



Collective attention in the age of (mis)information



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ABSTRACT

In this work we study, on a sample of 2.3 million individuals, how Facebook users consumed different information at the edge of political discussion and news during the last Italian electoral competition. Pages are categorized, according to their topics and the communities of interests they pertain to, in (a) alternative information sources (diffusing topics that are neglected by science and main stream media); (b) online political activism; and (c) main stream media. We show that attention patterns are similar despite the different qualitative nature of the information, meaning that unsubstantiated claims (mainly conspiracy theories) reverberate for as long as other information. Finally, we classify users according to their interaction patterns among the different topics and measure how they responded to the injection of 2788 false information. Our analysis reveals that users which are prominently interacting with conspiracists information sources are more prone to interact with intentional false claims.

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1. Introduction

The quantitative understanding of social dynamics allowed by the unprecedented availability of digital traces is far from trivial (Conte et al., 2012; Lazer et al., 2009). The growth of knowledge fostered by an interconnected world together with the unprecedented acceleration of the scientific progress has exposed the society to an increasing level of complexity to explain reality and its phenomena. Meanwhile, a shift of paradigm in the production and fruition of contents has occurred changing the quality of information.

Indeed, on the Web everyone can access and produce a variety of contents actively participating in the creation, diffusion and reinforcement of worldviews. Furthermore, such a large availability of user provided contents fostered massive recruitment of people around common interests, worldviews and narratives and thus affecting the evolution of the public opinion.

Conspiracy theories, in particular, find on the Internet a natural media for their diffusion and, not rarely, trigger collective counter-conspirational actions (Atran & Ginges, 2012; Lewandowsky, Cook, Oberauer, & Marriott, 2013). Narratives grounded on conspiracy theories tend to reduce the complexity of reality and are able to contain the uncertainty they generate (Byford, 2011; Hogg &

Blaylock, 2011; Fine, Campion-Vincent, & Heath, 2005). They can create a climate of mistrust or lead to disengagement from mainstream society or from officially recommended practices (Bauer, 1997).

We do not claim that conspiracy theories are all false, however, due to their nature of uncertainty containers are based on partial evidence, intuitions and often are the results of association rather than deduction.

In this respect, conspiracists tend to explain significant social or political aspects as plots conceived by powerful individuals or organizations (Sunstein & Vermeule, 2009). As these kind of arguments can sometimes involve the rejection of science, alternative explanations are invoked to replace the scientific evidence. For instance, people who reject the link between HIV and AIDS generally believe that AIDS was created by the U.S. Government to control the African American population (Bogart & Thorburn, 2005; Kalichman, 2009). Since unsubstantiated claims are proliferating over the Internet, what could happen if they were used as the basis for policy making? What about their potential effect on the public opinion?

The role of the socio-technical system in enforcing informed debates and their effects on the public opinion still remain unclear. However, The World Economic Forum, in its 2013 report (Howell, 2013), has listed the “massive digital misinformation” as one of the main risks for the modern society. People perceptions, knowledge, beliefs, and opinions about the world and its evolution get (in)formed and modulated through the information they can

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access, most of which coming from newspapers, television (Mccombs & Shaw, 1972), and, more recently, the Internet. The World Wide Web, more specifically social networks and micro-blogging platforms, have changed the way we can pursue intellectual growth or shape ideas. In particular, large social networks, with their user-provided content, have been facilitating the study of how the economy of attention leads to specific patterns for the emergence, production, and consumption of information (Dow, Adamic, & Friggeri, 2013; Lanham, 2007; Qazvinian, Rosengren, Radev, & Mei, 2011).

Despite the enthusiastic rhetoric about the ways in which new technologies have burst the interest in debating political or social relevant issues (Bekkers, Beunders, Edwards, & Moody, 2011; Crespi, 1997; Garcia, Mendez, Serdült, & Schweitzer, 2012; Gonzalez-Bailon, Borge-Holthoefer, Rivero, & Moreno, 2011; Guillory et al., 2011; Lippmann, 1946), the role of the socio-technical system in enforcing informed debates and their effects on the public opinion still remain unclear. Indeed, the emergence of knowledge from this process has been dubbed collective intelligence (Shum et al., 2012; Levy, 1999; Malone & Klein, 2007; Shadbolt, Hall, Hendler, & Dutton, 1987), although we have become increasingly aware of the presence of unsubstantiated or untruthful rumors. Mainly driven by audience purpose often false information is particularly pervasive on social media, fostering sometimes a sort of collective credulity.

