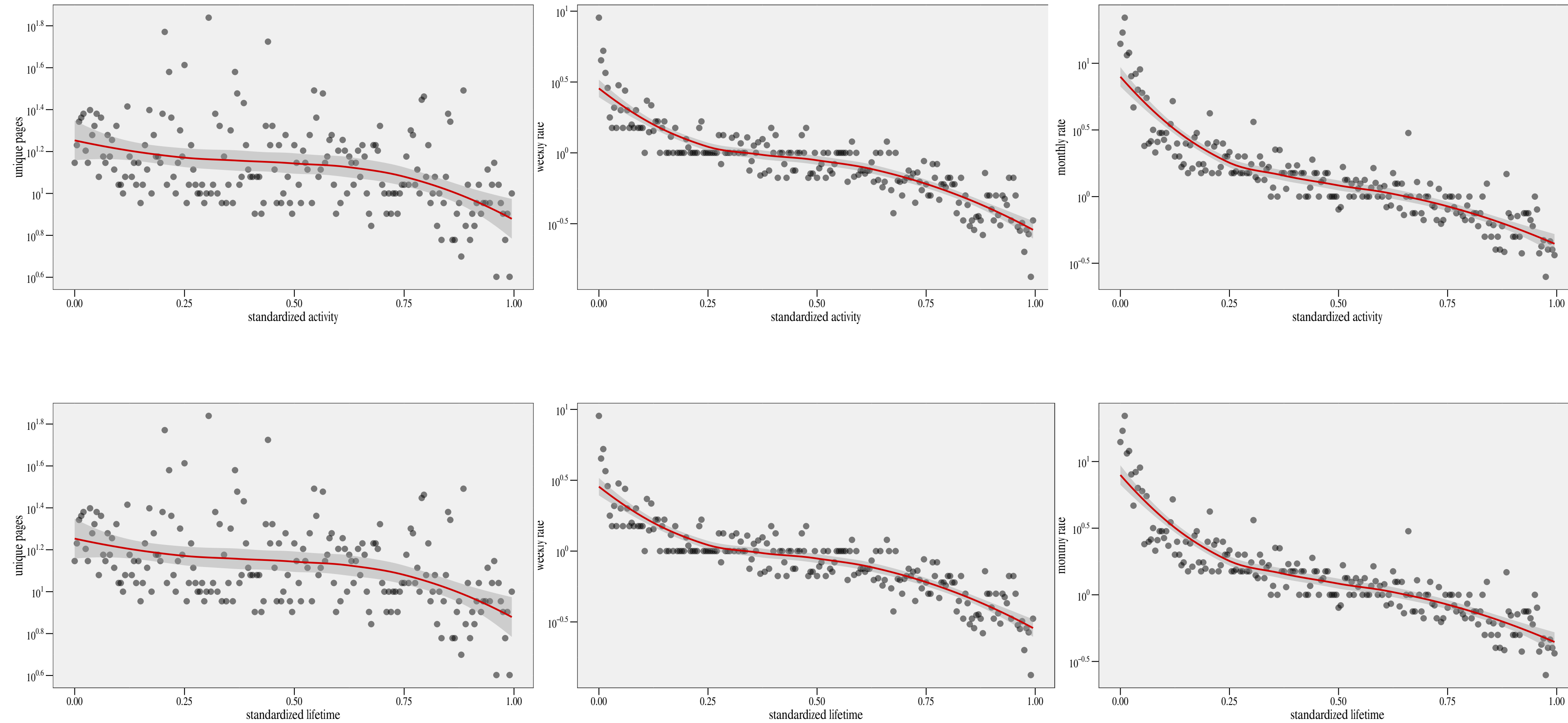
User Attention. News items on Facebook appear in posts that

PNAS

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

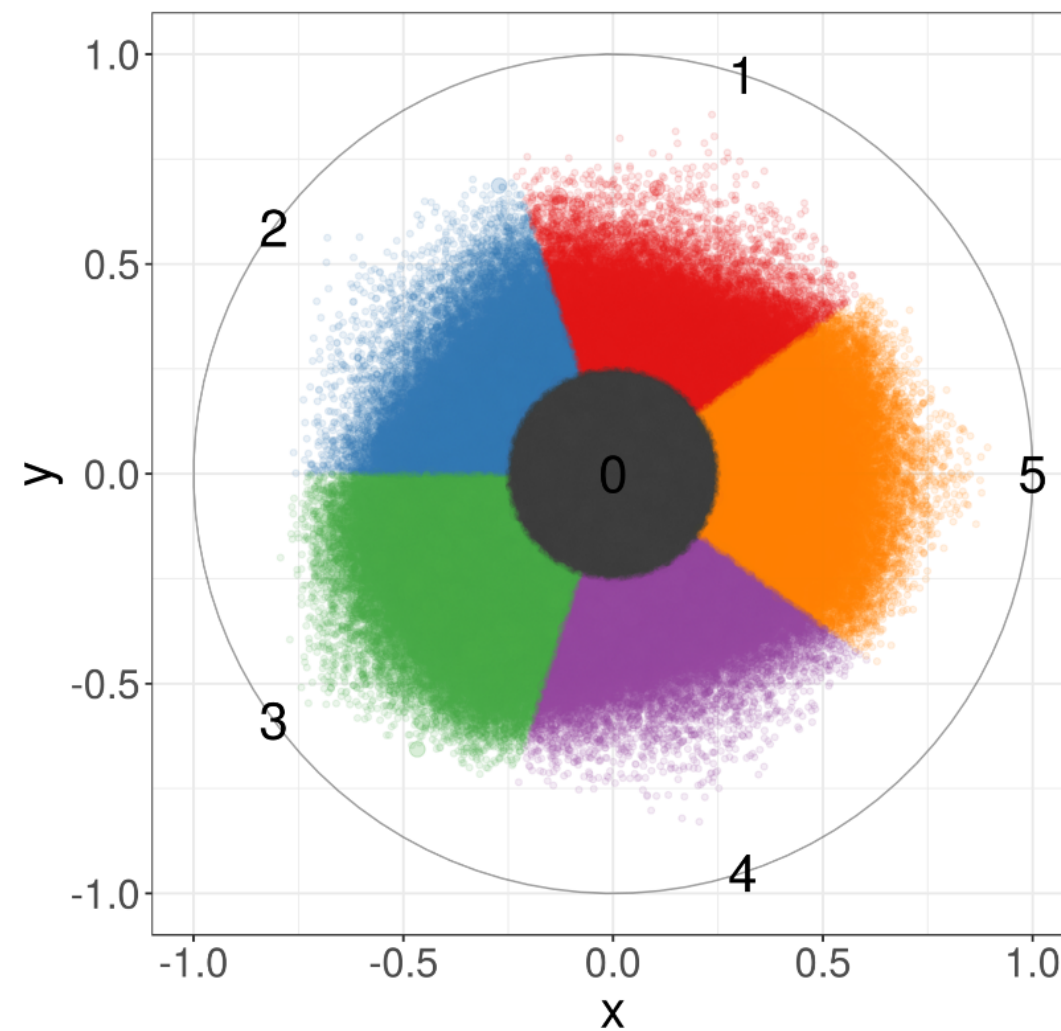
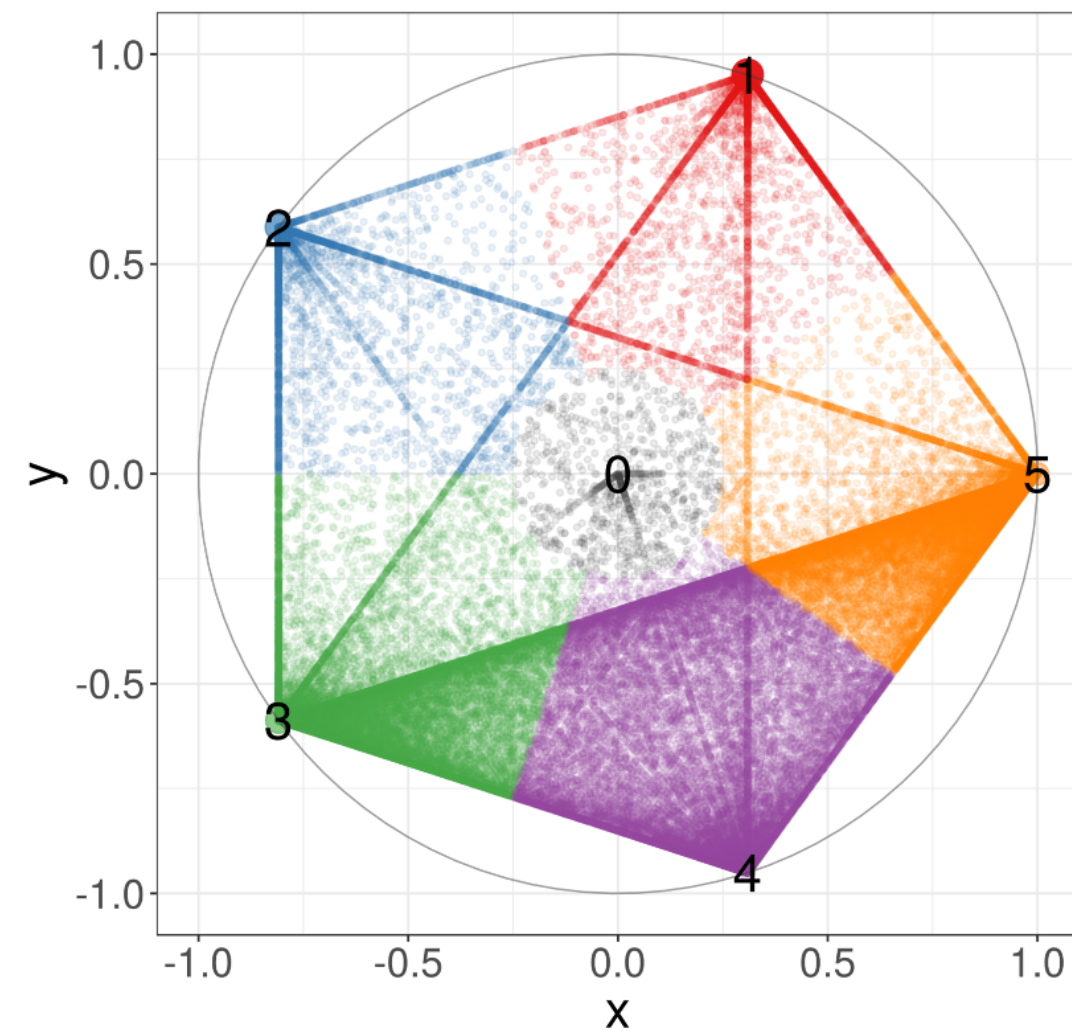
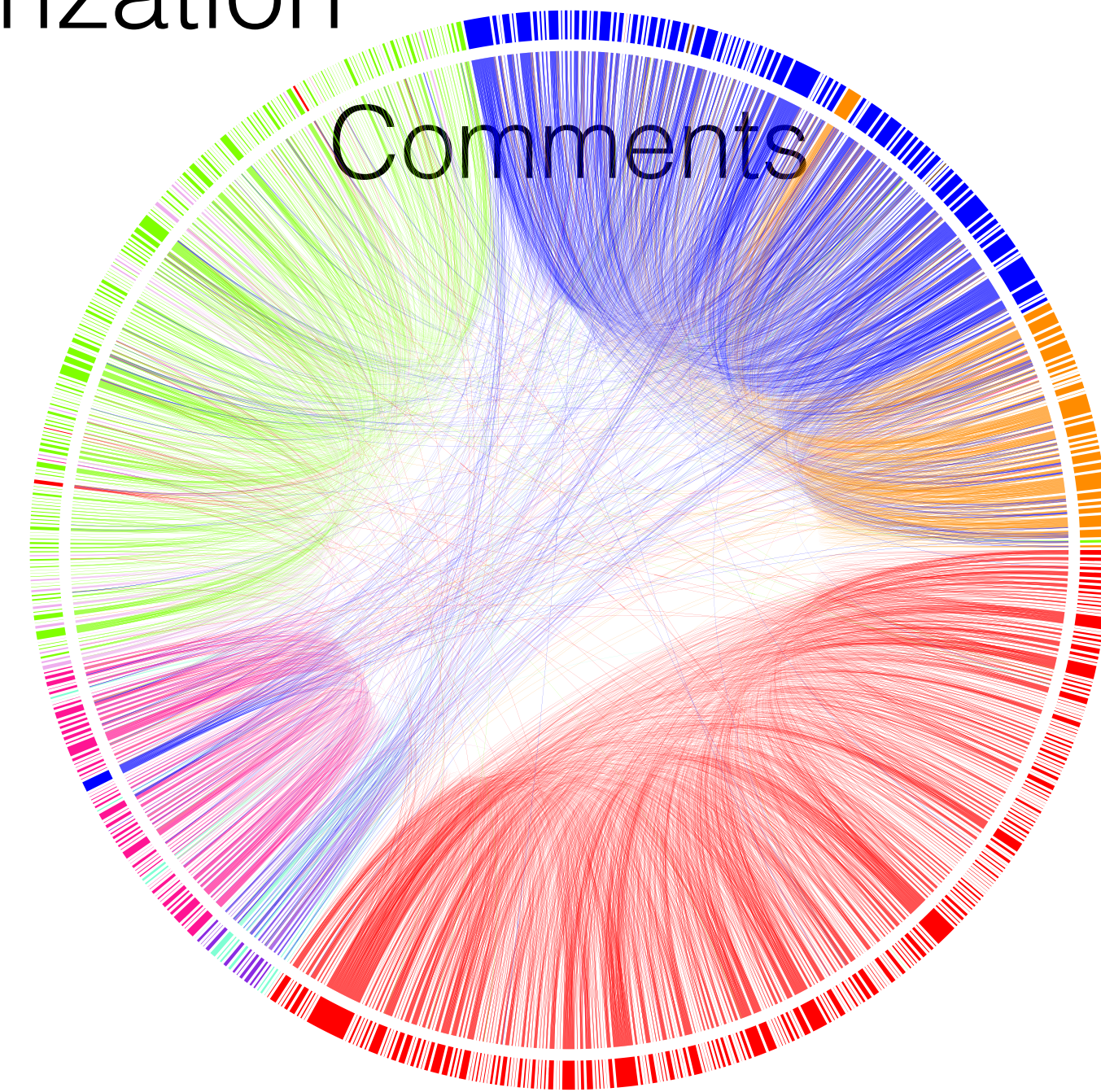
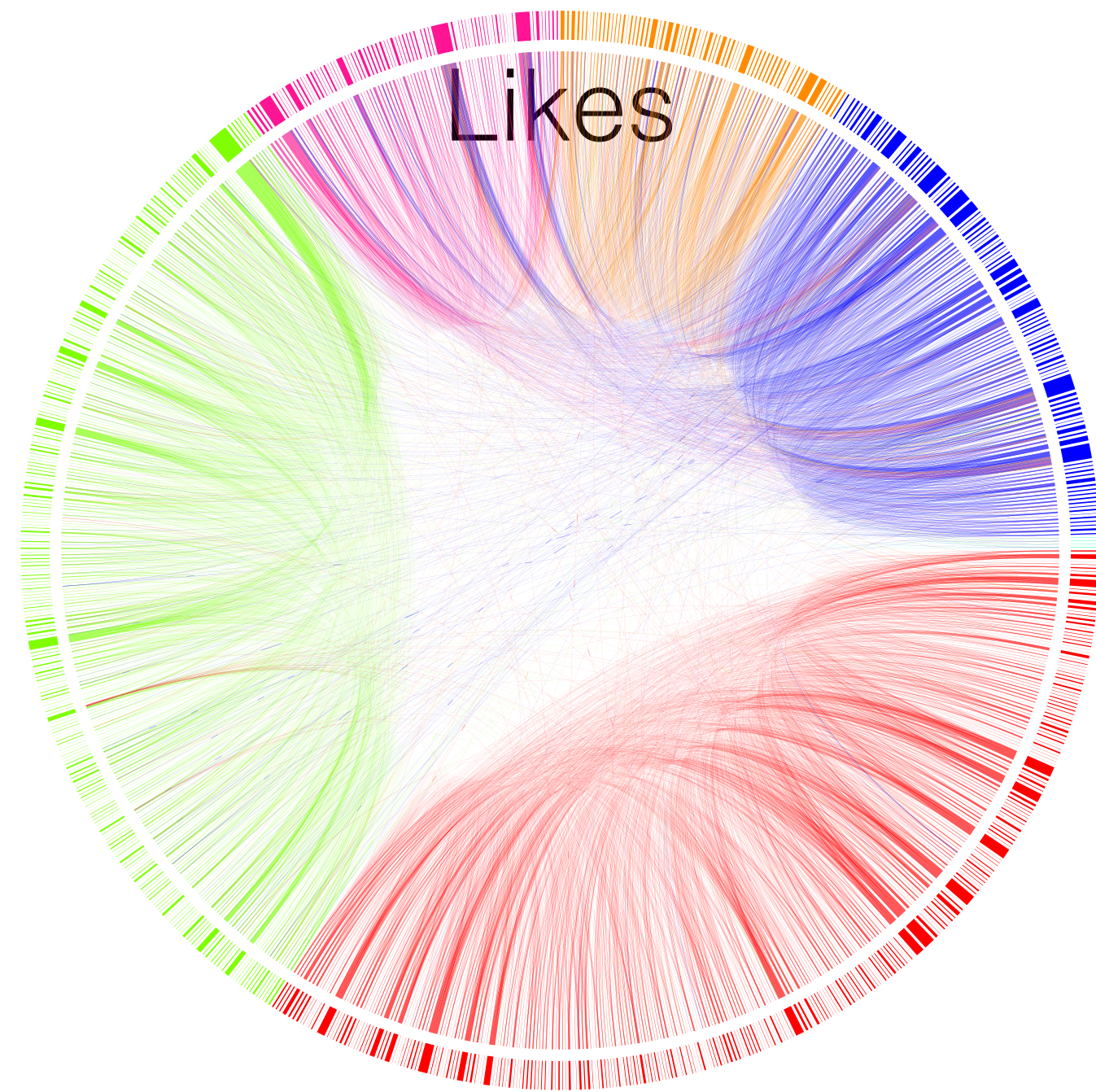


