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Loopholes in the Echo Chambers: How the Echo Chamber Metaphor Oversimplifies the Effects of Information Gateways on Opinion Expression

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ABSTRACT

Social media (SM) are often regarded drivers of personalized echo chambers in which only ideas resonate that individuals already hold, leading to more extreme opinions and intensified opinion expression. However, recent theorizing and evidence has cast doubts on the universal applicability of the echo chamber metaphor, pointing out that communication effects on opinion expression are much more complex than the metaphor suggests. Using the refugee crisis in Germany as a background, the current study challenges four implicit premises of the echo chamber metaphor empirically. The findings show a more complex picture than the metaphor implies: (1) Ignoring other information sources beyond SM may lead to severe misinterpretations; seeming evidence for echo chambers disappears after controlling for news media use. (2) SM reliance does not generally stimulate opinion expression. (3) Attitude extremity moderates the effect of SM reliance, suggesting that people with more extreme views are susceptible to echo chamber effects. (4) Attitude position on the issue-at-hand moderates the effect of SM reliance, which suggests that echo chambers do not completely shield their users from the public discourse. We propose the Echo Chamber Continuum (ECCo) Model to stimulate developing the echo chamber metaphor into a theory suitable for studying opinion formation.

KEYWORDS

Echo chambers; political information use; social media; selective exposure; climate of opinion; refugee crisis; mobile diary

Social media (SM) have become an important source of political information (Hölig and Hasebrink 2019) and introduced new ways of opinion expression (e.g., liking) (Porten-Cheé and Eilders 2015) that can impact public discourse (Knoll, Matthes, and Heiss 2020). Some view them as drivers of personalized “echo chambers” in which primarily ideas resonate that individuals already hold, resulting from and leading to more extreme opinions and intensified opinion expression (Porten-Cheé and Eilders 2015). Sunstein (2018) argues that SM enable likeminded individuals to group together,

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reinforce their shared views mutually, filter and re-frame external input, and thus get the impression of being a strong, growing group, fostering homogeneity within groups and polarization between groups. However, recent evidence has cast doubts on the validity or universal applicability of the echo chamber metaphor. Reality seems to be more nuanced, binding echo chamber effects to preconditions such as high initial attitude extremity or a near-exclusive reliance on one's SM ecosystem to get political information (Barbera 2020; Boulianne, Koc-Michalska, and Bimber 2020).

Aiming at an increased conceptual clarity on echo chambers, this study of information use's impact on opinion expression in Germany challenges four implicit premises of echo chambers on SM by putting them to an empirical test: (1) SM are the users' only information source that matters; other information sources can be ignored. (2) The content in SM and news media differ fundamentally, creating greater risk to end up in echo chambers when relying on SM. (3) Echo chambers apply to a similar degree to all users, independent of their attitude extremity. (4) Inside echo chambers, individuals' opinion expression will be intensified independent of the attitude they hold; they immunize against mainstream media's "big messages" and their potential for "silencing effects" on specific opinion camps (Noelle-Neumann 1984).

The study allows putting these presumptions to an empirical test due to three important advantages. In combination, they are novel and substantially extend the state-of-the-art: First, the study considers several gateways to political information, not SM in isolation. Second, it includes attitude extremity (moderate–extreme) and attitude position (left–right) as potential moderators. Third, the 14-day daily diary design is capable of exploring the development of individuals' opinion expression with high temporal resolution. If *change in* (rather than *level of*) opinion expression is analysed, it is much more plausible that it traces back to the information gateways used (and the content they provided), controlling for many long-term developments and traits that can affect opinion expression. After conceptualizing opinion expression and echo chambers, we discuss four implicit premises that our study challenges to derive hypotheses which we put to the test.

Opinion Expression Online

Political opinion expression is any action of an individual that tells, shows or gives hints to others what political opinions (or: political preferences) that individual holds. In liberal democracies, opinion expression is a form of low-threshold/high-prevalence political participation that simultaneously expresses and contributes to opinion formation of the individual and the public. Also, it feeds back into perceptions of climate of opinion, as a central component in the "spiral of silence" (Noelle-Neumann 1984). One particularly prominent and influential conceptualization is "willingness to speak out" (Scheufele and Eveland 2001) that encompasses only public behaviour. Typical measurements include hypothetical questions such as whether one would talk politics with a stranger on a train or bus, or whether one would participate in a broadcast interview (Glynn, Hayes, and Shanahan 1997). We use a broader concept and non-hypothetical self-report measurements, including private and semi-public expression of opinion, for three main reasons: First, the practical and conceptual distinction between public and private opinion expression (Scheufele and Eveland 2001) has become

blurred in online environments in which (inter-)actions thought to be private can become public easily. Second, the extent of (potentially) public opinion expression has increased, the threshold for opinion expression has lowered, and the spectrum has broadened with the new ways of expression online (Eilders and Porten-Chée 2016). Therefore, rather than using the classical hypothetical measures (Glynn, Hayes, and Shanahan 1997; Noelle-Neumann 1984), we can now assess (short-term recalled) behaviour because opinion expression will be more frequent. Third, mobile diaries (Baumert et al. 2017) can increase accuracy and temporal resolution in measuring opinion expression.

Opinion expression has rarely been studied in the context of echo chambers, where the attitude position was at the centre of interest. However, any echoing effect presupposes an initial “sound” that can “reverberate.” A principal source of the sounds that reverberate and constitute the echo chamber is that the likeminded people inside a (relatively closed) group intensively express their opinion. Looking at the effect of information use on opinion expression is thus key to understanding feedback mechanisms that could lead to echo chambers for political information.

Echo Chambers and Their Effects

“Echo chamber” originally refers to a physical “room with sound-reflecting walls used for producing hollow or echoing sound effects” (Merriam-Webster Dictionary n.d.). Metaphorically (Sunstein 2018), the term describes information environments created by personalized information sources (e.g., SM). Messages that are popular among likeminded individuals reverberate (individual, social and algorithmic selectivity reinforcing each other) so that the same messages are heard over and over again (Sunstein 2018). Such information environments will mainly develop in case of individuals with a homogenous network, fostered by homophily, overall leading to a low salience of challenging information and opinions (Barbera 2020). Ending up in echo chambers has always been possible (e.g., when joining a radical group), but may have become easier, more fluent, tempting, and frequent when using SM.

Echo chambers still lack a clear, consistent definition as a concept of media effects (Bright 2018). Sunstein (2018) based his considerations on anecdotal evidence and thought experiments. Many studies only use echo chambers as a conceptual “anchor” for investigating a multitude of different phenomena, such as selective exposure (Garrett 2009), cognitive dissonance (Bright et al. 2020), or political polarization (Barbera 2020). Studies that explore the concept of echo chambers *as such* in greater depth are still scarce. The existing studies clarify that reality is much more nuanced and the metaphor is an oversimplification (Bruns 2019). The likelihood for echo chambers to emerge is high only if specific conditions are met: if networks are homogeneous, topics are controversial, and political predispositions are strong (Barbera 2020).

If echo chambers emerge, opinion expression should be stronger inside them for three reasons: (1) the insiders’ attitude strength increases (Matthes, Rios Morrison, and Schemer 2010) along with the identification with their “opinion camp” (Iyengar, Sood, and Lelkes 2012; Powers, Koliska, and Guha 2019); (2) they expect a reduced likelihood of facing argumentative challenges or even social sanctions (Neubaum and Krämer

2018; Porten-Cheé and Eilders 2015); (3) engaging or provocative activity by other users may motivate opinion expression (Ziegele, Breiner, and Quiring 2014).

Questionable Premises of the Echo Chamber Metaphor

The above conceptualization, the prediction that algorithmic news recommendation results in echo chambers, and the way previous studies have tried to investigate echo chambers is characterized by several implicit premises that apply only partly or not at all (see also Bodó et al. 2019; Möller et al. 2018). We have reconstructed four such premises based on the literature on echo chambers that have not been explicated and discussed in conjunction yet. This can have far-reaching consequences if they lead to misleading conclusions by scholars. These four premises trace back to two key variables that we suggest should be used in echo chamber studies by default—*information menus* (premises 1/2) and *pre-existing attitudes* (premises 3/4):

1. SM are the only information source that matters.
2. The content in SM and news media differ fundamentally.
3. Echo chambers equally apply to all SM users.
4. Echo chambers effectively immunize against silencing “big message” effects.

Disclosing these implicit premises and challenging them empirically provides a good starting point for developing a clearer concept of echo chambers.

Premise 1: SM Are the Only Information Source that Matters

The vast majority of studies that find evidence of echo chambers investigate just one single SM, mostly Twitter (Colleoni, Rozza, and Arvidsson 2014). These studies neglect that SM are by far not citizens’ only gateway to information (Dubois and Blank 2018; Hölig and Hasebrink 2019). For our purpose of studying of opinion expression in Germany in general, focussing on one gateway and neglecting all others is not an option, given where Germans turn to get their political news: The German population still focuses on journalistic news sources for political information, particularly TV news (65%), printed newspapers (22%) and online news (80%, including SM)—compared to 45% using “SM” as a news source. People who exclusively rely on SM for political information are rare exceptions (Hölig and Hasebrink 2019). Most users will thus show hybrid patterns of political news use—some leaning more towards mass media, others leaning more towards SM. When investigating echo chambers, we should thus not focus on SM, but must control for the use of other information sources (Boulianne, Koc-Michalska, and Bimber 2020). This becomes even more critical because political information use on SM is positively correlated with political information use from other sources, e.g., as a common consequence of one’s level of political interest (Strömbäck and Shehata 2010). The general mobilizing effect of political information use may be mistaken for a specific effect of using SM for political information. This risk is high given that information consumption is positively associated with opinion expression (Ho, Chen, and Sim 2013); this does not preclude that SM use may increase

opinion expression even more strongly than other forms of media use (Knoll, Matthes, and Heiss 2020).

