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ARTICLE

Evidence in the service of dissent: strategic communication of science by German corona-protest movements

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Abstract

This study investigates how Germany's anti-lockdown and anti-vaccine protest movement, led mainly by the Querdenken network, allied with conspiracist and far-right groups, utilized scientific authority while opposing COVID-19 policy. We analyse posts published in 161 public Telegram channels using a computational pipeline that combines named-entity recognition, structural topic modeling, a BERT sentiment classifier, and an open-source large language model, Mixtral. We report that mentions of scientific information surged during periods of heightened policy uncertainty (e.g., national lockdowns and the vaccine-mandate debate), indicating tactical appeals to epistemic authority. References to science were initially scarce rather than hostile, but evolved into a selective, strategic endorsement: protest communities increasingly cherry-picked scientific claims to delegitimize containment measures (foremost, vaccination) while sidelining evidence contradicting their narrative. The findings show that, even among actors who reject official institutions, appeals to scientific language are strategically deployed as a discursive resource.

Keywords

Public understanding of science and technology; Science and media; Digital science communication

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1 ▪ Introduction

Societal crises create radical uncertainty, leaving political actors — whether in government or opposition — unsure how best to respond and mitigate damage. In such contexts, decision-making typically relies on scientific evidence, offering practical guidance for identifying and managing threats, but also serving as epistemic authority to legitimate policy choices [Boin et al., 2005; Parkhurst, 2017; Turner, 2001; Weible et al., 2020]. Against this epistemic backdrop, the boundaries between political communication and science communication become increasingly blurred [Scheufele, 2014], with scientists occasionally making political statements [Biermann et al., 2024] and politicians, interest groups, or social movements invoking scientific evidence to justify their claims in public debates [Fähnrich et al., 2020]. Non-institutionalised political actors, defined here as groups excluded from formal political institutions and mainstream media, also participate in this discourse, relying on alternative spaces, such as social media platforms, to communicate and mobilise [Jost et al., 2023]. Although such groups are often considered sceptical of scientific evidence or even anti-science [Walter et al., 2023], research gaps persist about whether and how scientific evidence is selected and presented within these alternative channels. This article addresses this gap and analyses how periods of heightened societal uncertainty shape references to science within communities of non-institutionalised actors.

We draw on the concept of *hidden transcripts* [Scott, 1990], referring to discourses used by marginalised groups away from public scrutiny, to theorise how non-institutionalised actors navigate societal uncertainty by referencing scientific evidence within digital alternative publics. We use the COVID-19 pandemic as a vivid example of a socio-scientific crisis, shifting political processes in most democratic countries onto previously unseen tracks of emergency restrictions. Various restrictive measures, including lockdowns and vaccination mandates, were justified by appeals to scientific authority not only by government but also by prominent scientists and scientific bodies under conditions of marked uncertainty, provoking resentment among parts of civil society and the broader public [Popescu & Jugl, 2025; Biermann & Taddicken, 2025]. In Germany, this resentment manifested in the Querdenken movement (or “lateral thinkers”), which challenged the government’s measures to curb the crisis and maintained far-reaching public channels on social media platforms [Primig, 2024]. In the further course of this article, we will refer to this specific group of non-institutionalised actors as *corona-protesters*.

Our analysis draws on a large corpus of Telegram content produced by corona-protest communities in Germany. To examine how these communities navigated uncertainty during the COVID-19 pandemic, we employ text-as-data approaches and sentiment analysis. We show that the corona-protesters are not a purely anti-science movement. This observation aligns with other studies [Lee et al., 2021; Berg, 2025], which demonstrate that non-institutionalised actors refer to science as a cognitive framework, actively employing it to justify their beliefs and unify movement participants in mobilization efforts. Accordingly, we demonstrate how appeals to science emerge during periods of high societal uncertainty, and how perceptions of science evolve over time, becoming more positive, though not predominantly so. Additionally, our analysis of content produced by corona-protesters reveals patterns in the instrumentalisation of science.

The rest of the paper proceeds as follows. In the next section, we present the corona-protesters in more detail and elaborate our conceptual framework for understanding

the science communication of corona-protesters. In the Data and Methods section, we describe the data and research design, followed by a section presenting the empirical results. In the Discussion and Conclusions section, we recap the study's main takeaways, explore the broader implications for science communication, reflect on the limitations of our approach, and suggest directions for future research.

2 ▪ The movement of corona-protesters in Germany

During the COVID-19 crisis in Germany, non-institutionalised political actors have reflected and exploited scientific expertise, a key reference point for the German government during the COVID-19 crisis [Hanson et al., 2021]. These non-institutionalised actors have emerged as prominent voices in public discourse, challenging official narratives, promoting alternative perspectives on the pandemic, and organising protests that have drawn thousands of participants [Heinze & Weisskircher, 2023].

Founded in Stuttgart in April 2020, "Querdenken 711" ("lateral thinking") rapidly expanded into a loose national movement whose organisers framed Germany's COVID-19 measures as unconstitutional [Buehling & Heft, 2023; Hunger et al., 2023]. Although the brand is new, it draws on earlier infrastructures: street-based protest networks opposing the European Union and immigration, esoteric health circles, and far-right alternative media [Weisskircher, 2023]. Ideologically, the coalition is eclectic [Liekefett et al., 2023] — centrists, politically undifferentiated, left- and right-wingers — but united by distrust of political elites and mainstream journalism [Hunger et al., 2023]. Increasing content moderation by platforms (e.g. Facebook, Twitter) pushed them to Telegram, whose broadcast channels, forwarding loops, and low moderation let administrators enlarge their audiences [Jost et al., 2023].

Interestingly, the Querdenken casts its dissent as a defence of "true science": leaders urge followers to "do your own research", circulate preprints, and share amateur data visualisations [Berg, 2025]. Challenging official science allows the movement to undermine pandemic policy on its own rhetorical turf, presenting activists as rational truth-seekers rather than fringe agitators while shifting blame to "corrupt" government and experts.

Estimating the actual number of supporters of the corona-protest movement in Germany is challenging. However, statistics from May 2023 reveal that over 20% of German residents remained unvaccinated, and a third of respondents expressed opposition to any protective measures in future pandemics [Carthaus, 2024]. These figures may indicate a possible upper limit to the pool of sympathisers, although vaccination status and policy scepticism do not automatically translate into active movement support.

3 ▪ Hidden transcript of corona-protesters: contesting science on Telegram

If concerned about being prosecuted for expressing opposition, non-institutionalised actors often avoid direct and potentially futile confrontation and rely on the so-called *hidden transcript*. Following Scott [1990], we define a hidden transcript as "off-stage" talk that subordinates use to criticise power-holders while maintaining a surface of compliance in the "public transcript". The transcript is "hidden" not because it is literally private, but because its

oppositional meaning is encoded in irony, selective quotation, or insider cues that sympathetic followers recognise and outsiders may miss. Hence, hidden transcripts are a strategic response to (perceived) suppression, i.e. they shift discourses into an alternative public, reducing the risk of direct conflict and diminishing the degree of control from the state.