# Users tend to focus on a limited set of information sources



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



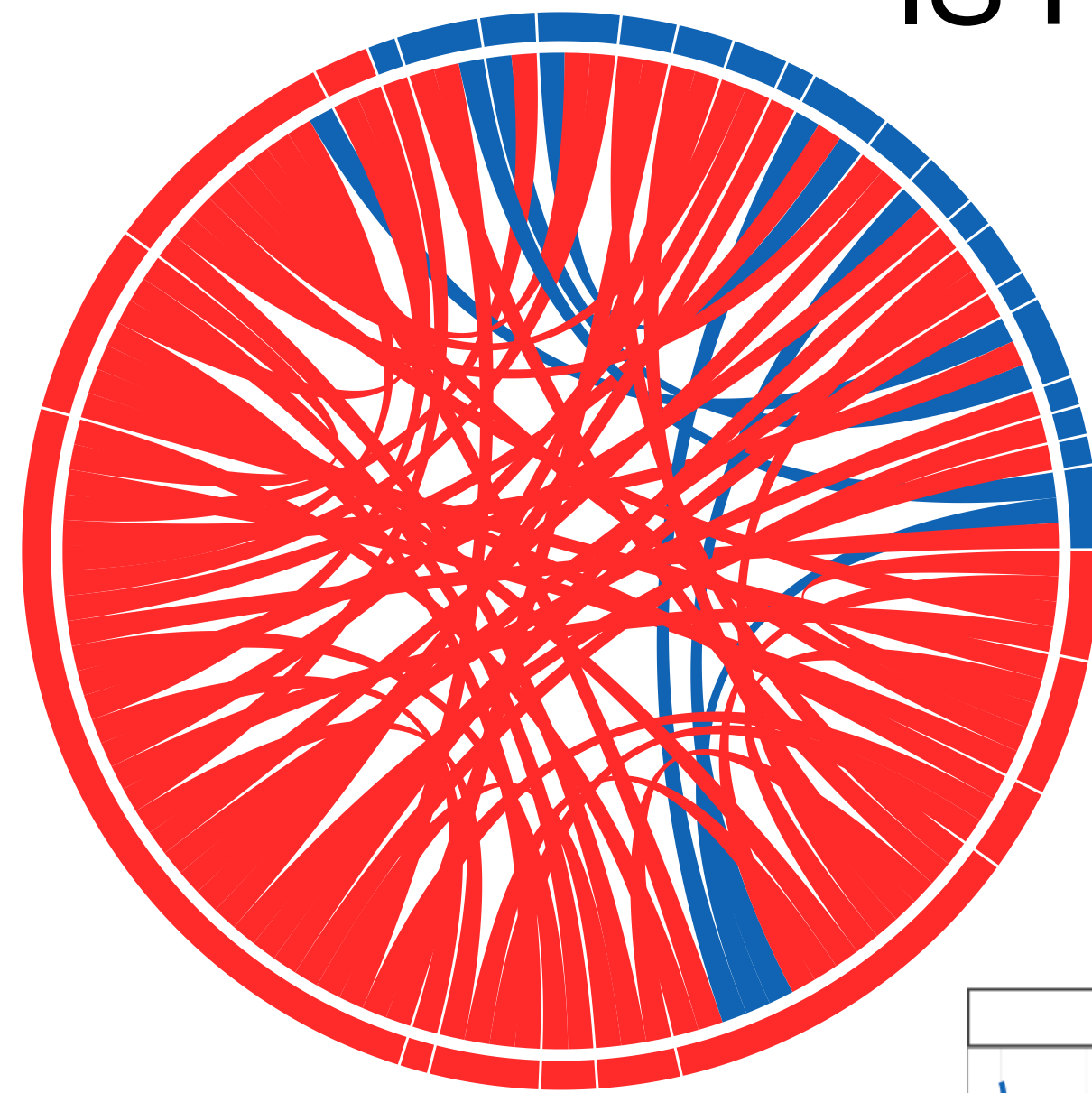
### Community Quadrant

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

### Standardized User Frequency

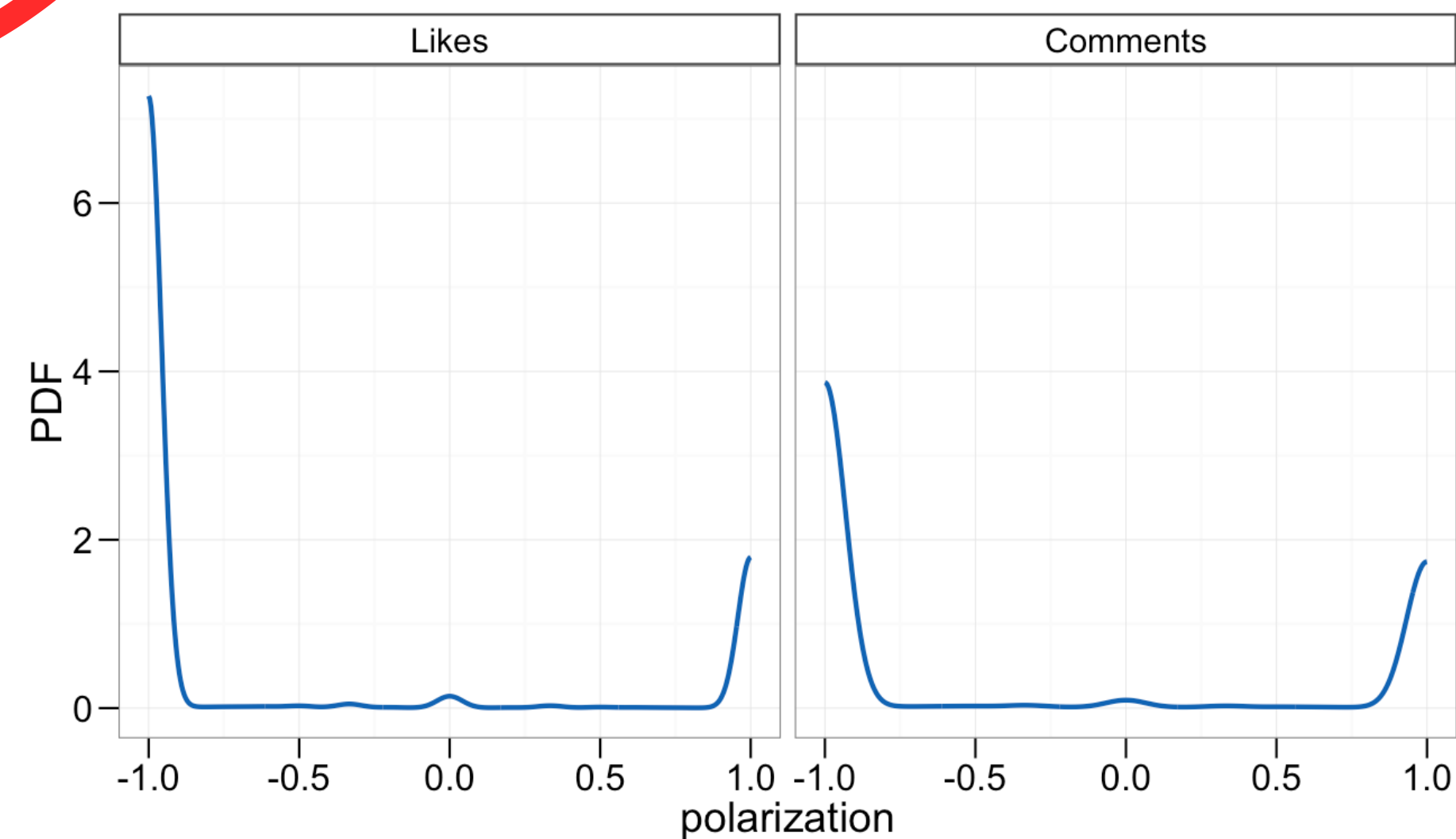
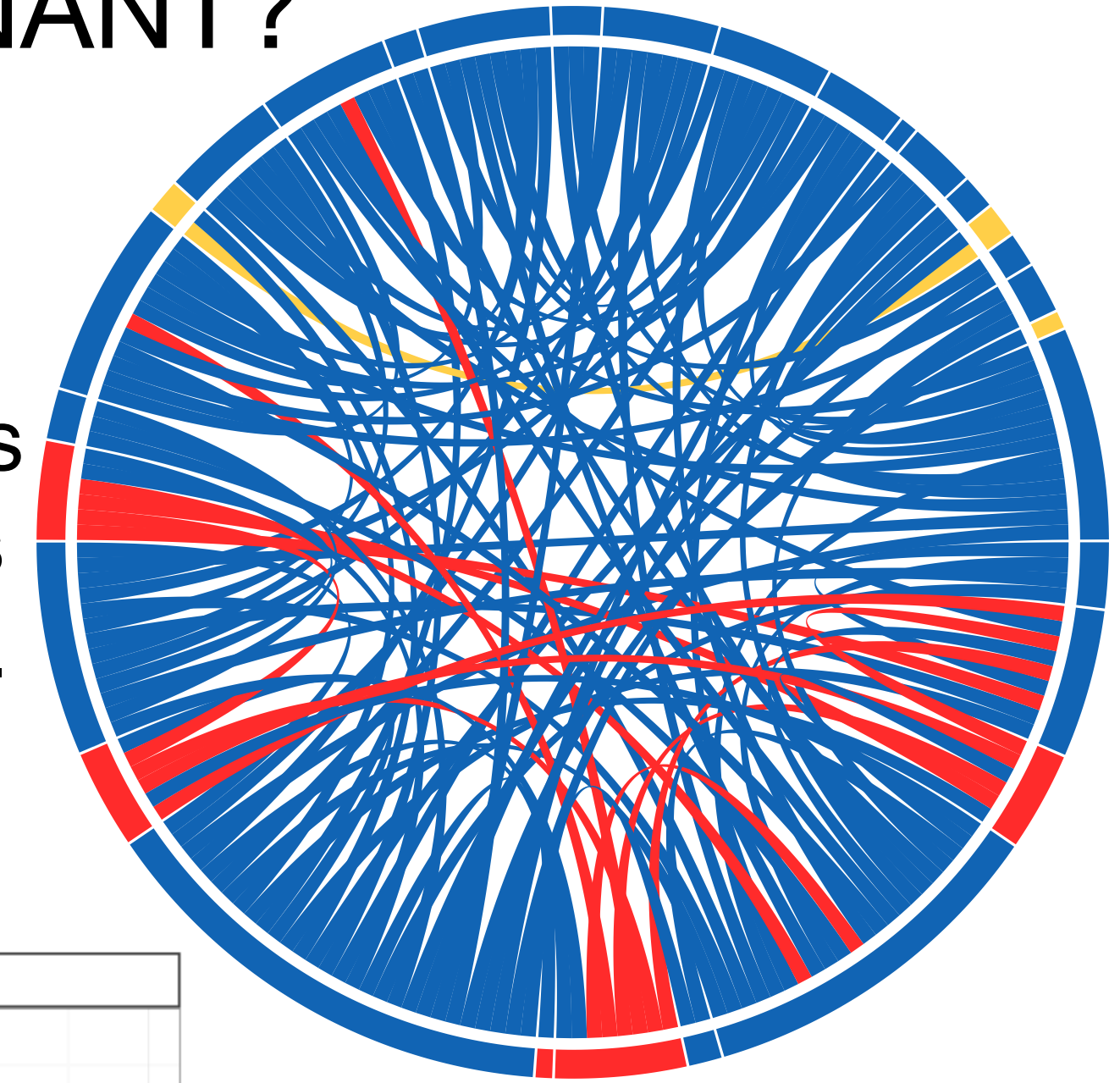
- 0.00
- 0.25
- 0.50
- 0.75
- 1.00

# 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](http://www.elsevier.com/locate/vaccine)



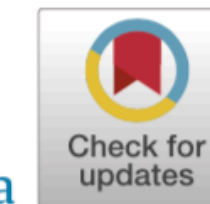
## Polarization of the vaccination debate on Facebook

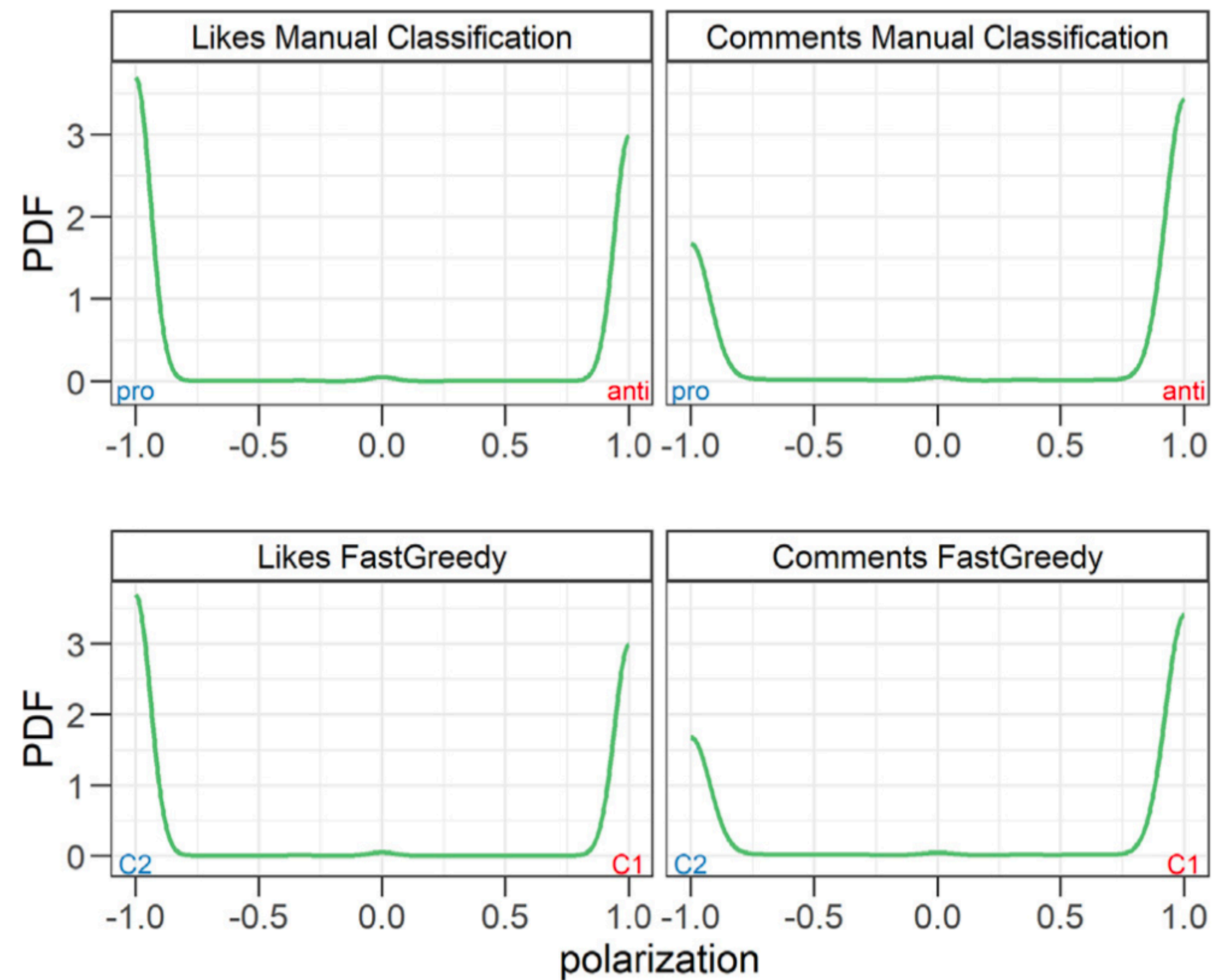
Ana Lucía Schmidt <sup>a,\*</sup>, Fabiana Zollo <sup>a</sup>, Antonio Scala <sup>b</sup>, Cornelia Betsch <sup>c</sup>, Walter Quattrocioni <sup>a</sup>

<sup>a</sup> Ca' Foscari University of Venice, Via Torino 155, 30172 Venice, Italy

<sup>b</sup> ISC-CNR, SC-CNR, Sapienza University of Rome, Via dei Taurini 19, 00185 Rome, Italy

<sup>c</sup> 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 EFFECT OF ALGORITHMS

Check for updates

## The echo chamber effect on social media

Matteo Cinelli<sup>a</sup> , Gianmarco De Francisci Morales<sup>b</sup> , Alessandro Galeazzi<sup>c</sup> , Walter Quattrociocchi<sup>d,1</sup> , and Michele Starnini<sup>b</sup> 