In our study, we will examine (a) the total volume of political information use (independent of the gateway); (b) the proportion of political information use via SM (SM gateway) as primary independent variables that could affect opinion expression. If concentrating only on (b), we would mistake general effects of exposure to political communication for specific effects of SM-reliance:

H1: The effect of SM-gateway political information use on opinion expression will be overestimated if the impact of total political information use (gateway-independent) is not considered.

Premise 2: The Content in SM and News Media Differ Fundamentally

Even when considering multiple gateways, there is a second implicit premise when expecting specific effects of SM-reliance: If we expect that the SM gateway stands out in terms of extent or direction of effect on opinion expression, the content received through the SM gateway should fundamentally differ from content accessed through other gateways.

Similarities between Gateways

A vast share of political information accessible via SM gateways uses or hyperlinks to content produced by traditional news organizations that are distributed on SM (Wallace 2018). Content available on SM and on news organizations' websites will overlap substantially. Furthermore, news consumers will select news outlets/stories actively and generally prefer content that matches their opinion about an issue or their broader political ideology (Stroud 2010). While it is technically possible to avoid news content on SM and exclusively use other sources to get political information, this will be a rare exception rather than the rule (Dubois and Blank 2018). Even if news are completely avoided, there seems to be a general positive correlation between information consumption and opinion expression (Ho, Chen, and Sim 2013). There might be a ceiling effect when support for one opinion is so overwhelming and expressing that opinion becomes needless ("solid state" of public opinion), but current controversial issues are unlikely to reach that point ("fluid state" of public opinion) while they are high on the public agenda (Noelle-Neumann 1984, 58–68). We therefore expect greater opinion expression among those who use more political information—relatively independent of the source they get the information from:

H2: More political information use (gateway-independent) stimulates more opinion expression.

Specifics of SM as Political Information Source

Despite all these similarities, the mode of pre-selecting and organizing content strikingly differs between news media and SM. News media typically address a target audience rather than individuals. As a result, there will be gaps between users' ideology and the content they receive—even if ideological fit was the users' sole criterion for selecting outlets or news stories (which it is not) (Garrett 2009). In contrast, the users'

profiles, activities and networks on SM allow for reasonable algorithmic estimates of their preferences. For nearly every topic, relevant content from an ideologically compatible “angle” should be available somewhere on the Web. Individualized “feeds” allow SM to automatically suggest content that fits their preferences (Thorson et al. 2019, 2). The way SM pre-select, organize, and suggest content is thereby capable of (a) strengthen attitudes and identification with one’s “opinion camp,” (b) reducing fear of social repercussions and reinforcing expectation of social support (Neubaum and Krämer 2018), and (c) providing engagements and provocations that motivate opinion expression in a way other information environments cannot (Ziegele, Breiner, and Quiring 2014). SM use could thereby boost opinion expression even more than political information from other sources:

H3: Greater reliance on SM for political information stimulates more opinion expression over time, compared to those relying less on SM and/or more on news media.

Premise 3: Echo Chambers Apply to All Users

Even if considering multiple gateways to news and their potentially differential effects on opinion expression: By not considering moderators or analysing specific sub-groups, many early studies presuppose that all users are more or less similarly vulnerable to ending up in echo chambers. In contrast, some authors (Stark, Magin, and Jürgens 2017; Barbera 2020; Bright et al. 2020) assume that echo chambers will only develop if people already hold extreme attitudes. There are persuasive arguments and empirical findings that the pervasiveness of partisan selective exposure (Stroud 2010) increases with greater extremity of attitudes (Bright 2018; Bruns 2019), ensuing greater involvement, commitment, and elaboration (Zaller 1992). It is plausible that a certain attitude extremity is necessary to accelerate and intensify the spiralling of content selection and attitude extremization (Schemer, Geiß, and Müller 2019). Political extremism also substantially increases the probability of ending up in homogeneous groups (Boutyline and Willer 2017), providing social reassurance necessary to stabilize or intensify extreme attitudes (Schemer, Geiß, and Müller 2019). Politically extreme ideologies are easier for algorithms to recognize as extreme political views find expression in distinct activity patterns, in distinct social network structures (Barbera et al. 2015), and in the content users create, like and share. This enables a more ideology-driven automated pre-selection of content that caters to individuals’ need for social validation. More extreme opinions, therefore, should interact with the effects of information exposure in general and SM reliance on opinion expression in particular.

H4: Attitude extremity moderates the effects of (a) political information use and (b) SM reliance on growth of opinion expression.

Premise 4: Echo Chambers Immunize against Silencing “Big Message” Effects

Echo chambers studies should consider (a) multiple information gateways that can have differential effects, (b) that people with more extreme attitudes may be more vulnerable to reinforced opinion expression. Additionally, research into echo chambers

implicitly assumes that echo chambers immunize against silencing “big message” effects as for instance predicted by the “spiral of silence” (Noelle-Neumann 1984).

We question this premise and assume that opinion expression reinforcement in echo chambers can vary by attitude position, according to the following mechanism: In most mediated conflicts, there is an inherent instrumentality of the debate for one of the camps (Kepplinger, Brosius, and Staab 1991), e.g., when increasing immigration typically tends to bolster support for protectionist ideologies. One side appears to be dominant and winning, the other appears to be struggling and losing ground (Noelle-Neumann 1984), for all eyes to see. More or less all news media will often repeat this “big message” on the climate of opinion in a similar way (Perse 2001), which can then silence one “opinion camp” while mobilizing the other.

Many studies investigating echo chambers implicitly assume that the “big message’s” inherent instrumentality is lost or neutralized inside the echo chamber. This neutralization develops through three resistance mechanisms: (1) *Blocking*: Many messages with opposing views from outside are blocked entirely from entering the echo chamber. (2) *Reframing*: Outside messages with opposing views that enter the echo chamber are reframed or reinterpreted. Insiders would try to undermine the message’s credibility, invalidate, refute or ridicule its arguments and positions—“motivated reasoning” (Druckman and Bolsen 2011) on steroids. (3) *Drowning out*: By mobilizing opinion expression inside the echo chamber, only attitude-consistent messages “echo” and grow ever louder and more unison, marginalizing challenging messages.

Through these mechanisms, each camp would get reinforced in their ideologically constituted echo chamber and mobilized to a roughly similar extent. For insiders, the gap between the “big message” and their own views may appear greater than it is (hostile media perceptions: Choi, Yang, and Chang 2009), increasing resistance. Cumulative and consonant exposure to a consistent media-reality of the issue (Perse 2001) and the “big message” on the climate of opinion would be nearly impossible. Consequently, chances for asymmetric mobilization of one camp’s opinion expression and silencing of the other camp—as predicted by the spiral of silence—would be slim. Neither camp would get the impression that their camp is marginalized, shrinking or losing (Schulz and Roessler 2012).

However, recent scholarship emphasizes that echo chambers are characterized more by “drowning out” and “reframing” rather than “blocking” (Bright et al. 2020; Powers, Koliska, and Guha 2019). Rather than being completely “soundproof,” their walls include “loopholes”—and reframing will usually be incomplete. As a side-effect of invalidating opposing views, echo chamber insiders will inevitably learn “meta-messages” about other opinion camps (the issues they find important, the views they hold, the arguments they use, how much support they enjoy) and the climate of opinion. Similar to the “spiral of silence” predictions, this kind of political information would not raise opinion expression in all camps to a similar extent, but rather have silencing or weaker mobilizing effects for one part of the ideological spectrum and stronger mobilizing effects for another part of that spectrum (asymmetric effect). This will occur even if one is already embedded in a group of likeminded individuals: if this group appears to be marginal or shrinking, a strong conviction would be needed to express one’s opinion (Noelle-Neumann 1984). To move beyond the premise of

relatively “soundproof” echo chambers, studies should consider an additional moderator – the attitude position individuals hold. One’s “attitudes position” (individual opinions) and one’s “opinion camp” (group identity) are mutually reinforcing social and cognitive-affective components (Iyengar, Sood, and Lelkes 2012) that can hardly be disentangled. Our study focuses on the “attitude” component because it is what we measure in our empirical study; but this also captures which “opinion camp” an individual belongs to.

H5: Attitude position moderates the effects of (a) political information use and (b) SM gateway reliance on growth of opinion expression.

Background

We test our hypotheses using the example of the long-lasting, highly salient, ongoing debate about migration in Germany—following the decision in August 2015 to admit refugees stuck in other EU countries to Germany. Over one million refugees passed the German border in 2015/16. In the wake of the “refugee crisis,” the German party landscape was transformed, establishing the right-wing populist Alternative für Deutschland (AfD) as a major political player. Migration was the single topic “owned” by the AfD, whose restrictive stance on migration policy played a key role in their resurgence (Köcher 2016). Simultaneously, opinions formerly viewed as “taboo” have gained momentum, especially on SM. The apparent dominance and activity of right-wing users and groups on SM has raised concerns (Grieben 2019).