We use Scott's concept as a formal, non-normative descriptor of backstage discourse, extending hidden transcripts beyond emancipatory subaltern contexts. Greenhouse [2005] shows how elites in liberal democracies cultivate off-stage justificatory talk to extend executive power; Massoumi and Morgan [2024] outline "hidden transcripts of the powerful", indicating that the same backstage/public dynamics structure dominant as well as subordinate actors. Following Ho [2011], we foreground impersonal domination (epistemic and statistical authority) alongside interpersonal coercion — an apt lens for examining pandemic governance's reliance on expertise. Relatedly, Kopper [2025] conceptualises vaccine non-compliance as infrapolitics — Scott's [1990] wider repertoire of low-profile resistance that includes hidden transcripts. Finally, groups such as conspiracy believers need not be objectively marginalised to engage in hidden transcripts: subjective powerlessness, anomie, and perceived procedural injustice — closely tied to conspiracy belief — can elicit collective action and sensemaking. Thus, actors who subjectively see themselves as persecuted by moderation or reputational sanctions turn to alternative media as functional backstages [Biddlestone et al., 2020; Goertzel, 1994; Frenzel et al., 2025; Klein, 2018; van Prooijen, 2011; Winter et al., 2023].

Regarding the example of corona-protesters in Germany, a key starting point is the observation that the lowest common denominator among the groups of corona-protesters is their determination to radically change the political system and the foundational structures of German society [Jost & Dogruel, 2023]. Moreover, governmental responses to misleading information [Eck & Hatz, 2020] put these groups outside the mainstream channels. Due to their non-institutionalised status, which entails exclusion from the political and media systems, these actors lack the capacity to enact significant changes in public life that conflict with their interests and beliefs [Zehring & Domahidi, 2023; Jost & Dogruel, 2023; Almodt, 2024]. Therefore, corona-protesters have to be considered as radically oppositional — indeed, anti-systemic — making them an object of governmental responses. Their consequent motivation to use Telegram as an alternative communicative space is evident and explicitly articulated by the protesters [Buehling & Heft, 2023].

At the same time, radical movements, despite opposing mainstream narratives, routinely reference mainstream media when addressing broader audiences — an indirect engagement that largely reinforces in-group views [Haller & Holt, 2019]. Government decisions regarding lockdowns, mandatory mask-wearing, and vaccinations were framed largely through appeals to scientific knowledge and data [Kuhlmann et al., 2022]. Virologists, epidemiologists, and other specialists became integral to government advisory bodies, communicating their research findings to the public [Kuhlmann et al., 2021; Hadorn et al., 2022]. Governments routinely cite newly released scientific outputs (e.g., preprints, peer-reviewed articles, and epidemiological model estimates) to justify decisions on lockdowns, mask mandates, and vaccination. This explicit appeal to expert evidence can also serve as a rhetorical "lightning rod", drawing criticism away from the government and toward science itself.
Non-institutionalised actors react to the established order by entering into dialogue with it [Brubaker, 2021]. Therefore, the line of inquiry we explore with the available data concerns

the idea of science as a point of reference in a time of crisis and radical uncertainty [Berg, 2025]. It is based on the assumption that individuals and groups are more likely to seek out and utilise authoritative sources to substantiate their views and actions during crises [Lee et al., 2021]. This behaviour is expected to be particularly pronounced among protest movements, as they seek to legitimise their stance and attract public attention, aligning with Scott's [1990] concept of utilising the public transcript while simultaneously undermining it with the hidden transcript. Moreover, as Berg [2025] shows in their qualitative study, Querdenken participants may also resort to the scientific method to navigate themselves in moments of uncertainty, as they perceive science positively as a method for finding truth. Nevertheless, they do not trust academic institutions as the only way to achieve certainty about scientific knowledge [Berg, 2025]. This aligns with the findings of digital ethnographic research based on U.S. social media data, which demonstrates how corona-sceptics adopt data-driven formats (e.g., COVID data visualisations) to advocate for radical policy changes [Lee et al., 2021].

Figure 1 illustrates why Scott's notion of hidden transcripts is suitable for analysing corona-protest communication in Germany. The post begins by quoting the Robert Koch Institut (RKI, an official institution for disease control and prevention) verbatim: "*The RKI counts all laboratory-confirmed SARS-CoV-2 detections as COVID-19 cases, regardless of clinical symptoms*". At first glance, this appears to be a neutral reproduction of an official definition. Yet the quotation is immediately followed by questions: why are asymptomatic positives omitted from the weekly report? Which symptoms are counted, and for how long? What do raw case numbers really tell us? These all cast doubt on the RKI's metrics and, by extension, on the state's entire pandemic narrative. Such manoeuvres exemplify how protest actors appropriate the state's "public transcript" (the authoritative language of incidence values, hospitalisations, ICU beds) while embedding a counter-narrative that sympathetic

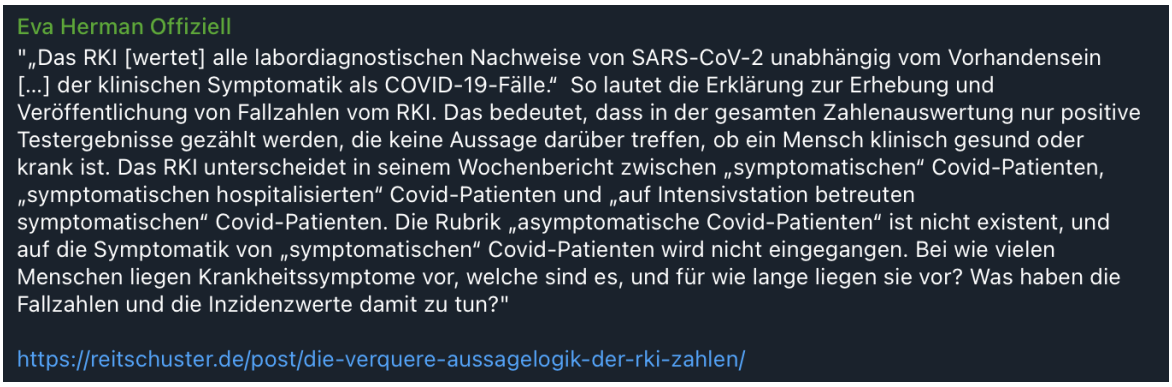

Figure 1. An example of a Telegram post with comments about RKI (Robert Koch Institut), https://t.me/EvaHermanOffiziell/83240.
Translation: "The RKI [evaluates] all laboratory diagnostic evidence of SARS-CoV-2, regardless of the presence [...] of clinical symptoms, as COVID-19 cases." This is the RKI's explanation for the collection and publication of case numbers. This means that only positive test results are counted in the overall statistics, which do not provide any information about whether a person is clinically healthy or ill... RKI distinguishes between "symptomatic" COVID patients, "symptomatic hospitalised" COVID patients, and "symptomatic" COVID patients cared for in intensive care. The category "asymptomatic COVID patients" does not exist, and the symptoms of "symptomatic" COVID patients are not addressed. How many people have symptoms of the disease, what are they, and for how long? What do the case numbers and incidence rates have to do with this?"

readers easily recognise. By leveraging the state's own figures, they criticise not just individual policies but the epistemic foundations that render those policies legible. Because the critique centres on figures everyone can see, resistance that would otherwise remain implicit becomes easier for both authorities and supporters to detect. Viewed through Scott's [1998] concept of legibility, which presents the state's attempts to simplify social complexity through statistics and other quantifiable tools, such resistance becomes more apparent. Applying this perspective to the communication strategies of corona-protesters in Germany reveals a dynamic interplay between the state's efforts to enforce order and opposition to it. Thus, we consider the hidden transcript theory, as described by Scott [1990], to be a suitable conceptual framework for analysing the communication of corona-protesters on Telegram.

