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PUBLIC SPHERE IN CRISIS MODE: HOW THE COVID-19 PANDEMIC INFLUENCED PUBLIC DISCOURSE AND USER BEHAVIOUR IN THE SWISS TWITTER-SPHERE

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In modern democracies, large societal crises like the COVID-19 pandemic are accompanied by intensified public discourse about which policies and strategies are adequate to fight the crisis. In such times, the public sphere switches to crisis mode with fundamentally different communicative dynamics compared to routinised periods. Data from social media platforms like Twitter offers new possibilities to study such dynamics. However, comprehensive studies on how crises affect discourse in distinct national publics are missing up to now. Based on 1,762,262 tweets referring to COVID-19 written between 1 January and 30 April 2020 by 56,418 validated Swiss users, we illustrate how the lockdown of public life in Switzerland affected the discourse in the Swiss Twitter-sphere. Based on public sphere theories, we identify four crisis-related dimensions for our analysis. We show that the pandemic led to a narrowing of the topic agenda and to a more inwardly oriented public sphere with increased Twitter activity by experts. Furthermore, actors from the social periphery were able to reach the centre of public discourse with their tweets. Overall our study shows how methodological innovation allows us to better connect an empirical analysis with the concept of a public sphere as a communication network.

KEYWORDS   COVID-19; social media; Twitter; crisis communication; public sphere

Introduction

The current COVID-19 pandemic is certainly one of the largest societal crises of the twenty-first century. Seldom has an event affected societies and citizens across the globe in a similar, immediate way. Europe, and Switzerland in particular, is among the regions most heavily affected by the crisis (European Centre for Disease Prevention and Control 2020). Large societal crises like the COVID-19 pandemic are not only followed by social, economic, or health-related challenges. In modern democracies, they are also accompanied by an intensified public discourse about the appropriateness of measures and strategies to solve crisis-related problems (Imhof 2011). While most citizens in Switzerland seemed to support the drastic state-enforced interventions in the first line, public discourse about the appropriateness of measures evolved quickly after the first positive effects of the lockdowns became evident (GFS Bern 2020). In addition, the high degree of uncertainty surrounding the pandemic, such as that surrounding face mask use, led

to challenging environments for authorities and health experts to communicate and eventually also for citizens to inform themselves. Digitised media add to these challenging environments as they allow ordinary citizens to articulate their opinion and participate in public discourse while news media, journalists, or authorities lose their exclusive function as gatekeepers and information brokers (Wallace 2018). Social media companies like Facebook and Twitter increasingly enable actors from the social peripheries to reach larger audiences (Kaiser, Rauchfleisch, and Bourassa 2020). The COVID-19 pandemic as a crisis challenges the normal mode of functioning of the public sphere and potentially also has a strong impact on the online communication of citizens, politicians, and institutions.

The public sphere is a valuable concept to comprehensively study communicative dynamics and processes during crises, for instance, which topics are prevalent, how information is disseminated, or which actors gain or lose influence. This is nothing novel; the concept of the public sphere has been applied to crises in modern mediated societies by researchers for several decades. However, as the public sphere has often been conceptualised as a network of communication (e.g. Habermas 1992; Benkler 2006), the concept of the networked public sphere has gained relevance in research on digitised media environments. Still, the COVID-19 pandemic is probably the first large-scale global crisis that happened under the condition of a highly digitised media environment. The combination of the concept of a networked public sphere and theories of the public sphere in crises, therefore, are particularly suited to study the communicative dynamics during the pandemic. We draw on various theoretical concepts to show the evolution of the public sphere in crises (Habermas 1992, 458ff.; Imhof 2011; Peters 1994, 50ff.).

While they come with some limitations, digital trace data from social media platforms like Twitter offer valuable opportunities to analyse communicative dynamics during crises. As mediated communication is increasingly taking place on digital platforms, data from such platforms become a valuable instrument for analysing public discourse in a non-reactive manner. In addition, digital trace data allows us to analyse network structures, which are usually concealed to researchers or difficult to measure with other methods or data (Rauchfleisch, Vogler, and Eisenegger 2020). More specifically, Switzerland represents an interesting case as Twitter is mainly used by journalists and politicians as an information source and for strategic communication (Rauchfleisch and Metag 2016; Metag and Rauchfleisch 2017; Keller 2020). We investigate the impact of COVID-19 on public discourse in the Swiss Twitter-sphere with regard to four dimensions derived from existing literature.

The Public Sphere in Crises

Social crises such as the COVID-19 crisis are accompanied by far-reaching changes in public communication dynamics. The increased uncertainty, the threat, and the heightened pressure to solve problems mean that the form and quality of public communication in social crises are fundamentally different from that in normal or routine phases. Drawing on various public sphere theorists, we summarise these changes in public communication in times of crisis in four dimensions (Habermas 1992, 458ff.; Imhof 2011; Peters 1994, 50ff.). We argue that crises lead to a narrowed focus on a few crisis-related topics (1), increasingly inward-oriented national public spheres (2), high reliance on actors with expert status in public discourse (3), and actors from the social periphery gaining interpretative power

(4). The study at hand investigates the public debate about COVID-19 on Twitter with regard to the four aspects of the public sphere in crises outlined above. Guided by our theoretical framework, we formulate four guiding research questions.