A multitude of mechanisms animate the flow and acceptance of false rumors (Kuklinski, Quirk, Jerit, Schwieder, & Rich, 2000), which in turn create false beliefs that are rarely corrected once adopted by an individual (Ayers & Reeder, 1998; Garrett & Weeks, 2013; Koriati, Goldsmith, & Pansky, 2000; Meade & Roediger, 2002). The process of acceptance of a claim (whether documented or not) may be altered by normative social influence or by the coherence with the individual system of beliefs (Frenda, Nichols, & Loftus, 2011; Zhu et al., 2010). On the other hand, basic questions remain on how the quality of (mis)information affects the economy of attention processes, concerning, for example, the A large body of literature addresses the study of social dynamics on socio-technical systems (Adamic & Glance, 2005; Friggeri, Adamic, Eckles, & Cheng, 2014; Hannak, Margolin, Keegan, & Weber, 2014; Kleinberg, 2013; Lewis, Gonzalez, & Kaufman, 2012; Mocanu et al., 2013; Onnela & Reed-Tsochas, 2010; Ugander, Backstrom, Marlow, & Kleinberg, 2012).

We observed that information-based community are aggregated around shared narratives and that the debates among them contribute to the emergence of the proliferation of political pages and alternative information sources with the aim to exploit the Internet peculiarities to organize and convey the public discontent (with respect to the crisis and the decisions of the national government).

Furthermore, we noticed the emergence of very distinct groups, namely trolls, building Facebook pages as a parodistic imitation of both alternative information sources and online political activism. Their activities range from controversial comments and posting satirical content mimicking alternative news sources, to the fabrication of purely fictitious statements, heavily unrealistic and sarcastic. Not rarely, these memes became massively diffused and were used as evidence in online debates from political activists (Ambrosetti, 2013).

Inspired by these lively and controversial social dynamics at the edge between virality and credulity, we addressed the quantitative analysis of the interlink between information sources (conspiracists news and mains news) and political discussion on the web. In particular, we want to understand the selection criteria of users mostly exposed to unsubstantiated claims.

We will first introduce our methodology of categorizing the Facebook pages, by taking into account their self-description as

well as the type of content they promote. We concentrate on alternative news sources, online political activism, and also on all the national mainstream news journals that we could find to have an active page on Facebook. In the following sections, through thorough quantitative analysis, we show that the attention patterns when faced with various contents are similar despite the different qualitative nature of the information, meaning that unsubstantiated claims reverberate as long as other, more verified, information. Finally, we measure how the social ecosystem responded to the perturbation of false information injected by trolls. We find that a dominant fraction of the users interacting with the troll memes is the one composed of users preeminently interacting with alternative information sources – and thus more exposed to unsubstantiated claims. Consumers of alternative news, which are the users trying to avoid the main stream media ‘mass-manipulation’, are the most responsive to the injection of false claims.

2. Ethics statement

The data are publicly available as they come from a public online social site (Facebook). However, any information has been analyzed anonymously and in aggregated form. The entire data collection process has been performed exclusively with the Facebook Graph API (Facebook, 2013), which is publicly available and for the analysis (according to the specification settings of the API) we used only public available data (users with privacy restrictions are not included in the dataset). The pages from which we download data are public Facebook entities (can be accessed anyone).

3. Data collection

The debate around relevant social issues spreads and persists over the web, leading to the emergence of unprecedented social phenomena such as the massive recruitment of people around common interests, ideas or political visions. Disentangling the many factors behind the influence of information sources on social perception is far from trivial. Specific knowledge about the cultural and social context (even if online) in which they manifest is fundamental. Hence, inspired by the success of political movements over the Internet, we start our investigation focusing on the social dynamics around pages of political activism on the Italian Facebook during the 2013 electoral campaign. On one hand, political activists conveyed the public discontent on the government and the economic conditions on a public arena; on the other hand, as the mainstream media are considered to be manipulated, alternative information sources were free to disseminate news neglected by mainstream media or by science. In addition, we notice the activity of an emerging group of users, namely trolls, producing caricatural versions of the stories diffused by alternative information sources and political activism pages. As an outcome of this period of observation, we compile a list of the most important and active Facebook pages of alternative information sources and political movements.