We define engagement with scientific institutions as any communicative act in which movement actors mention, share, praise, question, or criticise a scientific body, such as the Robert Koch Institute, Paul-Ehrlich-Institut, or WHO, or its outputs (peer-reviewed articles, preprints, data dashboards, press releases). Our focus on such scientific referencing isolates the distinctive rhetorical strategy that directly targets the government's source of legitimacy in its anti-corona responses, i.e., expert knowledge. It allows us to explore whether that strategy intensifies in response to epidemiological or policy shocks.

RQ 1: *When do corona-protesters in Germany reference the outputs of scientific institutions during the COVID-19 pandemic on Telegram?*

Previous research on the US context reveals that criticism of lockdowns or vaccines relied mainly on ideological frames [Walter et al., 2023], and protest leaders drew on what Mede and Schäfer [2020] call scientific populism: a discourse that delegitimises both political and scientific elites while claiming to speak the "real" truth.

As the crisis unfolded, the volume of COVID-19 research exploded, with the emergence of preprints, modelling dashboards, and rapid publications that sometimes qualified or contradicted earlier findings [Kreps & Kriner, 2020; Han et al., 2021]. This expanding evidence base supplied corona-protesters with fresh rhetorical ammunition. The theory of motivated reasoning helps explain how such material is used. People often do not process evidence neutrally; they tend to seek, evaluate, and remember information in ways that support preferred conclusions [Kunda, 1990]. They could now cherry-pick individual studies, highlight acknowledged limitations, and present selective endorsements as proof that the authorities were "hiding the real science". Thus, attitudes need not change; rather, as new studies appear, actors can selectively cite congenial findings and discount contrary ones, updating the set of references they mobilise without revising their underlying views.

In light of these perspectives, we pose the following research question:

RQ2: *How does the sentiment toward science related to COVID-19 in the corona-protest communities change over time?*

4 ▪ Data and methods

Our corpus comprises approximately two million messages (mid-2019–Dec 2023) from 161 public Telegram channels run by non-institutional political actors in Germany (far right, Querdenken, conspiracists). Starting from Jost and Dogruel [2023], we retained public

broadcast channels (admins post; subscribers read-only; replies typically disabled), so texts represent admin-to-follower statements; the full list appears in Appendix Table C1. After filtering to German and the study window (October 2019–December 2023), we analyze 1,402,461 posts (Figure A1) and derive task-specific subsets: (1) a science/COVID keyword corpus for topics/volume (126,389 posts; Table A1); (2) scientist mentions via named-entity recognition (NER) (7,630 posts; list of researchers from Leidecker-Sandmann et al. [2022]); (3) research-organization sentiment at the sentence level (90,968 sentences); and (4) publication links to academic domains (870 posts).

4.1 ▪ *Methods for research question 1: scientific discourse in COVID-19 posting*

We identified science-oriented COVID-19 posts via a three-step filter. First, COVID keywords (e.g., covid/corona/sars-cov) yielded 349,249 posts. Second, science keywords (e.g., research, study, professor, mRNA; Table A1) produced 231,907 posts; the list was compiled through close reading and expanded via openthesaurus.de. Third, intersecting the two sets yielded 126,389 posts. To validate the selection of relevant posts, we randomly sampled 100 posts (balanced between categories) and achieved a Macro F1 score of 0.96 (Table A2). To provide readers with an understanding of the topics discussed in the sub-corpus of science- and COVID-19-related Telegram posts, we fitted a structural topic model [STM, Roberts et al., 2019] with date and channel type as covariates to the 1,402,461 preprocessed messages; methodological details and validation (word/topic intrusion) are presented in Appendix A.

Modelling the use of scientific references. We model the daily share of science-framed COVID-19 posts across 161 channels using a multilevel (mixed-effects) regression to account for hierarchical structure (days nested in weeks/months) and to separate within-week fluctuations from between-week shocks:

$$\begin{aligned} \textit{Share of science-related posts}_i = \beta_0 + \beta_1 * \textit{COVID Cases} + \beta_2 * \textit{Share of science posts}_{i-1} \\ + X_2 * \textit{Controls}_{i,j} + \beta_3 * \textit{week}_t + u_i \end{aligned} \tag{1}$$

where i is the day, t is the week, and j is the month in which the Telegram post was published.

Control variables include lagged deaths (from the European Centre for Disease Prevention and Control), monthly unemployment rates for West and East Germany, and monthly inflation rates. We also utilise the World Uncertainty Index [Ahir et al., 2022] in robustness checks (more information on the rationale for controlling this parameter is provided in Appendix A). Given one-day reporting lags in news coverage, cases/deaths enter with a lag. The model tests whether epidemiological or macro shocks coincide with shifts in the proportion of posts referencing science (RQ1).

4.2 ▪ *Methods for research question 2: sentiment toward science*

To analyse the temporal variation in sentiment toward science, we apply the German Sentiment BERT model [Guhr et al., 2020]. Against human gold standard evaluation, the model achieved a conservative precision of 1.0 for positive sentiment (recall = 0.55) with an F1-Macro of 0.64 (see Table B1 in the Appendix). We therefore prioritise precise detection of genuinely positive posts, accepting some under-detection. Further validation details are in Appendix B.

We estimate sentiment using the following regression specification (Formula 2):

$$\begin{aligned} \textit{Science Sentiment} = {} & \beta_0 + \beta_1 * \textit{Trend}_i + \beta_2 * \textit{Trend}_i^2 \\ & + \beta_3 * \textit{cases}_{i-1} + \beta_4 * \textit{deaths}_{i-1} + u_i \end{aligned} \tag{2}$$

Trend: linear time trend capturing changes in sentiment over time.
Trend^2: quadratic time term capturing non-linear sentiment trends.
lagged-cases$_{i-1}$: previous-day COVID-19 cases, capturing delayed effects on current sentiment.
lagged-deaths$_{i-1}$: previous-day COVID-19 deaths, likewise capturing delayed effects.
We also re-estimate the model with negative sentiment as the dependent variable to compare its dynamics with positive sentiment.

Science, scientists, and research institutions as targets of corona-protesters. We assessed sentiment toward scientists, research institutions, and scientific publications. Entities were detected via NER [Akbik et al., 2019] and a curated list of 1,200 virology/epidemiology researchers [Leidecker-Sandmann et al., 2022]; science-related domains (journals, preprint servers) were also extracted (Table B2). For sentiment, we used German Sentiment BERT [Guhr et al., 2020] at the post level and Mixtral-8×22B [Jiang et al., 2024] at the sentence level. Sentence-level analysis was applied to institutional mentions to avoid contamination from unrelated text in long posts; scientists and web domains were classified at the post level due to frequent quoting and punctuation noise that hindered accurate sentence segmentation. This hybrid design strikes a balance between accuracy and computational constraints: BERT is less accurate at the sentence level, whereas Mixtral performs better but is more resource-intensive. Performance was overall acceptable but noisy (F1-macro: 0.51 for BERT; 0.64 for Mixtral). We consider these metrics acceptable for exploratory aggregate-level analyses and interpret results with caution. Validation details appear in Appendix B.