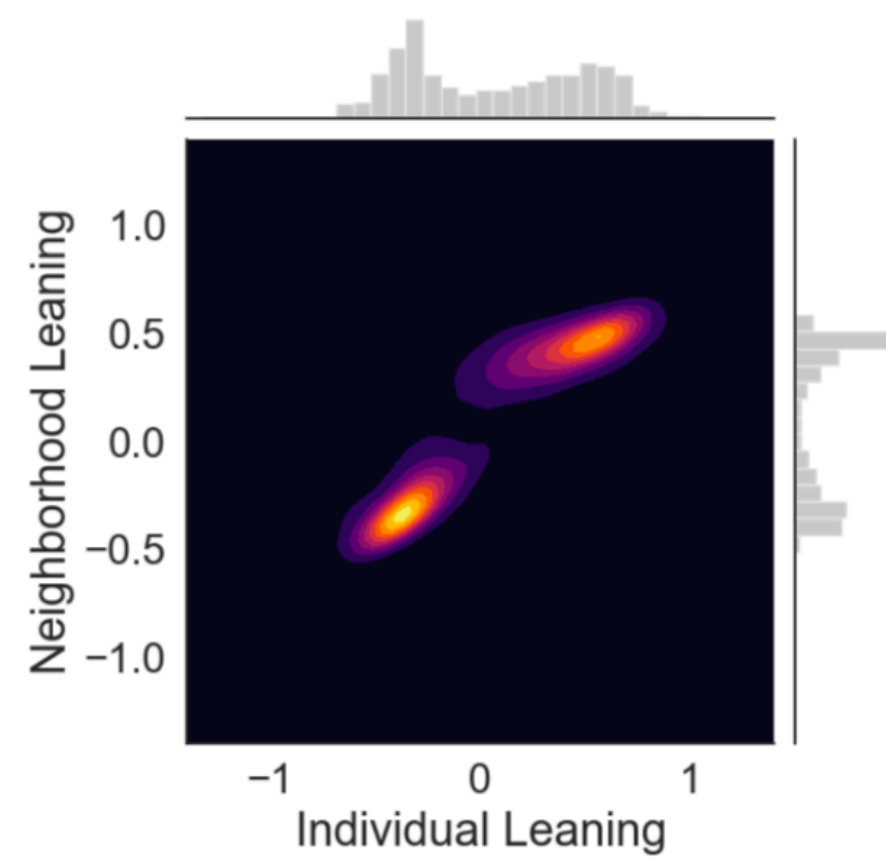
<sup>a</sup>Department of Environmental Sciences, Informatics and Statistics, Ca'Foscari University of Venice, 30172 Venice, Italy; <sup>b</sup>Institute for Scientific Interchange (ISI) Foundation, 10126 Torino, Italy; <sup>c</sup>Department of Information Engineering, University of Brescia, 25123 Brescia, Italy; and <sup>d</sup>Department 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)

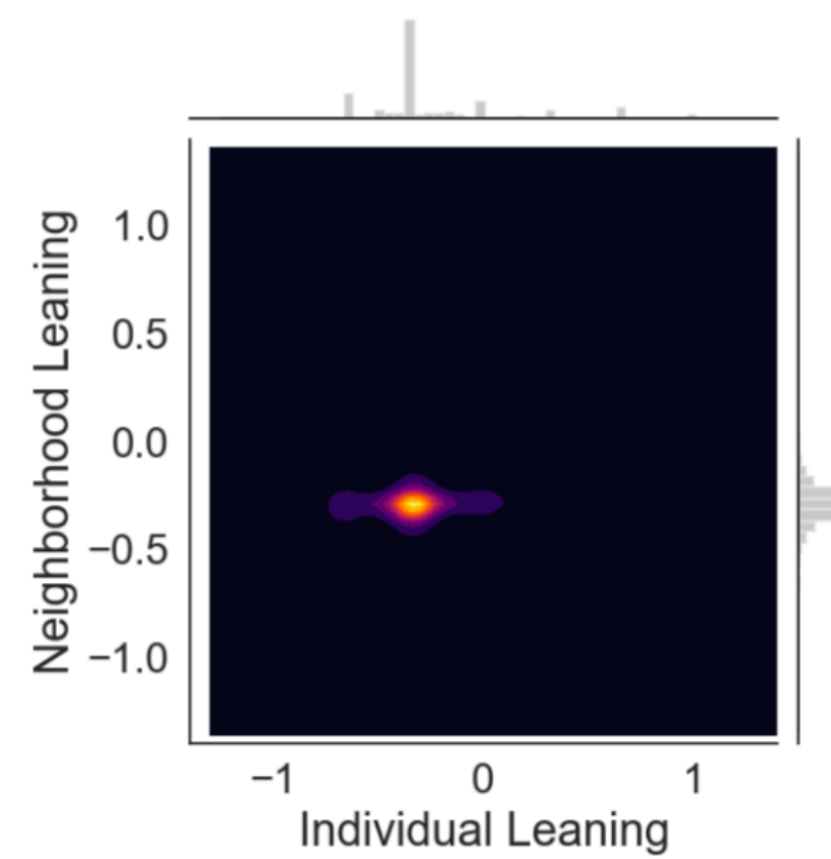
**Social media may limit the exposure to diverse perspectives and favor the formation of groups of like-minded users framing and reinforcing a shared narrative, that is, echo chambers. However, the interaction paradigms among users and feed algorithms greatly vary across social media platforms. This 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

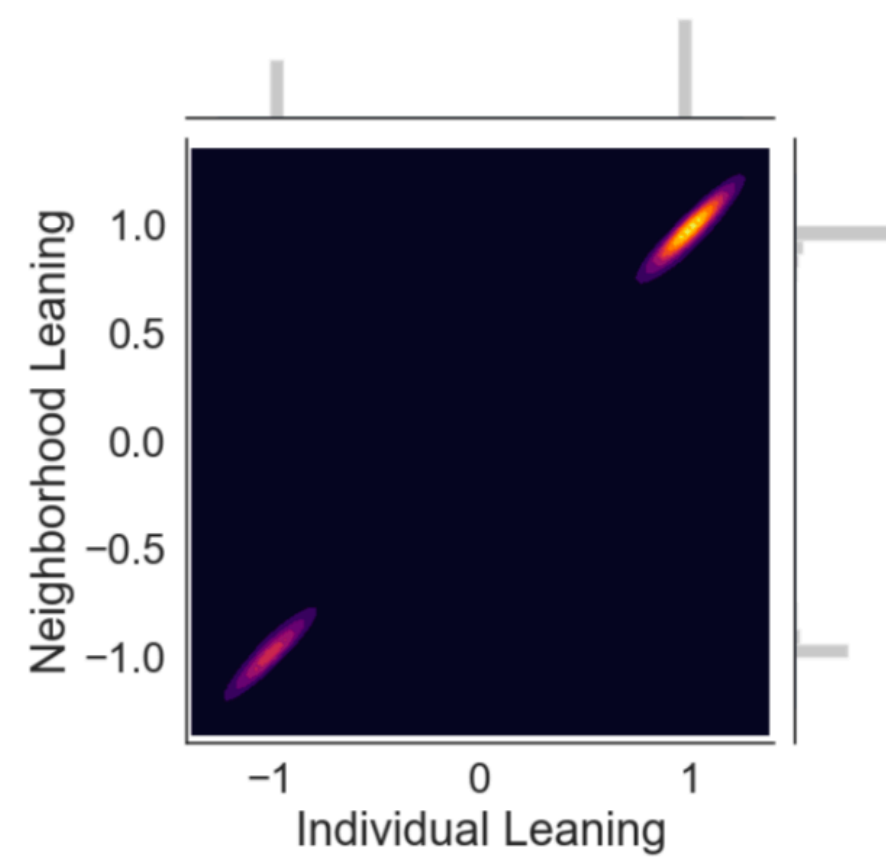
# POLARIZATION ON DIFFERENT PLATFORMS



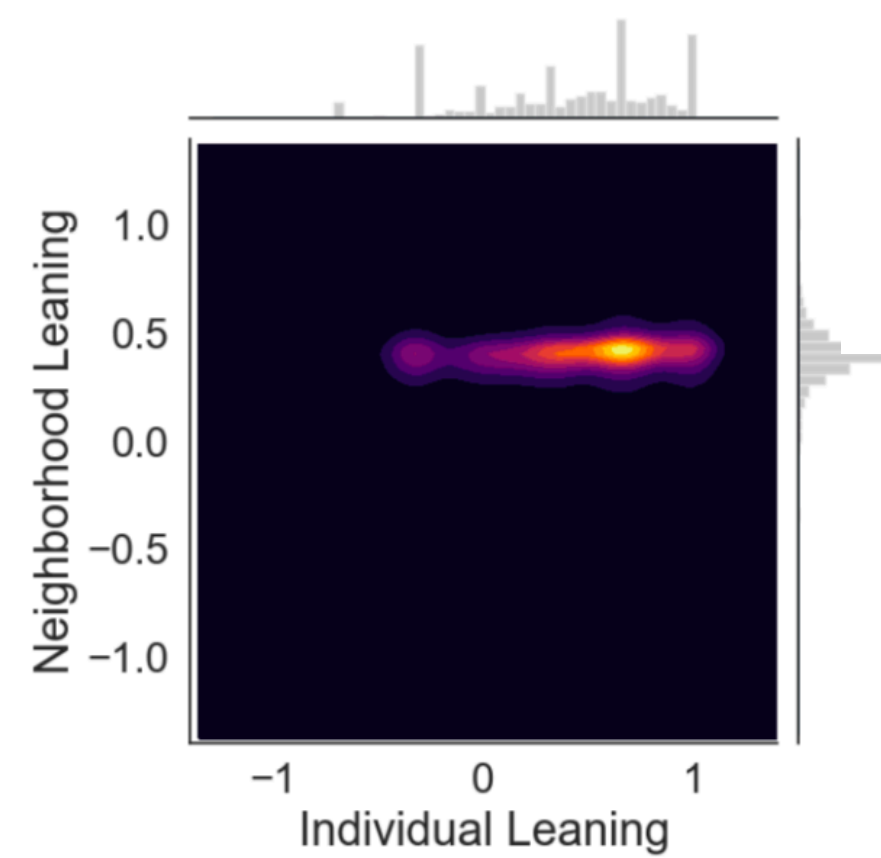
(a) Twitter



(b) Reddit

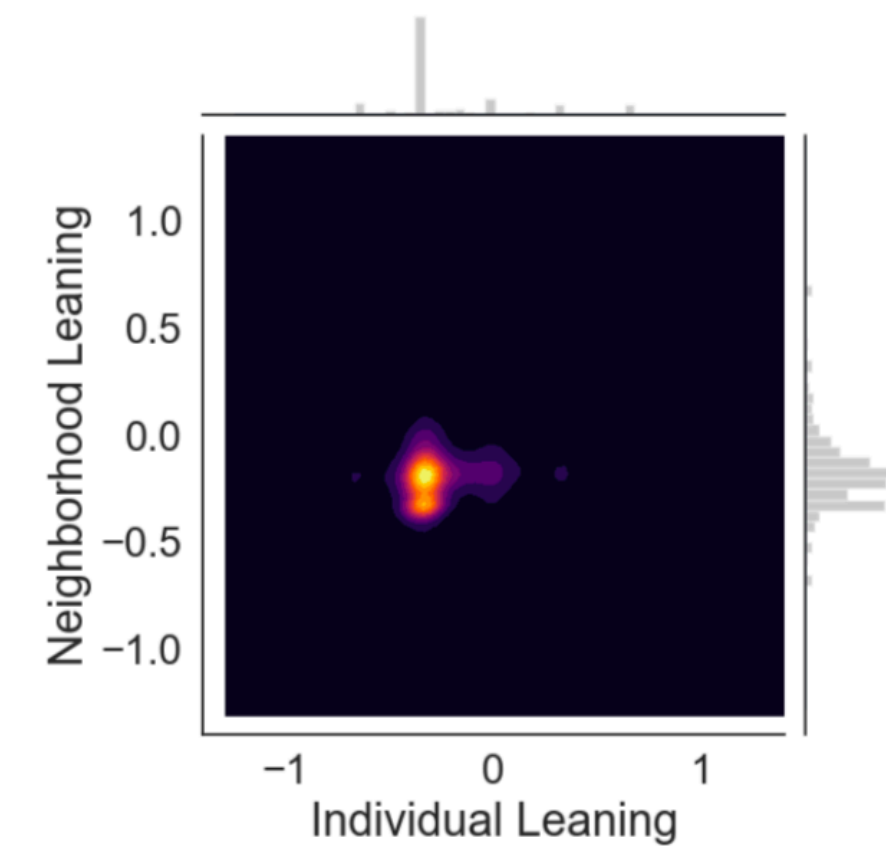
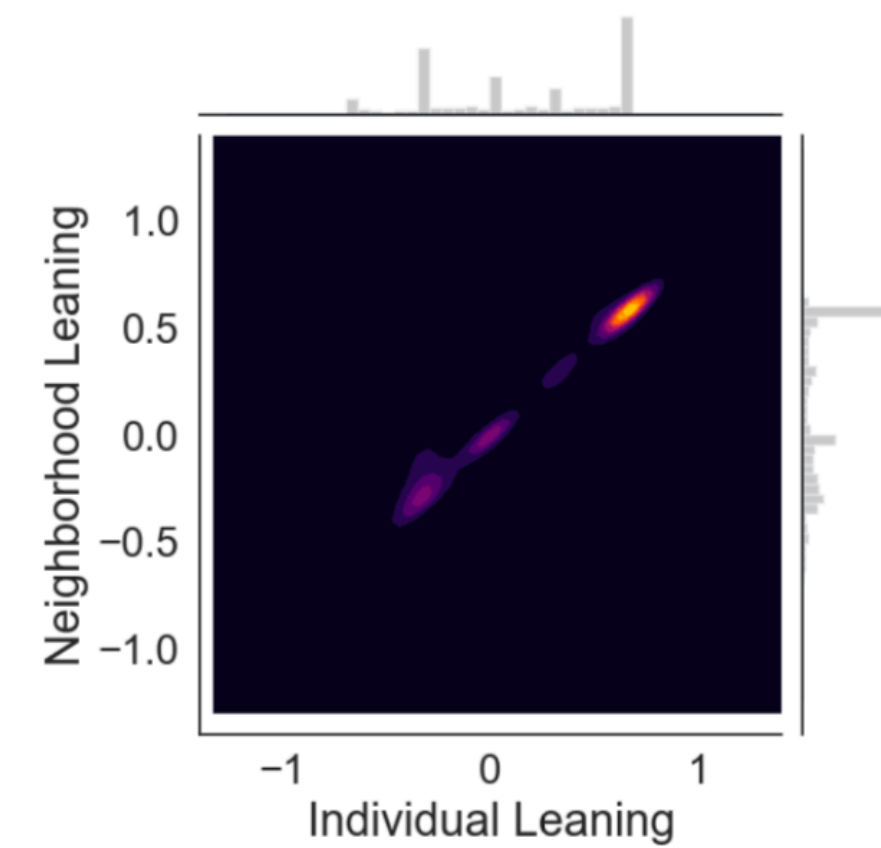


(c) Facebook



(d) Gab

## NEWS AND POLARIZATION



# MODELING ONLINE SOCIAL DYNAMICS

## Goal:

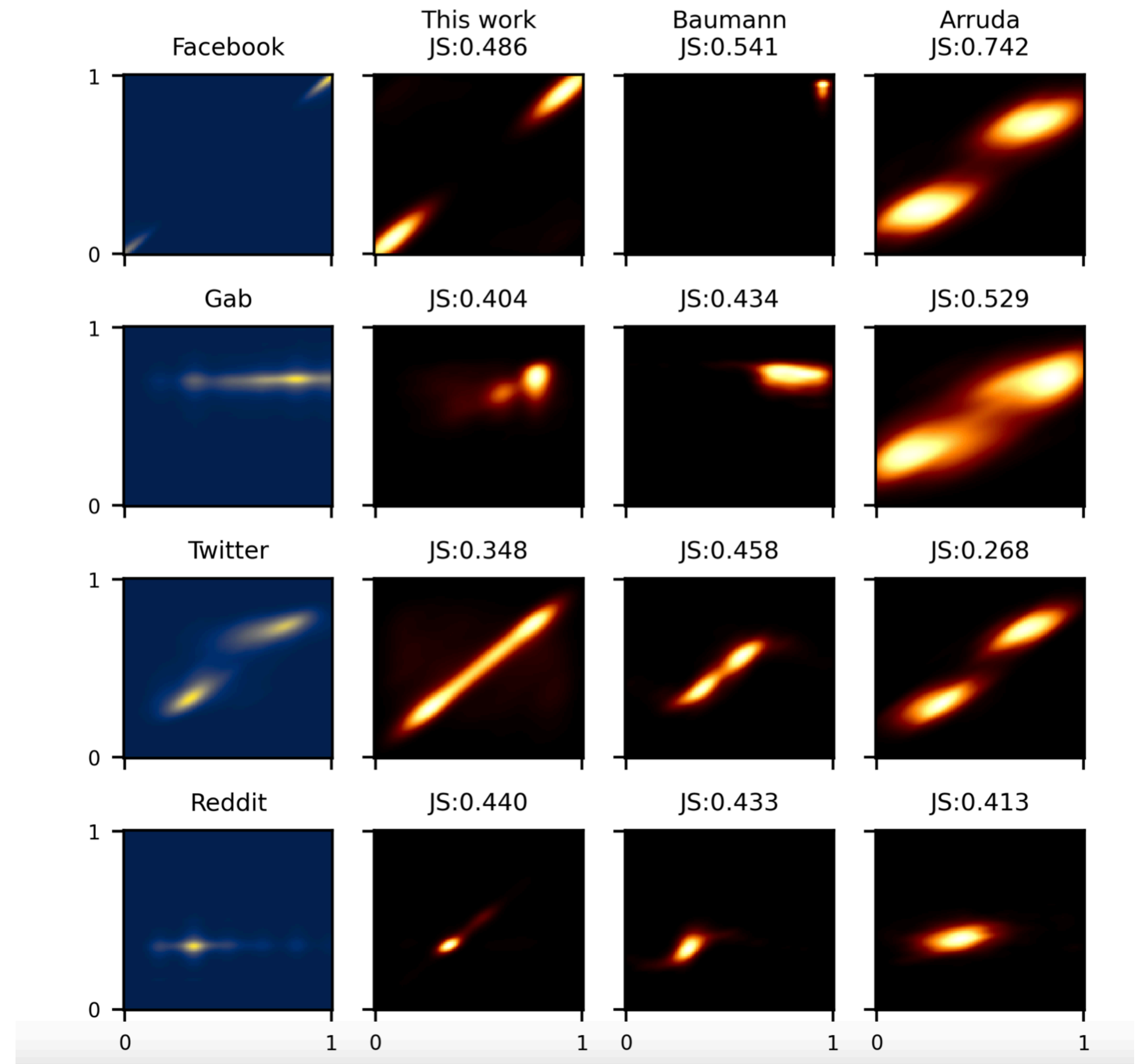
- Understand how polarization and echo chambers develop online by modeling opinion dynamics and validating these models with empirical data.