Narrowing of the Topic Agenda

Topics represent one of the most central elements of public discourse. The structure of the topic agenda, as well as its dynamics, indicate which issues are perceived as relevant in society. Social crises are characterised by condensation of communication, meaning the public agenda is reduced to few problems that are perceived as particularly urgent (Imhof 2011, 33). This focus on a few crisis-related topics in public discourse is accompanied by displacement effects. Less urgently perceived problems lose resonance on the public agenda. The most recent and prominent example of this development was the global financial and economic crisis in 2008/2009 (Eisenegger and Schranz 2012). First studies on the COVID-19 pandemic, such as regarding news coverage in Switzerland (Eisenegger et al. 2020), indicate a similar trend. Thus, following Imhof (2011), we investigate whether or not a narrowing of the topic agenda occurred, with COVID-19 dominating the public debate and pushing away other issues:

> RQ1: Has the COVID-19 pandemic led to a narrowing of the topic agenda in the Swiss Twitter-sphere?

Increased Inward Orientation

In modern globalised societies, many societal processes are no longer limited to national borders. However, political decision-making and participation is still mostly organised within nation-states. Consequently, discourse about such processes or issues in national public spheres can oscillate between a more national and a more transnational orientation (Peters et al. 2005). The degree of inward orientation in a national public sphere, meaning the relative importance of national orientation, gives us an idea about the importance and urgency of issues that must be solved within the nation-state framework. In crisis, a stronger inward orientation of the public discourse becomes apparent (Imhof 1993, 54ff.). This can be explained by the fact that the political problem-solving process and the passing of crisis-related laws still take place primarily in a national context. Even in crises such as the COVID-19 pandemic, which originated abroad, a tendency towards re-nationalisation of the public discourse should be observed. We, therefore formulate the following research question:

> RQ2: Has the COVID-19 pandemic led to an increased inward orientation in the Swiss Twitter-sphere?

Increased Activation of Experts

The possibility to participate and exert influence in public debates varies between different actors and can evolve over time (Koopmans 2007). Social crises are phases in which the social construction of reality (Berger and Luckmann 1989) becomes contentious, and the struggle for the correct view of the world intensifies. Therefore, strategies to legitimise one's own view by referring to actors of high credibility and epistemic definition of

power become important. In secular societies, strategies of rationalisation are particularly important in times of crisis, which are periods characterised by high uncertainty. By referring to experts or expert organisations, actors try to make their positions socially convincing. A certain view is "right" because certain expertise or experts recommend it (Sandhu 2017, 30). Crises are thus also characterised by an increased activation of experts meaning experts and expert organisations, often scientists or scientific organisations, gain weight as legitimising or delegitimising voices in public discourse. With regard to the COVID-19 pandemic, we ask:

> RQ3: Has the COVID-19 pandemic led to increased activation of actors with expert status in the Swiss Twitter-sphere?

Activation of the Societal Periphery

Social crises are further characterised by the fact that the routine mode of the political opinion-forming and decision-making process is switched to an extraordinary mode of dealing with problems (Peters 1993, 348). This shift to the extra-routine mode of problem processing is simultaneously accompanied by an activation of the public sphere. In crises, the public discourse intensifies and expands to a broader field of speakers. Formerly passive publics are transformed into active ones and become more involved in public debates (Dahrendorf 1986). In other words, the public sphere opens its "floodgates" to the interpretative offers of the social periphery and civil society, especially in the phase of the outbreak of the crisis, when the uncertainty is particularly high (Peters 1994, 44). For Habermas, the activation of the societal periphery is explained by the fact that civil society, in contrast to the centres of power, has greater sensitivity for perceiving and identifying new problem situations (Habermas 1992, 460–461). Beyond civil society, the crisis leads to an expansion of the spectrum of actors and communities who participate in the public discourse. This expansion of the speakers and communities involved in the crisis discourse is all the more pronounced, the more far-reaching the consequences of the crisis are perceived by the public (Imhof 2011, 176ff.). Crises also regularly lead to the differentiation of new communities, for instance, in the form of social movements that specialise in the crisis topic (e.g. COVID-19). During crises, it is more likely that peripheral actors become active and have an impact in public debates (Dahrendorf 1986). Regarding the COVID-19 pandemic, we ask the following research question:

> RQ4: Has the COVID-19 pandemic led to the activation of users at the social periphery in the Swiss Twitter-sphere?

Previous Studies on Covid-19 and Twitter

Twitter data has been used to investigate the two most recent large-scale epidemics before COVID-19 (Kim et al. 2016; Pruss et al. 2019). The focus on Twitter data is certainly also a result of the accessibility of the data, while other social media platforms, like Facebook and Instagram, limit the access to their data for researchers. However, digital trace data offer the advantage of being a non-reactive, timely, and inexpensive way to track user behaviour, and especially communication, during a pandemic. Not very surprisingly, the COVID-19 pandemic led to an abundance of Twitter studies by researchers from various disciplines. This included medical and epidemiological research, which uses Twitter data to model the spread of the pandemic (e.g. Huang et al. 2020) but also

studies by communication scholars (Park, Park, and Chong 2020), often focusing on the spread of misinformation (Gallotti et al. 2020; Kouzy et al. 2020).

The quick release of study results on communicative behaviour on Twitter during the pandemic can be of great advantage, for instance, to implement policies or tailor information campaigns to fight the spread of the virus. However, many studies were released very quickly and included a lot of descriptive ad hoc research without a theoretical foundation. In addition, studies on COVID-19 using digital trace data from Twitter also suffer from similar methodological deficits like Twitter studies in general (Rafail 2018). Only a few investigations go beyond tracking a small sample of keywords. Thus, usually, a baseline of communication besides the tracked discourse is missing. Furthermore, studies rarely tried to capture the long-term development of communication. Keyword-based sampling strategies usually do not allow us to compare communication during crises with communication before the crisis and, thus, are not suitable to investigate how communicative dynamics in a public sphere change in the course of a crisis like the COVID-19 pandemic.