During the time of our data collection (September 2016), the migration issue was omnipresent in the German public, both on- and offline. Germany’s grand coalition’s popularity plummeted while the then-struggling AfD revived, absorbing voters disenchanted with the grand coalition. The AfD reached up to 24% of the popular vote at regional elections in 2016. Immigration-skeptics appeared stronger than they were: In October 2015, 17% of the German population believed most Germans were in favour of admitting many refugees, while 69% believed most people are opposed—even though both opinion camps were of approximately similar size (Köcher 2015).

This is in line with the general pattern that increased immigration and debates about migration are typically instrumental for the political right (typically endorsing protectionism), and has helped many right-wing populist movements to gain a foothold in national parliaments across Europe (Aalberg et al. 2017). Beyond this mobilization on the political right, the issue also increased polarization in the party system, when the Green party garnered additional support on the political left by those disenchanted with the government coalition’s attempt to take a middle ground on migration. The Greens’ gains were certainly less pronounced than the AfD’s, however.

Even though the German news media was denigrated as “lying press” (“Lügenpresse”) by migration-skeptics during the “refugee crisis,” trust in news media was still high or even increasing (Jackob et al. 2019), and many people relied on mainstream news media for political information (Hölig and Hasebrink 2019). Narrow ideological tailoring of news is untypical in the German media system, and polarization is relatively low. The tone of media coverage about migration was positive and criticized the AfD and migration-skeptics (Haller 2017), but it would nevertheless put forth the

“big message” that the migration-skeptical camp is large, growing, dominates and changes political discourse. Migration-skeptics challenged the media’s reporting, particularly on SM as a preferred channel for right-wing populists (Boulianne, Koc-Michalska, and Bimber 2020) in their attempt to bypass the (purportedly hostile, left-wing) news media (Choi, Yang, and Chang 2009).

Method

Fieldwork and Sample

We conducted a panel study with 14 daily waves (online daily diary). On each day from September 6–20, 2016, the participants were asked to open-endedly name the two political issues they personally found most important at the respective day ($n = 8,565$ issue mentions). The daily questionnaires (CASI) could be answered from 17:00 every day within 24 h. The issue-related daily responses were combined with an initial recruiting survey (August 19–September 4, 2016) and a final survey (September 24–28, 2016) (see the Appendix for all relevant parts of the questionnaires). Fieldwork was commissioned to a professional market research institute, utilizing a commercial online access panel. Participants received the equivalent of up to €21 in incentives (€1 per diary day plus €3.50 for each of the longer recruiting and final surveys). A quota sample was drawn to match the population (German Internet users, 14–69 years) in terms of age, gender, education, and proportion of Facebook users. 1,818 persons were contacted, 459 agreed taking part, 355 completed all three parts of the study ($RR1 = 355/1818 = 20\%$). Final sample characteristics were: 54% female, age: $M = 44.85$ years ($SD = 14.12$), school education: $M = 10.99$ years ($SD = 1.70$).

Case Selection

Our focus on the refugee crisis resulted from a bottom-up process: The 8,565 political issue mentions were coded by three student coders (inter-coder reliability for recognizing “refugee crisis”: $\alpha_{\text{Krippendorff}} = .80$). Each issue mention was considered separately. 55% ($n = 4,752$) of all issue mentions were categorized as belonging to the “refugee crisis” topic complex, which we defined broadly, also capturing the political reverberations of the “crisis” (Table A1). It is even possible that the same person mentioned two issues on the same day which both belong to the “refugee crisis” topic complex (e.g., “causes of migration” and “increasing anti-immigrant sentiment”). These 4,752 issue mentions form the basis for our analysis.

Measures

Repeated Measures (Level 1: Issue Mentions)

Variables measured per issue mention included the main dependent and independent variables: opinion expression and importance of sources for political information.

Opinion Expression (Dependent Variable). For each issue mention, the participants were asked to indicate which of the following ways they had used today to express

their opinion about the issue: (1) press “like,” (2) write a text about it, (3) upload a photo/video, (4) speak out in personal conversations, (5) share it with others online, (6) comment others’ texts. The “yes” or “no” responses were summed, leading to a final score from 0 (no opinion expression today) to 6 (six ways of opinion expression used today) ($M = 0.72$; $SD = 1.01$).

Political Information Sources (Independent Variable). For each issue mention, the participants were first asked to rate the importance of three general information sources for obtaining information about the issue on the previous day they had mentioned: (1) offline media, (2) Internet, (3) personal conversations (original 1–5 scale recoded to: 1 = very important; 0.75, 0.50, 0.25, 0 = not important at all). Those who rated the Internet at least partly important (≥ 0.5 ; $n = 3815$ out of 4752 responses) were asked to rate the importance of 12 specific online sources for informing about the issue, using the same scale: (a) Facebook, (b) Twitter, (c) other SNS, (d) online news magazines, (e) newspapers online, (f) TV/radio online, (g) YouTube, (h) other video platforms, (i) Google search engine, (j) other search engines, (k) Wikipedia, (l) other Internet sources. For our analysis, we counted the highest value in each of the following categories: news media (1, d, e, f), SM (a, b, c, g, h), personal conversations (3), and search media (i, j, k). We used conversations ($M = .598$; $SD = .341$) and search media ($M = .409$; $SD = .387$) as control variables. News media reliance ($M = .826$; $SD = .250$) and SM reliance ($M = .302$; $SD = .362$) were averaged to obtain an index of political information media use, ranging from 0 (= both news media and SM are not important at all) to 1 (both news media and SM are very important) ($M = .564$; $SD = .232$). Then, the share of this score that stems from SM was calculated (SM gateway reliance, 0–1; $M = .207$; $SD = .228$).

Politics-Focussed SM Reliance (Independent Variable). Although we specifically asked for use of “political information” in SM, we collected additional data on how strongly the accounts of the Facebook users were focussed on political actors (rather than on private contacts and news media) to identify more politics-centred patterns of SM use. Facebook users (almost the entire sample) were asked how many Facebook pages they have liked (subdivided into different categories, including politicians/political parties/political campaigns) and how many users they follow. We computed the total number of all indicated likes/contacts that individuals reported ($M = 172.32$, $SD = 148.32$) and divided the number of politicians/political parties/political campaigns among the likes/contacts ($M = 4.39$; $SD = 8.94$) by this total number. Thereby, we obtained an index of politics-focus of SM profiles ($M = .014$; $SD = .038$)—0 would mean that none of the contacts/likes referred to political actors, one would mean that all contacts/likes referred to political actors; the maximum value observed was 0.27 (meaning 27% of contacts/likes referred to a political actor). This was weighted (multiplied) with SM reliance (see above), resulting in an index of *politics-focussed SM reliance* ($M = .005$; $SD = .016$). We use this to further explore *H3*, *H4* and *H5*.

Attitude Position and Attitude Extremity (Moderators). For each issue mention, participants rated the perceived spectrum of opinions about the two issues they had mentioned as important issues on a left–right scale, by marking the extreme points in the

societal discourse. Afterwards, they were asked if they have an opinion about the issue; if not, their *attitude position* was assumed to be equal to their general left–right orientation (one-time measure; original scale: 1–7, recoded to: $-1 =$ “extremely left” to $+1 =$ “extremely right,” $0 =$ “neutral”). If they stated to have an opinion, they were asked to place their own opinion within the spectrum they had marked in the previous question. The raw scores (-50 (left) to $+50$ (right)) were divided by 50, then ranging between -1 (left) and $+1$ (right). The poles of the scale were not explicitly labelled “left” or “right.” Therefore, it is possible that some participants only rated the extremeness of their opinion (which was the primary task) and not its left–right orientation. The score was therefore compared to the general (and explicit) left–right self-placement of participants (see above). If both left–right scores (general and issue-specific) differed by more than 0.5 points and had different signs, we reversed the issue-specific attitude position because participants most likely had not associated the issue-specific scale with a left/right political spectrum. The absolute value of the issue *attitude position* ($M = .015$; $SD = .386$; 16% of scores were “0” (scale-centre)) was used as a measure of *attitude extremity* ($M = .225$, $SD = .266$).

Time. The day on which the participant completed a diary entry was recorded automatically. The number of days after the start of the study was divided by seven, resulting in the number of weeks passed since the start of the study.

One-Time Measures (Level 2: Participants)

Variables on level two were measured once per participant in the recruiting or the final survey.

Controls. For purposes of control, we included the self-reported sex (1 = male/0 = female), age (years), education (years of school education), income per capita in household (€), employment (1 = full-time job/0 = no full-time job), news interest (5-point scale: 1 = low–5 = high), political interest (1 = low–5 = high), duty to keep informed (DKI; four items; 5-point scale: 1 = fully disagree–5 = fully agree), personality strength (10 items; 5-point scale: 1 = does not apply at all–5 = fully applies), and need for orientation (NFO; 9 items; 5-point scale: 1 = fully disagree–5 = fully agree). Personality strength, DKI and NFO were analysed using an exploratory factor analysis with Varimax rotation. For the first two concepts, all analyses suggested a one-factor solution as expected. NFO was – unexpectedly – split into two factors according to an exploratory factor analysis with Varimax rotation: need for information and need for opinion.

Centreing and Standardization

To facilitate interpretation of regression weights in the presence of multiple interaction terms, variables were standardized and centred according to the following specifications: Dichotomous variables (sex, employment), information use and source reliance scores (0–1) and time (weeks, 0–2) were kept. Continuous variables (age, income), rating-scale variables and their derivatives (e.g., political interest, DKI, personality strength) were z-standardized. Political left–right self-positioning ranged from -1 to

+1, with 0 (political centre) as a natural centre point. Missing values, which were rare for the variables considered, were estimated using the R 'Amelia' package for multiple imputation.