The dataset is composed of 50 public pages for which we download all the posts (and their respective users interactions) in a time span of six months (from September 1st, 2012 to February 28th, 2013). The exact breakdown of the data is presented in Table 1. We provide brief descriptions for each page in Supporting Information.

The categorization of the pages is based on their different social functions together with the type of information they disseminate. The first class includes all pages (that we could verify) of main stream newspapers; the second category consists of alternative information sources – pages which disseminate controversial

Table 1
Breakdown of Facebook dataset.

	Total	Mainstream news	Alternative news	Political activism
Distinct users	2,368,555	786,952	1,072,873	1,287,481
Pages	50	8	26	16
Posts	193,255	51,500	92,566	49,189
Likes	23,077,647	4,334,852	7,990,225	10,752,570
Comments	4,395,363	1,719,409	935,527	1,740,427
Likes to comments	4,731,447	1,710,241	1,146,275	1,874,931

Mainstream News: all the national newspapers present on Facebook. **Alternative News:** pages which disseminate controversial information, most often lacking supporting evidence and sometimes contradictory of the official news. **Political Activism:** gathering users to publicly convey discontent against the current political and socio-economic situation.

information, most often lacking supporting evidence and some – times contradictory of the official news (e.g. conspiracy theories, link between vaccines and autism, etc.). The third category is that of self-organized online political movements – with the role of gathering users to publicly convey discontent against the current political and socio-economic situation (i.e. one major political party in Italy has most of its activity online).

For all classes the focus of our analysis is on the interaction of users with the public posts – i.e., likes, shares, and comments. Finally, we got access to 2788 post ids from a troll Page ([Semplicementeme, 2012](#)). All of these posts are caricatural version of political activism and alternative news stories, with the peculiarity to include always false information. Despite the small dimension (7430 unique users, 18,212 likes, 11,337 comments and 9549 likes to comment) the page was able to trigger several viral phenomena, one of which reached 100 K shares. We use troll memes to measure how the social ecosystem under investigation is responding to the injection of false information.

4. Results and discussion

4.1. Attention patterns

Our analysis starts by providing an outline of users' attention patterns with respect to different information coming from distinct sources – i.e., alternative news, main stream media and political activism. As a first measure, we count the number of interactions (comments, likes, or likes to comments) by users and plot the cumulative distribution function (CDF) of the users' activity on the various page categories in [Fig. 1](#). CDF shows that user interactions

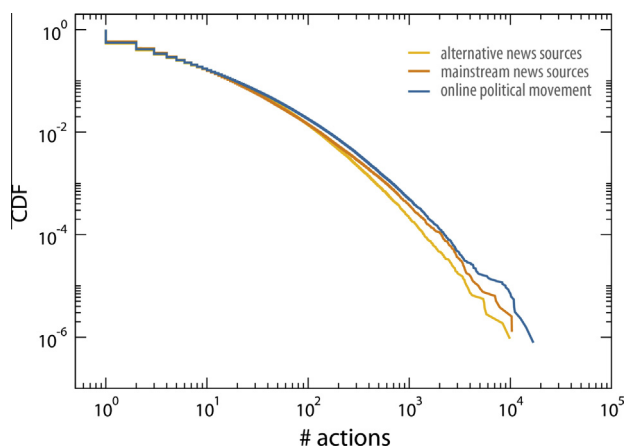


Fig. 1. Users Activity. Cumulative distribution function (CDF) of users' activity, grouped by page type. An action can be a like, comment, or like to comment. The distributions are nearly identical.

with posts on all different types of pages does not present significant differences. The similarity is also conserved after further grouping comments and likes separately (see in [Supporting Information Figs. 5 and 6](#)).

Here, the social response is not affected by the topic nor by the qualitative nature of the information. Posts containing unsubstantiated claims, or about political activism, as well as regular news, cannot be distinguished through simple statistic signatures based on user engagement patterns. These different topics reverberate at the same way in this ecosystem.

As the potential of information to trigger discussions can be quantified through comments, in order to have a more precise picture of the users' attention, we zoom into the level of posts. This level of resolution is useful to understand the temporal evolution of posts and for how long the debate on a topic persists, using the comments as a first-order approximation of the level of interest.