Our study analyses the impact of the COVID-19 pandemic on public discourse in the Swiss Twitter-sphere. We tackle the shortcomings of typical Twitter studies by using data from our tracker that continuously covers the whole Swiss Twitter-sphere since April 2019 and can benchmark communication about COVID-19 with other communication as well as compare it with communication before the emergence of the crisis. We can thus analyse how communicative dynamics in the Swiss Twitter-sphere change over time.

Methods and Data

Our analysis is based on digital trace data from Swiss Twitter users. Although only 13 percent of the population use the platform (Reuters Institute for the Study of Journalism 2020), Twitter plays an important role in the agenda-setting process in Switzerland as many journalists, politicians and scientists use it regularly (Rauchfleisch and Metag 2016; Metag and Rauchfleisch 2017; Keller 2020). Thus, while Twitter data is obviously not representative of the Swiss population, it is still an important sphere that can best be characterised as an elite network (Rauchfleisch and Metag 2016). The data from Twitter also allows us to answer research questions, especially with regards to network structures between users, that cannot be answered with different more representative data sets and methods.

For our investigation, we rely on a tracker system that covers the whole Swiss Twitter-sphere (n = 297,967 users). Users were identified through an iterative procedure based on automatic and manual work steps (for details see Vogler et al. 2019). We further extended our original sample of users for the COVID-19 analysis with users that were created in the second half of 2019 or during the crisis. By relying on the infomap algorithm (Rosvall and Bergstrom 2008), we identified 4,108 communities with at least 10 accounts each for our tracker. We manually checked and labelled the largest 106 communities. We then used these 106 communities as a fixed set and assigned users from the remaining smaller communities between them. For all these remaining accounts, we checked which of the 106 communities contained most of their followers. If this was not conclusive, we checked which community contained most of their followees. We repeated this procedure until all accounts could be assigned to one of the 106 communities.

All tweets written by users of the Swiss Twitter-sphere are downloaded to a server on a daily basis. The tracked users wrote 19,975,187 tweets between January 1 and April 31,

2020, with 1,721,489 tweets (23.3 percent normal tweets; 8.3 percent replies; 68.4 percent retweets) from 56,418 users implicitly or explicitly referring to COVID-19. We selected the time frame for our analysis as the first national interventions were introduced on March 11 followed by a lockdown on March 16. We can thus compare the time before as well as during the COVID-19 crisis. To identify relevant tweets, we relied on a comprehensive list of 21 keywords (e.g. covid, epidemic, pandemic) in 4 different languages (German, French, Italian, English). As we track the whole Swiss Twitter-sphere we could identify additional replies (4.1 percent additional tweets) without a relevant keyword that were sent to one of the explicit COVID-19 tweets or one of the replies newly identified in the iterative process. We identified these replies by checking the "reply to tweet id field" and included the replies that were written in response to one of the tweets including a keyword. To answer RQ2 and RQ3 we use the communities that we identified for the tracker system and focus on the 20 most active and relevant communities (43,890 users; see Table 1) that wrote 83.4 percent of all tweets about COVID-19 (we dropped communities with a very narrow and specific focus, such as a dating community and fan communities of celebrities like the Swiss football star Xherdan Shaqiri).

To answer RQ1, we analyse if a narrowing of the topic agenda in the Swiss Twitter-sphere can be found. We are able to do this because our tracking captures all Twitter communication from the Swiss Twitter-sphere without any thematic restrictions. For our first research question, we rely on a time series analysis. We estimate the impact of the COVID-19 topic on the total Twitter attention volume, which includes all topics during the study period. We use the Tweet volume before the 11 March 2020 to estimate a counterfactual trajectory for the future with a Bayesian structural time-series model (Brodersen et al. 2015). We then compare the estimated volume after the 11 March with the actual volume to evaluate the impact of COVID-19 on the Swiss Twitter sphere. We choose the 11 March for our model as on that day the state of emergency was announced in Southern Switzerland. This was the first major government intervention before a national lockdown was announced on the 16 March. In addition, we analysed all hashtags in the complete dataset (incl. non-COVID-19 related tweets) to investigate which events were discussed most intensively in the Swiss Twitter-sphere. While hashtags certainly do not capture all existing topics in online discussions, they capture all important events (Lehmann et al. 2012) and allow, in most cases, for enough nuance (Huynh, Legara, and Monterola 2015). For each week, we calculated the overrepresentation of hashtags (keyness: Bondi and Scott 2010) compared to the week before and visualised for each week the eight most overrepresented hashtags with their intensity. Instead of using absolute counts, we rely on the number of unique users that used a hashtag in a given week to correct for potential spam behaviour.

To answer RQ2, we analyse if an increased internal orientation can be found in the Swiss-Twitter sphere. We do so by looking at how the COVID-19 pandemic influenced the sources used by Swiss Twitter users. We investigate if tweets posted by Swiss users got retweeted more often than tweets from foreign users and if Swiss URLs are shared more often than foreign URLs. We distinguish between internal retweets, which are retweets of tweets written by other users within the Swiss Twitter-sphere, and external retweets, which are retweets from tweets written by users outside of the Swiss Twitter-sphere. For the analysis of URLs, we again distinguish between internal and external URLs. The .ch top-level domain allows us to clearly identify URLs from Switzerland. We, thus, compare sharing of these internal Swiss URLs to all other URLs. As many URLs on

TABLE 1
Overview of the communities identified for this analysis with the most important statistics for each community.

