OPEN ACCESS Top-Quality Science
Peer Reviewed
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Review of Communication Research
2021, Vol.9
ISSN: 2255-4165

Echo Chambers on Social Media: A Systematic Review of the Literature

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Abstract

There have been growing concerns regarding the potential impact of social media on democracy and public debate. While some theorists have claimed that ICTs and social media would bring about a new independent public sphere and increase exposure to political divergence, others have warned that they would lead to polarization through the formation of echo chambers. The issue of social media echo chambers is both crucial and widely debated. This article attempts to provide a comprehensive account of the scientific literature on this issue, shedding light on the different approaches, their similarities, differences, benefits, and drawbacks, and offering a consolidated and critical perspective that can hopefully support future research in this area. Concretely, it presents the results of a systematic review of 55 studies investigating the existence of echo chambers on social media, providing a first classification of the literature and identifying patterns across the studies' foci, methods and findings. We found that conceptual and methodological choices influence the results of research on this issue. Most importantly, articles that found clear evidence of echo chambers on social media were all based on digital trace data. In contrast, those that found no evidence were all based on self-reported data. Future studies should take into account the possible biases of the different approaches and the significant potential of combining self-reported data with digital trace data.

Highlights

- This article attempts to provide a comprehensive account of the literature on the existence of social media echo chambers.
- We provide a comparative perspective by addressing variations and patterns across the studies' foci, methods and findings.
- A majority of the studies focus on communication and interactions on social media, while the rest focus on content exposure.
- The studies in our sample relied on two types of data: digital trace data and self-reported data.
- Articles finding clear evidence of echo chambers were all based on digital trace data, while those finding no evidence were all based on self-reported data.
- Future studies should consider the strengths and weaknesses of different approaches and the significant potential of combining self-reported data with digital trace data.
- State of the literature at January 2020.

Suggested citation: Terren, L. & Borge, R. (2021). Echo Chambers on Social Media: A Systematic Review of the Literature. *Review of Communication Research*, *9*. 99-118. https://doi.org/10.12840/ISSN.2255-4165.028
Keywords: echo chambers; filter bubbles; social media; selective exposure; algorithmic curation; systematic literature review.

Editor: Giorgio P. De Marchis (Universidad Complutense de Madrid, Spain).
Reviewers: Mathieu O'Neil (University of Canberra, Australia), Mohamed Ben Moussa (University of Sharjah, United Arab Emirates). Two reviewers prefer to stay blind.

Received: Aug. 12th 2020 **Accepted:** Mar. 15th 2021 **Prepublished:** Apr. 2021 **Published:** May 2021

Content

Introduction

Throughout the last decades, the advent of the internet and the Web 2.0 have drawn a significant amount of scholarly attention to their potential impact on democracy and the public sphere. The latter, following Dahlgren's (2005) more recent take on Habermas' (1991[1962]) seminal work, is to be understood as "a constellation of communicative spaces in society that permit the circulation of information, ideas, debates, ideally in an unfettered manner, and also the formation of political will" (p. 148). Some adopted an optimistic view, seeing these new technological developments as enabling a diversification of communicative action and the promotion of viewpoint diversity (e.g., Gimmler, 2001; Papacharissi, 2002); as advancing freedom, disrupting the elites' grip on democratic discourse and ultimately leading to the creation of an online knowledge commons (Benkler, 2006; Rheingold, 2003); or as providing opportunities to participate in civic life as well as increasing incidental exposure to news and political opinions (Bode, 2012; Gil de Zúñiga *et al.*, 2012; Xenos *et al.*, 2014). Others, however, were more pessimistic, thinking that digital technologies would lead to polarization through users' careful selection of information that matches previous beliefs and the formation of increasingly homogenous online groups (McPherson *et al.*, 2001). Among the most emblematic embodiments of this pessimistic vision, we find Sunstein's (2001; 2017) metaphor of the echo chamber and Pariser's (2011) image of the online filter bubble. The underlying assumption behind the idea of echo chambers is that social media users selectively engage with like-minded others and ideologically-aligned content, thus rarely being exposed to the conflicting ideas that make up the agonistic public sphere (cf. Mouffe, 2005). This process is believed to be exacerbated by social media platforms' algorithmic curation of content based on users' past activity (cf. filter bubbles), which limits the novelty and diversity of the content that users are exposed to, and which – instead of contributing to viewpoint diversity – leads to online clustering and polarization. Within the framework of this paper, the metaphors of the echo chamber and the filter bubble are thus to be understood as a situation or a space in which pre-existing beliefs are repeated and reinforced – like reverberations in an acoustic echo chamber. For the sake of clarity, we will use the term "echo chambers on social media" to refer to both the issue of echo chambers and filter bubbles. While the concepts of echo chambers and filter bubbles – which are not mutually exclusive – are often used interchangeably and can be considered as embodying the same problem when it comes to political information environments and polarization, there is a distinction in the situation they depict (Nguyen, 2017). Indeed, the notion of the echo chamber usually refers to a situation in which users

mostly communicate with – and are exposed to content from – like-minded others. This situation is often attributed to homophily, the human tendency to interact and associate with similar others (McPherson *et al.*, 2001); selective exposure, which is linked to processes of challenge avoidance and reinforcement seeking and translates into the tendency to consume ideologically-aligned information (Garrett, 2009; Stroud, 2010); or confirmation bias, the propensity to seek, choose and interpret information in line with one's own belief system (Nickerson, 1998). These tendencies are assumed to stem from our willingness to avoid cognitive dissonance, the psychological stress that is experienced when one simultaneously holds multiple contradictory beliefs (Festinger, 1957).

On the other hand, the concept of the filter bubble is usually associated with the idea that social media users are mostly exposed to ideologically-aligned content in their news feed, as a result of the platforms' algorithmic selection of content based on users' past behavior (Raynauld & Greenberg, 2014; Thorson *et al.*, 2019).

Generally speaking, there is variation in the way that this issue is addressed and understood, with different scholars choosing different empirical approaches and building their analysis around different terms. Yet, the core normative concern remains the same: the potential breakdown of a shared environment for information seeking, debate, and opinion formation. Social media have the potential to be a free and autonomous space for information and communication among citizens, contributing to the public sphere as envisaged by Habermas (1991[1962]) and Dahlgren (2005). However, this potential is not realized when diversity is lacking, when there is no (or little) exchange of opinions, no reasoned debate between opponents, and therefore no common ground or shared concerns.