## Approach:

- Developed a flexible opinion dynamics model incorporating both human cognitive biases and algorithmic factors.
- Validated the model using Jensen-Shannon divergence to compare simulated opinion distributions with actual data from various social media platforms.

## Key Findings:

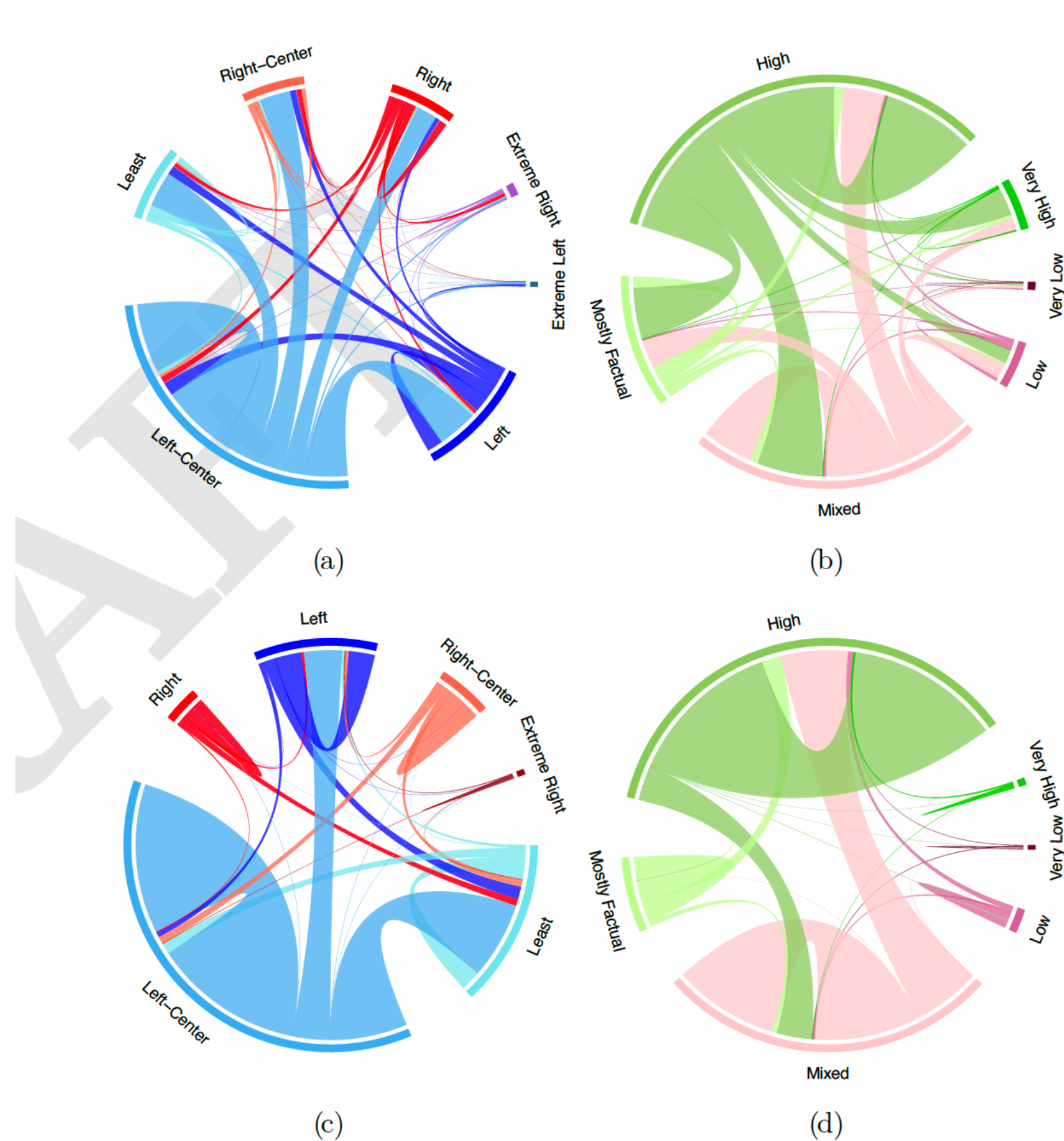
- The interplay between algorithmic bias and user behavior significantly shapes opinion polarization.
- Model parameters were fine-tuned to reflect specific characteristics of each social media platform, aiding in the understanding of how platform dynamics influence discourse.



Valensise, Carlo M., Matteo Cinelli, and Walter Quattrociocchi.

“The drivers of online polarization: Fitting models to data.” *Information Sciences* 642 (2023): 119152.

# Homophily and News Diet: Joining Qualitative and Quantitative Research



**Fig. 1.** Upper panel: Chord diagram illustrating the distribution of news based on the political (a) or factuality (b) classification of the users who shared them. The flows are proportional to the volume of links shared in each class. Lower panel: Chord diagram with flow representing the volume of followers' categories according to the root users class. Followers and root users are categorized using their political bias (c) or factuality (d) class. In both panels, colors indicate the specific class that characterizes the user. Overall, we observe a general coherence of users posting content of the same category, while limited interactions exist among opposite categories.

## Objective:

Investigate how users identify and interact with reliable vs. questionable content.

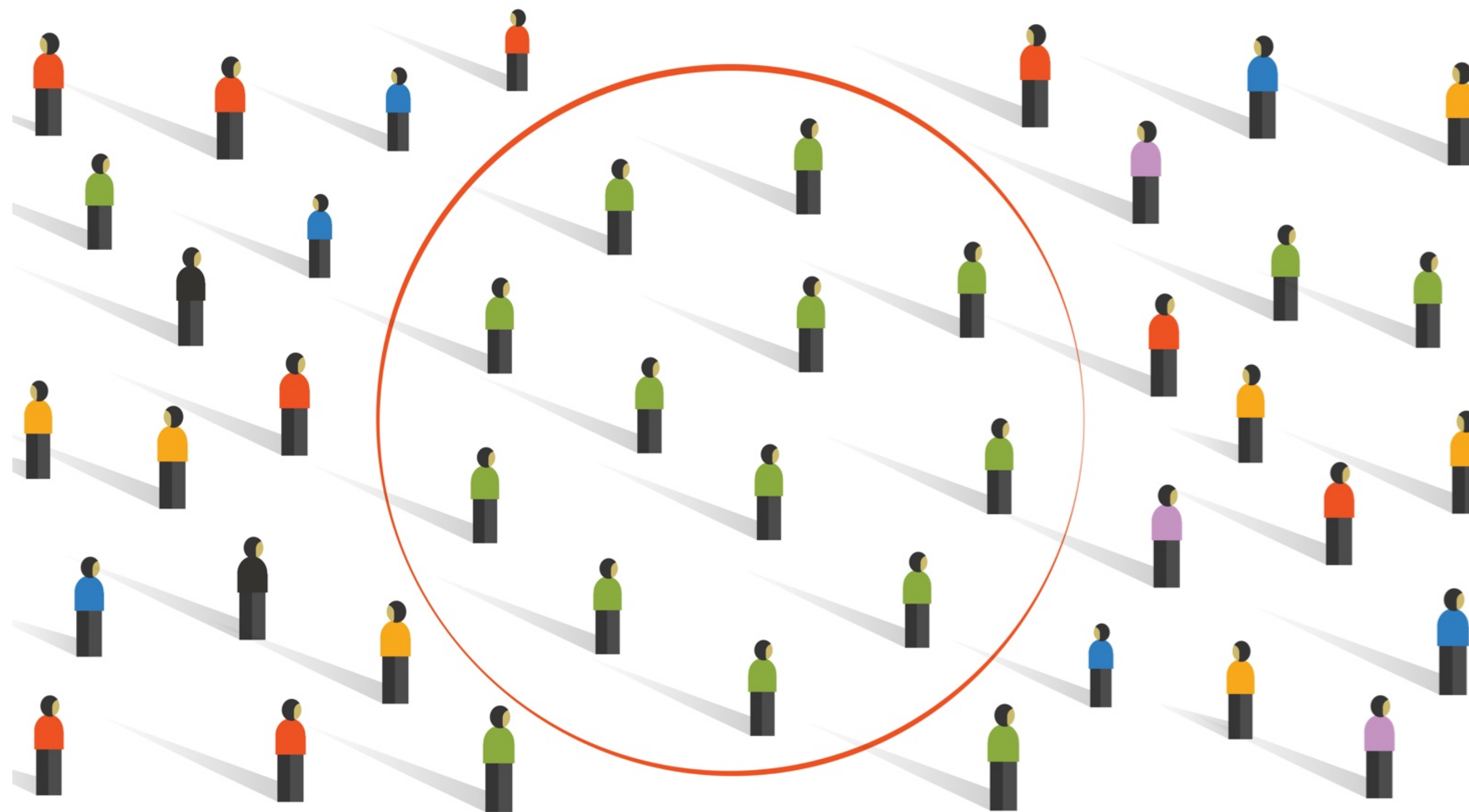
## Method:

- Applied the Misinformation Susceptibility Test (MIST-20) to 463 users.
- Analyzed content engagement of 4 million Twitter followers.

## Findings:

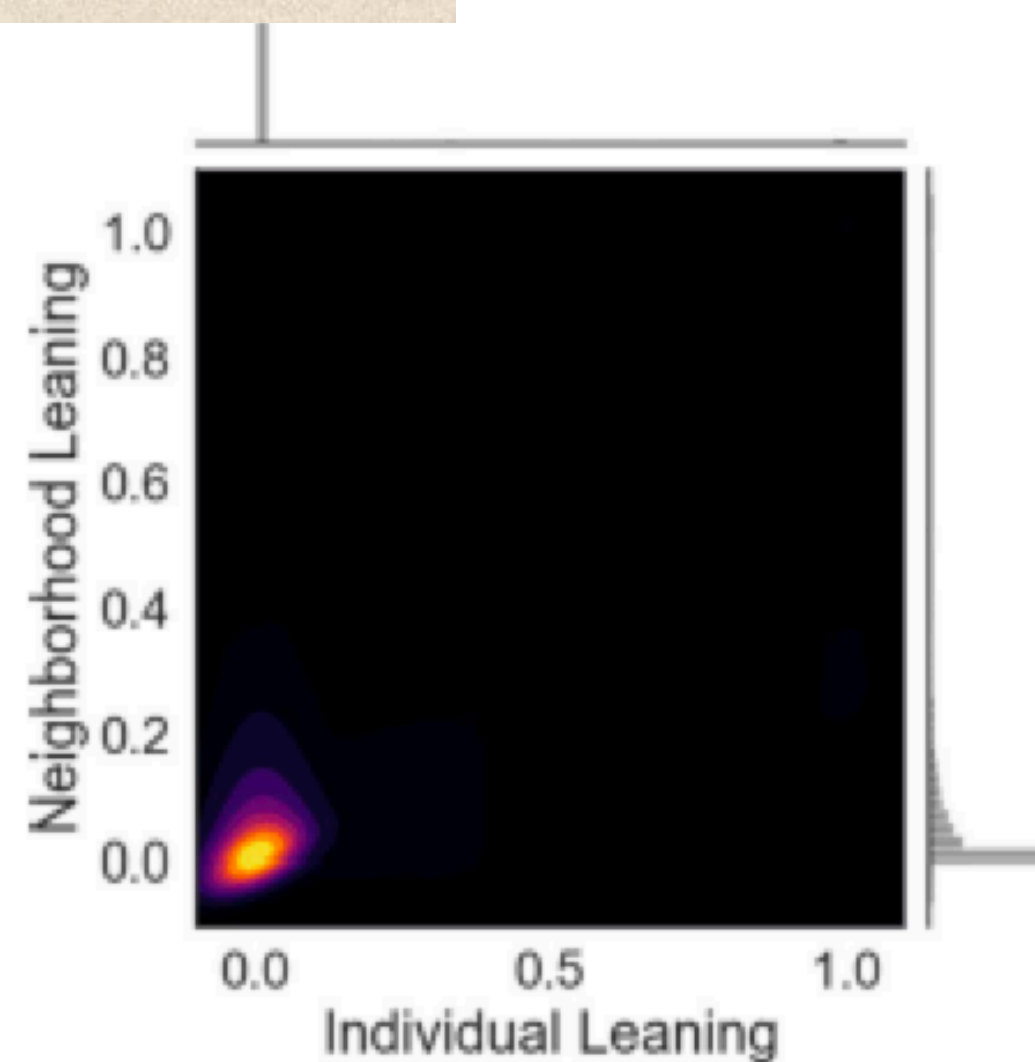
- Strong link between misinformation susceptibility and content's trustworthiness and bias.
- Homophily influences engagement, reinforcing echo chambers.
-

## ECHO CHAMBERS; NORMS AND MODERATION ON SOCIAL MEDIA

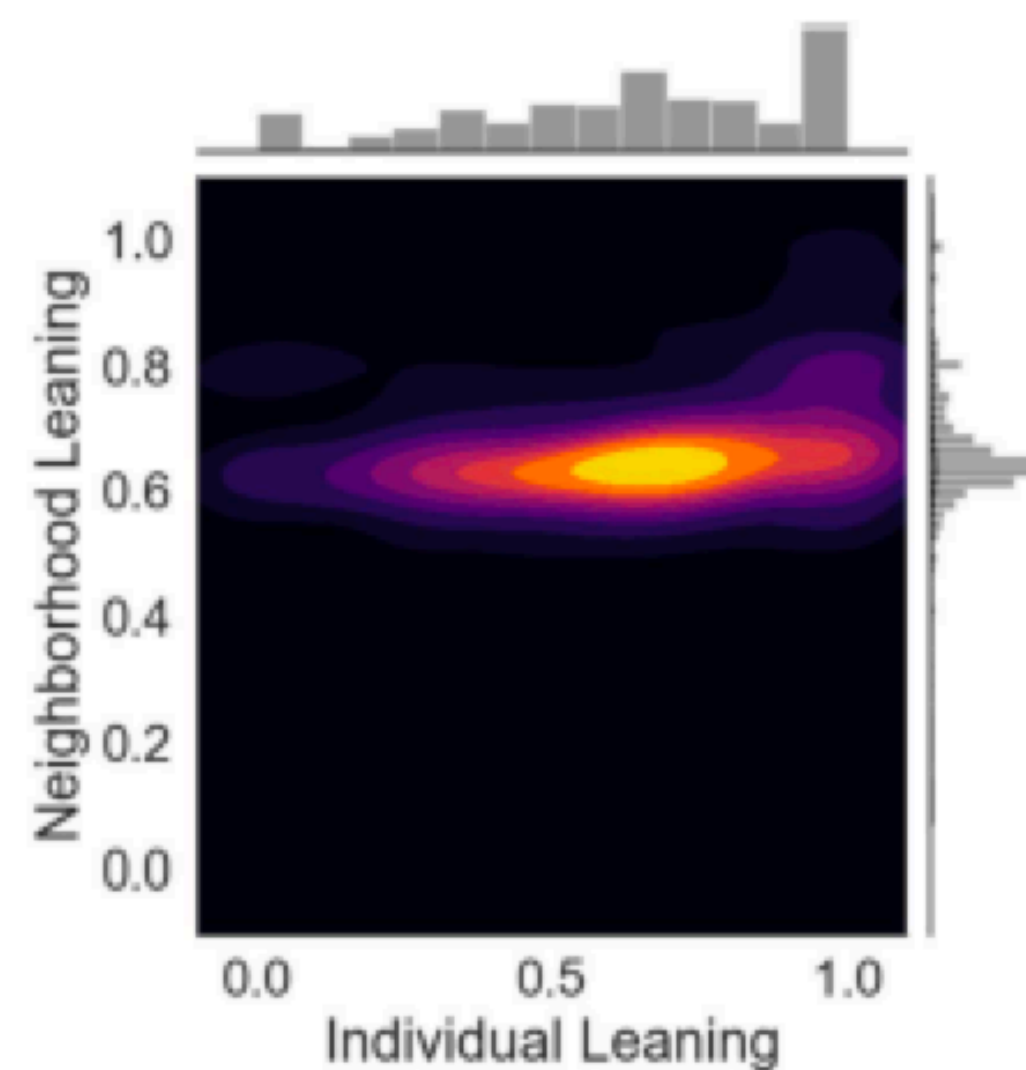


Moderation is the backbone of maintaining a positive online community on social media. It involves overseeing user-generated content to ensure it aligns with platform guidelines, helping to prevent the spread of misinformation, hate speech, and harmful content. Moderators use various tools to filter and manage content, fostering a safe and inclusive environment for all users.