Community	Tweets in %	Unique users in %	Average coreness	Typical User
German-Speaking Mainstream	25.65	21.56	37.62	NZZ, srfnews, viktorgiacobbo
French-Speaking Mainstream	18.55	12.77	23.4	RTSinfo, DariusRochebin, ChristianLevrat
NGO Geneva	12.34	6.7	14.93	WHO UNHumanRights ICRC
Science	5	5.99	17.11	EPFL, ETH, UNIGEnews
Italian-Speaking Mainstream	4.1	2.27	20.39	RSIonline, CdT_Online, MarcoRomanoPPD
Digital Switzerland	3.86	8.36	32.38	Swisscom_de, digitec_de, dgt_switzerland
Financial Industry	2.85	3.05	23.57	UBSschweiz, FintechCH, finews_ch
Tourism	2.47	2.36	15.64	Switzerland Tourism, zermatt_tourism, regionduleman
Geneva Youth	2.15	3.34	11.71	N/A
Sport	1.44	2.72	19.09	Rogerfederer, SteffiBuchli, YannSommer1
Communications Industry	1	1.82	23.11	swissmarketing
Authorities	0.84	0.64	31.78	BR_Sprecher, ignaziocassis, vbs_ddps
World Economic Forum (WEF)	0.74	0.47	12.32	wef, DavosCongress, openforumwef
Healthcare	0.74	0.8	24.32	BAG_OFSP_UFSP, UniSpitalBasel santesuisse
First Responders	0.49	0.62	21.21	StadtpolizeiZH, Bern_Stadt, Alertswiss
Arts	0.47	0.46	14.73	ArtBasel, Fond_Beyeler, KunsthalleZH
Music	0.41	1.2	14.21	Ticketcorner, gurtenfestival, Mx3music
E-Sports	0.4	1.78	9.1	eSportsCH, esportsleaguech switzerlanCH
Churches	0.37	3.73	30.9	Kathch, AbtUrban, refpunktch
Public Transport	0.34	5.58	27.45	Sbbnews, PostAuto, vbz_zueri_linie
Others	16.59	22.21	13.04	-

Twitter are shortened (e.g. by services such as bit.ly or dlvr.it), we unshortened all shortener service URLs in tweets, extracted the domains, and then classified them as internal URLs when they use .ch as the top-level domain. We excluded all twitter.com URLs for this analysis, as every quoted tweet and every embedded picture contains this URL.

To answer RQ3, we analyse if scientists in general, as well as experts with special knowledge on pandemics and viruses (epidemiologists and virologists), become more active than other users in the course of the pandemic. For our third research question, we rely on matching (Ho et al. 2011) as a method, as a comparison with the rest of the

population probably would be biased. First, we analyse the users of the science community (n=3,381) and also defined a subgroup of pandemic experts that mention a keyword related to virology or epidemiology ("epidem" or "virol") in their account description (n=79). We then create two matched samples of identical size as the science community and the pandemic experts respectively, with users from the general Swiss Twitter-sphere population. The selected accounts used for matching with the expert groups show similar account level features, meaning followers count, friends count, account age, and verified status, between January 1 and March 10. We thus compare accounts that show the same level of activity before the first government intervention on 11 March. This procedure allows us to compare the effects of the crisis on the expert communities with similar other accounts.

Finally, we examine if the COVID-19 pandemic enabled users positioned in the periphery to reach the centre of the Swiss Twitter-sphere to answer RQ4. We calculated two different centrality measurements based on the follower networks of all active users. On the one hand, we calculated the coreness, which "reflects the location importance of a node in the network" (Liu et al. 2016, 290) to identify more peripheral nodes (lower k-core) and core nodes (higher k-core; see also Table 1). We also calculated the normalised closeness centrality, which measures how close a node is to all other nodes in the network as the average length of the shortest paths (Okamoto, Chen, and Li 2008). We thus checked for every node how many jumps in the follower network they are away on average from all other nodes in the network by always taking the shortest possible paths through follower relations. A low normalised closeness centrality thus indicates that a node can be reached on average by all other nodes in the network by fewer steps than a node that has a high normalised closeness centrality score. Both measures were calculated based on the follower relations (how they follow each other) of all 56,418 active users in the four months.

Results

Rq1: Topic Agenda During Covid-19

The descriptive analysis of the data already shows the impact of COVID-19 on the tweet volume in the Swiss Twitter-sphere (see Figure in appendix). The highest volume with COVID-19 relevant tweets was measured on the 16 March. On that day, the Federal Council announced a national state of emergency and announced a lockdown of public life. To further investigate the potential impact of COVID-19 on the Swiss Twitter-sphere we use a Bayesian structural time-series model (Brodersen et al. 2015). Our model estimates a substantial effect of the COVID-19 crisis on the total volume of tweets in the Swiss Twitter-sphere of 23 percent (SD=0.93), which translates into 34,793 more tweets on average per day than before March 11 (see Figure in appendix). Thus, the tweet volume is significantly different from the expected tweet volume after the 11 March.

From January to April 2020, there was a clear narrowing on the topic agenda in the Swiss Twitter-sphere, with a focus on the pandemic. This is shown by analysing the relative importance of the top eight hashtags per week over time in the entire dataset of around 21 million tweets. The coronavirus took on an increasingly dominant role in tweets of Swiss users (see Figure in appendix). Until mid-February, other topics were important events in the Swiss Twitter-sphere, such as the conflict between the U.S. and Iran, the World Economic Forum (WEF), climate change, or the Cryptoleaks intelligence affair. Time and

again, sporting events such as tennis with Roger Federer or the Champions League also stood out. From the beginning of March at the latest, the debate about the coronavirus almost completely displaced other topics. Only towards the end of April hashtags that have no relation to the coronavirus gained relatively more attention again. They refer to topics such as Ramadan or Earth Day. Also, the use of hashtags with references to the pandemic evolved over time. At first, rather unspecific hashtags mentioning the disease or the virus (e.g. #covid19 or #coronavirus) were predominant. Later on, the discourse widened and led to the use of a broader set of hashtags, especially related to prevention measures against the pandemic (e.g. #flattenthecurve, #stayathome or #coronalockdown). Thus, even though the pandemic was by far the most dominant topic in the Swiss Twitter-sphere, the discourse related to the pandemic became more diverse over time.