The information segregation that likely results from echo chambers and filter bubbles is a serious concern, given the increasing reliance on social media for news consumption (Pew Research Center, 2018) as well as the fact that political deliberation and awareness of other political opinions represent cornerstones of a healthy democracy. Exposure to opposing viewpoints induces reflective political reasoning (Muradova, 2020), while the confrontation of ideas is a trigger for deliberation (Guttman and Thompson, 1998). The issue with social media, however, is the tendency to build up closed communities mostly valuing like-minded and inside voices, and turning into echo chambers that preclude deliberation. It is an issue that has implications for political polarization, being one of the main challenges of our time, and that touches upon the ability of digital media to help with the formation of an informed public opinion and the promotion of political deliberation, diversity, and tolerance.

Several widely-cited scientific works have found support for the "social media echo chamber hypothesis", highlighting the clustered nature of online social networks (Barberá, 2015a; Conover *et al.*, 2011; Aragó *et al.*, 2013; Schmidt *et al.*, 2017). Yet, the contrasting nature of the literature – scientific or otherwise – as well as the different approaches that are used warrant deeper investigation. So far, there is no comprehensive account (to the best of our knowledge) of the literature on the existence of echo chambers on social media. This systematic review intends to provide such an account, taking stock and providing a first classification of the scientific knowledge on the topic. It aims to shed light on the different approaches, their similarities, differences, benefits and drawbacks, and offer a consolidated and critical perspective that can hopefully support future research in this area.

Concretely, this article presents the results of a content analysis of 55 peer-reviewed studies investigating the existence of echo chambers on social media. It provides an encompassing perspective by addressing variations and patterns across the foci, methods, and findings of these studies, before moving on to a discussion and a conclusion.

The results highlight a division between studies that focus on social media communication and interactions or on content exposure; and another division between those that rely on digital trace data or those that rely on self-reported data. Most significantly, our results highlight the influence of conceptual and methodological choices on research outputs. Although a majority of the studies included in this review found some evidence of echo chambers on social media, conceptual and methodological choices seem to weigh on the findings of these studies (see Table 1). Indeed, in our sample, the studies that focused on interactions and/or relied on digital trace data tended to find significantly more evidence of echo chambers and polarization than the studies that focused on content exposure and/or relied on self-reported data. Among the latter, some found no evidence of echo chambers, finding – on the contrary – heterogeneity and cross-cutting interactions and exposure on social media.

While this tendency might be better understood by taking into account the respective weaknesses and potential biases

of these two approaches and types of data, it is not uncommon in the social sciences to find different results depending on the methodological approach. Social media research is not an exception[1].

In sum, this paper constitutes a first classification of the peer-reviewed literature on social media echo chambers, shedding light on the different approaches and potential biases, and further suggesting the need to consider the promising – yet challenging – combination of digital trace data and self-reported data in future studies.

Scope and Methodology

The development of the Web 2.0 and the widespread adoption of social media have given rise to a plethora of studies and research areas of which we cannot give a complete account here. For the sake of manageability and coherence, and drawing on existing guidelines for selection and reporting (Fink, 2014; Moher *et al.*, 2009), this systematic review will take into account scientific studies investigating the existence of echo chambers on social media, written in English, and published in peer-reviewed journals or in peer-reviewed conference proceedings before the 1st of January 2020 (which corresponds to the cut-off point of this systematic review). Narrowing down our topical scope meant discarding a significant number of studies touching upon – or based on – the idea of social media echo chambers but not specifically centered on the presence (or absence) of echo chambers on social media. Many of these studies departed from the assumption that there *are* echo chambers on social media and looked at – among others – their polarizing effect; the causes and consequences of online selective exposure (e.g., Borah, Thorson, and Hwang 2015); or different tools to counter the formation of echo chambers, burst the filter bubble by increasing exposure diversity or raise awareness among social media users (e.g., Bozdag & van den Hoven, 2015). Other types of discarded works included studies on echo chambers online but not specifically on social media, such as studies on internet browsing recommender systems (Nguyen *et al.*, 2014), or hyperlink interaction patterns online (Häussler, 2019).

Although restrictive, the decision to exclusively take into account peer-reviewed journals and conference proceedings is – aside from the above-mentioned issue of manageability – based on a willingness to establish systematic search criteria to identify relevant studies. This approach more closely conforms to the methodological norms of primary empirical research, such as transparency and reproducibility. These selection criteria, however, meant overlooking potentially important contributions published in technical reports, books and book chapters (e.g., Pariser, 2011; Sunstein, 2001, 2017), press articles, as well as in studies published in other languages. Therefore, this paper should not be seen as a review of all the existing literature on social media echo chambers, but as a systematic review[2] of a representative collection of the academic literature, following the selection criteria laid out at the start of this section.

Based on a sample of the peer-reviewed literature on the existence of echo chambers on social media, this review will take an encompassing look at how the issue is approached, the methods and data that are used, and the findings that are generated.

In order to identify and retrieve relevant studies published in peer-reviewed social science journals and conference proceedings, we performed a clearly-defined keyword search in two dedicated academic databases: *Scopus* and *Web of Science*. An additional search was then performed in *Google Scholar*, to account for peer-reviewed journals or conference proceedings missed by the above-mentioned databases and/or published in lower impact journals or conferences. We performed Boolean searches using the following keyword phrase: "social media" OR "social network*", in combination with (AND) "echo chamber*" OR "filter bubble*". This was done through a topic search, looking for correspondence in the studies' titles, abstracts, and keywords. The same Boolean search was carried out in *Google Scholar*. However, as this search engine tends to inflate the number of relevant studies

[1] See, for example, meta-analyses from Shelley Boulianne (2009, 2015) on the effects of the Internet and social media on political participation where studies using panel data are less likely to report positive and statistically significant coefficients between internet or social media use and participation, compared to cross-sectional surveys.

[2] Given the broad character of the collected literature as well as the fact that many of the studies on the existence of echo chambers on social media are qualitative and not based on statistical results, a meta-analysis was not applicable.

(the Boolean search yielded more than 10,000 results), we focused on the first 500 results, sorted by relevance.

The searches in *Scopus* (222 results), *Web of Science* (169 results) and *Google Scholar* (first 500 results) together yielded 891 studies that were then subject to a careful eligibility assessment process detailed in the PRISMA flow[3] diagram (see Figure 1). Titles and abstracts of extracted records were independently reviewed by a second investigator (RB) and potential discordances were resolved through discussion with a third party.