Analysis

We computed mixed-effects models with up to 28 responses (14 days, 2 per day) being nested in each participant. 4,752 responses (issue mentions) by 355 participants were analysed. Exploratory analyses of the dependent variable's distribution and the models' residuals suggested that logarithmizing the dependent variable in a linear mixed model gave the best results, preferable to Poisson and negative-binomial error distributions in a generalized mixed model. The latter two led to non-symmetrical distributions of residuals, substantial heteroskedasticity and problematic QQ-plots.

A first series of model comparisons established that a null model (only random effects: random intercepts for participants) was improved by adding control variables, political information use, (politics-centred) SM reliance, and all relevant interaction terms (M0-M4). It showed that the "full" model including the interactions was superior to all other models. A second series of model comparisons attempted to simplify the full model by removing (a) attitude extremity as a moderator, (b) attitude position as a moderator, (c) all interactions involving politics-centred SM reliance, (d) removing all interactions involving politics-centred SM reliance and SM reliance. It showed that all attempts to reduce model complexity also harmed model fit significantly, leaving us with the "full model" for all analyses (model R0-R2c). A third series of model comparisons (X0-X1) removed all information use and source reliance variables except for SM reliance, leading to a model that presupposes a SM-centred information environment (SIE); the full model, in contrast, fits a hybrid information environment (HIE).

Results

Explorative Analyses

We inspected the correlations between the hypothesis-relevant independent variables, finding mostly low associations. As expected, the measures of *political information use* and *SM reliance* are correlated strongly (Table A2).

We also explored which factors affect the salience of the migration issue. Participants were more likely to mention the migration issue if they were older, were more right-leaning, and as time progressed. Overall, issue salience was not strongly influenced by the variables we tested, indicating that most participants mentioned migration-related issues often and relatively independent of stable characteristics (Table A3).

(1) SM Are Not the Users' Only Information Source That Counts (H1)

We compared the SIE model with the HIE model to test *H1*. The more comprehensive HIE model is superior in explanatory power/model fit (Table 1). The coefficients involving SM reliance differ fundamentally between SIE and HIE. In particular, a seeming strong positive effect of SM reliance on opinion expression in the SIE model vanishes

Table 1. Models of opinion expression in comparison.

	Df	-2 LogLik (deviance)	Deviance change	AIC	BIC	Marginal R ²	Conditional R ²
<i>Baseline models</i>							
M0 (new: Intercept)	3	3939	–	3945	3964	.000	.565
M1 (new: Controls)	20	3770	169.36*** [M0]	3810	3939	.117	.369
M2 (new: Info use)	23	3518	251.55*** [M1]	3564	3713	.193	.587
M3 (new: Source rel.)	25	3511	7.22* [M2]	3561	3722	.197	.590
M4 Full model	41	3431	79.76*** [M3]	3513	3778	.205	.595
<i>Reduction models 1</i>							
X0: HIE	41	3431	–	3513	3778	.205	.595
X1: SIE	27	3575	144.29*** [X0]	3629	3804	.171	.582
<i>Reduction models 2</i>							
R0: Full model	41	3431	–	3513	3778	.205	.595
R1a: No extremity interactions	35	3467	35.68*** [R0]	3537	3763	.200	.595
R1b: No position interactions	35	3448	16.59* [R0]	3518	3744	.203	.592
R1c: No PCSMR interactions	36	3459	27.56*** [R0]	3531	3763	.204	.593
R2c: No SMR/PCSMR interactions	31	3477	18.72** [R1c]	3539	3740	.202	.590

Note. Linear mixed-effects model with restricted maximum likelihood (REML) estimation ($n = 4752$). Tests for deviation change: the model the tested model is compared to is given in square brackets.

* $p < .05$, ** $p < .01$, *** $p < .001$.

in the HIE model (Table 2; Figure 1). Apparently, it is an effect of general political information use rather than of gateway-specific SM use. The seeming reduction of opinion expression over time among those who use SM more (according to the SIE model) also proves spurious in the HIE model. The HIE uncovers that SM use's effect on opinion expression depends on one's attitude position and one's opinion extremity, which was not detected by the SIE model. The finding that over-time effects of SM use may depend on attitude extremity changes its direction in the HIE model.

This supports *H1*: Neglecting the HIE and focussing on a SIE results in misleading conclusions resulting from omission bias in the SIE model. Three out of three significant effects in the SIE did not hold in the HIE, and the HIE discovered two additional effects of SM use the SIE did not find (Table 2).

(2) Political Information Use Stimulates Opinion Expression through Every Gateway (H2, H3)

Similarities between Gateways (H2)

The data contradict *H2*: The growth in opinion expression over time did not increase with greater political information use (Table 3; Figure 2).

Specifics of SM as Political Information Source (H3)

The data do not support *H3*: Higher SM reliance (= lower news media reliance) was not associated with a faster growth rate of opinion expression. Opinion expression even shrank among those with high SM reliance whereas it was stable among those with low reliance on SM (Table 3; Figure 2).

Alternative Analysis

It is possible that political information via SM is particularly partisan if it comes from political actors one follows. Therefore, we tested whether *H3* probably applies only to those with more politics-centred SM reliance. But this more restricted version of *H3* is

Table 2. Social media environment model (SIE) versus hybrid information environment model (HIE).

	Dependent variable: opinion expression		
	Social media information environment (SIE) B [95% CI]	Extended social media information environment (eSIE) B [95% CI]	Hybrid information environment (HIE) B [95% CI]
<i>Fixed part</i> (Intercept)	0.23*** [0.16; 0.30]	0.06 [-0.02; 0.14]	-0.21** [-0.34; -0.08]
Time	0.03* [0.00; 0.06]	0.04* [0.01; 0.06]	0.11** [0.03; 0.18]
Attitude Position (P)	-0.01 [-0.08; 0.07]	-0.01 [-0.09; 0.07]	0.20* [0.00; 0.41]
Attitude Extremity (E)	0.07 [-0.04; 0.19]	0.09 [-0.02; 0.21]	0.20 [-0.11; 0.51]
Time × P	-0.01 [-0.06; 0.05]	-0.01 [-0.06; 0.05]	-0.11 [-0.26; 0.04]
Time × E	-0.01 [-0.08; 0.07]	-0.06 [-0.15; 0.02]	-0.25* [-0.48; -0.02]
<i>Information use</i>			
Info use	-	-	0.63*** [0.42; 0.85]
Info use × Time	-	-	-0.18* [-0.33; -0.03]
Info use × P	-	-	-0.53* [-0.94; -0.12]
Info use × E	-	-	-0.37 [-1.00; 0.25]
Info use × Time × P	-	-	0.28† [-0.03; 0.58]
Info use × Time × E	-	-	0.51* [0.05; 0.97]
<i>Social media reliance</i>			
Social	0.36*** [0.28; 0.44]	0.35*** [0.26; 0.45]	-0.03 [-0.24; -0.18]
Social × Time	-0.11*** [-0.17; -0.05]	-0.11** [-0.18; -0.05]	0.01 [-0.14; 0.15]
Social × P	0.06 [-0.08; 0.21]	0.12 [-0.05; 0.29]	0.64** [0.26; 1.03]
Social × E	0.08 [-0.13; 0.29]	0.16 [-0.08; 0.39]	0.72* [0.14; 1.31]
Social × Time × P	0.03 [-0.08; 0.14]	-0.07 [-0.20; 0.06]	-0.36* [-0.64; -0.08]
Social × Time × E	0.17* [0.02; 0.33]	0.07 [-0.11; 0.25]	-0.45* [-0.88; -0.02]
<i>Politics-centred social media reliance</i>			
PCSMR	-	1.38 [-0.76; 3.52]	2.51* [0.35; 4.66]
PCSMR × Time	-	-0.60 [-2.08; 0.88]	-0.98 [-2.47; 0.50]
PCSMR × P	-	-2.86 [-7.24; 1.53]	-3.21 [-7.61; 1.19]
PCSMR × E	-	-6.96* [-12.75; -1.16]	-7.99** [-13.83; -2.15]
PCSMR × Time × P	-	4.39** [1.24; 7.53]	3.93* [0.78; 7.09]
PCSMR × Time × E	-	5.92** [1.62; 10.22]	7.20** [2.88; 11.51]
<i>Conversations reliance</i>	-	0.38*** [0.29; 0.47]	0.43*** [0.34; 0.53]
<i>Search reliance</i>	-	0.12*** [0.08; 0.17]	0.12*** [0.08; 0.17]
<i>Random part</i>			
Var(Person)	0.101***	0.097***	0.098***
Var(Residual)	0.101	0.101	0.101
<i>Model fit</i>			
Marginal R ²	.171	.200	.205
Conditional R ²	.585	.592	.595

Note. Linear mixed-effects model with restricted maximum likelihood (REML) estimation ($n = 4752$).

† $p < .10$, * $p < .05$, ** $p < .01$, *** $p < .001$.

not supported either: The slight increase in growth of opinion expression if politics-centred SM reliance is high falls short of statistical significance (Table 3; Figure 2).

Removing SM reliance or politics-centred SM reliance from the analysis entirely results in significant reduction of model fit (M2→M3, R0→R2c) (Table 1). Therefore, it seems premature to dismiss a potential “special” effect of SM reliance on opinion expression. But if it exists, it must be very weak.