Rq2: Inward Orientation of Communication

To evaluate the internal orientation of the communication we first analysed all retweets by Swiss users and whether users retweeted tweets from other accounts within or outside of the Swiss Twitter-sphere. Overall, most communities show a tendency toward increasing inward orientation over time, with a peak in March when the first lockdown was imposed (see Figure 1). The healthcare, first responders, as well as the authority's communities, have the strongest internal orientation. Regarding the mainstream communities, we see a slightly lower internal orientation in the French- and Italian-speaking communities. Only the internationally oriented WEF as well as the NGO Geneva community show a clear declining internal orientation over time.

We used a similar approach for the URLs and compared the percentage of URLs with the .ch top-level domain shared in tweets (see Figure in appendix). Similar to the analysis of the retweets we see a trend towards a higher internal orientation over time. This trend is also clearly evident for the German-speaking mainstream communities, which is by far the largest community. Not very surprising the internationally oriented WEF and NGO Geneva communities show an extremely low percentage of .ch URLs as their accounts often share international .org URLs.

Rq3: Increased Activation of Experts

For our third research question, we tested whether accounts of the science community (n=3,381) or users that mention a keyword related to virology or epidemiology in their account description increased their tweeting behaviour in comparison to the general Swiss Twitter population during the crisis.

Pandemic science experts, meaning virologists and epidemiologists, are more active than the average account in the population (see Figure 2). The activity of the pandemic science experts is also clearly higher than the average level of the matched accounts, which have similar features with regard to followers count, friends count, account age, and verified status. We also observe that the activity level of the pandemic science experts converges again towards the beginning of May and even is slightly below the matched accounts at the very end of our period of analysis. The accounts of the science community, however, show similar activity when compared to the matched accounts as well as to the average user.
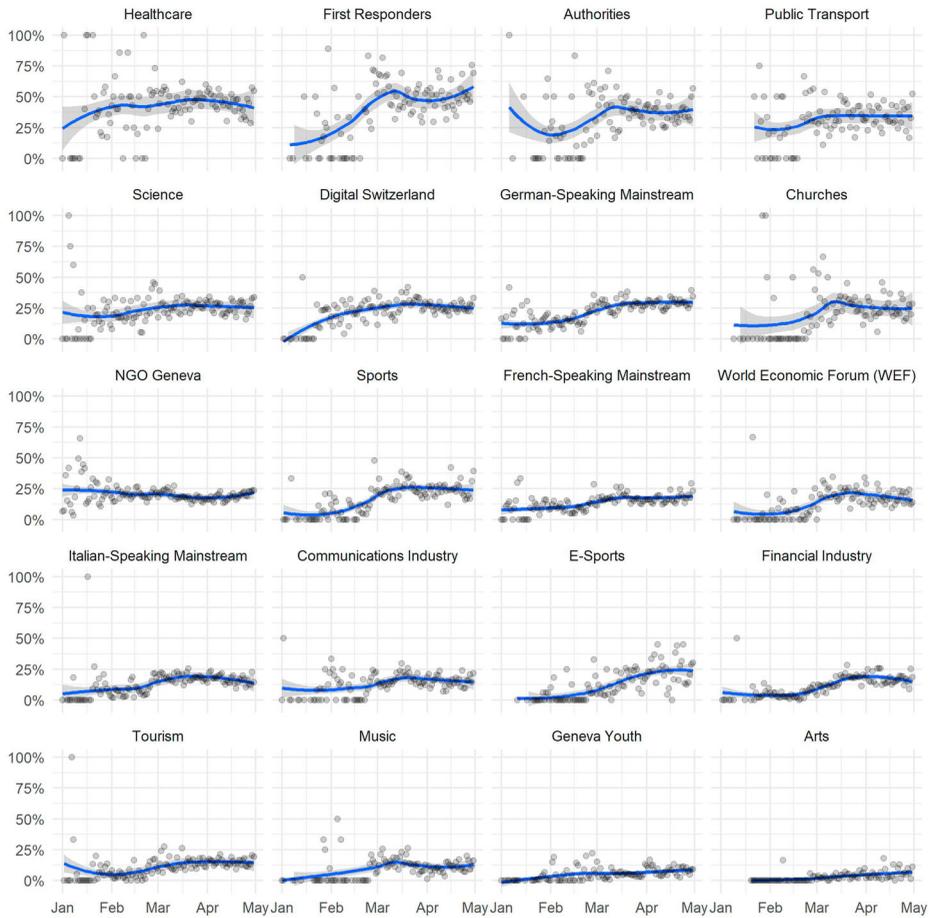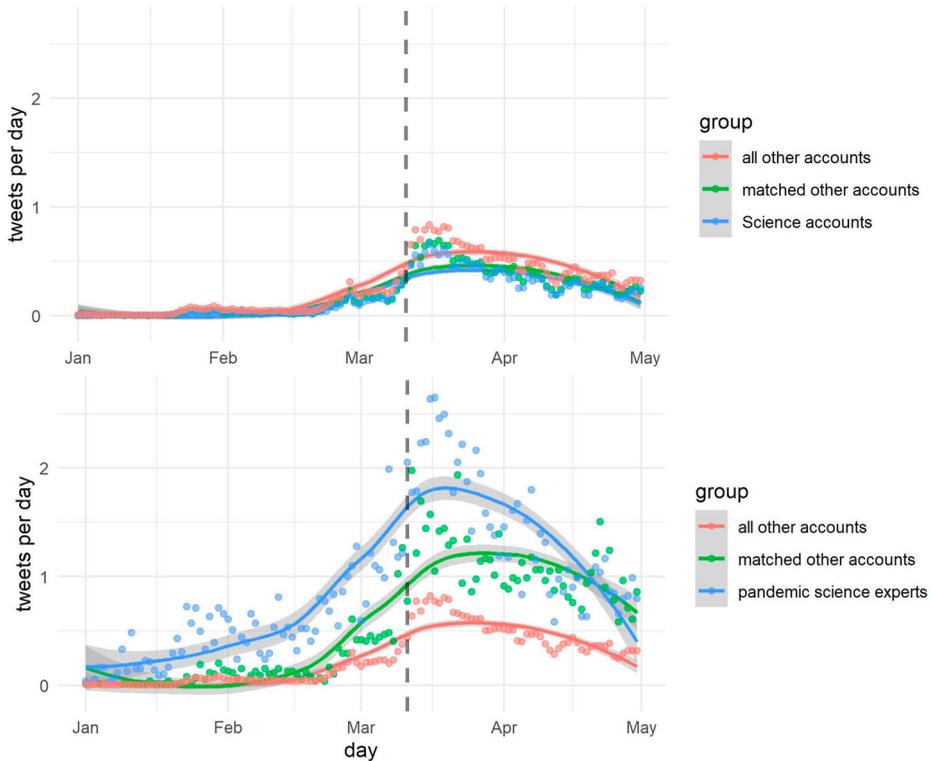
FIGURE 1
Internal orientation (y-axis) with retweets measured daily for 20 communities. Estimated lines with confidence intervals with Local Regression Models (Cleveland and Grosse 1991).