The 891 results were first checked for duplicates (n=164), after which the titles and abstracts of the remaining 727 studies were screened. Based on the exclusion criteria laid out in Figure 1, 509 records were excluded in this first broad screening process. The full text of the remaining 218 studies was then checked for relevance in a second in-depth screening process. This last step of eligibility assessment left us with 55 studies (46 articles and 9 conference proceedings)

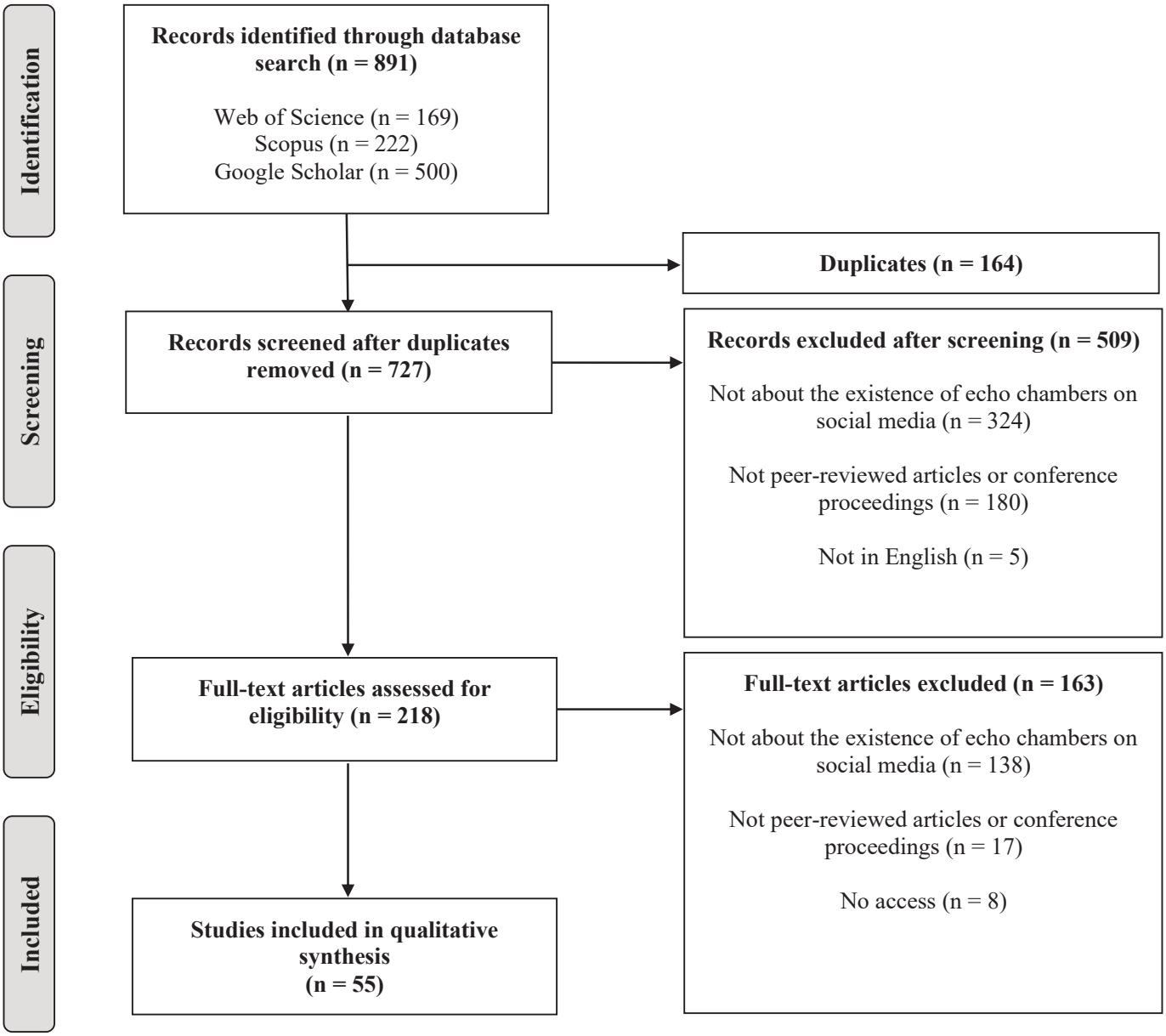

Figure 1. PRISMA flow diagram

[3] PRISMA is an evidence-based minimum set of items for reporting in systematic reviews and meta-analyses. See http://www.prisma-statement.org/

that were included for analysis in this systematic literature review.

Throughout the articles' screening and selection process, we started building an analytical framework to classify the studies using a bottom-up approach, which resulted in the use of three main categories: foci, methods, and findings. This process allowed us to evaluate the role of conceptual and methodological choices on research findings on this topic. It also helped us to identify similarities and differences, assess strengths and weaknesses, and provide a broader view of scholarship on this crucial issue.

Results

In this section, we scrutinize the studies included in this systematic review and try to make sense of a diverse set of research outputs on the existence of echo chambers on social media.

Although we did not restrict our search by year of publication, the studies in our sample were published between 2011 and 2020 (year of the search cut-off point), with a significant increase from 2014 onwards.

Taking into account the number of occurrences of analytically-relevant keywords in the full text of the 55 studies included in our sample, Figure 2 shows the rather obvious centrality of the concept of "exposure" as well as a significantly more important focus on echo chambers than on filter bubbles (although these were both included in the keyword search). Despite these two being closely related, this imbalance suggests a more important emphasis on communication, interactions, and exposure to like-minded *users* (closer to the concept of echo chambers), and a less important emphasis on algorithms and on exposure to like-minded *content* (closer to the concept of the filter bubble), as will be further developed in the next section.