# FROM ECHO CHAMBERS TO ECHO-PLATFORMS: TWITTER VS GAB



(a)



(b)

# Online Conspiracy Communities' Resilience to Deplatforming

## Study Focus:

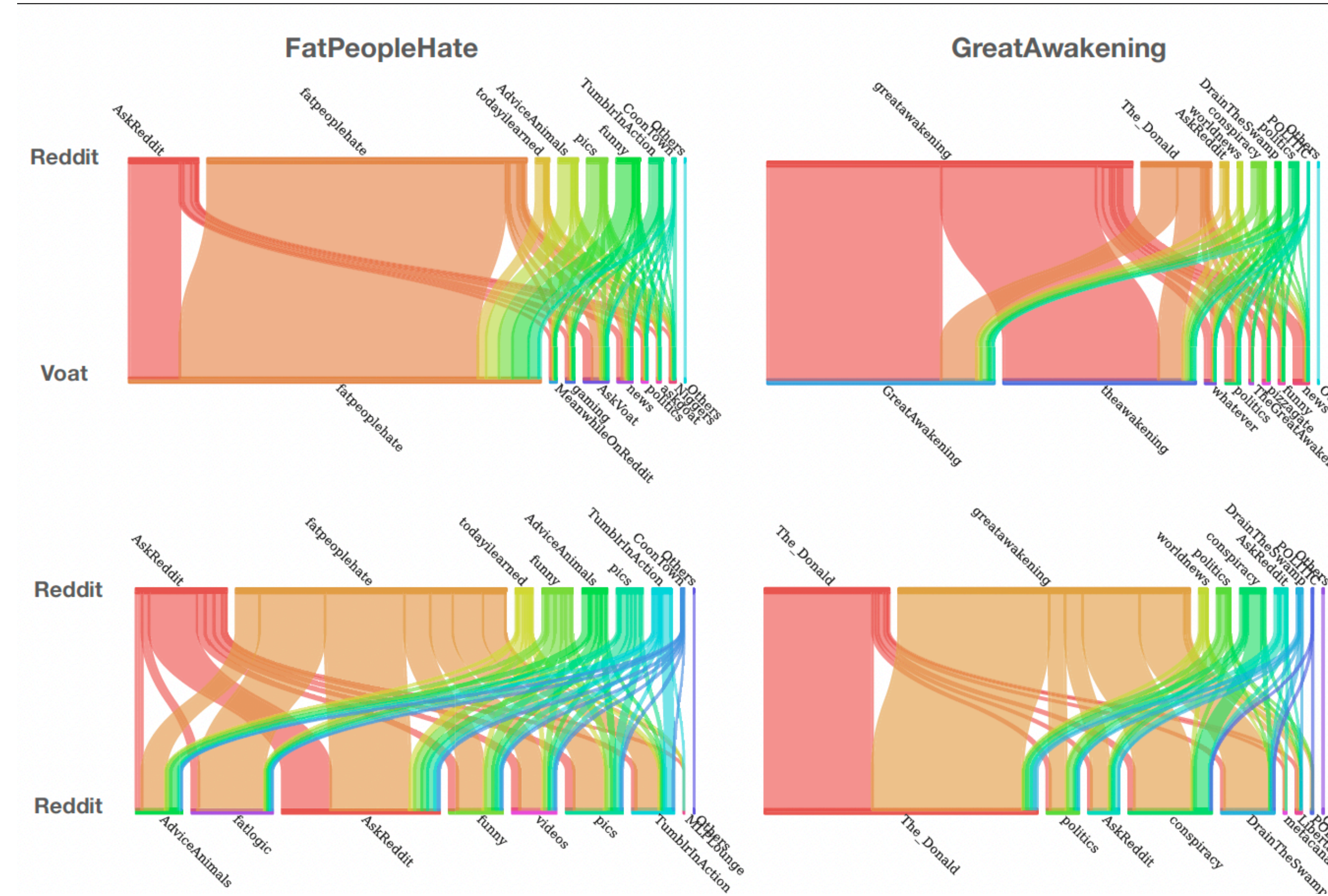
- Examined the effects of deplatforming on users of banned communities by comparing a conspiracy-focused group (GreatAwakening) with a non-conspiracy hate speech group (FatPeopleHate).

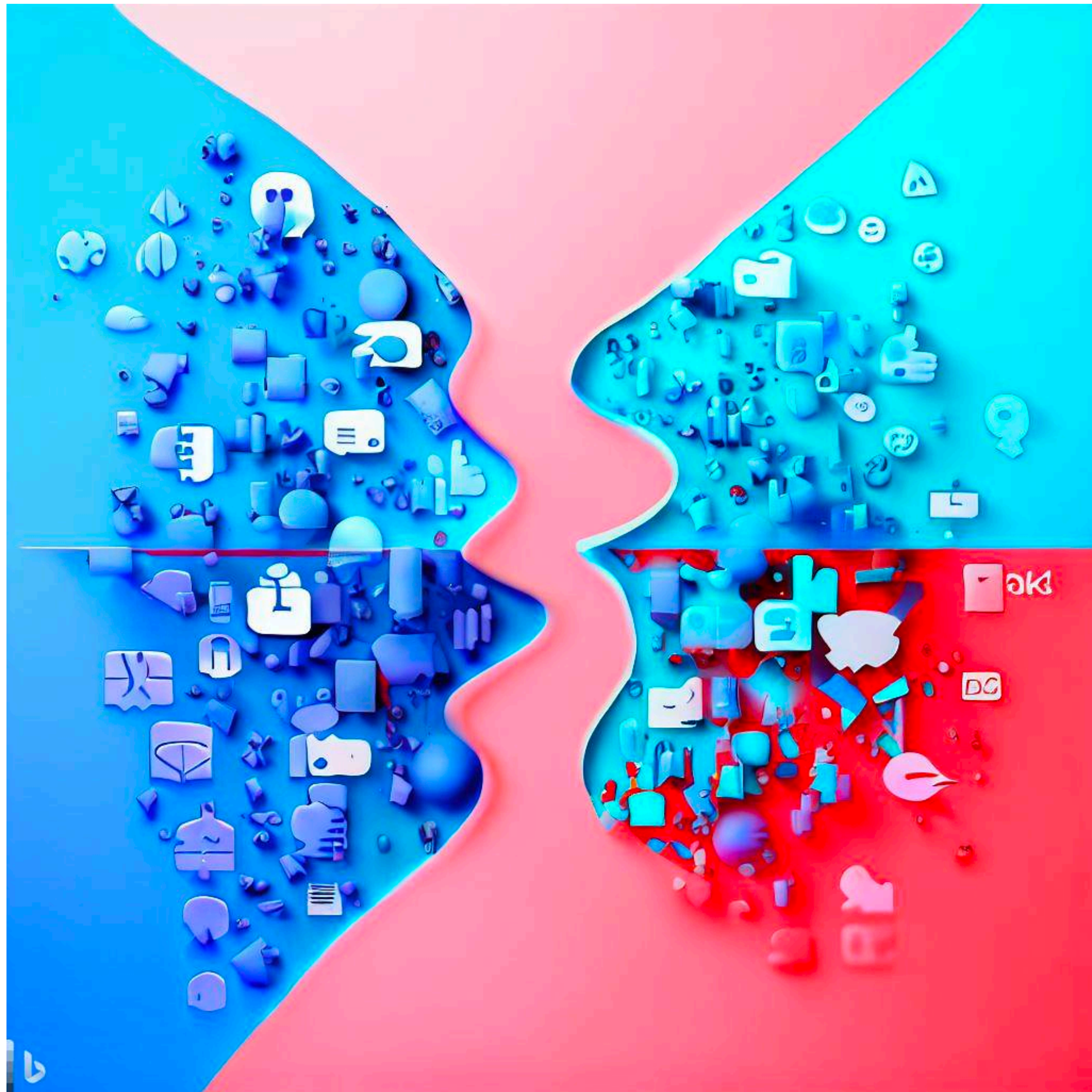
## Key Findings:

- Conspiracy group members were more likely to migrate entirely to new, unmoderated platforms like Voat.
- These users managed to maintain or even increase their engagement and reconstruct their social networks on the new platform.
- Overall, while user activity generally decreased, the use of toxic language significantly increased post-migration.

## Implications:

- Suggests conspiracy communities are particularly resilient to platform bans, maintaining strong ties and high engagement even after migration.





**Fake news vs. real news is not the issue.**

The issue is too much information spreading on entertainment-oriented platforms.



# Beyond Fake News: Infodemic (information overload)

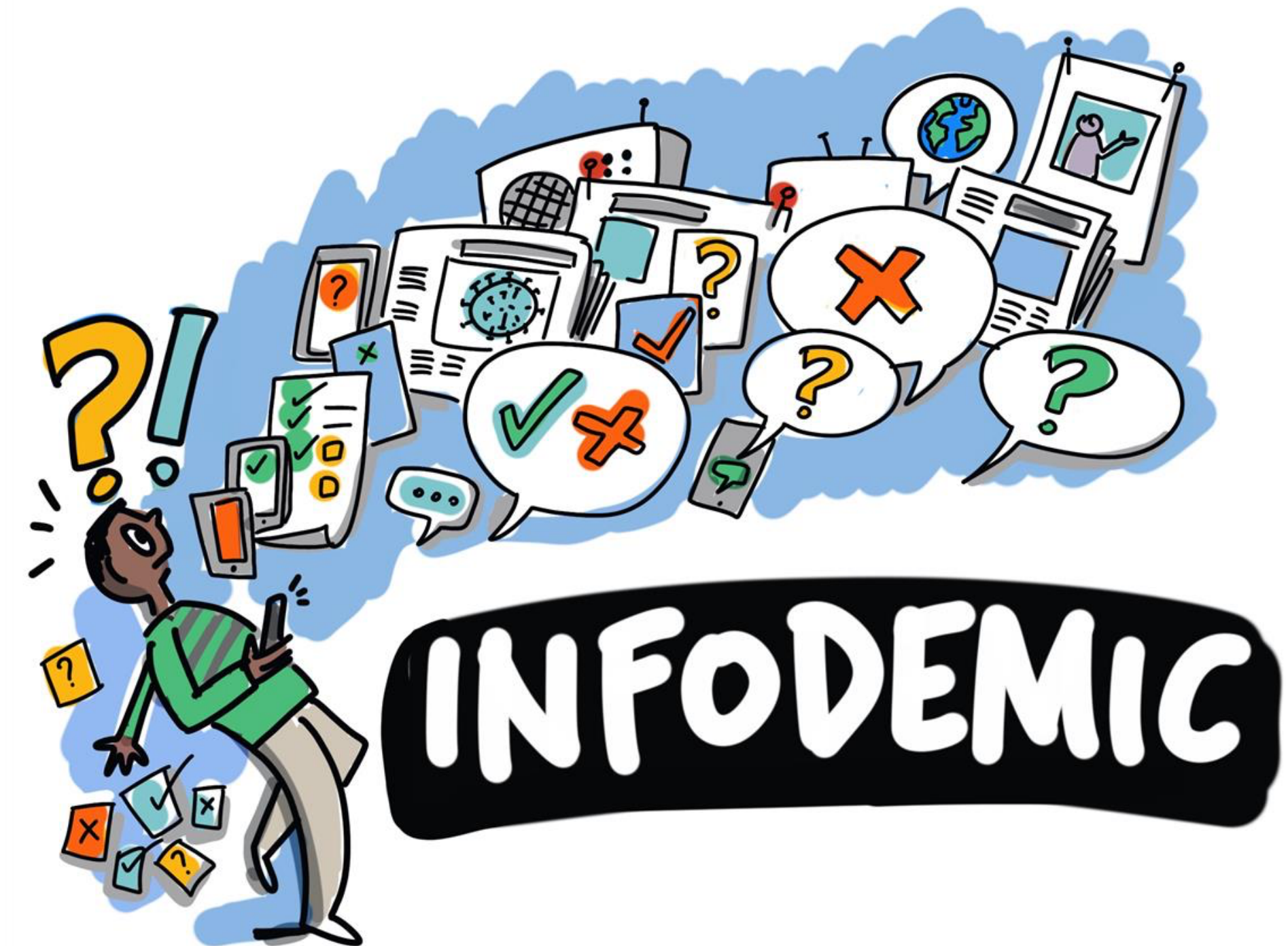
## Infodemics: Overload and Impact During Health Crises

### Definition:

An infodemic involves the rapid spread of both accurate and misleading information during a disease outbreak, exacerbated by digital connectivity.

### Consequences:

- Compromises public health by fostering confusion and risky behaviors.
- Erodes trust in health authorities, weakening outbreak responses.
- Prolongs outbreaks due to public uncertainty on protective measures.



# The COVID-19 Social Media Infodemic

[https://arxiv.org/abs/  
2003.05004](https://arxiv.org/abs/2003.05004)