Rq4: Activation of the Societal Periphery

To analyse whether the periphery or the centre of the network was active first, we focus on coreness as well as the normalised closeness centrality (based on indegree). We calculate these measurements based on the follower network of all active users during the COVID-19 crisis and then assign this value to all the tweets posted by these users. In order to analyse the changes over time, we then calculate the average score for all tweets published on a given day by using the centrality measurement of the user sending a tweet.

Based on the average normalised closeness centrality, we see a clear drop towards the population mean in January, which is followed by a stable trend on the level of the population mean ($b = -1.484e-7$, $t(119) = -8.76$, $p < .001$; see also appendix). This means accounts that are less central (higher closeness centrality) with regard to reaching every

FIGURE 2
Average daily tweets for accounts of users from the science community (top) and pandemic science experts (bottom), all other accounts and the matched samples. Dashed line indicates the time before the 11 March for the activity level that was used for the matching. Estimated lines with confidence intervals with Local Regression Models (Cleveland and Grosse 1991).

other account within the network were more prevalent in the beginning. These are mostly internationally oriented accounts from the NGO Geneva as well as the science community. Both communities contain many individuals or organisations which deal with the pandemic or health-related topics professionally. It is to some extent obvious that they communicate about the pandemic at an earlier stage than other users.

With the coreness measure, we observe the opposite trend ($b = .13$, $t(119) = 10.25$, $p < .001$; see also appendix). In the beginning, accounts with a low k-core were more prevalent. Towards February, the population mean was reached, and afterward the average daily k-core increased even more. This means that while at the beginning, accounts from the periphery were most active, this changed over time with a stronger dominance of accounts belonging to the core of the Swiss Twitter-sphere.

While the two opposing trends for the coreness as well as the closeness centrality seem counterintuitive, they make sense when we consider what we actually measured. A lower normalised closeness centrality indicates a more central position, while for the coreness it is the opposite as more central accounts have a higher coreness. For example, some of the more international science and Geneva NGO accounts have a low

closeness centrality (which means more central) as they are followed by accounts in all three different language regions but mostly from other accounts in peripheral commu- nities and thus have a lower k-core. However, in comparison to the most important accounts with regard to follower relations, they have a low coreness if we consider their status within the Swiss Twitter-sphere (see also Table 1). In other words, the coreness shows whether an account has many connections and belongs to the general core of the network, whereas the closeness centrality shows how quickly an account can reach all other accounts in the network.

Additionally, we investigated whether more peripherally positioned users or more central users have an impact on Twitter with their behaviour during the COVID-19 crisis. We used the same method as described above to calculate the average score for all retweets published on a given day by using the centrality measurement of the retweeted user. While the analysis with the retweeted users shows a positive trend for the coreness over time ($b =$ 0.1096, $t(119) = 3.04$, $p < .01$; see also appendix), we could not identify a clear trend for the closeness centrality over time ($b = 9.426e\text{-}09$, $t(119) = 0.65$, $p = .52$). This means that users located more towards the periphery were initially retweeted more often. At the beginning of March, the coreness clearly increases on average and stays on a higher level than before.

Conclusion and Discussion

By using extensive digital trace data, we showed that the COVID-19 pandemic and the lockdown of public life clearly had an effect on the Swiss Twitter-sphere in general and on the public discourse on Twitter about the pandemic. We analysed four dimensions, which we derived from theories on the public sphere in crises.

First, we showed that the pandemic was a very important topic in the Swiss Twitter- sphere and also led to increased activity overall. The events, therefore, had an effect on the intensity of public discourse and seemingly activated the public sphere to a certain extent. Our analysis also confirmed a narrowing of the topical agenda in the Swiss Twitter-sphere. The pandemic pushed aside other relevant topics, for instance the debate about climate change, which was very present before the pandemic (Eisenegger et al. 2020). The hashtag analysis additionally showed that the diversity of topics decreased during the pandemic, even despite the aforementioned increase in Twitter activity. However, within the topic of COVID-19, the discussion was relatively multifaceted, which is mirrored in the use of many differ- ent hashtags with references to the pandemic. Thus, the crisis led to a focus on one overarching main topic, meaning the pandemic, but to an augmented diversity within the discourse.