In [Fig. 2](#) we show, for each page category, the probability density function of the post interest lifetime. This measure is computed as the temporal distance between the first and last comment of the post. Collective debates persist similarly, independently of whether the topic is the product of conspiracist or mainstream source. Given the social context of these groups, what potential does a hurtful meme harness? In other words, how significant is the concurrent presence of users between different pages and how strong is the overlap? Starting from the null-hypothesis, that each user has neither affiliation nor preference, we investigate the interaction dynamics of the different communities by quantifying the users that are present in both spaces. The result in [Table 2](#) hints that

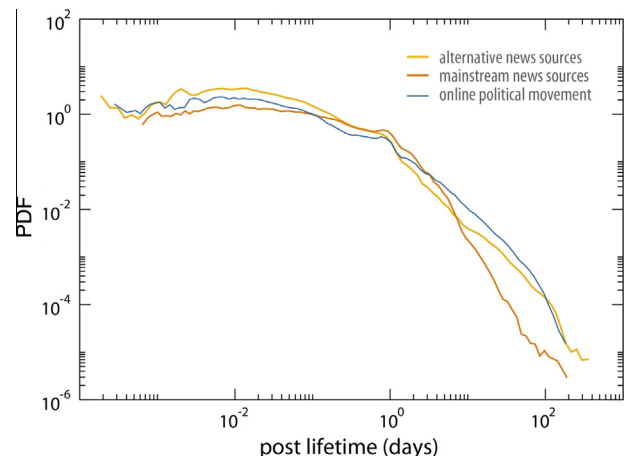


Fig. 2. Post lifetime. Probability density function, grouped by page type, of the temporal distance between the first and last comments of the post. Posts with qualitatively different topics (alternative information, political activism, and mainstream news) show a similar behavior.

Table 2

Common users between classes of pages.

Class A	Class B	Common users (AB)	Ratio (AB/A) (%)	Ratio (AB/B) (%)
Political movement	Alternative news	360,054	28.0	33.6
Political movement	Mainstream news	254,893	19.8	32.4
Mainstream news	Alternative news	278,337	35.4	25.9

Many users make active contributions on pages with very different profiles. Several members of the political discussion are involved on both alternative news pages and mainstream newspapers pages in comparable ways.

indeed a considerable number of users interact with pages of different classes. The political discussion and alternative news get informed dominantly from each other rather than from mainstream media, while users of the first two sets are almost equally represented within the followers of mainstream newspapers.

In this portion of the Italian Facebook ecosystem conspiracist rumors spread and trigger hated debate, representing an important part of the information flow animating the political scenario and shaping the public opinion.

4.2. Response to false information

Above results reveal that users consume unsubstantiated and main stream News in similar ways. In our study, both are consumed by users of political activism pages. Continuing our investigation, we want to understand if this information context might affect the users' selection criteria. Therefore, we measure the reaction of users to a set of 2788 false information injected by a troll page – i.e., a page promoting caricatural version of alternative news and political activism stories (see Table 3).

In order to perform this analysis, we applied a classification strategy aimed at discriminating typical users for each one of the three categories of pages. In particular, we were interested in distinguishing users based on their behavior. Having access to the 6 months historical likes, comments, and likes to comments on all posts within the timeframe (and within the privacy restrictions), we quantify the interaction of each user with the posts in each class. As we did this, the following assumptions were in place:

- The topic of the post is coherent with the theme of the page on which it was published.
- A user is interested in the topic of the post if he/she likes the post. A comment, although it reflects interest, is more ambiguous, and, therefore, is not considered to express a positive preference of the topic.
- We neither have access to nor try to guess the page subscription list of the users, regardless of their privacy settings. Every step of the analysis involves only the active (participating) users on each page.

According to these assumptions, we use solely the likes to posts. For instance, if a user likes 10 different posts on one or multiple pages of the same political movement, but that user never liked posts of any other topic, we will label that user to be associated with the political movement. Since it is not always the case that

there is a clear preference, we have to take into account the random sampling bias error – since our data set represents indeed a sample of the users' Facebook activity. Given the limitations of the API, the only information we have about the user is how that user interacted with the posts we have downloaded.

The labeling algorithm for each user is to calculate the 95% confidence interval of percentage of likes of posts in each topic. Only if the confidence interval of the preferred topic does not overlap the other two topics, we assign the user a label. Although the true affiliation of the individual behind the end user can be a subjective matter, we believe that filtering out versatile users allows us to focus precisely on the rare, and more interesting, cases of interaction between highly polarized users.