5 ▪ Results

5.1 ▪ *RQ1. Timing and correlates of references to science and scientific institutions*

Figure 2 plots the monthly number of COVID-19 posts across 161 Telegram channels, with dashed lines indicating major German pandemic milestones. Activity spiked after the first nationwide lockdown on 22 March 2020 and in early April, when Hendrik Streeck's Heinsberg Study, reporting unexpectedly low within-household secondary infection risk, entered public debate. Posting volume rose once more around the "lockdown light" of 2 November and peaked in mid-December during the stricter hard lockdown (mandatory FFP2 masks, closure of non-essential businesses and schools, Christmas contact limits). Thereafter, it declined steadily, punctuated by smaller bursts coinciding with later policy changes, and stabilised at a low plateau by late 2023. Reference to science was therefore most intense during the acute crisis phase and waned as restrictions eased.

The science-focused COVID-19 sub-corpus contained 126,389 messages and is organised into 25 topics that revolve around biomedical evidence and expert authority (Figure 3). Specific examples include adverse-event risk and vaccination cost-benefit debate (Topic 1), monitoring data such as RKI case counts and PCR-test positivity (Topic 23), political quarrels between ministers and virologists about restrictive measures (Topic 11), and discussions of

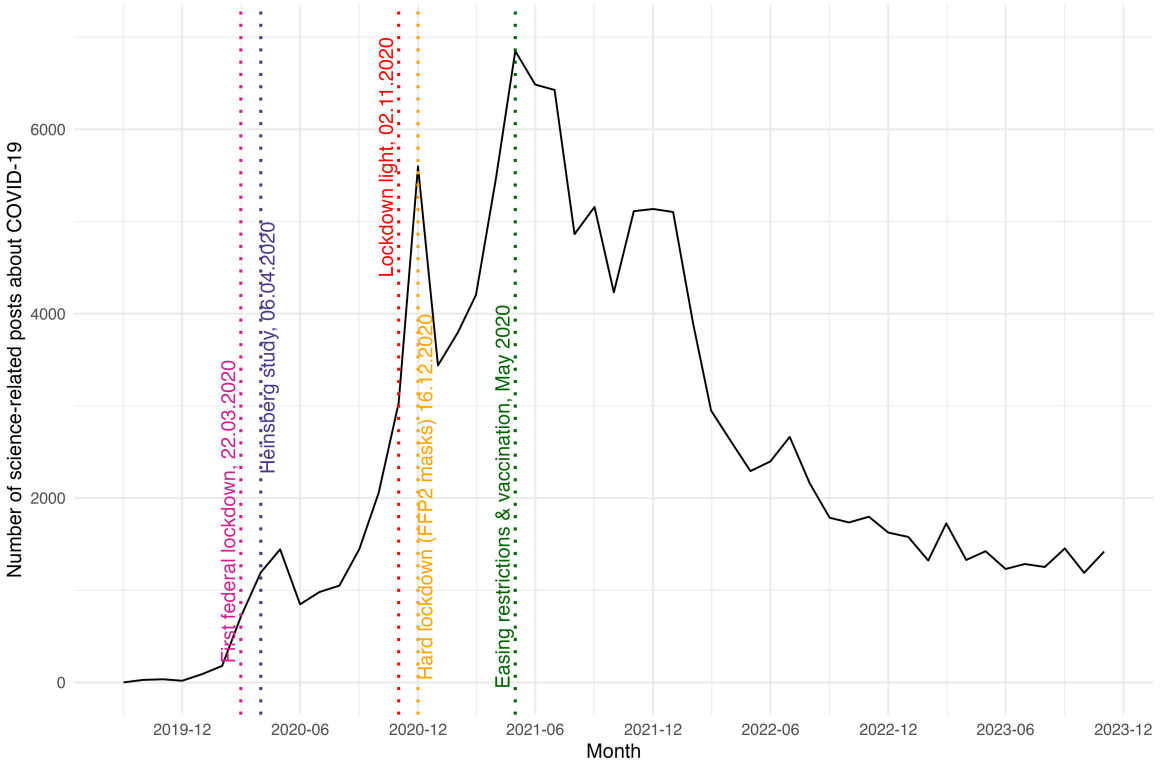

Figure 2. The monthly distribution of the science-related Telegram posts about COVID-19.

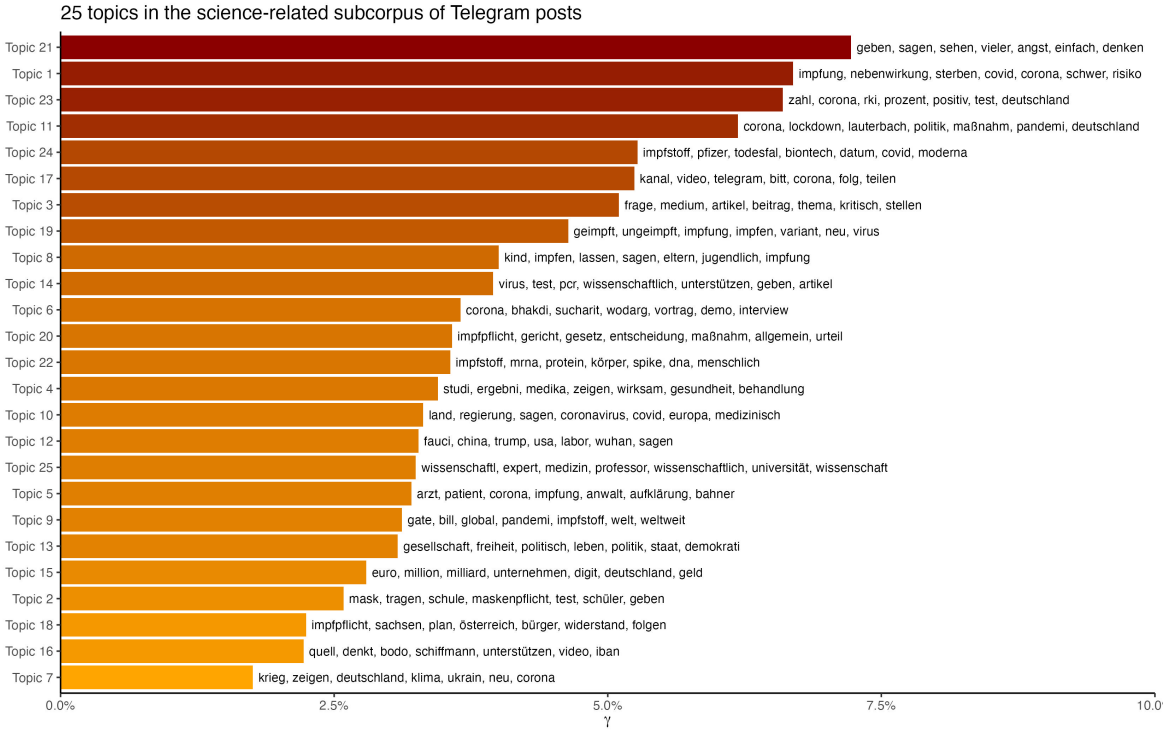

Figure 3. Topics in Telegram posts pre-selected by keywords referring to the science-related discussions about COVID-19.

mRNA platforms, spike proteins, and DNA interactions (Topic 22). Almost half of the total topic probability was absorbed by vaccine-oriented themes (Topics 1, 8, 18, and 19), emphasising that scientific rhetoric was deployed chiefly to contest Germany's immunisation policy. STM of the remaining 1,276,072 messages (Figure A5 in the Appendix) yielded a 51-topic solution dominated by macrosocial or tactical frames such as state-overreach claims, protest-mobilisation calls, partisan electoral commentary, and exogenous events like Russia's invasion of Ukraine. When COVID-19 emerged in this second model (for instance, Topics 14, 22, and 43), it was primarily addressed through legal or moral lenses, such as compulsory vaccination bills or children's mask mandates, rather than through scientific evidence.