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



More than 3.7M users



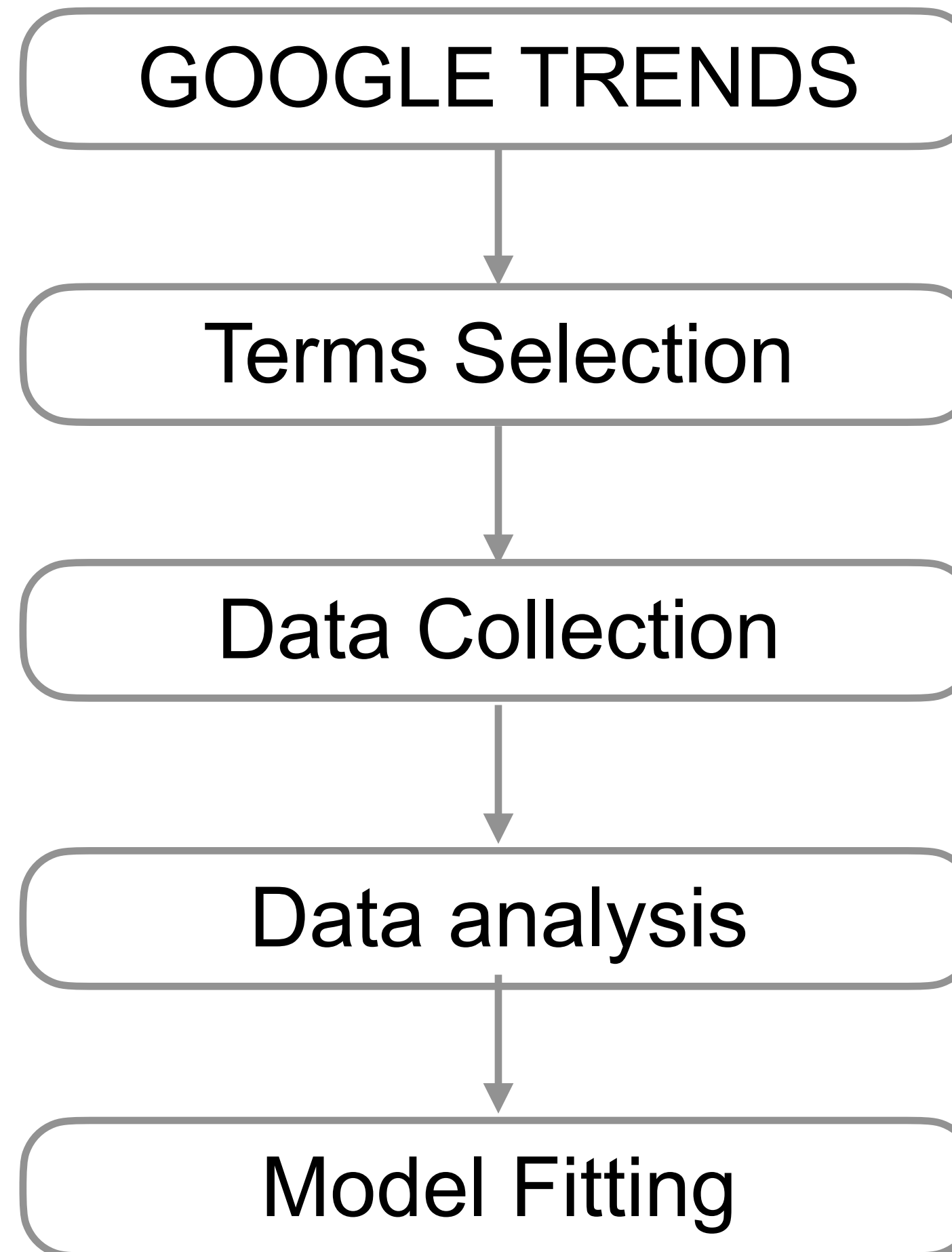
More than 8M of unique  
contents



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

# The COVID-19 Social Media Infodemic

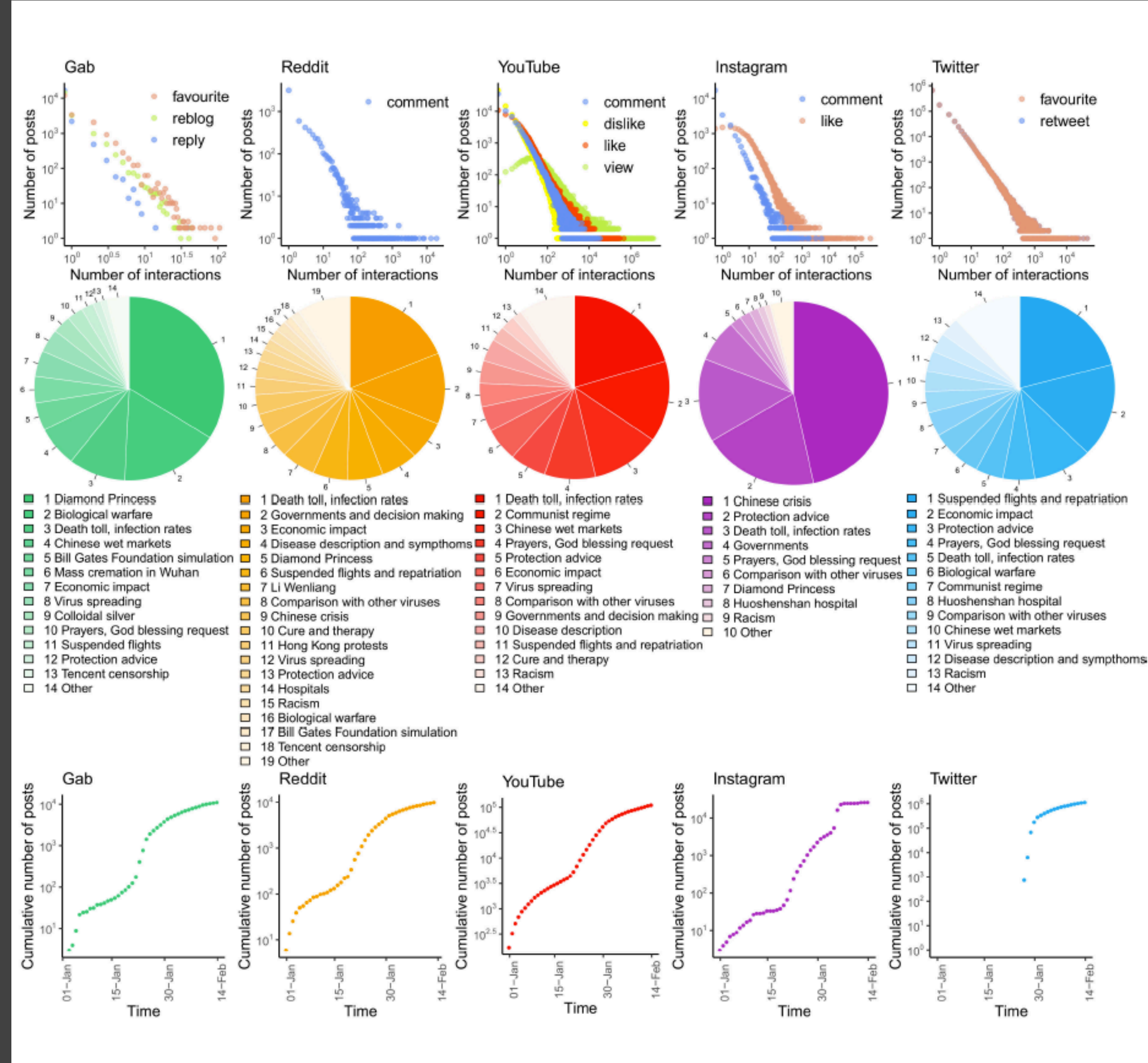
## Workflow



# 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



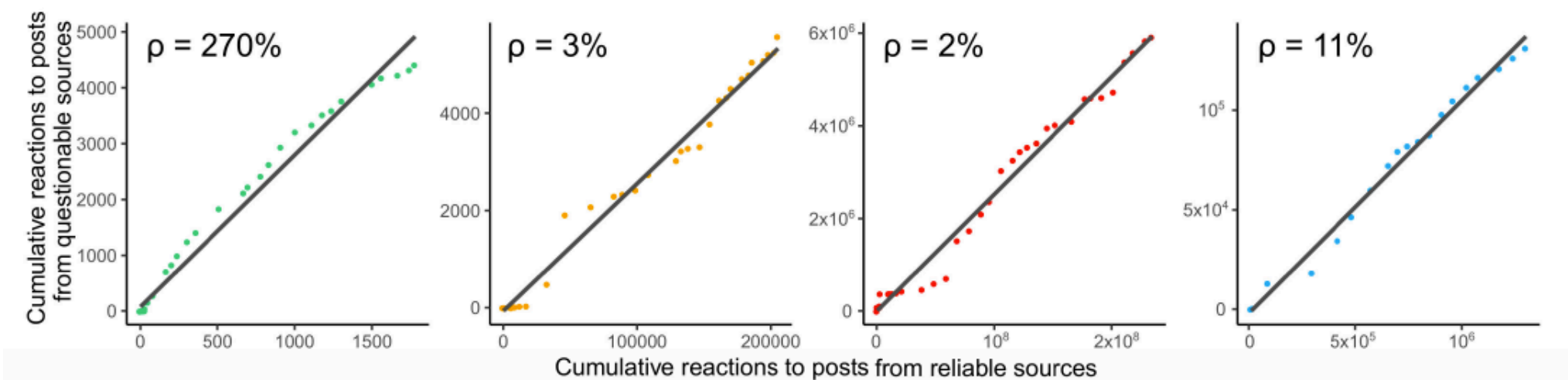
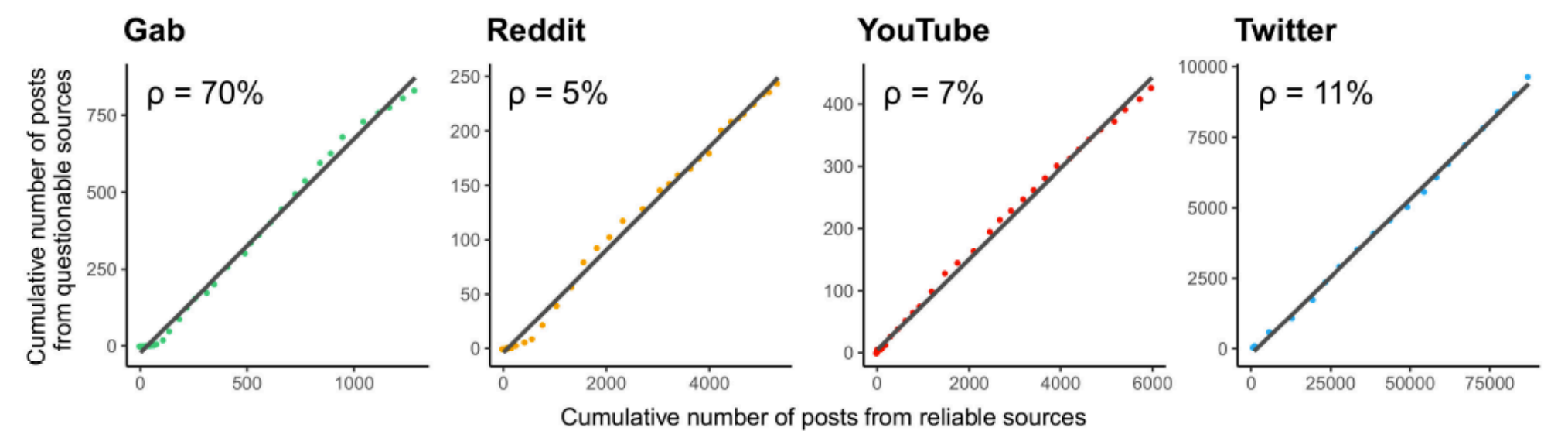
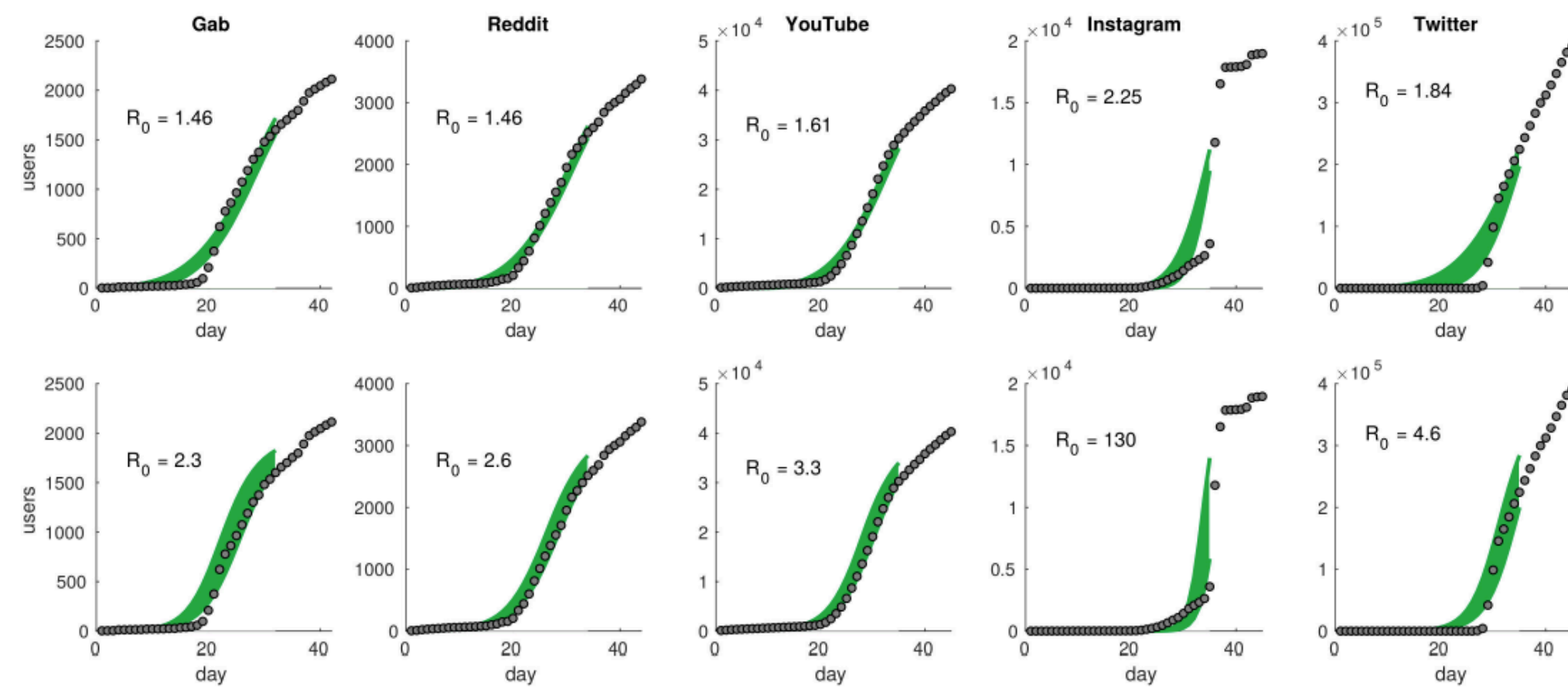
# The COVID-19 Social Media Infodemic

## 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. Briand<sup>1</sup>, Matteo Cinelli<sup>2</sup>, Tim Nguyen<sup>3</sup>, Rosamund Lewis<sup>4</sup>, Dimitri Prybylski<sup>5</sup>, Carlo M. Valensise<sup>6</sup>, Vittoria Colizza<sup>7</sup>, Alberto Eugenio Tozzi<sup>8</sup>, Nicola Perra<sup>9</sup>, Andrea Baronchelli<sup>10</sup>, Michele Tizzoni<sup>11</sup>, Fabiana Zollo<sup>2</sup>, Antonio Scala<sup>12, 13</sup>, Tina Purnat<sup>3</sup>, Christine Czerniak<sup>1</sup>, Adam J. Kucharski<sup>14</sup>, Akhona Tshangela<sup>15</sup>, Lei Zhou<sup>16</sup>, Walter Quattrocchi<sup>17</sup>  

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

[Get rights and content](#)

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.

# 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



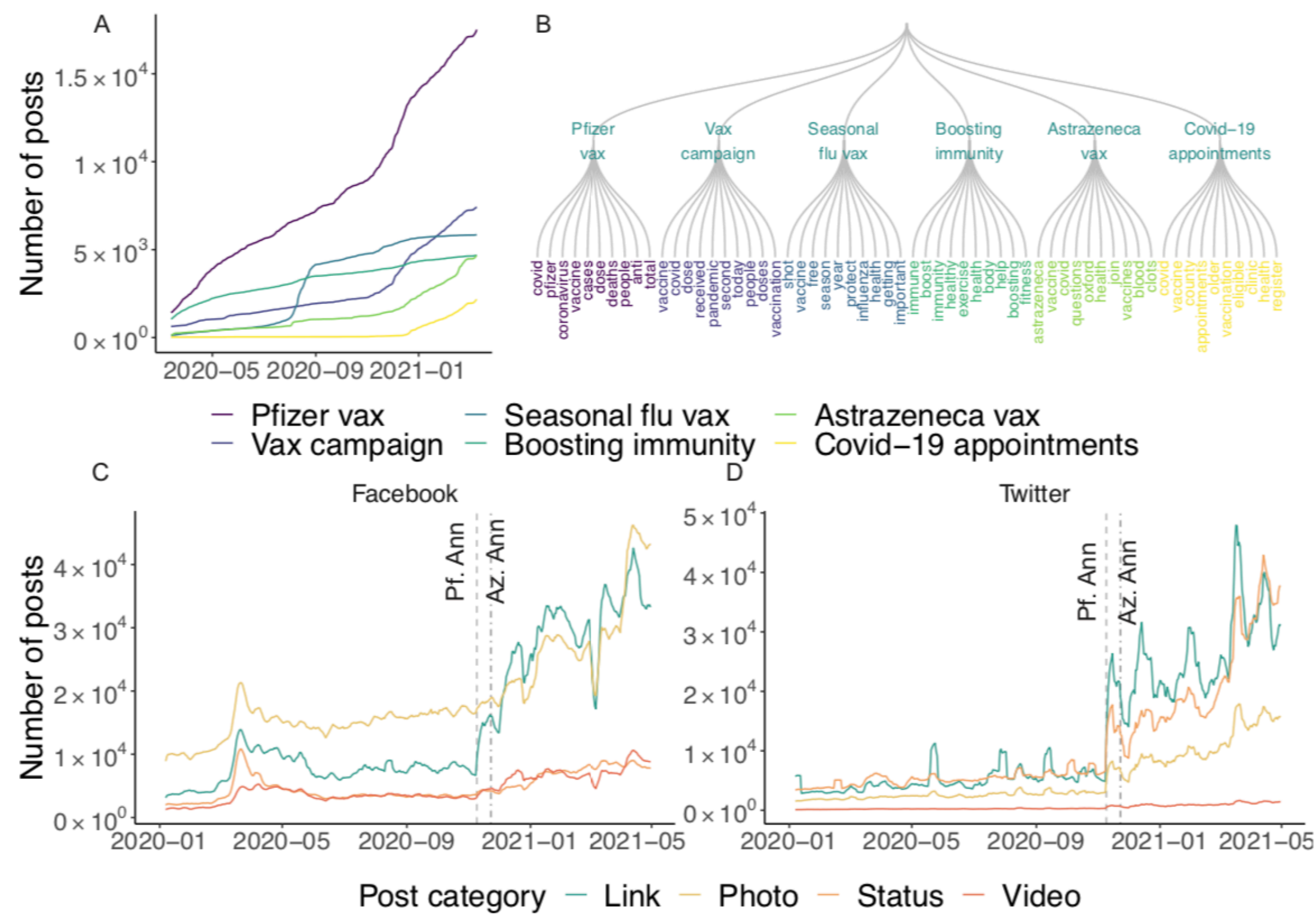


Figure 1: **Vaccine debate on social media platforms.** Panel A: evolution of debated topics over time. Panel B: Keywords representing the main topics. Panel C and D: seven days moving average of posts divided by category for Facebook and Twitter respectively. Dashed lines represent the announcement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