Second, our analysis revealed a very clear trend to an increased inward orientation in the public discourse about COVID-19 on two levels. On the one hand, Swiss users increas- ingly retweeted the tweets of other Swiss users. On the other hand, Swiss users also increas- ingly shared tweets with URLs of Swiss websites, which clearly indicates that domestic sources became more important over time. The internal orientation gained weight even though internal as well as external retweets and URLs were used more frequently following the higher volume of tweets. The communities with the strongest internal orientation as regards retweets and URLs were first responders and healthcare. Both communities were all very immediately affected by the COVID-19 pandemic. The result therefore suggests that internal orientation depends on communities under review and is highest among communities directly affected by the crisis. However, our analysis does not include the

content of the tweets, and users might still mainly discuss international issues with regard to the COVID-19 crisis. Still, in the case of URLs, these tweets, whether they focus more on the international or the national dimension of the crisis, most likely include a Swiss perspective.

Third, our analysis showed increased activation of scientists with expert knowledge on pandemics and viruses, meaning epidemiologists and virologists. The group with virologists and epidemiologists not only shows a high activity level but is substantially more active compared to the average user of the Swiss Twitter-sphere as well as selected users with similar account-level features. In turn, the general science community did not show above-average tweet activity. This can be interpreted as the outcome of increased demand for information specifically related to the pandemic by the public, which is also mirrored in increased demand for experts in media coverage (Eisenegger et al. 2020). This demand was met by experts who reacted with increased Twitter activity. As many journalists and politicians use Twitter as an information source or platform for strategic communication (Rauchfleisch and Metag 2016; Metag and Rauchfleisch 2017; Keller 2020), the increased activity might also be the result of an increased interaction between the pandemic science experts, politicians, and the media. Some of the virologists and epidemiologists were very present in the media and also members of the Swiss *COVID-19 Science Task Force* that advises public authorities. In general, our results indicate that Twitter activity is not only the result of deliberate decisions of the users to communicate but rather steered by a complex milieu of push and pull factors (Van Dijck 2011) which seems to be especially true for experts with essential knowledge during a crisis.

Fourth, we were able to show that in the course of the COVID-19 pandemic, the weight shifts between actors from the centre and the periphery. While peripheral actors gain influence in phases of crisis outbreak, when uncertainty of orientation is high, the weight shifts to actors from the centre the more political solutions are sought and implemented. More peripheral communities such as the Geneva NGO or science community with a lower coreness score (see also Table 1) were amongst the most active already in the beginning when COVID-19 as an issue had not yet arrived in Switzerland as a domestic issue. The increase of the average coreness score for the active as well as the retweeted users shows that over time more central users became more dominant. Still, this does not mean that peripheral users suddenly became passive. They just became, on average, less visible as overall more central users became active. This periphery in conceptualisations of the public sphere often consists of weak publics that are not part of the mainstream and are rather disconnected and extreme (Kaiser and Rauchfleisch 2019). However, the periphery in the Swiss Twitter-sphere consists more of elite accounts from internationally oriented communities instead of marginalised groups that usually form counterpublics (Fraser 1990; Kaiser and Rauchfleisch 2019), or what Habermas (1992) calls weak publics.

While we solely focused on the Swiss Twitter-sphere, our findings can still be generalised to a certain extent within the European context. We believe that similar trends with regard to the shift of the discourse from the periphery to the centre, as well as the role of experts in public discourse, can be observed in other European countries. However, countries such as the US with higher overall polarisation will most likely be different, and the overall structure with regard to the periphery will look different. Still, our study also shows the importance of looking at other aspects of public discourse during the COVID-19 crisis besides misinformation which seems to be the main focus of many international Twitter studies (Gallotti et al. 2020).

Our study has some limitations. First of all, as we have already mentioned at the beginning, Twitter is not representative of the Swiss public sphere. Further studies could, therefore, consider the public discourse during the pandemic in legacy media or on further social media platforms, such as Facebook. Second, tweeting is a very public form of social media communication as most content is accessible to users as well as to non-users. Anecdotal evidence shows that during the pandemic, a lot of mediated communication also took place in non-public or semi-public spaces such as closed Facebook groups or messenger apps like WhatsApp or Telegram. Telegram and so-called alternative social media are of special relevance, as radical viewpoints and misinformation have been shown to be shared through such channels, following the deplatforming of users from mainstream social media like Twitter or Facebook (Rogers 2020). Further studies could, thus, also try to investigate the discourse on the COVID-19 pandemic beyond publicly available content on social media or legacy media. This is also of conceptual interest, as phenomena like the privatisation of public discourse or even deplatforming question the value of the public sphere as a holistic concept. Third, our dimensions cover central but not all crisis-related influences on the public sphere. In particular, our study did not consider the style of communication. The rising intensity of conflict in crises is considered to go hand in hand with an increase in emotionality (arousal) of the public discourse (Imhof 2011). Especially on social media, emotions play an important role during crises and can lead to what Papacharissi (2016) calls affective publics. Thus, future studies could investigate if a higher emotionalisation or arousal can be observed during a crisis. Despite the limitations, our comprehensive approach with digital trace data, which includes the possibility to benchmark the COVID-19 pandemic with the total Twitter activity as well as with the period before the outbreak, delivers new insights into the functioning of the networked public sphere in crisis periods.

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Appendix

Figure: Measured tweet volume per day about COVID-19 (blue line) and the total tweet volume measured from the whole Swiss Twitter sphere (red line). The dashed blue line shows the counterfactual trajectory with confidence intervals (blue area). The dashed vertical line indicates 11 March, the declaration of emergency in southern Switzerland.

Figure: For each week the 8 hashtags with the highest keyness in comparison to the prior week. Y-axis (on a log-scale) shows how many unique users have used the hashtag during a given week.