Table 1 addresses the question of which contextual factors are associated with the greater production of science-related posts in corona protest communities.

Across all mixed-effects models, the coefficient on lagged COVID-19 cases was positive and statistically significant, indicating a small lagged association: higher case counts were followed by a slightly higher share of science-related content in corona-protester Telegram communities. In contrast, lagged deaths did not show a robust association. Substantively, the estimated coefficient on lagged cases ranged from 0.005 to 0.009 across specifications, meaning that a one standard-deviation increase in the prior day's case count was associated with about a 0.5 to 0.9 percentage-point increase in the share of science-related posts (e.g., from roughly 10% at the intercept to 10.5–10.9%). This reflects a small but statistically reliable lagged association.

Table 1. Multilevel regression model estimates.

Variable	*Model 1 (most parsimonious)*	*Model 2 (nested within month-year)*	*Model 3 (lagged share science included)*	*Model 4 (uncertainty included)*
Intercept	0.099 (0.003)***	0.098 (0.006)***	0.078 (0.004)***	0.074 (0.006)***
COVID Cases$_{t-1}$ (std.)	0.009 (0.002)***	0.008 (0.002)***	0.007 (0.002)***	0.005 (0.002)**
COVID Deaths$_{t-1}$ (std.)	0.0004 (0.002)	-0.0000 (0.002)	0.0006 (0.002)	-0.002 (0.002)
Share Science$_{t-1}$	–	–	0.214 (0.035)***	0.385 (0.033)***
Monthly Uncertainty (std.)	–	–	–	-0.057 (0.017)***
Random Intercept	*Week*	*Month-Year*	*Week*	*Month-Year*
Observations	764	764	764	764
Groups (Week/Month-Year)	110	26	110	26
Residual SD	0.020	0.024	0.021	0.022
Week/Month-Year Intercept SD	0.030	0.029	0.023	0.015
REML	-3462.7	-3419.1	-3479.9	-3530.3

Note: table shows the association of different variables with the production of science-related posts in the communities of corona-protesters. *** $p < .001$, ** $p < .01$.

More complex specifications (e.g., using month-year random intercepts or logged predictors) replicated these findings and yielded unstable effects related to COVID deaths (see Table A3 in the Appendix). When models employed non-lagged, standardised predictors, both daily cases and deaths demonstrated a small, statistically significant positive association (Model 2, Table A3 in the Appendix). Including a lagged share of science-related posts highlighted strong temporal persistence, as indicated by the previous day's level of science-related posts (Models 3 and 4, Table 1). Neither monthly uncertainty, analysed as a continuous measure or through categorical tertiles, nor economic indicators (inflation changes, long-term unemployment) substantially changed the core findings (Model 4, Table A3 in the Appendix). Overall, the share of science-related posts was correlated with its own past levels and was modestly associated with the rise in COVID-19 cases.

5.2 ▪ *RQ2. Sentiment toward science over time*

Figures 4 and 5 illustrate the sentiment towards scientific information about COVID-19 in posts from communities of corona-protesters over time. Both figures show a clear temporal alignment between major COVID-19 policy decisions and shifts in sentiment regarding science-related content. Negative sentiment science-related posts (Figure 5) showed a surge coinciding with the first federal lockdown in March 2020 and remained elevated through the end of that year, peaking around periods of heightened restrictions (e.g., mandatory FFP2 masks in December 2020). These negative posts then steadily tapered off from mid-2021 onward. In contrast, the positive-sentiment curve (Figure 4), although lower in absolute volume, spiked in mid-2020, aligning with the easing of restrictions and the early phases of the vaccination campaign. The positive sentiment also exhibited transient peaks around events such as the announcement of the light lockdown regime (November 2020) and rebounded again in late 2023. Taken together, and consistent with the exploratory nature of these figures, the patterns tentatively suggest that heightened negativity coincided with stricter anti-corona policy measures, whereas positive sentiment increased more modestly around policy relaxations and implementation milestones (e.g., vaccination campaigns, the Heinsberg study).

We estimated separate regression models to explore the temporal dynamics and determinants of positively and negatively valenced science posts.[1] The results of the regression analysis are summarised in Tables 2 and B6.

Controlling for the lagged case and death counts, as well as prior posts, the results indicated that *Trend* was positively and significantly associated with the number of positive science posts. Specifically, each one-unit increase in time corresponded to an estimated 0.009 increase on the log scale of positive science posts ($p < 0.001$). This suggests a gradual upward trend in the production of positive science posts over time. However, $Trend^2$ was negative and statistically significant ($p < 0.01$), indicating a decline in this positive trajectory as time progresses.

Neither lagged COVID-19 case counts nor death counts significantly predicted daily positive science posts, suggesting that short-term fluctuations in pandemic severity were not strong

1. In both cases, the data distribution demonstrated overdispersion, with the variance-to-mean ratios being 2.02 and 15, respectively. The Vuong test indicated a preference for the negative binomial regression over the zero-inflated negative binomial and Poisson regressions in both models.

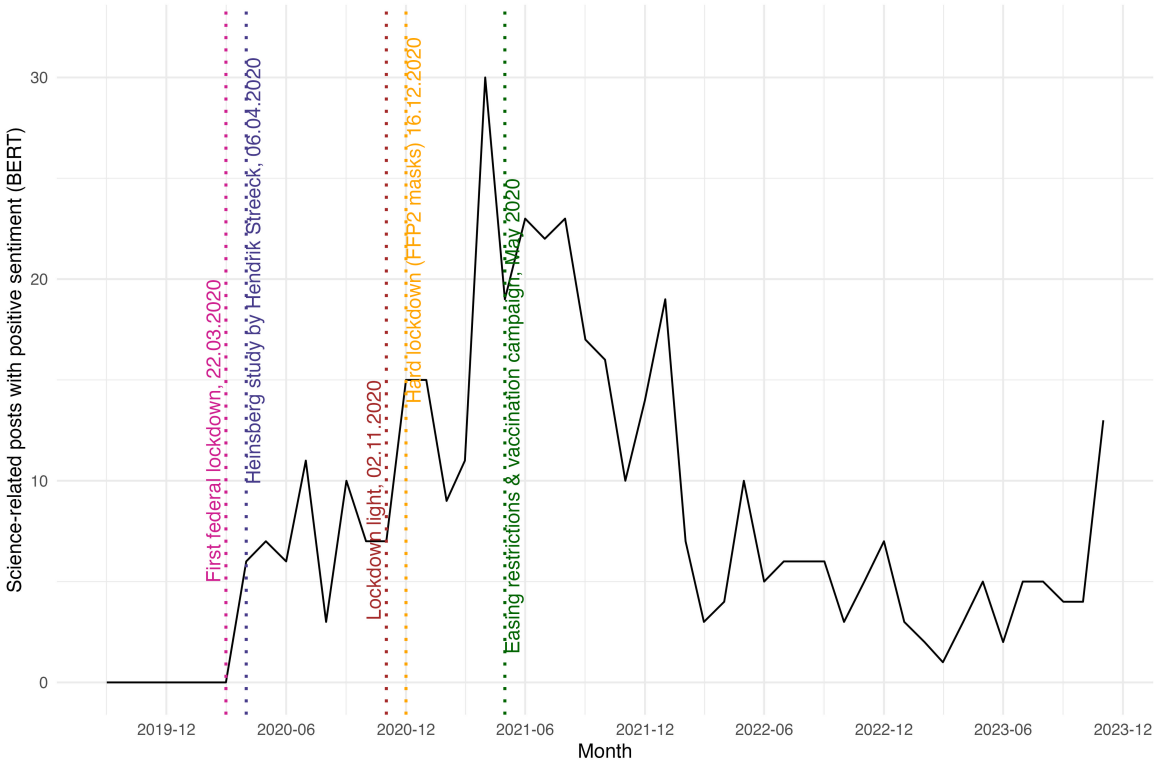

Figure 4. Temporal change in the number of science-related positive sentiment Telegram posts.