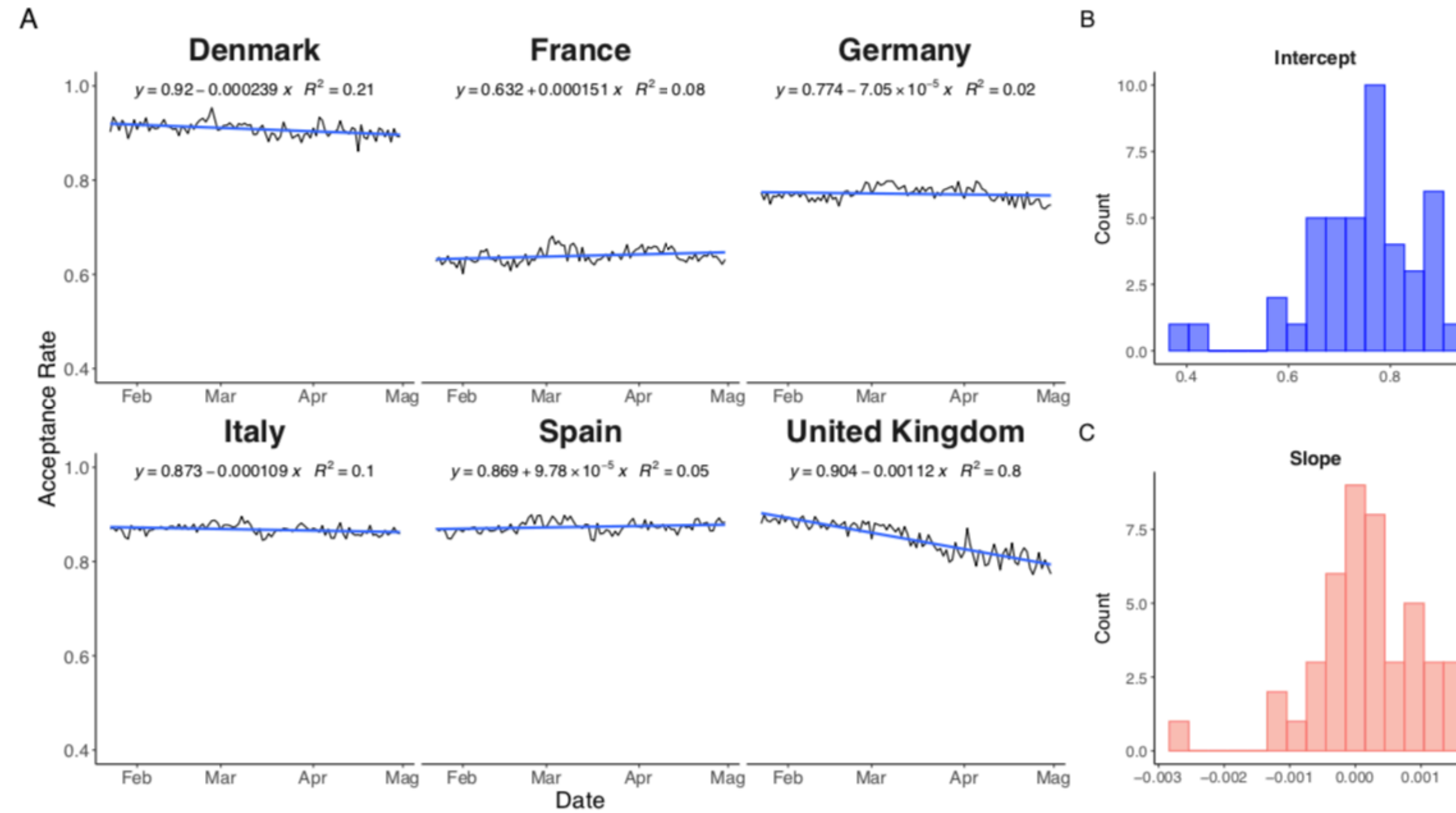


Figure 3: **Steady acceptance of COVID-19 vaccines.** Panel A: Black lines represent three days moving average of vaccine acceptance rate for Denmark, France, Germany, Italy, Spain, and United Kingdom from 23 January to 30 April 2021 according to Facebook COVID-19 Trends and Impact Survey. The blue lines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

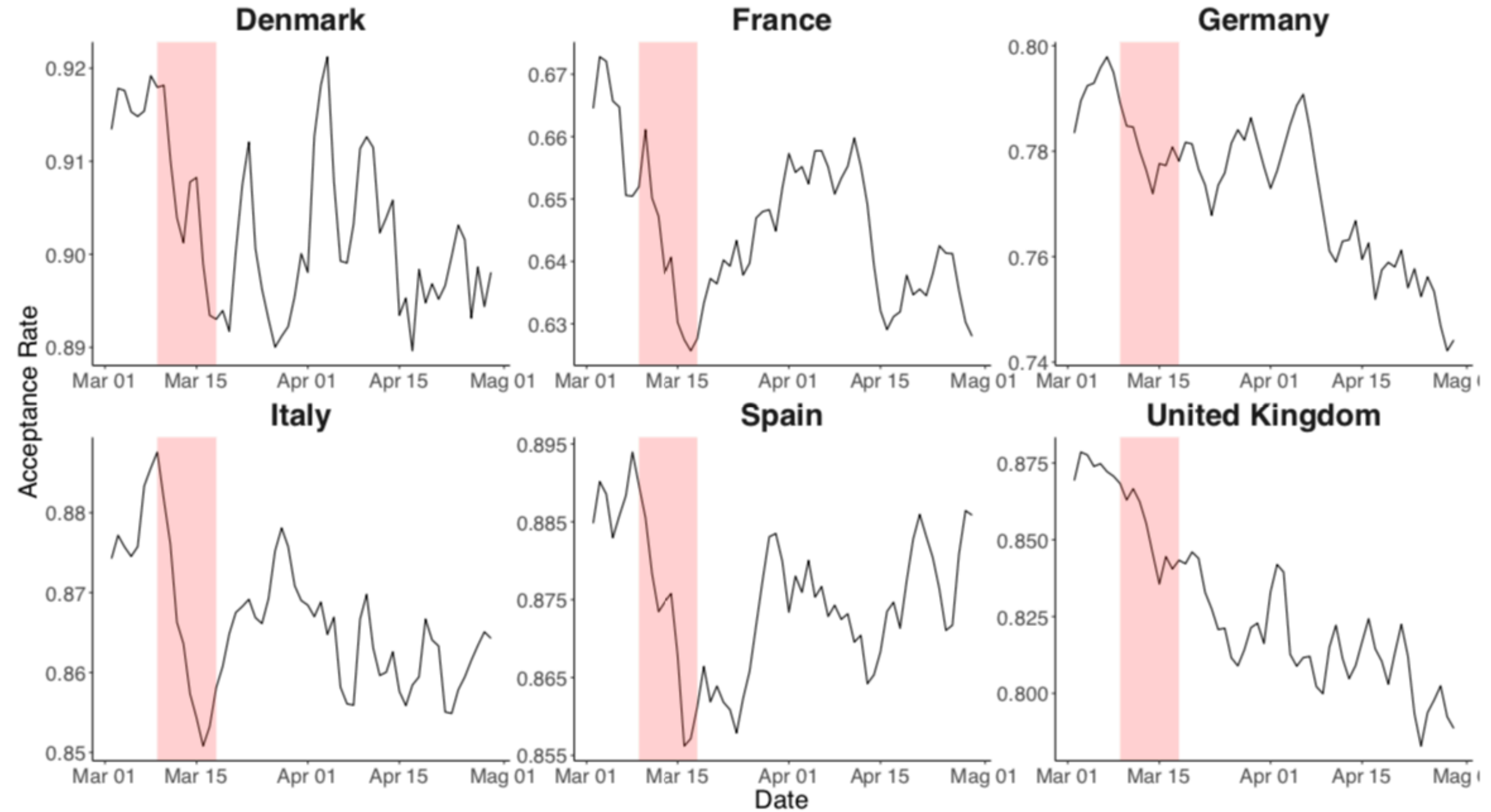


Figure 4: **Impact of AstraZeneca concerns on vaccine acceptance rate.** Black curve: three days moving average of vaccine acceptance rate for Denmark, France, Germany, Italy, Spain, and United Kingdom from 23 January to 30 April 2021 according to Facebook COVID-19 Trends and Impact Survey. Red area: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

# Characterizing Facebook Engagement Dynamics

## Study Overview:

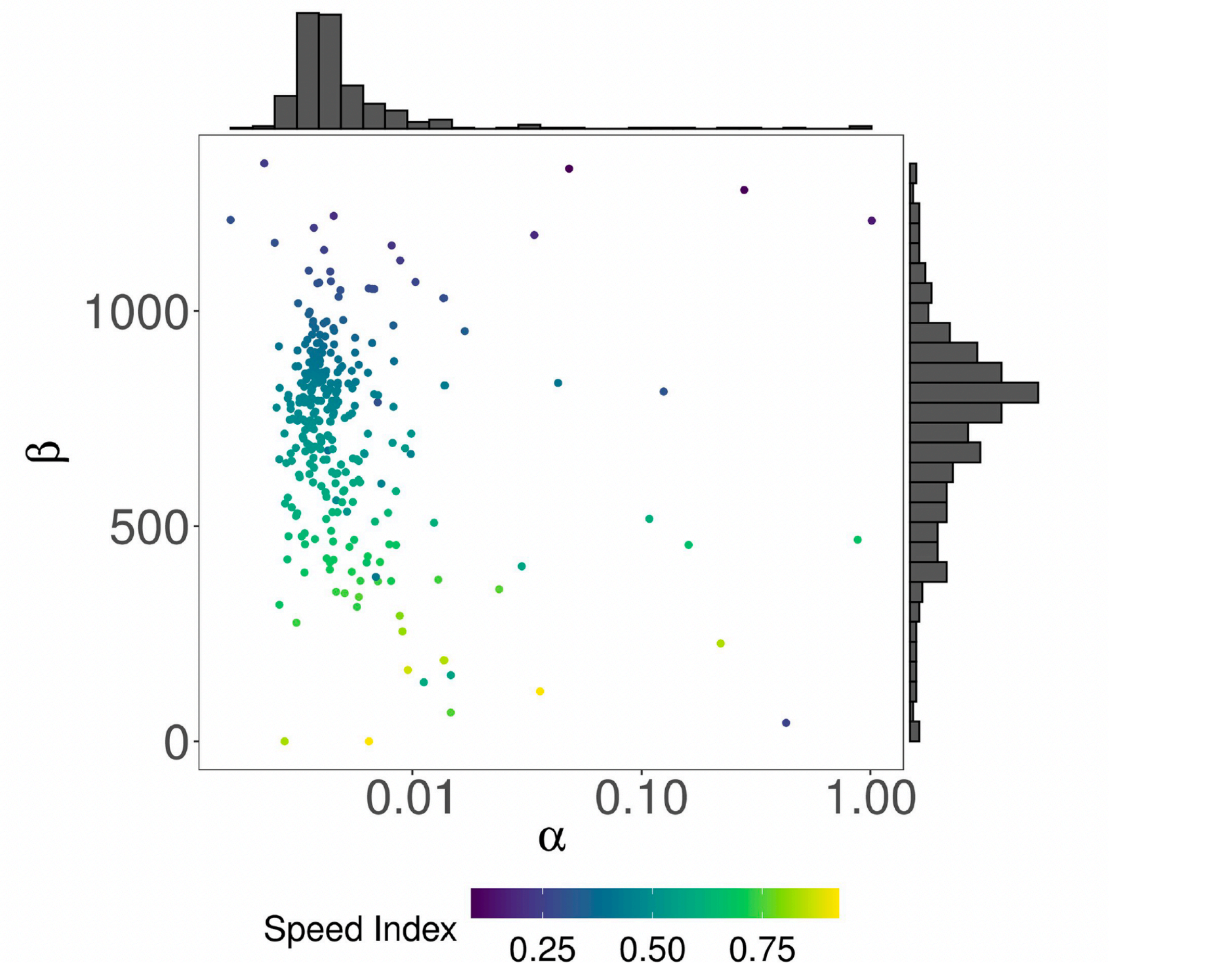
- Analyzed 57 million Facebook posts across 300 topics from 2018 to 2022.
- Investigated how topics like scandals and social issues evolve in engagement and impact user polarization.

## Key Methods:

- Used logistic functions to assess the growth and patterns of topic engagement.
- Developed a "Love-Hate Score" to gauge the sentiment of user reactions and predict the potential for adverse reactions.

## Findings:

- Engagement patterns showed similar growth across different topics, suggesting universal behaviors in how topics gain attention.
- Early bursts of engagement can predict negative user reactions, highlighting the impact of how topics are presented.

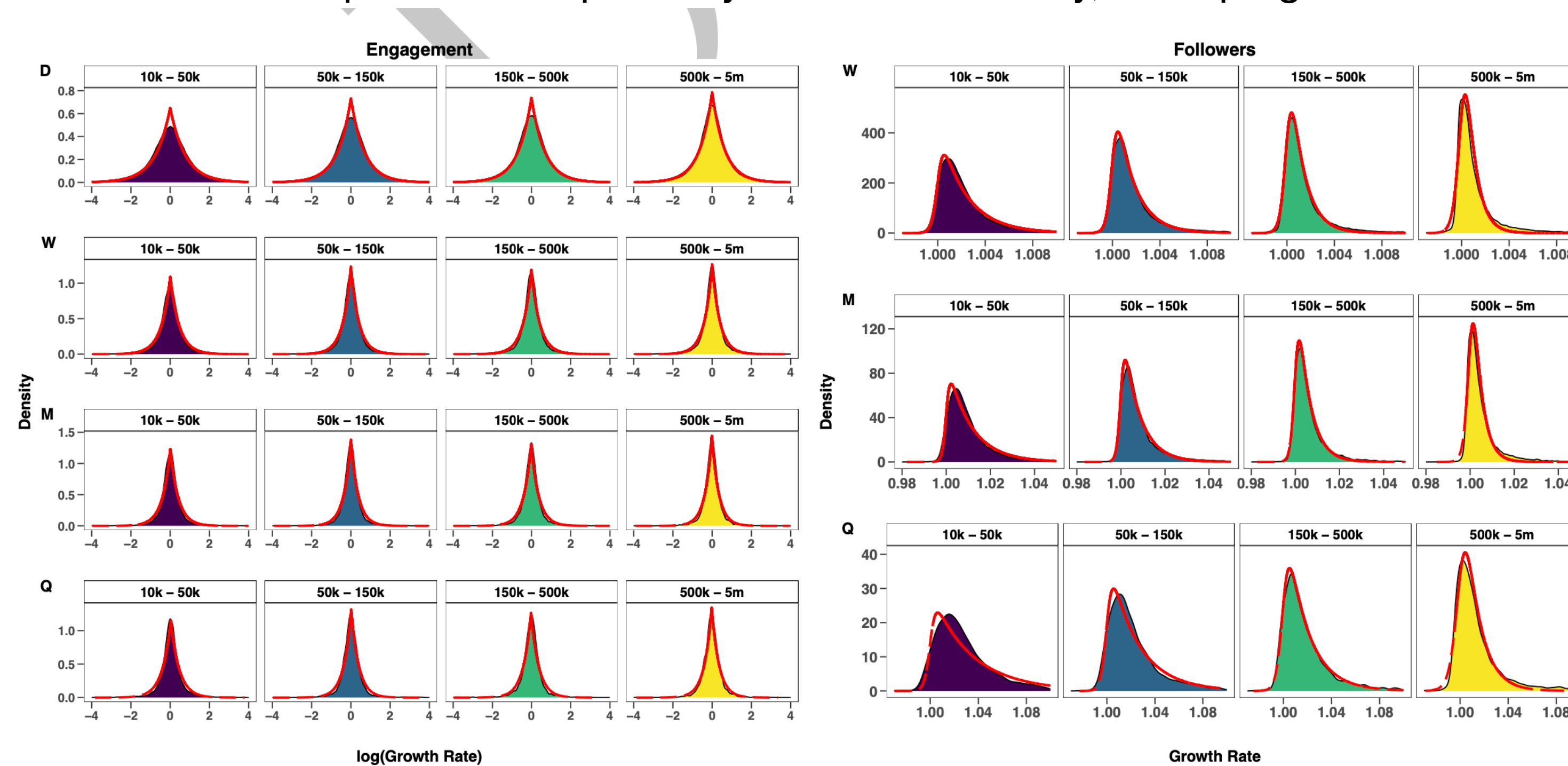


# Exploring News Virality on Social Media

Analyzed data from over 1,000 news outlets with around 57 million posts spanning 2008 to 2022 on Facebook.

## Key Insights:

- Virality of news is not determined by the size or historical engagement of outlets, challenging assumptions about influence dynamics on social media.
- Engagement from unreliable sources tends to decrease over time, reflecting growing audience discernment.
- Random processes rather than outlet prominence primarily drive news virality, reshaping our understanding of content spread on digital platforms.



**Fig. 2.** Comparison of observed and theoretical growth rate distributions for Engagement and Followers. Red lines denote theoretical densities obtained by fitting empirical ones, with labels D, W, M, and Q indicating Daily, Weekly, Monthly, and Quarterly timescales.