(3) Development of Echo Chambers Is Confined to People with Extreme Attitudes (H4)

To investigate H4, we included interactions between (a) exposure variables (political information sources, SM reliance, politics-focussed SM reliance), (b) attitude

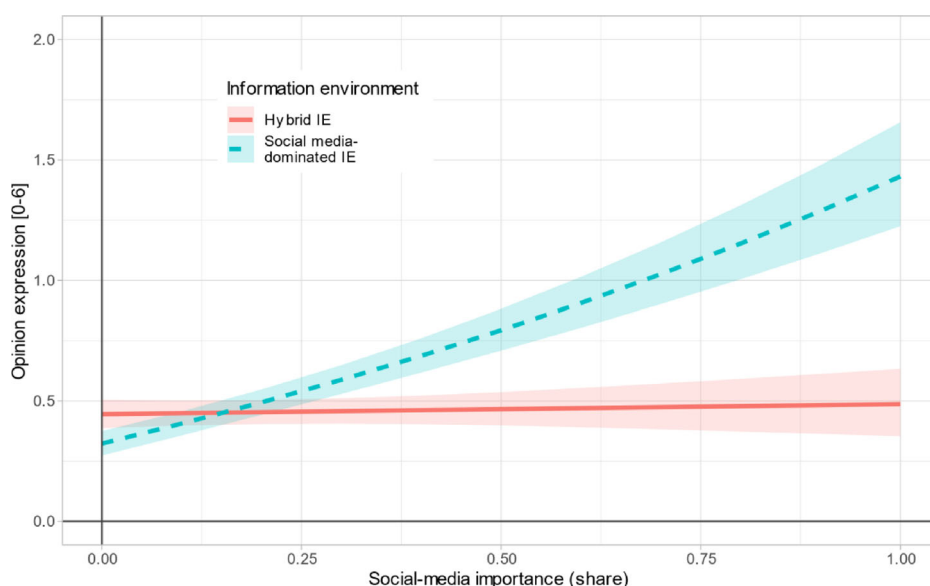


Figure 1. Misleading cross-sectional relation between social media reliance and opinion expression (steep blue curve) vanishes when considering the broader, hybrid information environment (flat red curve).

position towards immigration policy, and (c) time in the full model. Dropping these interactions would harm model fit significantly ($R0 \rightarrow R1a$), supporting *H4* (Table 1). We will check the three interaction terms that involve within-person change over time more closely, plotting the relevant interactions.

Over two weeks, opinion expression grew among people with extreme attitudes and shrank among people with moderate attitudes if they used a lot of political information. The trend was reversed among those who used very little political information. SM reliance also interacts with attitude extremity. If SM reliance was high, opinion expression shrank among those with extreme attitudes and remained stable among those with moderate attitudes. If SM reliance was low, opinion expression grew slightly among those with extreme attitudes and remained stable among those with moderate attitudes. Overall, SM do not seem to systematically motivate radicals more than moderates; contrarily, there were signs that more extreme persons were discouraged from expressing their opinions when relying strongly on SM. If politics-focussed SM reliance was high, opinion expression grew substantially among people with extreme attitudes, whereas it was constant among moderates. If politics-focussed SM reliance was low, opinion expression was stable both among extreme and moderate people. If high SM reliance is coupled with a network that features a lot of politicians and parties, politically extreme persons are systematically more motivated to express their opinion, while politically moderate persons' opinion expression remains unaffected by politics-centred SM reliance (Table 3; Figures 3–5).

(4) Opinion Expression is Conditional on Attitude Position – Even on SM (H5)

To look into *H5*, we included interactions between (a) exposure variables (information use, SM reliance, politics-focussed SM reliance), (b) attitude position towards

Table 3. Models of opinion expression in comparison.

	Opinion expression (Log-regression)			
	Position		Extremity	
	Model R1b <i>B</i> [95% CI]	Model R0 <i>B</i> [95% CI]	Model R1c <i>B</i> [95% CI]	Model R0 <i>B</i> [95% CI]
<i>Fixed part</i> (Intercept)	-.18 [-.29; -.08]**	-.22 [-.34; -.10]**	-.20 [-.33; -.07]**	-.22 [-.34; -.10]**
Age	.07 [.03; .11]**	.07 [.03; .11]**	.07 [.04; .11]**	.07 [.03; .11]**
Personality strength	.05 [.01; .09]*	.05 [.01; .09]*	.05 [.01; .09]**	.05 [.01; .09]**
Subjective informedness	.03 [.02; .05]**	.03 [.02; .05]**	.03 [.02; .05]**	.03 [.02; .05]**
Time	.05 [.00; .11] [†]	.11 [.03; .19]**	.10 [.02; .18]**	.11 [.03; .19]*
Pos. (P)/Extr. (E)	.22 [.01; .42]*	.22 [.01; .42]*	.21 [-.11; .52]	.21 [-.11; .54]
Time * P/E	-.12 [-.28; .02]	-.12 [-.27; .04]	-.27 [-.50; -.04]*	-.26 [-.51; -.02]*
Information use				
Info use	.55 [.37; .71]**	.64 [.43; .89]**	.61 [.40; .83]**	.64 [.43; .89]**
Info use × Time	-.07 [-.19; .04]	-.19 [-.36; -.04]*	-.17 [-.33; -.01]*	-.19 [-.36; -.04]*
Info use × P/E	-.56 [-.93; -.13]**	-.57 [-.98; -.17]**	-.37 [-1.01; .28]	-.40 [-1.06; .25]
Info use × Time × P/E	.30 [.02; .62]*	.29 [-.02; .56] [†]	.55 [.05; 1.00]*	.54 [.07; 1.00]*
Social media reliance				
Social	.12 [-.05; .31]	-.04 [-.24; .16]	.00 [-.20; .20]	-.04 [-.24; .16]
Social × Time	-.09 [-.21; .02]	.01 [-.13; .15]	.00 [-.15; .14]	.01 [-.13; .15]
Social × P/E	.70 [.32; 1.11]**	.69 [.28; 1.07]**	.76 [.18; 1.37]*	.75 [.13; 1.32]*
Social × Time × P/E	-.44 [-.72; -.17]**	-.37 [-.63; -.08]*	-.55 [-.99; -.09]*	-.48 [-.90; -.05]*
Politics-centred social media reliance				
PCSMR	.95 [-.93; 2.70]	2.58 [.62; 4.78]*	2.24 [.03; 4.49]*	2.58 [.62; 4.78]*
PCSMR × Time	.72 [-.42; 1.90]	-1.03 [-2.51; .24]	-.93 [-2.39; .61]	-1.03 [-2.51; .24]
PCSMR × P/E	-4.45 [-8.84; .04]*	-3.69 [-8.52; .20] [†]	-8.47 [-14.3; -2.71]**	-7.85 [-13.6; -1.89]**
PCSMR × Time × P/E	5.49 [2.61; 8.38]**	3.56 [.83; 6.76]*	8.78 [4.48; 12.63]**	7.53 [3.22; 11.61]**
Conversations reliance	.43 [.34; .52]**	.43 [.34; .53]**	.44 [.34; .54]**	.43 [.34; .53]**
Search reliance	.12 [.08; .17]**	.13 [.09; .17]**	.13 [.08; .17]**	.13 [.09; .17]**
<i>Random part</i>				
Var(Person)	.098***	.100***	.097***	.097***
Var(Residual)	.101	.101	.101	.101
<i>Model fit</i>				
Marginal R ²	.200	.205	.202	.205
Conditional R ²	.594	.594	.590	.594

Note. Linear mixed-effects model with restricted maximum likelihood (REML) estimation ($n = 4752$).

[†] $p < .10$, * $p < .05$, ** $p < .01$, *** $p < .001$.

immigration policy, and (c) time. Dropping these interactions would harm model fit significantly (R0→R1b). In line with *H5*, attitude position matters as a moderator. But which interactions play an important role?

If using lots of political information, right-leaners' opinion expression increased slightly over time, whereas left-leaners' opinion expression decreased. When using little political information, the direction of effects was reversed. Greater SM reliance led to growth of opinion expression among left-leaners and shrinkage among right-leaners. If SM reliance was low, the effects were reversed. Greater politics-centred SM reliance led to increased growth of opinion expression among right-leaners and decreased growth of opinion expression among left-leaners; if politics-centred SM reliance was low, opinion expression was stable independent of attitude position (Table 3; Figures 3–5).