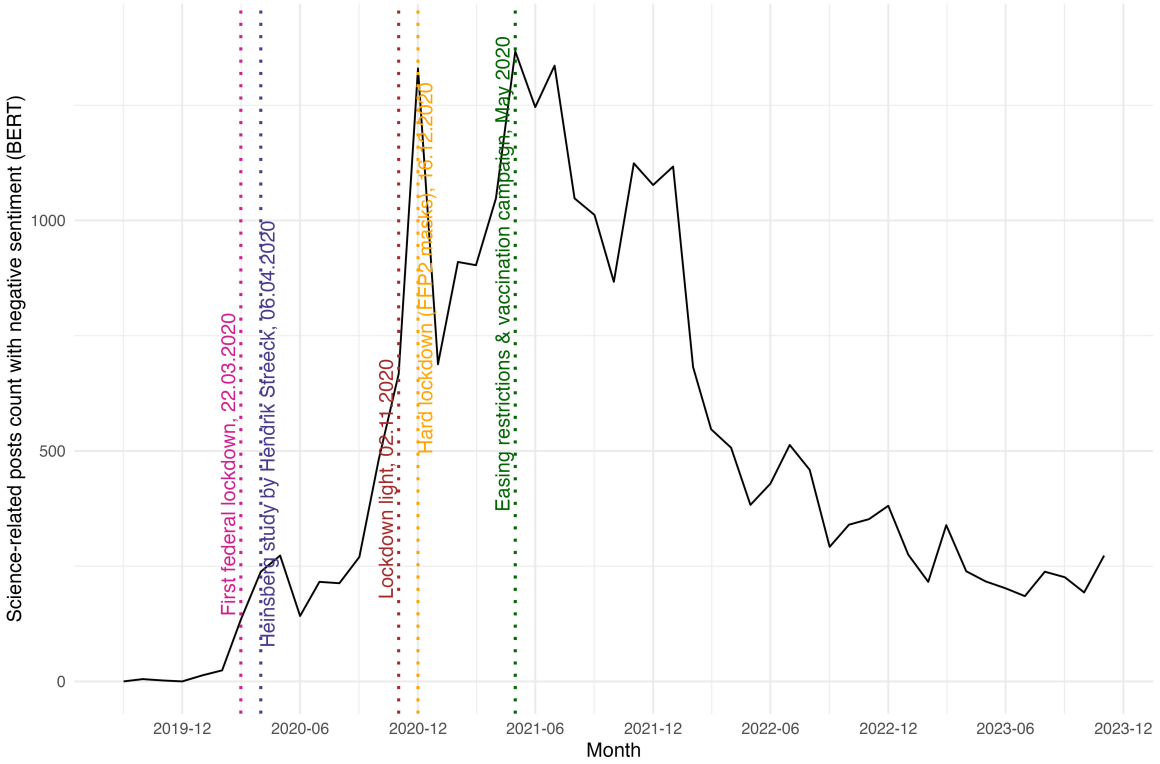

Figure 5. Temporal change in the sentiment (negative) towards science in the COVID-related Telegram messages.

Table 2. Negative binomial regression estimates for positive science-related sentiment posts.

Variable	*Estimate*	*Std. Error*	*t-value*	*p-value*
Intercept	-3.071	0.483	-6.35	0.000
Trend	0.010	0.002	3.99	0.001
$Trend^2$	-0.000009	0.000003	-3.12	0.002
$COVID\ Cases_{t-1}$	-0.000001	0.000002	-0.85	0.395
$COVID\ Death_{t-1}$	-0.00008	0.0002	-0.37	0.710
$Positive_{t-1}$	0.065	0.044	1.49	0.136

Note: clustered standard error by month-year; Augmented Dickey-Fuller test strongly rejects the null of a unit root, indicating that we deal with a stationary process.

associating factors of these posts once time trends were taken into account. Similarly, the coefficient on lagged positive-sentiment science posts had a positive coefficient but did not reach statistical significance, suggesting limited evidence of strong persistence or autocorrelation in posting activity.

Using robust standard errors clustered by month-year, we found that the positive association with time (*Trend*) and the negative quadratic term ($Trend^2$) were robust to potential within-month correlation patterns. These findings collectively indicate a gradual increase in positive science-related posts over time, with a slight slowing of the upward trend at later points in the observed period.

Next, we modelled daily negative-sentiment science posts (Table B6) with a negative binomial regression that includes linear (*Trend*) and quadratic ($Trend^2$) time terms, lagged COVID-19 cases and deaths, and the previous day's negative posts — mirroring the positive-post specification to handle overdispersion.

The results revealed a significantly positive linear trend and a negative quadratic term, indicating an upward trajectory in negative science posts that gradually decelerated over time. Moreover, lagged share for negative posts was positively and significantly associated with current negative science sentiment, suggesting some persistence from one day to the next. Meanwhile, lagged COVID-caused death numbers were positive and significant, indicating that increases in pandemic-related deaths predicted slightly higher levels of negative science posting. Conversely, lagged COVID-19 cases were not statistically associated with the number of negative science posts, once trends and other predictors were included.

The next step in this exploratory analysis is to present how mentions of scientists, academic institutions, and publications vary in the channels of corona-protesters. Figure 6 indicates that *references to scientists* grew steadily during the early stages of the COVID-19 pandemic, as evidenced by a rising trend from spring 2020 through late 2020. Mentions reached a local peak around the second wave of policy measures (e.g., the lockdown light and the adoption of FFP2 mask mandates) and remained relatively high in early 2021 when controversies surrounding vaccines were prominent. After the mid-2021 period, the overall volume of posts mentioning scientists substantially decreased, although occasional spikes (notably in mid-2022) reflected short-term surges in discourse. By late 2022 and into 2023, the number of daily posts referencing scientists appeared to stabilise at a lower level. This pattern suggests that attention to scientific expertise was highest during moments of heightened policy debate and uncertainty, subsequently declining as pandemic-related measures normalised.