In trying to investigate the existence of echo chambers on social media, the studies in our sample used a variety of

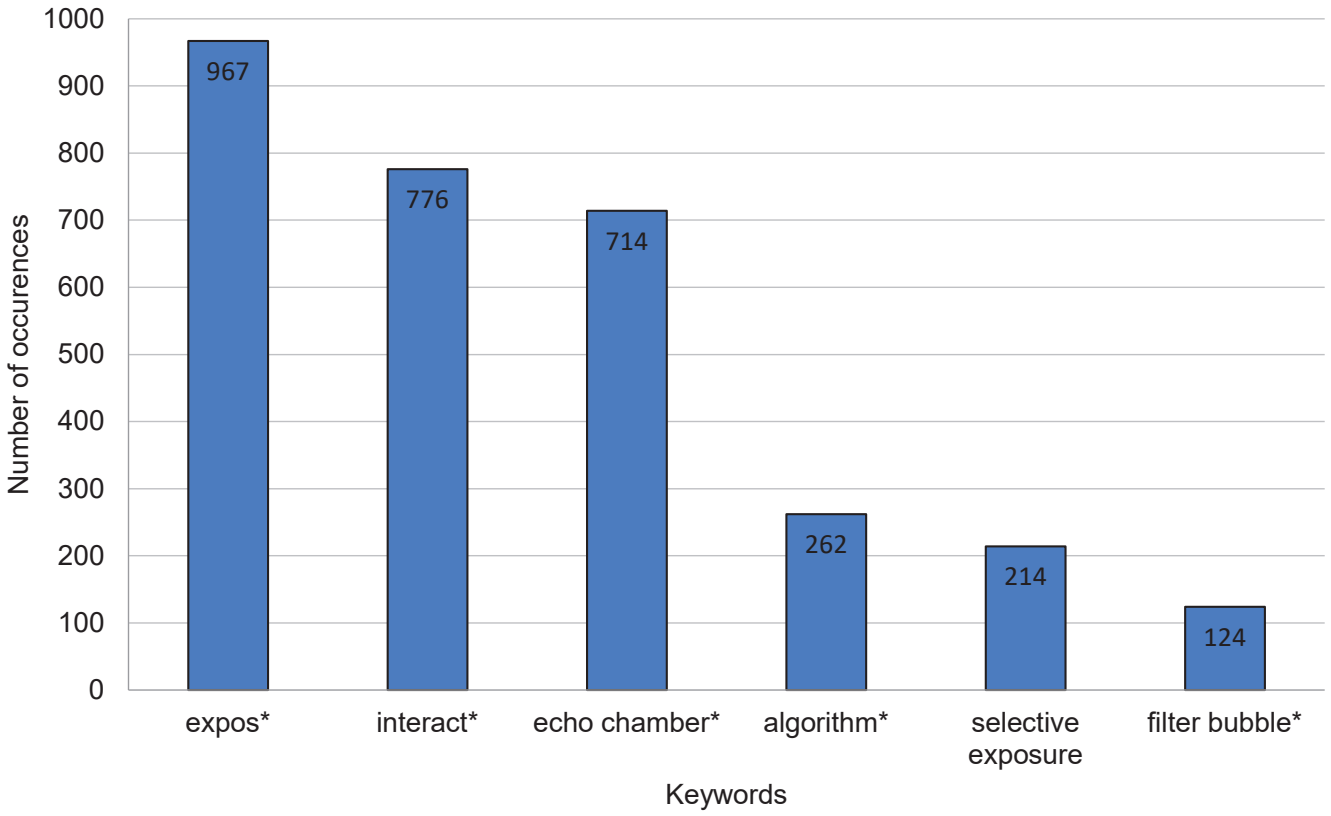

Figure 2. Number of occurrences of analytically-relevant keywords[4] from all the studies included in the sample.

[4] The * at the end of the keywords were used to include all the variants of these words. For example: algorithm* accounts for algorithm, algorithms, algorithmic and algorithmically.

approaches –both in terms of focus and methodology– which are reviewed in the following sections.

1. Foci: Communication and Interactions vs. Content Exposure

Although the 55 studies included in this review are about the existence of echo chambers on social media, they differ in their chosen focus to address this issue and how they operationalize it. Yet, a broad distinction could be made between two types of studies: those focusing on communication and interactions on social media (usually more related to the issue of echo chambers), and those looking at content exposure on social media (usually more related to the issue of filter bubbles). Broadly speaking, studies focusing on communication and interactions tend to operationalize the issue of echo chambers as the presence or absence of cross-cutting interactions between social media users. The idea is that the development of a public sphere through social media is only possible when political discussions are characterized by the presence of opposite ideas and diverse sources of information are shared on online social networks (Dahlgren, 2005). The main assumption underlying this approach is that fragmented and homogenous online publics within social networks reflect echo chambers and polarization (Batorski & Grzywinska, 2018).

Studies focusing on content exposure tend to operationalize the issue as the presence or absence of cross-cutting content in users' news feeds. The general assumption behind this approach is that exposure to diverse content and opinions will be associated with lower levels of polarization, and vice versa (Williams *et al.*, 2015).

Studies focusing on communication and interactions

As it can be expected when studying echo chambers on social media, a significant share of the studies in our sample focused on communication and interactions between different (and often ideologically-discordant) users on social media.

More specifically, some of these studies looked at the level of interactions between climate skeptics or activists (Williams *et al.*, 2015), followers of two gun policy organizations (Merry, 2015), the audiences of partisan TV shows (Hayat & Samuel-Azran, 2017; Jacobson *et al.*, 2016), between users on both sides of the left-right ideological divide (Grömping, 2014; Takikawa & Nagayoshi, 2017), or on opposite sides of a polarized political issue (Balcells & Padró-Solanet, 2016; Del Vicario *et al.*, 2017; Furman & Tunç, 2019).

Others used a communication approach to focus on social media use and polarization. While some analyzed social media's potential contribution to partisan polarization by looking at the *Twitter* readership of more extreme or moderate politicians (Hong & Kim, 2016), others studied the relationship between political communication on social media and extremity of attitude in different contexts (Chan & Fu, 2017; Lee, 2016; Bodrunova, Litvinenko, Gavra, & Yakunin, 2015).

Many of the studies focusing on communication and interactions analyzed political homophily and the level of social media interactions between groups or entities that are already highly polarized (e.g., conspiracy vs. scientific; democrats vs. republicans), which is a potential bias that ought to be taken into account.

Also, interactions on social media are not uniform, and different studies focused on different social media platforms and different interaction networks (e.g., reply, mention, follower, or retweet networks for *Twitter*). One ought to consider the fact that these choices can have a significant influence on the results. Indeed, with some knowledge of microblogging platforms such as *Twitter*, one could assume that the mention and reply networks – being more confrontational in nature – will tend to display less segregation and more cross-cutting interactions. The follower and retweet networks, on the other hand, will tend to show more political homophily, endorsement and ideologically-congruent interactions, as suggested by previous studies (Williams *et al.*, 2015; Esteve Del Valle & Borge Bravo, 2018; Conover et al., 2011).

Studies focusing on content exposure

Although a larger number of studies looked at communication and interactions on social media, close to a quarter focused on the content that users are exposed to and consume on social media. This approach is based on the premise that the more users are exposed to opinion-reinforcing content in their social media news feeds, the more they can be considered as being in an echo chamber/filter bubble.