Discussion

The echo chamber metaphor has been omnipresent in the discourse about the societal and political effects of SM. It describes personalized information environments

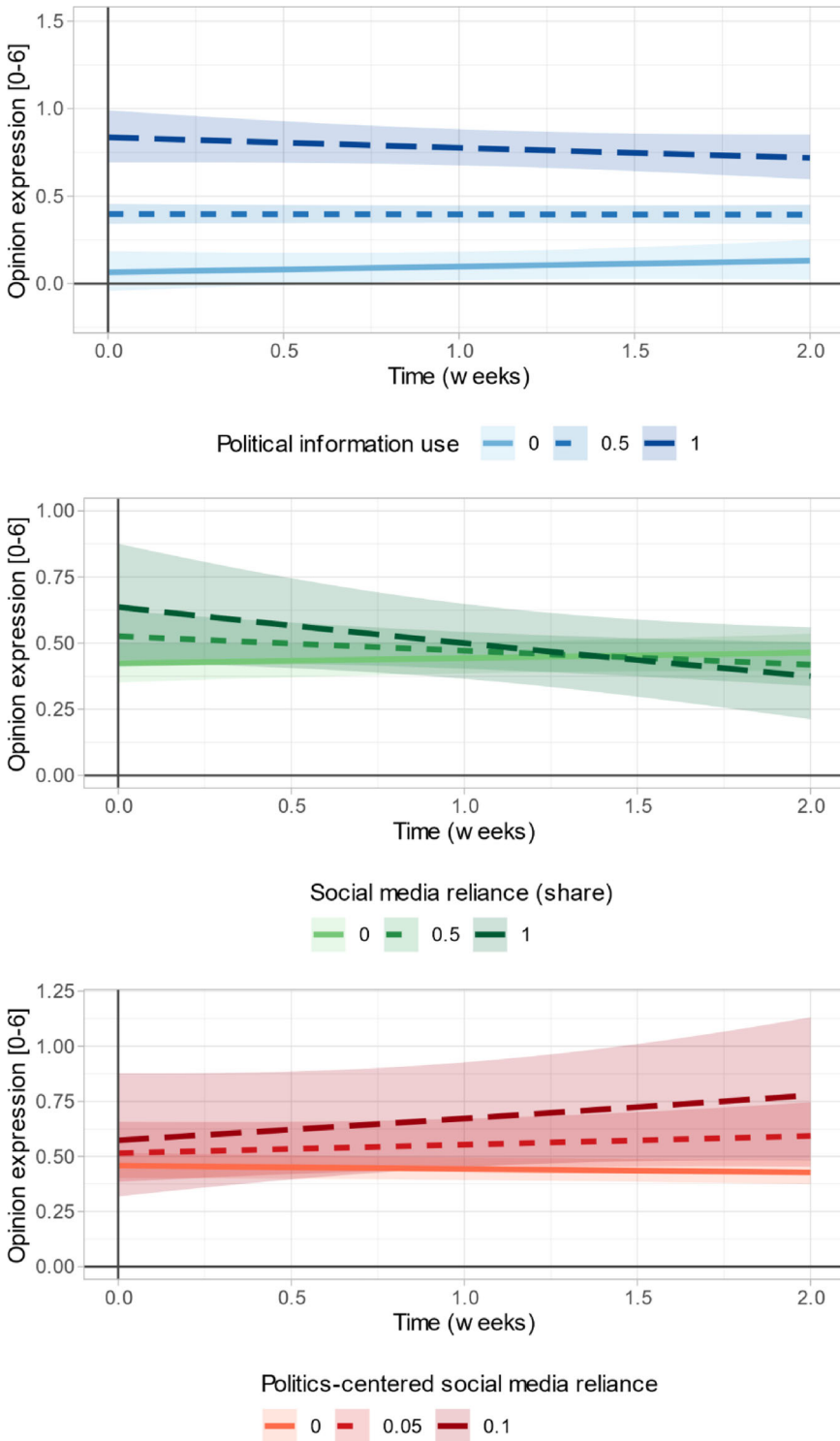


Figure 2. Opinion expression's (y) response to information use/source reliance (colors, panels) over time (x).

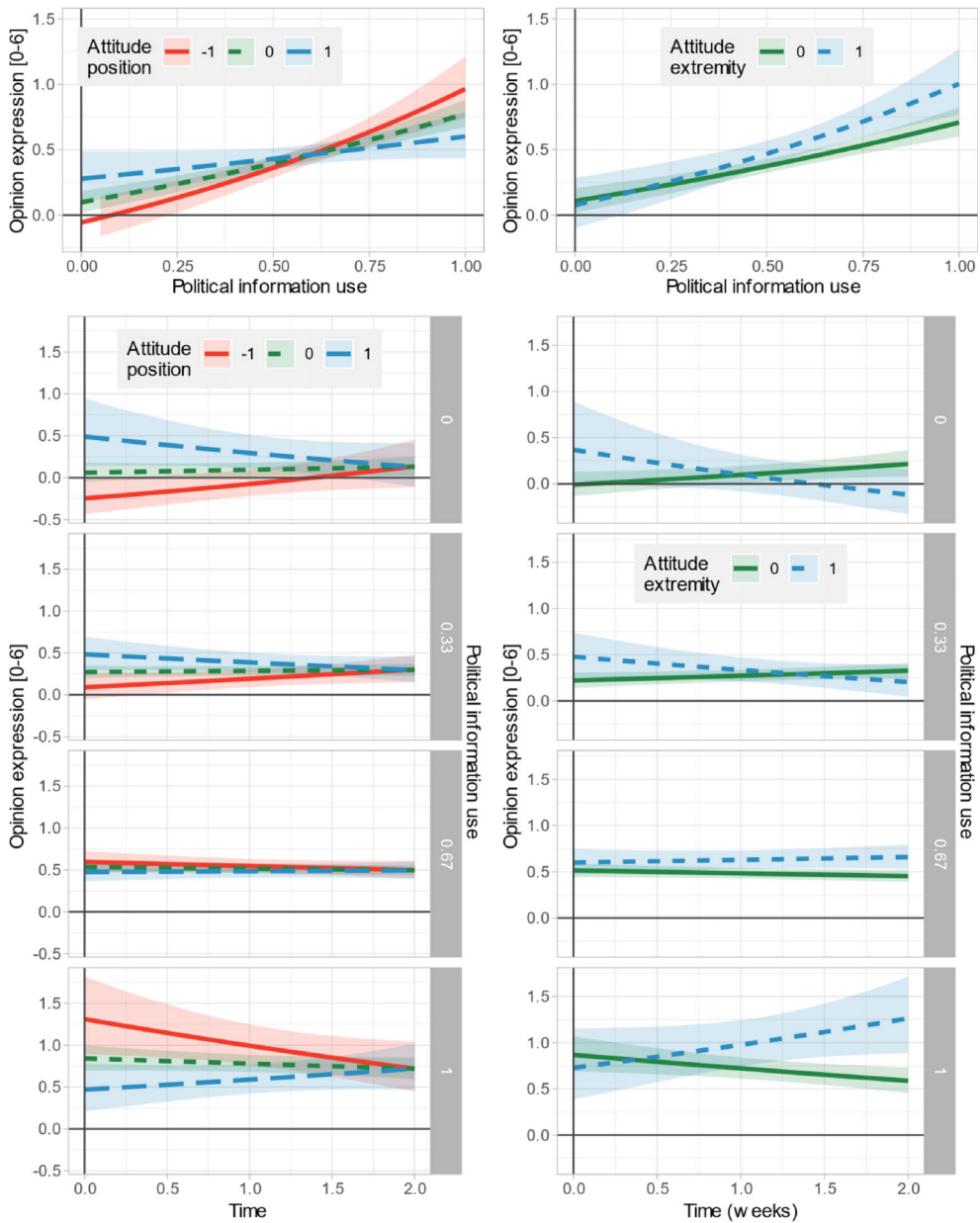


Figure 3. Opinion expression's (y) response to political information use (panels from top to bottom), attitude position (colors in left panels), attitude extremity (color in right panels) over time (x). Top-most panel shows the cross-sectional relationships.

that filter out attitude-inconsistent and amplify attitude-consistent messages, leading to more extreme opinions and intensified opinion expression. As intuitive as the echo chamber metaphor may seem—it is still just a metaphor that should not be overstrained. A closer look and rigid scholarship have revealed several implicit and often unrealistic premises. Our study challenges four of them, putting the metaphors' practical relevance into perspective.