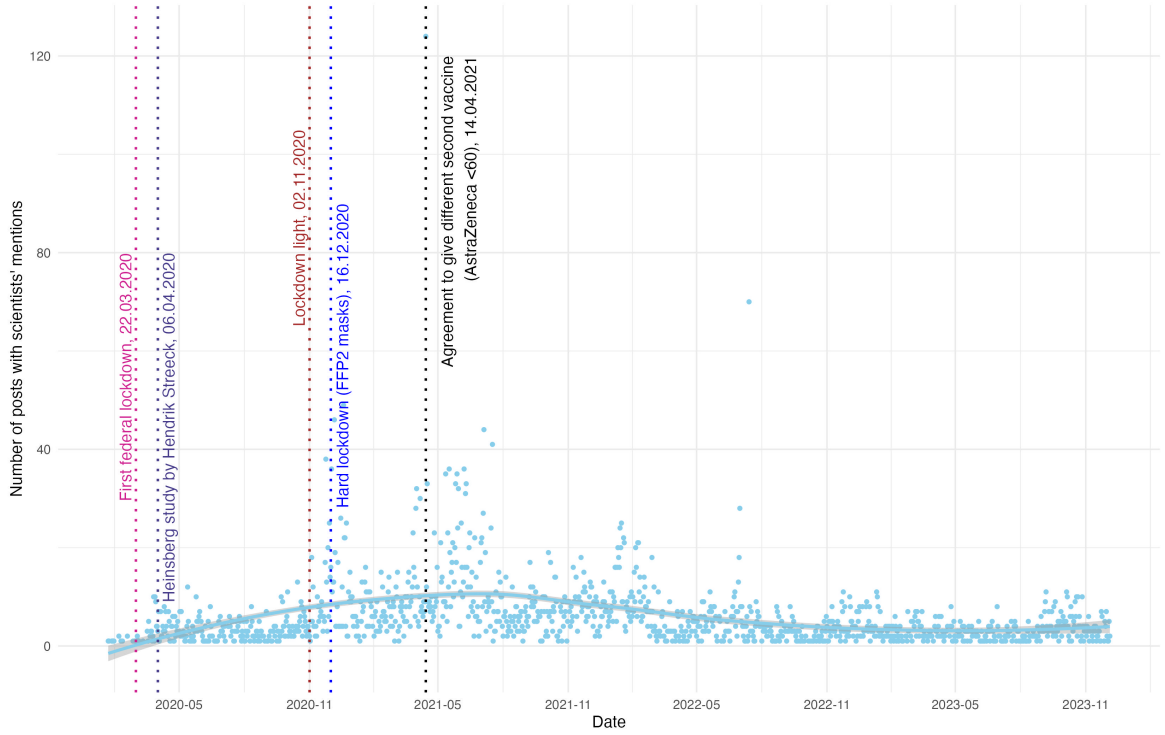

Figure 6. Daily distribution of Telegram posts mentioning scientists. Shaded regions denote LOESS (local polynomial) confidence intervals. N = 7,630 posts.

Figure 7 shows that neutral sentiment (orange) dominated mentions of scientists. Negative sentiment surpassed positive sentiment, indicating that public discourse was more critical or contentious than supportive. Figure 8 shows the density distributions of negative, neutral, and positive sentiment probabilities for Telegram posts referencing scientists. Most posts displayed very low probabilities of being negative or positive, suggesting that negative or strongly positive sentiment was relatively rare. In contrast, the neutral probabilities were strongly concentrated at the right end of the X-axis. Thus, a large fraction of such posts was classified as predominantly neutral.

Regarding *academic institutions*, the time series revealed that negative sentiment mentions (red) were consistently more frequent than positive ones (green) and tended to fluctuate in conjunction with major pandemic-related policy events (Figure 9). The local polynomial (loess) trend line for negative sentiment showed a rise through 2020 and early 2021, peaking around heightened policy debates (e.g., the light lockdown mode and mandatory FFP2 masks). Afterwards, there was a gradual, though not entirely smooth, downward trajectory in negative sentiment through 2022 and beyond. By contrast, positive sentiment mentions remained comparatively lower, with only modest increases over time and a more stable pattern overall. This difference between the negative and positive sentiment series suggested that within corona-protesters' communities, academic institutions were presented negatively more often than positively, potentially reflecting their scepticism or criticism tied to evolving pandemic policies, which were based on scientific expertise from academic institutions.

For academic publications, the neutral sentiment was dominant, peaking during key pandemic events such as lockdowns and vaccine-related decisions, while positive and

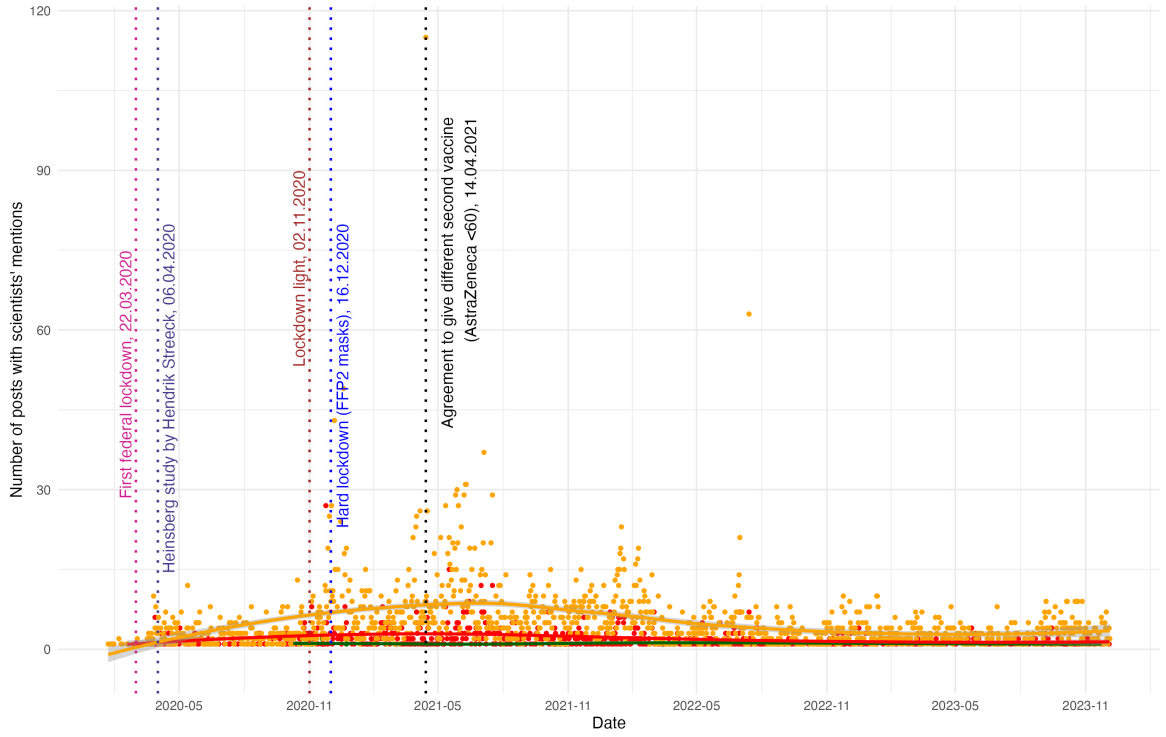

Figure 7. Daily sentiment distribution in Telegram posts mentioning scientists. Red = negative, green = positive, orange = neutral. Shaded areas show LOESS confidence intervals. N = 7,630 posts.