In Fig. 3 we illustrate for each page type, the respective contributions brought by labeled (polarized) users. It is important to note that this measure is not designed to describe the overall affiliation of the members of the page. The fractions are computed by taking all the posts from a class and counting percentage of users coming from each profile.

Mainstream media pages, present a more balanced distribution of user classes. However, users labeled as political activists are more active on alternative information pages than on mainstream newspapers. According to this partitioning of the information space, now we are able to distinguish interactions occurring between users pertaining to different regions of the information/narrative space.

Given the outline of users distribution within the various classes, we want to see which users are more responsive to the injection of false information in terms of interaction. As before, we cannot use the comments as discriminators, as they can represent either positive or negative feedbacks with respect to the published topic. Therefore, we focus only on the users liking 2788 troll posts.

As previously mentioned, troll posts are related to arguments debated by political activists or on alternative information sources but with a clear parodistic flavor. For instance, one of the most popular memes that explicitly spread a false rumor (in text form) reads: Italian Senate voted and accepted (257 in favor and 165 abstentions) a law proposed by Senator Cirenga aimed at funding with 134 billion Euros the policy-makers to find a job in case of defeat in the political competition. We were able to easily verify that this meme contains at least four false statements: the name of the senator, the total number of votes is higher than possible, the amount of money (more than 10% of Italian GDP) as well as the law itself. This meme was created by a troll page and, on the wave of public discontent against Italian policy-makers, quickly became viral, obtaining about 35,000 shares in less than one month. Shortly thereafter, the image was downloaded and reposted (with the addition of a commentary) by a page describing itself as being focused on political debate. Nowadays, this meme is among the arguments used by protesters manifesting in several Italian cities. This is a striking example of the large scale effect of misinformation diffusion on the opinion formation process. As shown in Fig. 4 by counting the polarized users that liked the posts, we find that the most susceptible users to interact

Table 3

t-test on the different distributions coming from the different classes.

Class A	Class B	p-value
Political movement	Alternative news	0.3249
Political movement	Mainstream news	0.9863
Mainstream news	Alternative news	0.2768

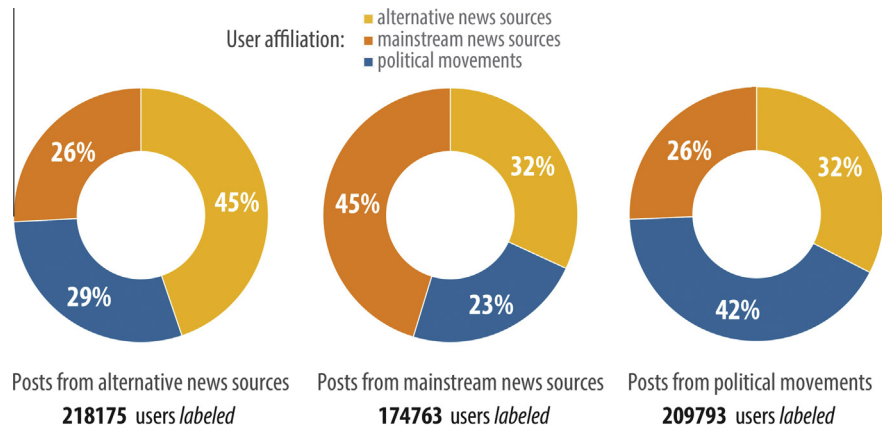


Fig. 3. For each page type: fractions of users with strong affiliations.

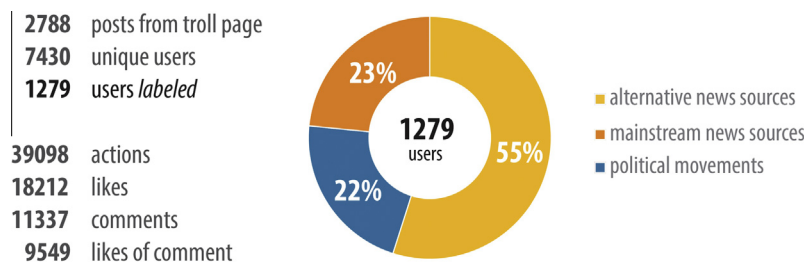


Fig. 4. Social response to intentionally injected false information. Labels represent user affiliation. The users more responsive to the injection of false information are the ones having strong affiliation alternative information sources.

with false information are those that are mostly exposed and interacting with unsubstantiated claims (i.e. posts on alternative information pages).