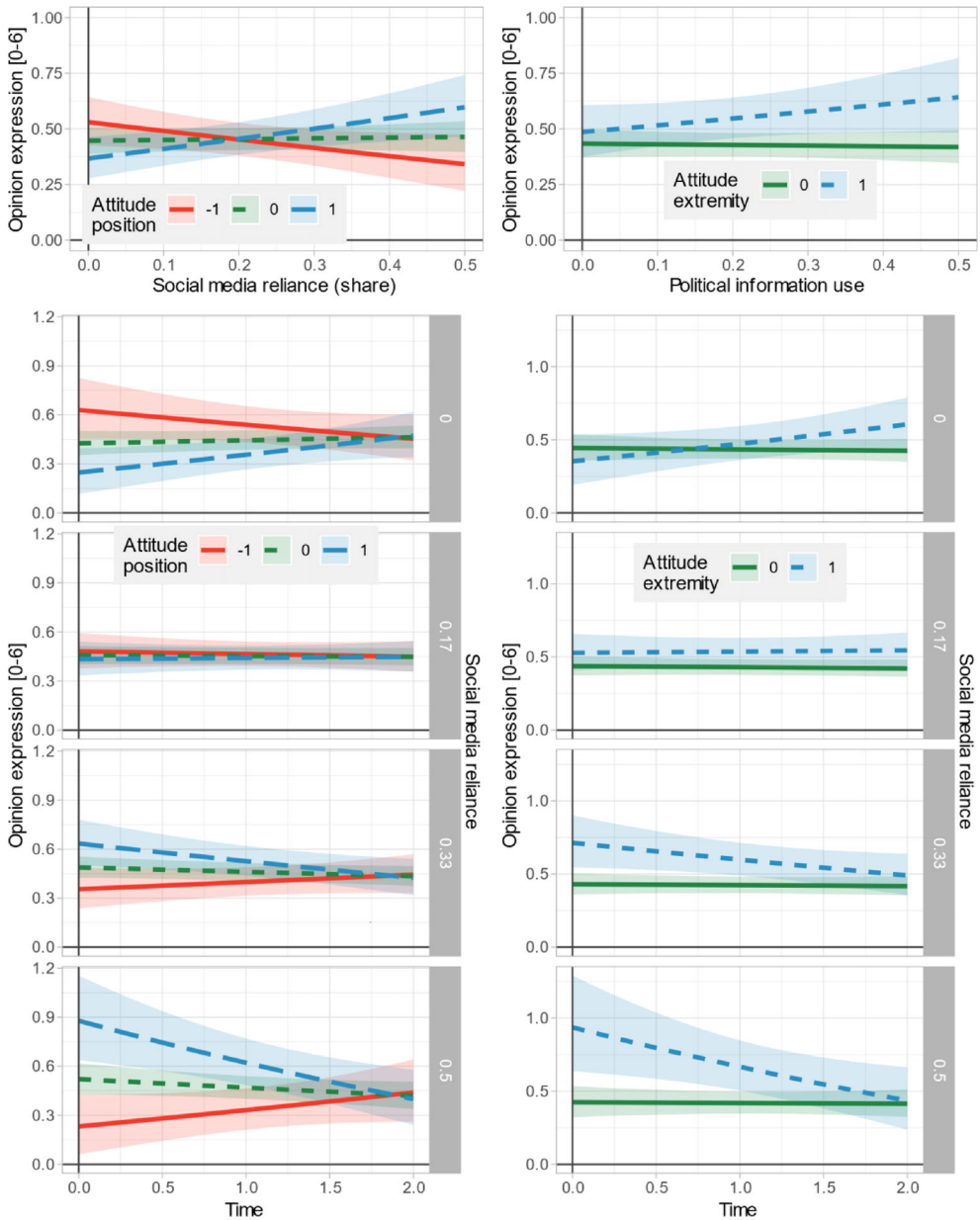


Figure 4. Opinion expression’s (y) response to social media reliance (panels from top to bottom), attitude position (colors in left panels), attitude extremity (color in right panels) over time (x). Top-most panel shows the cross-sectional relationships.

Concerning the *ignorance of political information sources besides SM (premise 1)*, our findings show that the use of news media has become entangled with SM use in the current HIE (Dubois and Blank 2018). Ignoring political information use in the news media and only looking at SM use would lead to drawing exaggerated conclusions on how SM use for political information affects opinion expression (*H1 confirmed*).

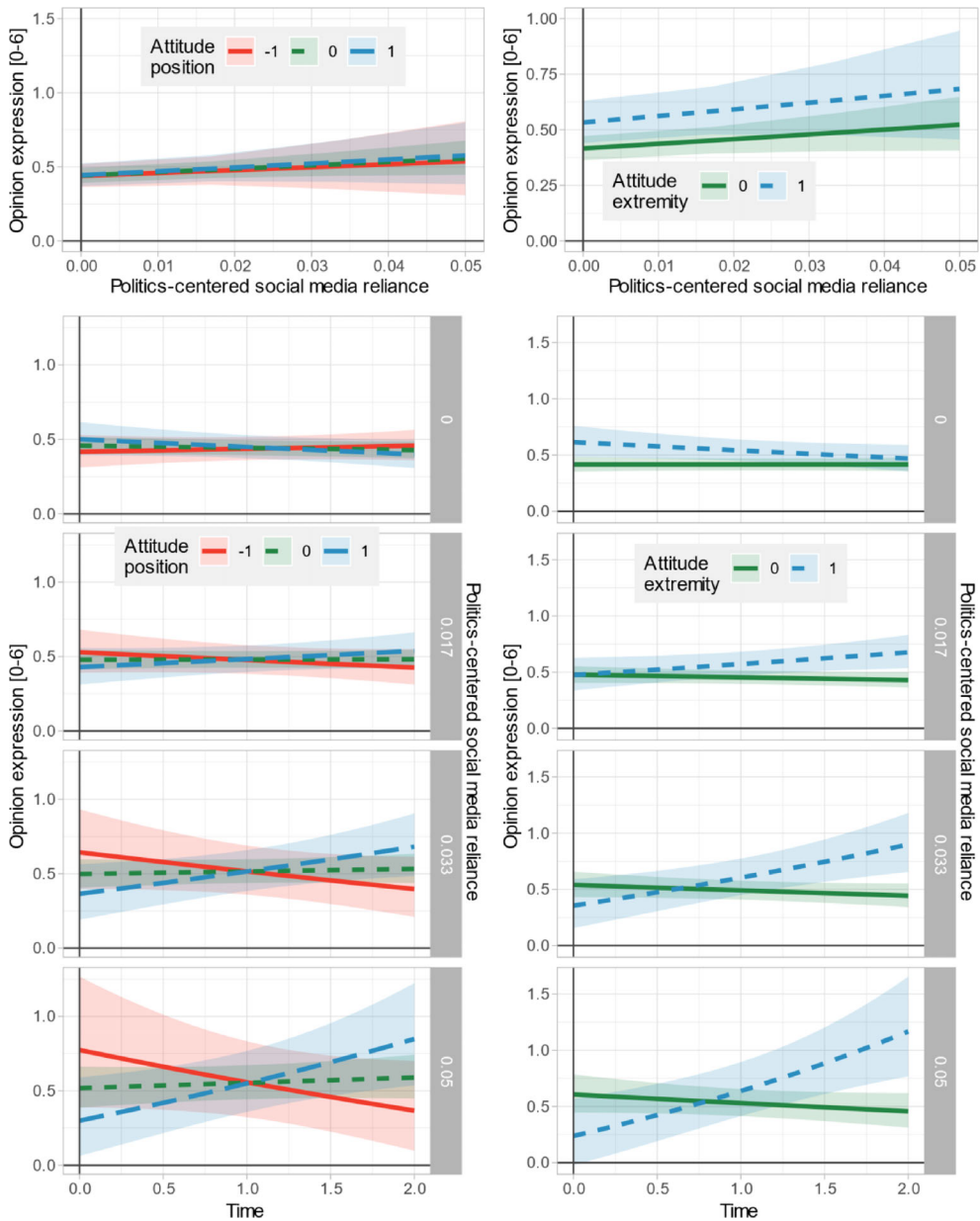


Figure 5. Opinion expression's (y) response to politics-centered social media reliance (panels from top to bottom), attitude position (colors in left panels), attitude extremity (color in right panels) over time (x). Top-most panel shows the cross-sectional relationships.

This is dangerous because these misleading results from an incomplete model seem to support another premise of the echo chamber metaphor: that *those who rely more on SM than on news media for political information express their opinion more strongly* (premise 2). What we actually find is that stronger opinion expression is simply an effect of more political information use, regardless of the gateway used to obtain that information, and SM do not provide any additional general reinforcement (H2). We would mistake the general

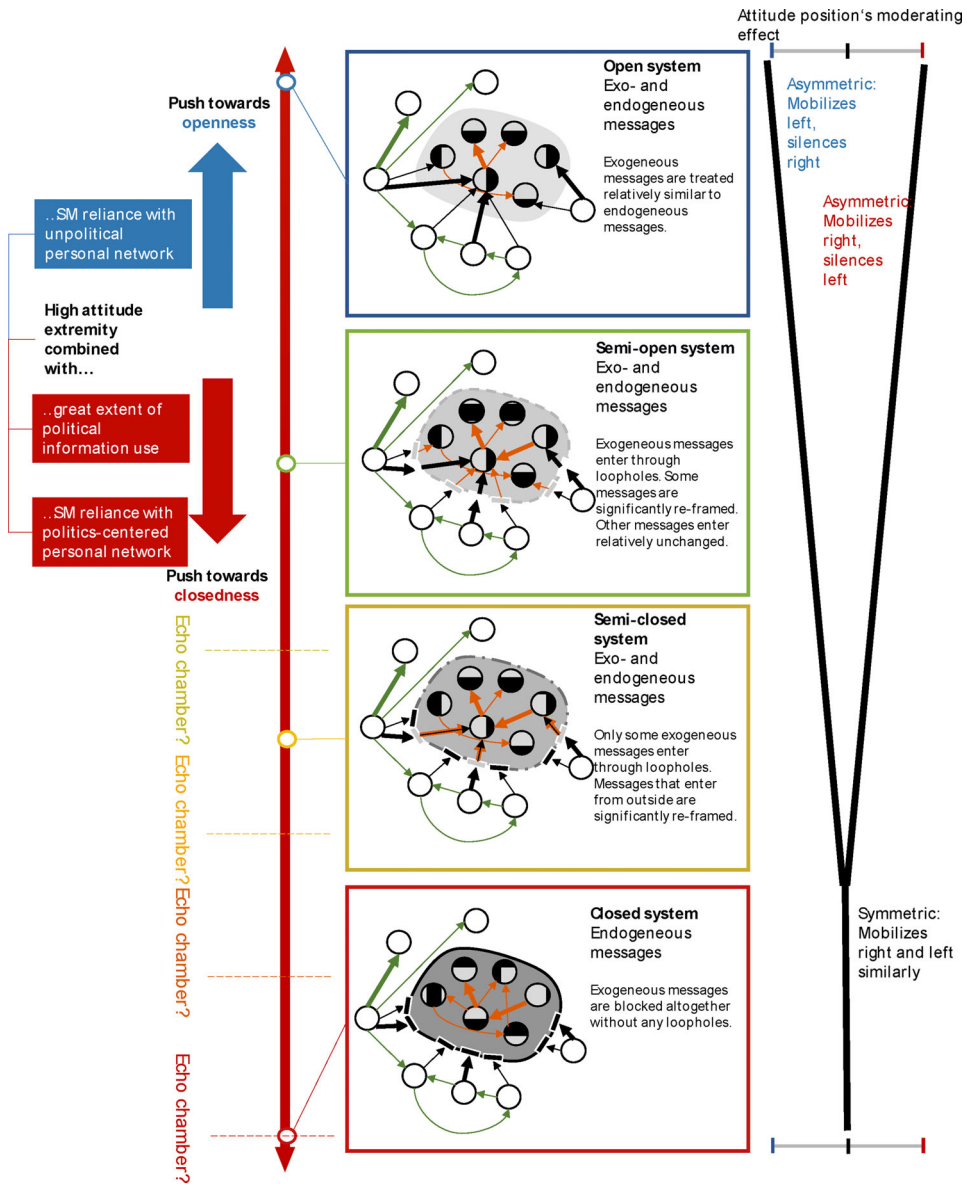


Figure 6. The Echo Chamber Continuum (ECCo) Model. Continuum between open and closed information environments as mixtures of blocking, reframing and drowning out. Attitude extremity and information repertoires affect openness/closedness. Which degree of closedness constitutes echo chambers?

reinforcement effect of political information use (a consequence of users' selectivity) for an echo chamber-like effect of SM use (and a consequence of algorithmic pre-selection). Notably, this effect is only visible as between-person differences and not as within-person change over time (*H3* rejected).