Some of these studies looked at the relationship between network diversity and content exposure on social media (Wohn & Bowe, 2016), and the role of "weak ties" or heterogeneous friends in increasing content diversity (Bakshy *et al.*, 2015).

Others observed the diversity and the nature of news or information that is reached from social media platforms (Flaxman *et al.*, 2016; Nikolov *et al.*, 2015), or the level of viewpoint diversity encountered in *Twitter* users' news feeds (Bozdag *et al.*, 2014).

Some scholars focused on selective exposure and news consumption habits among social media users, looking at the relationship between social media use, media diversity, and the likelihood of being in an echo chamber (Dubois & Blank, 2018; Messing & Westwood, 2014). Studying content exposure on social media is challenging, given researchers' severely limited access to the actual content of social media news feeds and the subsequent need to rely on individual self-reports and proxies for exposure. Some of the limitations of the above-mentioned studies include small, unrepresentative samples as well as a focus on active news consumers and users who openly volunteer their ideological affiliation online.

While most of the studies scrutinized social media echo chambers by either looking at communication and interactions or content exposure on social media, a few studies took both perspectives into account. For example, some focused on the relationship between exposure and subsequent interactions with specific types of content, whether looking at scientific and conspiracy pages and topics (Bessi *et al.*, 2016; Del Vicario *et al.*, 2016), Brexit-related posts (Del Vicario *et al.*, 2017), or exposure and subsequent engagement with "supportive", "oppositional", and "mixed" networks on social media (Vaccari *et al.*, 2016). While these studies – by taking both perspectives into account – might do more justice to the complexity of the issue of social media echo chambers, they do not account for the diversity (or lack thereof) of the content that users are exposed to in their social media news feeds.

Overall, and as already suggested in Figure 2, it seems that scholars tend to favor analyses of communication and interactions on social media over analyses of exposure to like-minded content, although this is – arguably – equally problematic and essential to our understanding of users' political information environment. Moreover, the decision to focus on communication and interactions or content exposure might also weigh on the findings, as will be further developed later on in this article. The larger number of studies focusing on communication and interactions could be partly due, on the one hand, to the difficulty of obtaining data on the content that users are exposed to in their social media news feeds, and on the other hand, to the relative ease of gathering digital trace data (detailed in the next section), often in the form of social network analyses, giving the researcher access to interaction data for thousands, sometimes millions, of social media users. In spite of this, one ought to consider the need to take into account both communication and interactions (arguably more related to social media use) and content exposure (arguably more related to the design and functioning of social media platforms) if we are to better understand the issue of the potential breakdown of a shared environment for information seeking, debate, and opinion formation. This encompassing view could probably more easily be achieved through a mixed-methods approach, focusing on both self-reported data (shedding light on individual-level characteristics and on the media repertoire of individual users) and digital trace data (allowing for direct observations of human activity and behavior across entire networks), as will be developed in the following sections.

2. Research Methods and Data

Although there were variations in the methods applied and the data used in the studies included in this review, we were able to group all the studies into two main methodological (i.e., data collection) approaches. The first – and most frequently used – approach consisted in direct observations of online activity through the use of digital trace data (n=43), while the second approach was based on self-reported data obtained from social media users themselves (n=11), mostly through surveys, interviews, or focus groups. We found that only one of the 55 studies included in our sample combined digital trace data with self-reported survey data, despite the advantages of this approach. This could be partly due to the challenges associated with such combination, as will be touched upon later in this section.

Studies based on digital trace data

Digital trace data can be briefly defined as records of activity that took place in the digital world (Howison *et al.*, 2011). In our sample, most of the studies that relied on digital trace data focused on the social network *Twitter* (n=28), while the rest used *Facebook* (n=10), *YouTube* (n=1), or a combination of multiple platforms (n=4). Although *Twitter* – with 330 million active users globally in 2019 (Statista, 2019) – is not representative of the world's online population (estimated at

more than 4 billion in 2019 - Internet World Stats, 2019), it is arguably the most open and easily-accessible source of social media data.

It is worth mentioning that a large majority (n=44) of the studies included in this review based their analysis on a single social media platform, which potentially limits the generalizability of the results.

Although digital trace data can be collected and analyzed in different ways, among the studies that used this type of data, we found an overwhelming majority of social network analyses, systematically looking at social media activity in the environment in which it naturally occurs. Broadly speaking, Social Network Analysis (SNA) investigates patterns in relationships between interacting units, looking at network structures in terms of nodes (usually individual users) and ties or edges (the interactions or relationships that exist between these nodes) (Prell, 2011; Scott & Carrington, 2011). This type of analysis can be performed using a variety of digital tools for data processing and visualization (e.g., NodeXL, R, Python, Gephi, UCINet).

These SNAs took different forms. Some used social network maps to identify the formation – around specific topics or debates – of distinct ideological clusters (Barberá, 2015a; Del Vicario *et al.*, 2016, 2018; Wieringa *et al.*, 2018), and the distance between them (Garimella, 2017; Lynch *et al.*, 2017). Others looked at the frequency and direction of edges (i.e., relationships and actions between users, such as likes, retweets, comments, etc.) between ideologically-discordant users as well as the distance between them (Bodrunova, Smoliarova, Blekanov, Zhuravleva, & Danilova, 2018; Colleoni, Rozza, & Arvidsson, 2014; Takikawa & Nagayoshi, 2017; Williams *et al.*, 2015). SNAs were also carried out by focusing on the sharing of URLs and hyperlinks across different social media platforms (Bessi *et al.*, 2016; Callaghan *et al.*, 2013), or from social media to news websites (Garimella *et al.*, 2018). Others retrieved content produced by ideologically-distant groups or pages and looked at users' interactions in relation to them (Bessi *et al.*, 2016; Del Vicario *et al.*, 2016; Merry, 2015; Del Vicario *et al.*, 2017). Some studies relied on "click experiments", investigating the place of social media in users' news consumption habits via web tracking data (Flaxman *et al.*, 2016; Nikolov *et al.*, 2015).