According to our results, users with strong preferences for alternative information sources, perhaps motivated by the will to avoid the manipulation played by mainstream media controlled by the government, are more susceptible to false information. Our result suggests that those who took a less systematic (more heuristic) approach to evaluating any evidence were more likely to end up with an account that was more consistent with their previous beliefs even if these are parodistic post (see Figs. 5 and 6).

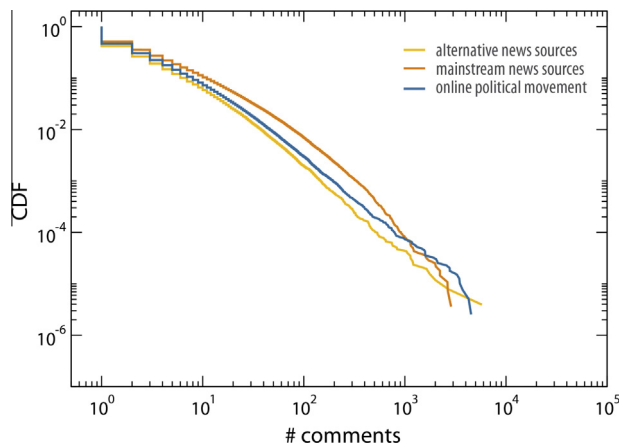


Fig. 5. Users' likes cumulative distribution function, grouped by page type.

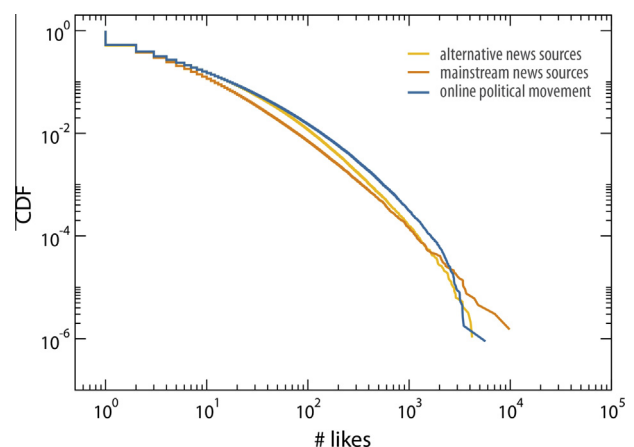


Fig. 6. Users' comments cumulative distribution function, grouped by page type.

5. Conclusions

Conspiracists generally tend to explain a significant social or political aspect as a secret plot by powerful individuals or organizations (Sunstein & Vermeule, June 2009) and their activity is proliferating over the web. This study provides a genuine outline of the online social dynamics and, in particular, on the effect of Facebook on bursting the diffusion of false beliefs when truthful and untruthful rumors coexist. Several cultures coexist, each one competing for the attention of users. Specifically, we observe a strong interaction between political discussion and information sources (either alternative or main stream). From our analysis we confirm

the possible danger that can be generated by the conspiracy thinking entering in the political discussion and decision. In fact, coherently with the quasi-religious approach of conspiracists (Franks, Bangerter, & Bauer, 2013) most of the online activism Facebook pages contain claims that mainstream media is manipulated by higher entities (and thus the information is be not neutral or reliable). Such an antagonism makes any kind of persuasion process, even if based on more solid information, very difficult. As a response to partisan debates, the emergent groups of trolls began to provide parodistic imitations of a wide range of online partisan topics. Despite the evident parodistic (and sometimes paradoxical) contents, not rarely, troll memes fomented animated debates and diffused through the community as any other information would. We find that, out of the 1279 labeled users interacting with the troll memes, a dominant percentage (55%, as opposed to 23% and 22% for other groups) is constituted of users preeminently interacting with alternative information sources and thus more exposed to unsubstantiated claims. The results of our study rise a real warning, as the higher the number of circulating unsubstantiated claims and the unprecedented proliferation of conspiracy-related content online the manipulation of users is possible.

Additional information

The authors declare no competing financial interests.

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Appendix A. Supplementary material

Supplementary data associated with this article can be found, in the online version, at <http://dx.doi.org/10.1016/j.chb.2015.01.024>.

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