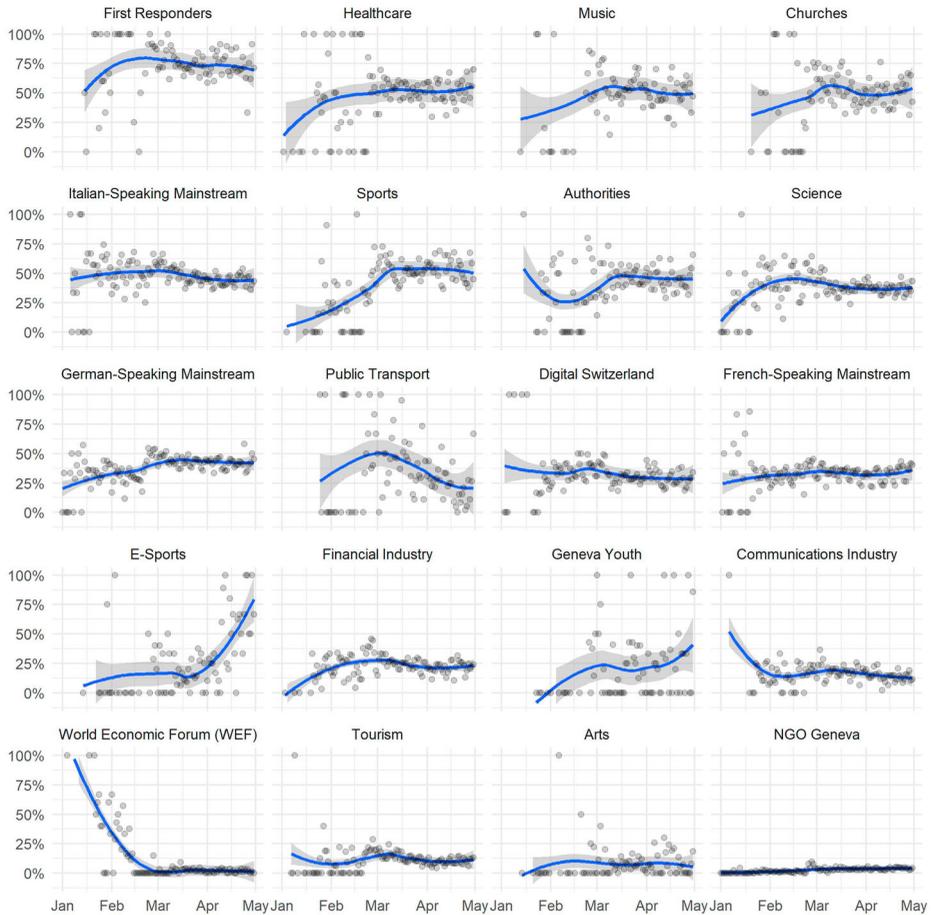RQ2: Inward Orientation of Communication

Figure: Internal orientation (y-axis) with .ch URLs shared in tweets measured daily for 20 communities. Estimated lines with confidence intervals with Local Regression Models (Cleveland and Grosse 1991).
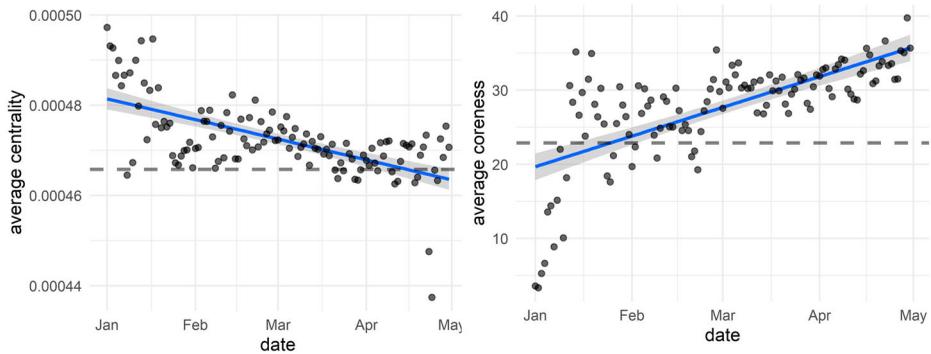
Figure: Daily average normalised closeness centrality (left) and coreness (right) for all tweets published by users on a given day. Dashed lines indicate the population closeness centrality and coreness mean score. Linear regression lines are plotted with confidence intervals.
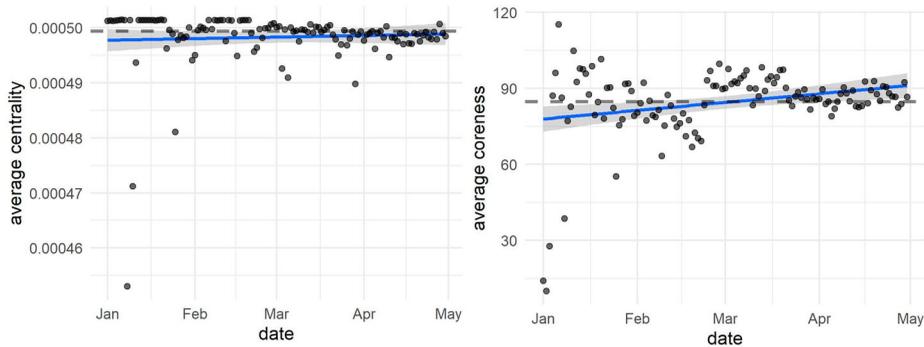

Figure: Daily average normalised closeness centrality (left) and coreness (right) for all retweeted Swiss users on a given day. Dashed lines indicate the closeness centrality and coreness mean score for all retweeted Swiss users. Linear regression lines are plotted with confidence intervals.

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