Digital trace data, and SNAs in particular, are very good at illustrating movements and trends in network dynamics, including the formation of ideological clusters, the quantity of interactions between distinct users, or the centrality of specific users (e.g., "opinion leaders"). Digital trace data provide unsolicited and precise records of human behaviour in their "natural" environment, and can be collected from numerous platforms. This being said, the notable potential of this approach should not cloud the need for individual-level data and qualitative, in-depth assessments of these social media interactions, which could for instance shed light on the nature (e.g., whether more supportive, confrontational or deliberative) of these interactions. Indeed, few of the studies included in this review have carried out SNA to focus on the nature of social media interactions. Williams *et al.* (2015) retrieved *Twitter* data on climate-related hashtags and performed a sentiment analysis, classifying users based on their expressed attitude towards climate change. Balcells and Padró-Solanet (2016) built a manageable sample of *Twitter* replies by users following accounts for or against Catalan independence and manually coded them to assess their deliberative character. It is one of the only studies in our sample that qualitatively focused on the deliberative nature of social media interactions.

Over-relying on digital trace data and SNA without taking into account the nature of social media interactions nor the content to which social media users are exposed in their news feeds might not only promote a one-sided view of online media environments, but might also exaggerate the level of fragmentation or segregation that actually exists (Webster & Ksiazek, 2012). Digital trace data generally provide incomplete or no information about individual attributes or their activity across different online and offline spaces. On their own, they are arguably of limited use in linking human behaviour with social science theories or in shedding light on individual-level factors explaining these human behaviours (Stroud & McGregor, 2018).

Finally, SNAs usually rely on social media platforms' Application Programming Interface (API), which cannot account for acts of "disconnectivity" like "unfriending" or "unliking", and which might therefore paint a biased picture of social media communication (John & Nissenbaum, 2019).

Studies based on self-reported data

The second approach was based on more traditional means of data collection, relying on self-reported data for which users were asked about their own social media usage and news consumption habits, mostly through surveys and – to a lesser extent – focus groups and interviews.

Within this approach, some scholars used survey re-

sponses combined with regression analyses to study the links between the use of diverse media and respondents' network diversity (Hampton *et al.*, 2011) or the likelihood of users finding themselves in echo chambers on social media (Dubois & Blank, 2018). Other studies combined survey methods with experiments reproducing online settings and exposing users to opinion-challenging arguments, subsequently analyzing reported perceptions and attitude change (Karlsen *et al.*, 2017). In a similar study, users were exposed to news stories from left- and right-wing newspapers to look at the role of social and political cues on news content selection using a web interface similar to *Facebook* or *Twitter* (Messing & Westwood, 2014).

Several studies investigated respondents' *Facebook* use and their interactions through focus groups and follow-up interviews (Wohn & Bowe, 2016) or through survey questions and follow-up interviews (Grevet *et al.*, 2014; Seargeant & Tagg, 2018).

Although self-reported survey data provide rich individual-level data shedding light on – for instance – sociodemographic characteristics and outcome variables such as political attitudes, they are not devoid of limitations. Studies relying on individually self-reported data – besides being based on significantly smaller samples – are exposed to measurement issues (Andersen *et al.*, 2016) and social desirability bias (Fisher, 1993; Stodel, 2015; Vraga & Tully, 2020), or the tendency of survey respondents to give approval-seeking answers, over-reporting "good behaviors" and under-reporting "bad" or objectionable ones. They also suffer from the potential lack of accuracy of retrospective self-reports, which might be worsened by today's image-saturated and fast-paced digital information environments (Stier *et al.*, 2020).

Studies combining digital trace data and self-reported data

Among the 55 studies included in this systematic review, only one combined digital trace data with self-reported (survey) data, despite the advantages of such an approach (Resnick *et al.*, 2015). Eady *et al.* (2019) combined survey data (including self-reported ideological placement) with data from respondents' public *Twitter* accounts. They analyzed the political and media environment of these users by merging ideology estimates with content from the set of *Twitter* accounts followed by the respondents in order to see whether – and the extent to which – liberals and conservatives encounter cross-cutting content. By linking survey data with digital trace data, these researchers were able to study online behavior and political information environments at the individual level, using publicly available data.

The integration of digital trace data and self-reported survey data seems to be significantly underexplored in the study of social media echo chambers, although it represents a promising way to account for the respective weaknesses of these two types of data. Their combination allows for the cross-validation of measurements, using both rich individual-level data and large-scale social media data, providing more depth of analysis and a more fine-grained understanding, while observing online behavior and dynamics in their natural environment.

This being said, the combination of digital trace data and self-reported survey data is not without challenges. Perhaps most importantly, these include ethical issues of consent at different levels. Indeed, researchers need explicit consent for different stages, as well as active participation in these stages (e.g., survey, online platform, web tracking). These multiple stages increase the risk of low consent and response rates, and subsequently, of potential selectivity bias (Jürgens *et al.*, 2020). Other issues include the representativity of subsets of (active and motivated) social media users or the equivalence of conceptual measurements across online and offline indicators (for a review on integrating digital trace data and survey data, see Stier *et al.* 2020).

3. Findings: Echo Chamber vs. Public Sphere?

After scrutinizing similarities and differences in terms of the topics addressed, and the methods and data used, we shall now review what these studies have found and concluded. Going through the findings, a clear distinction could be made between studies that painted scenarios of echo chambers, public sphere, or a combination of both. More concretely, we could divide the studies between (i) those that found clear evidence of echo chambers on social media; (ii) those that generated mixed findings; and (iii) those that did not find evidence of echo chambers on social media, instead finding evidence of heterogeneity and cross-cutting interactions and exposure. The "mixed findings" category refers to studies that found echo chambers to be likely on social media, but under certain conditions. The findings of the studies in our sample were independently coded by two investigators. As nuances in these findings could be subject to inter-

pretation, we performed a reliability test. The inter-coder reliability was satisfactory (Krippendorff's alpha of 0.90).

When comparing the studies' methods/data and foci with their findings, clear patterns emerged (see Table 1). Indeed, while more than half (n=24) of the studies based on digital trace data (n=43) found clear evidence of echo chambers on social media, none of the studies based on self-reported data did. Additionally, 22 out of the 24 studies that found clear evidence of echo chambers on social media either focused on communication and interactions (n=16) or combined a focus on communication/interactions and content exposure (n=6). On the other hand, only 2 out of these 24 studies focused solely on content exposure on social media.