Our study contests the premise that *everyone will be caught in an echo chamber* (premise 3). Rather, particular groups may be more likely to drift into echo chambers: persons

with extreme opinions about the issue-at-hand (Bruns 2019). We found that the extremity of opinions had an impact on how political information use and SM reliance impact opinion expression (H4). Specifically, more extreme individuals grew more motivated to express their opinions over time if they used more political information and if they exhibited greater politics-centred SM reliance. They grew less motivated if they had a greater SM reliance. This indicates that politically more extreme individuals respond positively to political information exposure (*selective* exposure, that is), and politics-heavy SM reliance may boost this effect. Regular SM reliance, in contrast, even appears to discourage more extreme individuals from expressing their opinions to some extent. This stands in stark contrast with an unconditional interpretation of the “echo chamber” metaphor. The findings suggest a two-fold conditionality: politically more extreme individuals (condition 1) can experience (algorithmically) amplified selectivity *if* they have a strongly politics-centred network on SM (condition 2).

Furthermore, in contrast to *premise four* that *echo chambers immunize against camp-specific silencing effects of “big messages,”* our findings indicate that there are still “big messages” that penetrate the walls of echo chambers. This explains why political information exposure would motivate opinion expression on one side of the political spectrum while depressing it on the opposite side, which is what we found: Left-right position regarding the issue (and general political left-right orientation) moderates the effects of political information use, SM reliance and politics-centred SM reliance to make an impact on growth/shrinkage of opinion expression. If in “soundproof” echo chambers without “loopholes,” both camps should get reinforced in their opinion expression to a similar extent.

The exact interaction findings regarding H5 are complex. Left-leaners are demotivated to express their opinions by more political information use and by politics-centred SM reliance (slope grows more negative); in contrast, greater SM reliance motivated them to express their opinions (slopes grow more positive). This suggests that more politics-centred information use (political information use; politics-centred SM reliance) transported a “big message” that motivated the right-leaners and demotivated the left-leaners on the migration issue. SM reliance for political information (in a non politics-centred network) provided, to some extent, a “refuge” or “revitalization space” for left-leaners who faced an adverse “big message.”

These findings and their directions are of course tied to the specific political debate. They can motivate either left- or right-leaners, depending on the kind of “big message” and the momentum in the debate. We interpret this finding as signs for the persistence of “big messages” in the political information environment, but also for SM’s capability of shielding individuals from these big message effects to some extent. This complex interplay appears to be typical for HIEs.

The two-week study period was marked by messages that featured the widespread criticism and diminishing popularity of Angela Merkel and her government, and by the electoral successes of the migration-skeptic AfD – who had carried favourable results in two important regional elections, one shortly before and one within the two-week period. This may have contributed to creating the impression of a favourable political momentum (including a climate of opinion) for the right, migration-skeptic camp.

Theoretical Mechanisms

This study has looked into gross effects of drawing political information from different gateways. We conclude that the assumed mechanisms may apply, but in a more limited fashion than the echo chamber metaphor suggests. It has shown that conceptions of the different gateways' effects are obviously too simple, but that gateways can nevertheless have explanatory power if attitude position and attitude extremity are taken into account. The "big message" effects suggest that "loud" messages from the surrounding information environment can reach almost all individuals, and not all of them are reinterpreted within the echo chamber—loopholes into echo chambers do not only exist, but they seem to reduce many of the negative impacts echo chambers are usually ascribed. Future studies should look into different cues and mediators of these effects to identify more specific mechanisms. In the same vein, a theoretical model of echo chambers must relate to previous theories and models in communication—for example selective exposure (Stroud 2010) or the spiral of silence (Noelle-Neumann 1984)—in order to clearly identify and not to overstate the novelties of the phenomena we observe on SM: Is it a "spiral of silence" that emerges within the echo chamber? Then, state fear of isolation and climate of opinion perceptions should mediate the effects on opinion expression, and climate of opinion cues should have a strong impact. Or do messages increase attitude certainty such that people think it is less risky to express their opinions? Then, exposure to strong arguments should play a key role. Or does involvement/commitment with the issue or better prospects of success lead to greater motivation to argue in favour of one's position?

Probably, several of these mechanisms interact in bringing about the de-facto effects we have observed. Their interplay is more complex than the widespread concern that SM generally promote echo chambers which does not resonate with our data. One must be careful not to mix helpful metaphors such as the echo chamber with theorizing which must take into consideration continuities and conditionalities a metaphor can ignore in the spirit of clarity. The premises we challenged are a valuable starting point.

Keeping our results in mind, we want to put forth an analytical conceptual framework for rigidly studying echo chambers – the Echo Chamber Continuum (ECCo) Model (Figure 6): Obviously, an echo chamber is not a completely closed information environment. Equally unlikely is an "entirely open" information environment where all messages have a similar chance of reaching a particular person irrespective of ideological distance. Both scenarios can, however, be thought of as ideal-types. As poles, they span a continuum describing different degrees of a delimitation of information environments. Every actual information environment can be located on this continuum as a specific mixture of openness and closedness, of *blocking*, *reframing*, and *drowning out*. A great extent of (selective) information use combined with high attitude extremity can increase the likelihood of getting encapsulated in an echo chamber. The degree to which algorithmically amplified selectivity in SM reinforced these effects, according to our data, was conditional on the politics-centeredness of one's personal network on SM.

In reality nearly every individual will be exposed to both supportive and opposing views. However, at what degree of isolation from the outside world do we actually speak of an echo chamber—and does such a general "critical turning point" even exist? Due to the focus of the current discussion on the negative consequences of

echo chambers, a working definition could be: We speak of an echo chamber if the closedness of an information environment causes (more) harm (than good) to individuals and/or society. But that would be a vague demarcation: A degree of closedness that is unproblematic for one individual can have fatal consequences for another, and which consequences are negative and which are positive is always contestable. In academic discourse, it may be more helpful to speak of “algorithmically amplified” selectivity or motivated reasoning, not “echo chambers.”

Limitations and Outlook

This study has some noteworthy limitations. Our quota sample is not a strict random sample of the general population; it excluded offliners and might be object to selection bias. However, we had to weigh these restrictions against the opportunity to find people who volunteered to take part in a two-week daily diary, enabling us to study opinion expression longitudinally. Future studies may extend the time frame beyond 14 days, and may scale down the temporal resolution. Moreover, we did not survey the content actually received by our participants. Our measure of opinion position may have produced errors because participants did not take left-right orientation but only extremity into account; however, the results are robust: using general left-right self-placement yielded mostly similar results.

The generalisability of our results is limited due to the framework conditions of our survey (topic, time, country). Most likely, the omnipresence and societal relevance of the refugee crisis created favourable conditions for a “big message” with the potential to permeate the walls of echo chambers. Less intense coverage would probably create more favourable conditions for echo chambers to play out. However, our study provides a valuable starting point. Checking the study’s robustness and mapping the conditions under which echo chambers are more or less likely and relevant is nevertheless necessary.

Repeatedly applying our design in long-term and cross-nationally comparative studies will contribute to a better understanding of such framework conditions. This allows assessing how virulent echo chambers are and how much they could grow if the framework conditions change. It could also help specify how technological changes and political communication practice interact in creating echo chambers. Longitudinal comparisons could improve our understanding of effects of dynamic changes in the algorithms of SM. For example, in an update of the news feed in 2018, Facebook explicitly strengthened the prominence of posts assumed to stimulate discussions and other “meaningful interactions” such as shares and likes in users’ networks (Mosseri 2018). This change made the quality of the relationships (affinity) an even more central selection criterion (DeVito 2017) at the expense of news providers—even those whose pages the users have liked on Facebook themselves. The possible consequences can be far-reaching: The focus on user reaction-provoking content will most likely increase the visibility of entertaining and provocative content. Political content exposure, as a consequence, would be marginalized, and a greater proportion would be humorous, provocative, polarizing and/or cynical. This change moreover reinforces the effect of network heterogeneity: users with more heterogeneous (homogeneous)

networks should receive more heterogeneous (homogeneous) content. Taken together, this change of the algorithm could increase the likelihood and closedness of echo chambers, and further research into the effects thereof is urgently needed.

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Data Availability Statement

The data that support the findings of this study are available on request from the corresponding author, S. G. The data are not publicly available due to the joint ownership of the data by the principal investigators (B.S., M.M., P.J.) and the Media Authority of North Rhine-Westphalia (LfM).

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