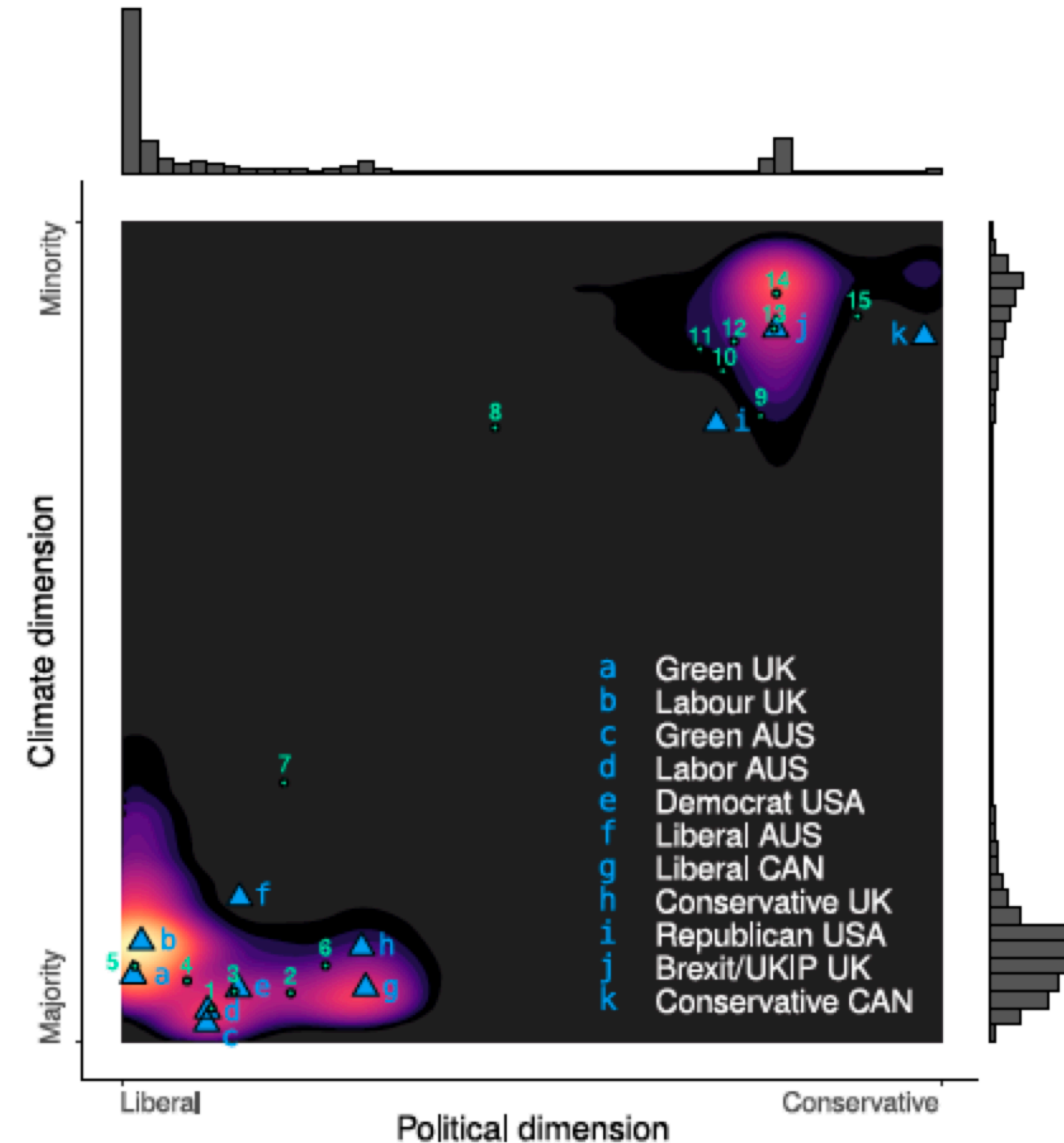
# INFODEMICS AND CLIMATE CHANGE

**Observation:** General interest in climate change remains limited, yet discussions spike significantly during key events like the COP meetings.

## Key Insights:

- COP26 marked a substantial increase in ideological polarization compared to earlier COP sessions, driven by a surge in right-wing participation.
- The rise of 'climate contrarian' views, particularly themes of political hypocrisy, gained cross-ideological traction, highlighting shifting dynamics in climate discourse.

- 1 Anti-Morrison
- 2 Biodiversity & Localism, Women at COP, Climate Finance, Youth
- 3 Climate Justice  
Decolonise Climate
- 4 Sustainable Transport
- 5 Activists for Climate Action
- 6 Climate Crisis
- 7 Anti-Johnson
- 8 Anti-Sturgeon
- 9 Climate Alarmists
- 10 Wind Energy & Nuclear
- 11 Thunberg Cult
- 12 Chinese Absence, Vaccine Passports
- 13 Anti-Biden, Didn't Vote Green, Arctic Ice, Climate "Scam", Benefits of Warming
- 14 Illegal Immigration, Net Zero Referendum, Private Jets, Hypocrisy, CO2
- 15 Anti-Trudeau



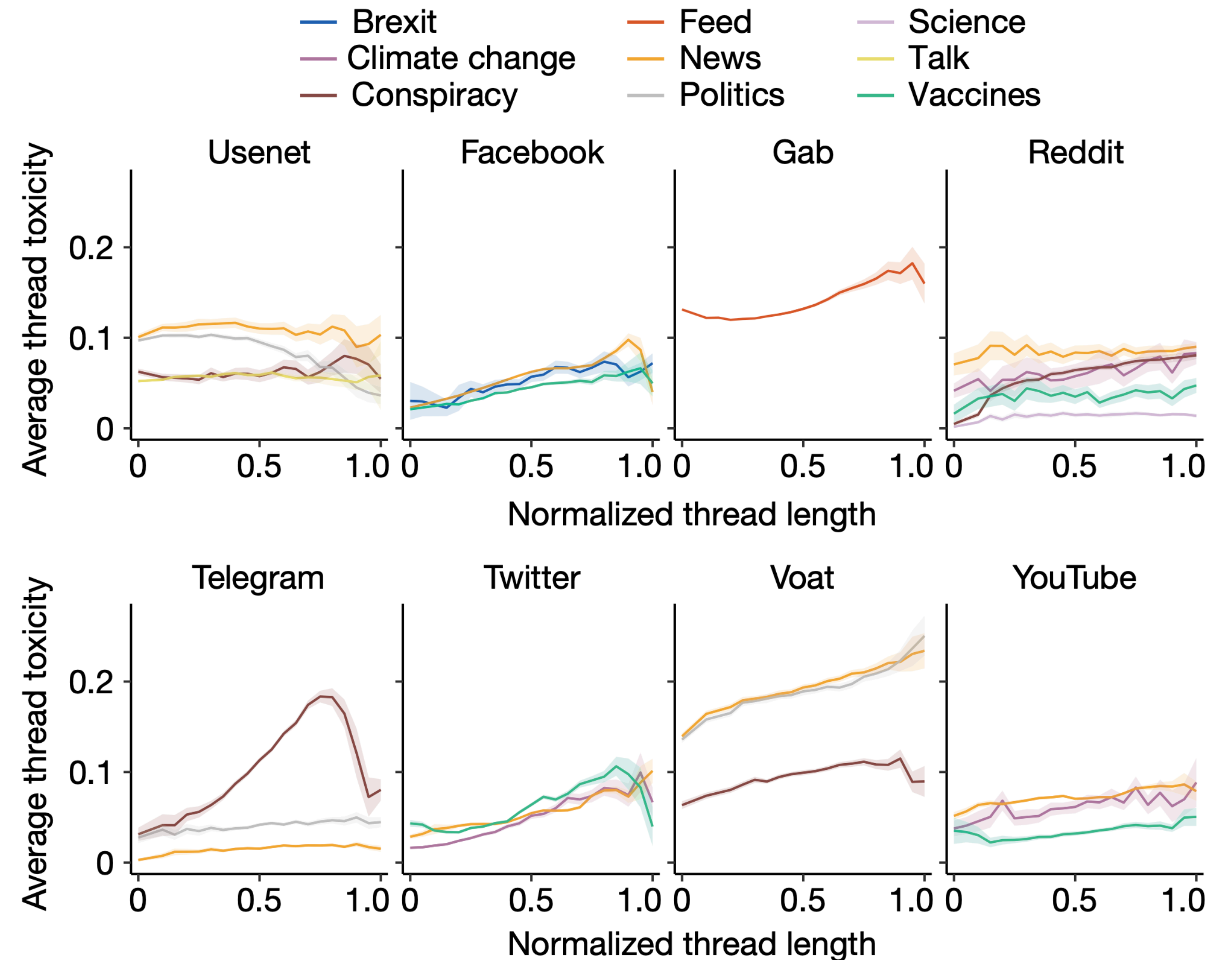
**Growing Climate Polarization on Social Media  
Nature Climate Change (2022)**

# TOXICITY IN ONLINE CONVERSATIONS

**Objective:** Investigate how user interactions and content toxicity have evolved across various social media platforms over the last 34 years.

**Analyzed 500 million comments from 8 different platforms**

- Despite platform and societal changes, toxic interaction patterns remain consistent.
- Long conversations and those with diverse viewpoints show increased toxicity.
- User engagement does not decline with increased toxicity, suggesting resilience to toxic content.



**Fig. 2 | Toxicity increases with conversation size.** The mean fraction of toxic comments in conversations versus conversation size for each dataset. Trends represent the mean toxicity over each size interval and their 95% confidence

# VOCABULARY IN ONLINE CONVERSATIONS

## Objective:

- Analyze the vocabulary size across 300 million comments to understand linguistic behavior patterns on social media.

## Methods:

- Examined comments from various platforms including Facebook, Twitter, and Reddit using metrics like type-token ratios and lexical richness.
- Employed tokenization and stemming for text preprocessing.

## Findings:

- General consistency in vocabulary usage across platforms, with most users employing between 5 to 10 unique words.

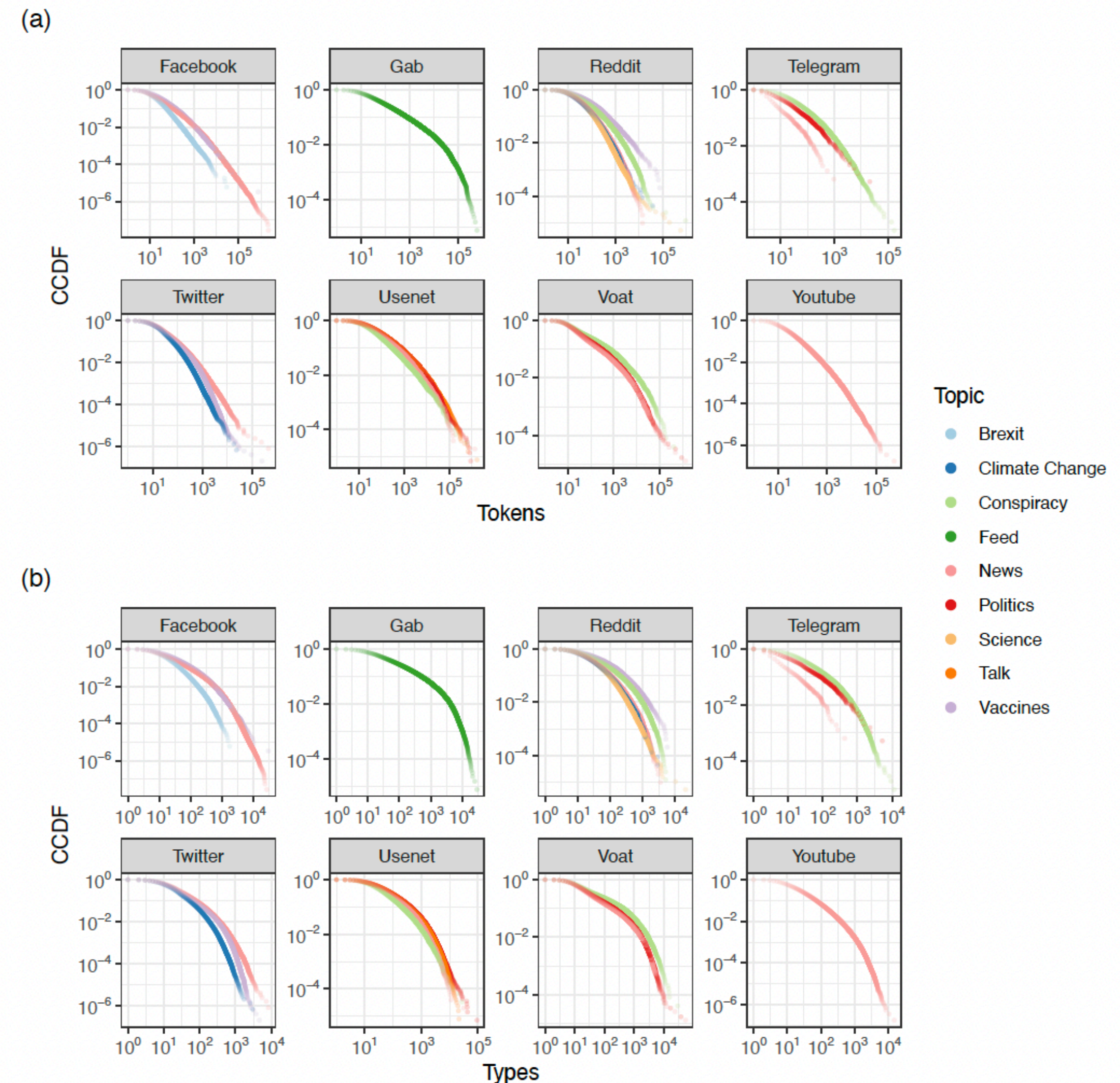


Fig. 1. CCDF of the distributions of number of (a) tokens and (b) types used by each user.

# Global Election Dynamics on Social Media in 2024

**Objective:** Explore information diffusion and user behavior across social media during global elections, focusing on social media role in political engagement and discourse.

**Methods:**

- Analyzed posts from 336 political parties and 508 news agencies across 31 countries.
- Employed Principal Component Analysis (PCA) to distill main discussion topics and assess user interactions.

**Key Findings:**

- Identified principal themes in political discourse such as economy, politics, and international relations.
- Discovered patterns of correlation and differentiation among these themes, which reflect varying political landscapes and user engagements.

**Insights:**

- Political parties mostly discuss internal politics; lighter topics like entertainment are more popular among news outlets.
- Engagement patterns vary significantly by country, reflecting diverse media landscapes and political cultures.

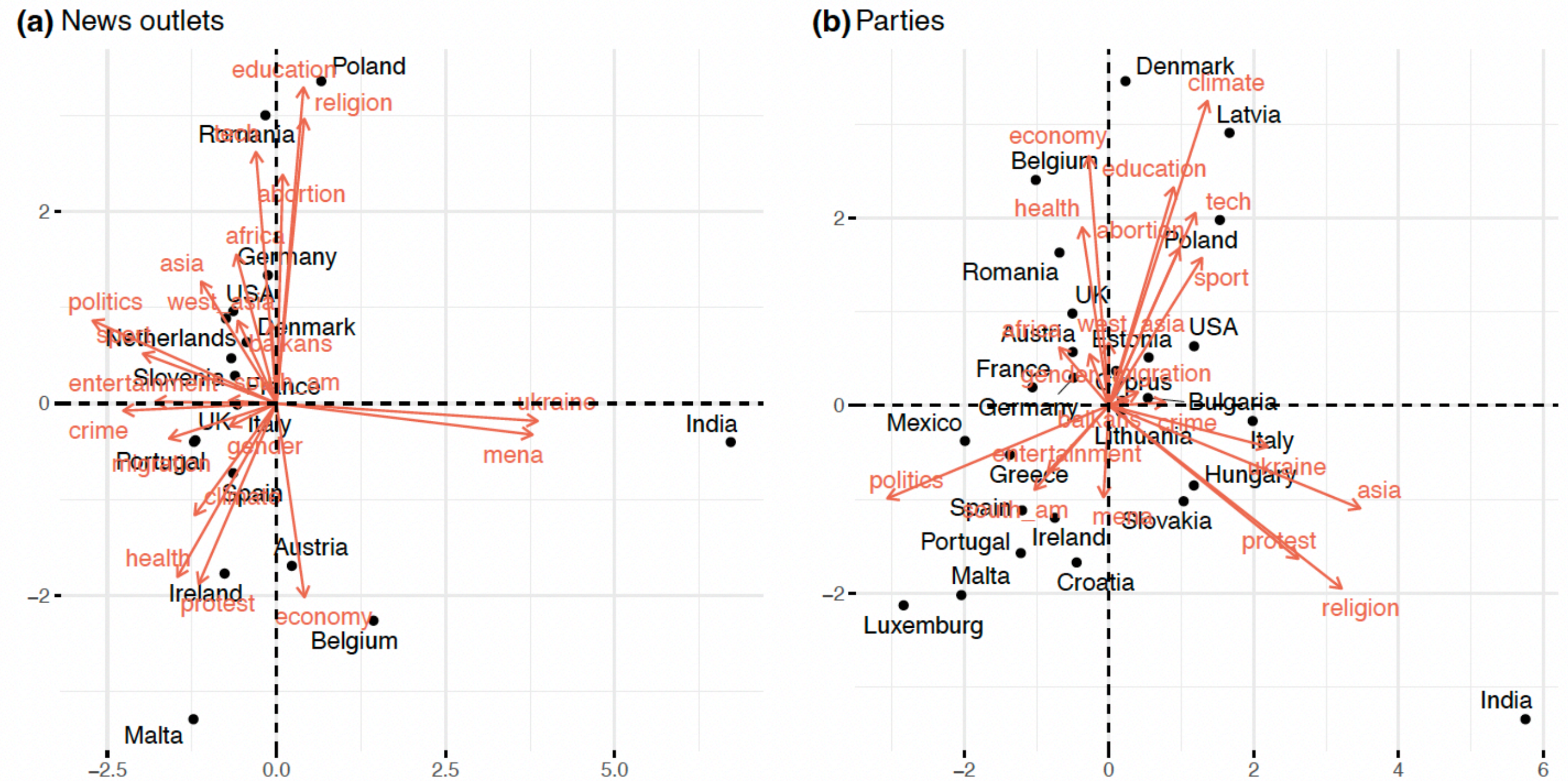


Fig 4. Most engaged topics in each country, as revealed by PCA.



# THANK YOU



# 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