These results – which might help us better understand the sometimes contrasting nature of the literature on social media echo chambers – suggest that the findings of research on this issue are significantly influenced by the studies' focus and methodological approach. This further reflects the impact of conceptual, measurement and data choices on research outputs. These choices inevitably highlight some aspects of media environments at the expense of others (Napoli, 2011). In this sense, it is worth mentioning another

Methods/data	Findings		
	Evidence of echo chambers on social media	**Mixed findings**	**No evidence of echo chambers on social media**
Digital trace data	24 studies: Del Vicario *et al.* 2016** Williams *et al.* 2015* Hong & Kim 2016** Bessi *et al.* 2016** Jacobson et al. 2016** Batorski & Grzywinska 2018* Zollo *et al.* 2017* Nikolov *et al.* 2015*** Del Vicario *et al.* 2017** Lynch *et al.* 2017* Hayat & Samuel-Azran 2017* Chung-hong & King-wa 2017* Merry 2015; Grömping 2014* Takikawa & Nagayoshi 2017* O'Callaghan *et al.* 2013*** Garimella *et al.* 2018** Park *et al.* 2016* Bodrunova *et al.* 2018* Schmidt *et al*. 2018* Chen & Milojević 2018* Del Vicario *et al*. 2018* Wieringa *et al*. 2018** Furman & Tunç 2019*	19 studies: Balcells & Padró-Solanet 2016* Colleoni *et al.* 2014** Barberá *et al.* 2015a* Flaxman *et al.* 2016*** Bozdag *et al.* 2014*** Garimella *et al.* 2017* Bright 2018* Bodrunova *et al.* 2015* Bakshy *et al.* 2015*** Hanusch & Nölleke 2018* Esteve Del Valle & Borge Bravo 2018* Shore *et al*. 2018** Dehghan 2018** Matuszewski & Szabó 2019*** Cota *et al*. 2019* Bodrunova *et al*. 2019* Rathnayake & Suthers 2019* Hodson & Petersen 2019* Urman 2019***	-
Self-reported data	-	6 studies: Vaccari *et al.* 2016** Wohn & Bowe 2016*** Grevet *et al.* 2014* Seargeant & Tagg 2018** Karlsen *et al.* 2017* Lee 2016**	5 studies: Hampton *et al.* 2011** Dubois & Blank 2018*** Lee *et al.* 2014** Semaan *et al.* 2014** Messing & Westwood 2014***
Combination of both	-	1 study: Eady *et al*. 2019***	-

Table 1. Foci, methods/data and findings of the studies in our sample (n=55). "Foci" legend: * Communication/interactions; ** both communication/interactions and exposure; *** exposure.

potentially important distinction, namely that between *media-centric* and *user-centric* approaches. Studies based on digital trace data and focusing on communication and interactions will tend to favor a media-centric approach, accounting for activity across entire networks and platforms. On the other hand, studies based on self-reported data and focusing on content exposure will tend to take a user-centric approach, accounting for the media repertoire of individual users (Webster & Ksiazek, 2012), as will be further developed in the discussion.

Evidence of echo chambers on social media

Close to half of the studies found clear evidence supporting the "social media echo chamber hypothesis", according to which social media users will most likely interact with like-minded others and/or be exposed to ideologically-aligned content on social media. As mentioned above, 22 out of the 24 studies in this category focused on communication and interactions or combined a focus on communication/interactions and content exposure, and all of them relied on digital trace data (as shown in Table 1).

The findings pointing to the existence of echo chambers on social media varied across the studies reviewed in this paper. On several occasions it was concluded that social media activity is characterized by attitude-based homophily and takes place within segregated communities of like-minded users. Conflicting narratives on controversial topics were shown to lead to the clustering of users into homogenous echo chambers, whether around conspiracy and scientific topics (Schmidt *et al.* 2018; Bessi *et al.*, 2016; Chen and Milojevic, 2018; Del Vicario *et al.*, 2016; Zollo *et al.*, 2017), within the framework of Hong Kong's Occupy Movement (Chan & Fu, 2017), or in the context of Egypt's uprisings between 2011 and 2013 (Lynch *et al.*, 2017). Others found that social media users tend to selectively expose themselves to and engage with a restricted array of content and information sources that correspond to their political orientation, thereby severely limiting the potential for cross-cutting exposure and interactions (Grömping, 2014; Jacobson *et al.*, 2016). Two social network analyses on climate change (Williams *et al.*, 2015) and gun control (Merry, 2015) found that most *Twitter* users only (or almost only) interact with like-minded others, while avoiding direct confrontation with their "opponents".

A study of *YouTube*'s recommender system suggested that users find themselves in echo chambers when consuming content on the platform. In this instance, they identified the existence of an extreme-right filter bubble in which users who click on extreme-right content are highly likely to be recommended further extreme-right content (Callaghan *et al.*, 2013).

A social network analysis of the *Twitter* activity surrounding Korea's 2012 presidential campaign found an overwhelming majority of retweets and a small number of replies and mentions, suggesting that, more than debating with one another, users relayed other users' content. This is in line with the idea that social media such as *Twitter* work as echo chambers in which dominant opinions are reinforced at the expense of plurality (Park *et al.*, 2016).

Mixed findings

Close to half of the studies included in our sample generated mixed findings. Among these, some found evidence of echo chambers on social media, but mostly around political topics (Barberá, 2015a; Grevet *et al.*, 2014), controversial issues (Garimella, 2017), or between groups that are further apart in ideological terms (Bright, 2018; Eady *et al.*, 2019).

Other studies found that social media users tend to be mostly exposed to ideologically-aligned content but to a somewhat limited extent (Bakshy *et al.*, 2015; Flaxman *et al.*, 2016), or that disagreement persisted on social media, despite users' tendency to engage with networks that support their views (Vaccari *et al.*, 2016). Some argued that the level of ideological segregation on social media depended on the profile of the users. They found that followers of Democrat accounts showed higher levels of political homophily than those following Republican accounts (Colleoni *et al.*, 2014).

No evidence of echo chambers on social media

Only five out of the 55 studies included in this review did not find any evidence of echo chambers on social media; instead, they found evidence of heterogeneity and cross-cutting exposure and interactions. All five studies based their analysis on self-reported data and either focused on exposure or combined a focus on exposure and communication/interactions (see Table 1). For example, through a survey of internet users in the UK, a study by Dubois and Blank (2018) found no evidence of echo chambers on social media. Their results showed that, on the contrary, social media users tended to check multiple sources and tried to confirm information using external searches, thereby often encountering things they disagreed with and opinions that changed their views. Similarly, others (Semaan *et al.*, 2014) found that

– far from creating echo chambers of like-minded users – social media activity gave users access to a heterogeneous group of people with whom they could discuss political issues. Their results showed that their sample of interviewees actively sought out an environment that could facilitate deliberation. According to other scholars, social media use increases users' network diversity (Lee *et al.*, 2014; Hampton *et al.*, 2011;) and exposure to a variety of news and politically-diverse information (Messing & Westwood, 2014), thereby lessening concerns about social media echo chambers.

In this section, we have highlighted the findings of the studies included in our sample. As we have seen, the literature is not unanimous on the existence of echo chambers on social media. Different studies – and different approaches – generate significantly more or less evidence of segregation and polarization on social media, further emphasizing the weight of methodological and measurement choices on research findings.

Discussion and Conclusions

In this article, we have provided a first classification of the literature on social media echo chambers and identified patterns across the studies' foci, methods and findings. These were characterized by a significant focus on communication and interactions, as well as a tendency of studies focusing on communication/interactions and/or based on digital trace data to generate more evidence of echo chambers than studies focusing on content exposure and/or based on self-reported data.

Throughout the analysis, we noticed that a majority of the studies focused on communication and interactions on social media, while fewer of them focused on content exposure, or combined both perspectives. Although this can partly be explained in terms of data availability, future studies should consider that an exclusive focus or an over-emphasis on communication and interactions on social media might not only weigh on the findings (potentially overestimating polarization), but also miss the bigger picture. Indeed, the problem not only lies with users communicating with like-minded others on social media but also (and perhaps even more importantly) with users – often passively – consuming and being exposed mostly or solely to attitude-reinforcing content (cf. metaphor of the filter bubble). Users that are actively engaged in political debates on social media (and more specifically on *Twitter*, like in many of the studies included in this review) represent a minority in comparison to those who use social media to consume media content and inform themselves. As an illustration, a 2016 survey of social media users in the US found that most of them never (50% of respondents) or hardly ever (24%) commented, posted, or discussed about politics with others on social media (Statista, 2016).

As we saw in this paper, there were not only differences in the way echo chambers were operationalized (e.g., cross-cutting content exposure vs. interactions), but also in the way that social media interactions were operationalized, whether taking into account (in the case of *Twitter*) the follower network, the retweet network, the mention, or the reply network. Future scholars should consider that the decision to focus on one network or the other might influence the results in a way that cannot be overlooked.

As shown in Table 1, the results of research on this issue seem largely influenced by the choice of methods and approach to data collection, with most evidence of echo chambers found through analyses based on digital trace data. As mentioned before, methodological and conceptual choices often weigh on research outputs. In our case, it might be said that digital trace data and a media-centric approach – for instance, by focusing on specific (often polarized) networks or by neglecting the role of user agency across different platforms and networks – could overestimate the level of fragmentation that actually characterizes social media. On the other hand, it might be said that survey data and a user-centric approach – for instance, by relying on small samples and on potentially inaccurate and biased self-reports – might underestimate fragmentation and polarization on social media. When studies are focused on individual behavior and take into account user agency on different platforms and networks and across longer timeframes, a different (and perhaps deeper) vision might show individuals being exposed to and interacting with opposing viewpoints (Barberá, 2015b; Dubois & Blank, 2018; Semaan *et al.*, 2014).

Given the centrality of the exchange of information and opinions characteristic of the notion of public sphere, the issue of social media echo chambers cannot be captured solely through structural analyses of online networks or qualitative methods based on self-reported data. Indeed, more attention should be given to online intertextuality and methods of discourse analysis, which are key to better understand the multimodal forms of expression encountered

on social media (Herring, 2019).

In our sample, a clear distinction could be made between the many studies based on digital trace data and those based on self-reported data, both approaches providing rich insights. However, as we have seen, each of these approaches also comes with potential drawbacks and biases (e.g., lack of individual-level data and depth of analysis in the case of digital trace data; inaccuracy of retrospective self-reports; social desirability bias and issues of generalizability in the case of self-reported data). While these issues need to be addressed, the significant potential of combining self-reported data with digital trace data should be taken into account in future studies. This could provide a more complete account of users' political information environments through a combination of rich individual-level data and conspicuous observations of online behavior in its natural setting. Although challenging on several counts, such a combined approach could help to account for the respective weaknesses of these two types of methods/data and perhaps contribute to disentangling the apparent relationship between methodological choices and research findings. An insightful account of potential ways forward can be found in Stier *et al.* (2020) and their special methodological issue on integrating digital trace data and survey data. Finding innovative ways to combine these two types of data (for instance, through survey experiments and web tracking - see Vraga & Tully, 2020) could also make it easier for future studies to take into account both communication/interactions and content exposure on social media, allowing for a more comprehensive understanding of this multifaceted issue.

Among the studies in our sample, there seems to be a broader consensus supporting the "social media echo chamber hypothesis". However, considering the potential biases of the different approaches and the seeming correlation between foci, methods and findings, one ought to be careful not to fall in "absolutist" interpretations of the results in terms of the full-fledged existence or nonexistence of echo chambers on social media. While social media use can sometimes positively contribute to – and at other times impede – democratic deliberation and plurality, there is a need to acknowledge the fact that this is far from being a binary issue. Moving beyond the metaphors of the echo chamber and the filter bubble, we ought to consider that any given increase in opinion-reinforcing arguments and decrease in opinion-challenging information is a likely source of polarization. There can certainly be different magnitudes of echo chambers, the lowest of which should already be seen as problematic. This magnitude will depend upon the network, the issue, as well as a multifaceted interplay between the architecture of social media platforms and users' individual characteristics. It would perhaps give us perspective to see this issue in relation to an ideal environment in which social media would truly enhance democratic deliberation, an environment reminiscent of early optimism about the potential of social media and ICTs in contributing to the creation of an independent public sphere and in diversifying people's networks and perspectives.

Although research on the existence of echo chambers on social media is still relatively young, through this review we were able to identify relevant similarities and differences, and provide a descriptive, yet critical, picture of the peer-reviewed work on this timely issue.

This is a challenging and rather fragmented field of research, often relying on variables and data that are difficult to gather, measure, and interpret. Still, the importance and potential of research on social media echo chambers – and their implications for political deliberation and democracy – are manifest.

This paper shed light on the restrictive – and potentially biased – character of one-sided operationalizations of the issue of social media echo chambers as well as of one-sided data collection approaches. Future scholars should carefully take into account the available body of work and avoid reproducing studies that focus solely on communication and interactions or content exposure, or rely solely on digital trace data or self-reported data, as such approaches might fail to do justice to the complexity of the issue of political exposure on social media.

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