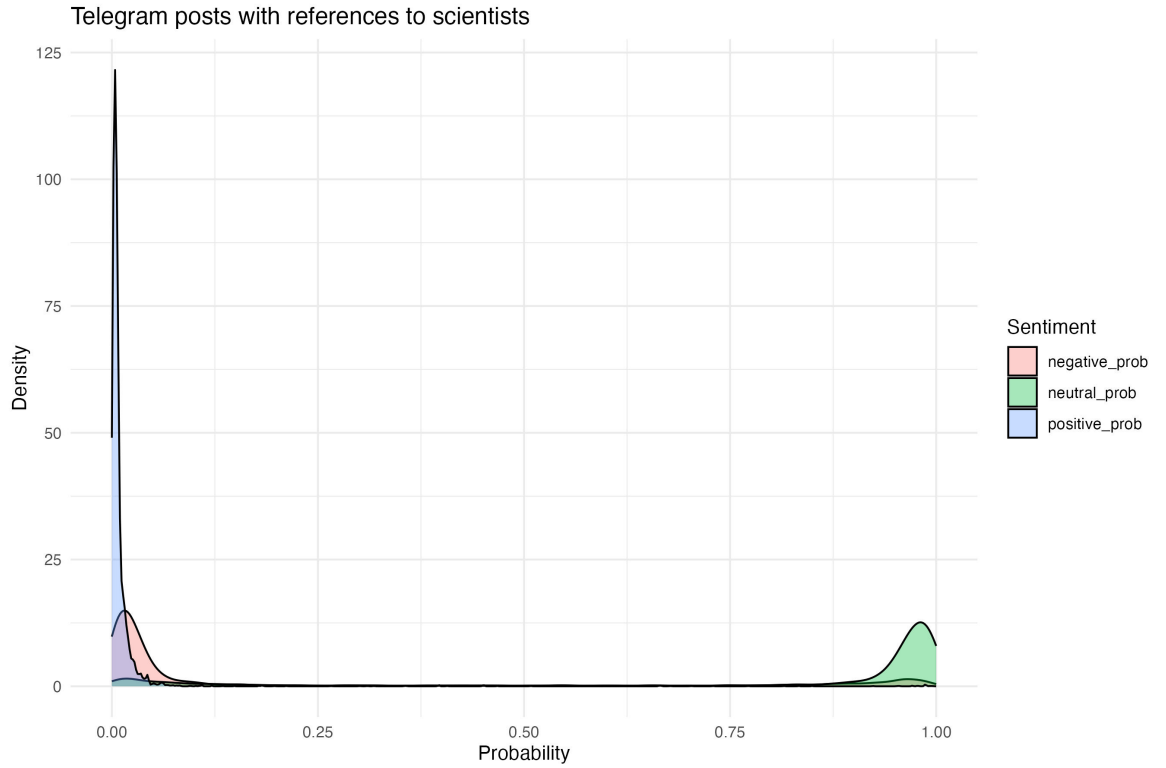

Figure 8. Density of sentiment probabilities (0–1) in Telegram posts mentioning scientists (y-axis: density). N = 7,630.

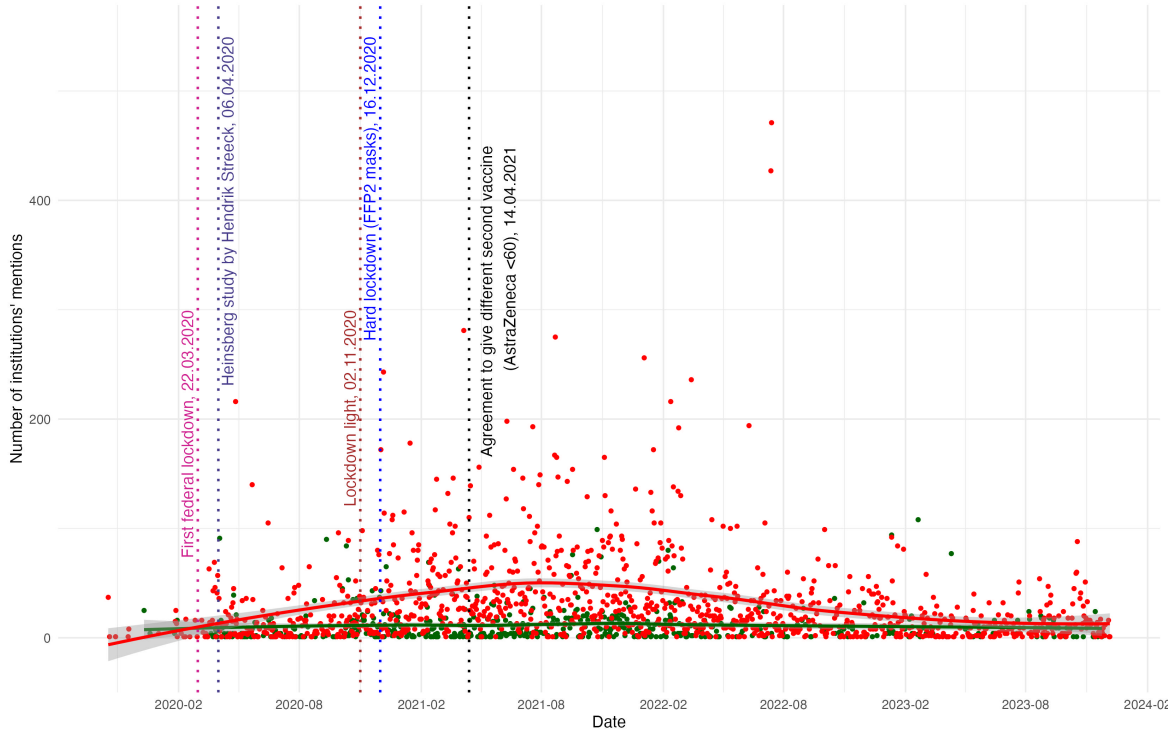

Figure 9. Daily distribution of sentences mentioning academic institutions by sentiment in Telegram posts. Red = negative, green = positive. Shaded areas show LOESS confidence intervals. N = 90,968 sentences.

negative sentiment remained comparatively lower (see Appendix Figures B2 and B3). Similar to the sentiment towards scientists (Figure 8), most posts referencing scientific web domains were neutral (see Appendix, Figure B4).

Examples of Telegram posts mentioning scientists, scientific publications, and academic institutions are presented in Appendix C.

6 ▪ Discussion and conclusions

6.1 ▪ *Summary*

Based on text data from Telegram communities, we examine how German corona-protesters use scientific evidence to navigate the societal uncertainty caused by the pandemic. Regarding RQ1, COVID-related discussions demonstrated significant temporal fluctuations that closely aligned with major policy interventions in Germany. Posts spiked during the March 2020 lockdown, rose again after the Heinsberg study in April, and climbed with each major restriction — "lockdown light" and the later hard lockdown with FFP2 mandates — before peaking in late 2020 and steadily tapering off. By late 2023, science-related postings had returned to a much lower baseline, reflecting the waning public engagement as the crisis receded. Multilevel regression models indicate that the production of science-focused content in corona-protest communities was modestly associated with increases in COVID-19 case counts. In contrast, death counts did not show a robust association. Topic modelling

results further clarify that science-related COVID-19 communication is tightly connected to the vaccination issue (but not limited to it), whereas broader corona-protest discourse relies on legal or moral frames. Theoretically, this underscores the usefulness of combining Scott's [1990] concept of *hidden transcripts* with communication-science models: selective expert citation becomes the mechanism through which protest groups speak to, yet undermine, the public transcript of state authority.

Regarding RQ2, the positive association between the progression of time and sentiment in messages containing science-related cues suggests that sentiment towards scientific information gradually improves over time. This trend indicates that there has been a notable shift towards a more favourable view of scientific information among corona-protesters as the pandemic has progressed. This result may suggest how these non-institutionalised groups attempt to instrumentalise science for their own purposes, either by highlighting the shortcomings of research from official institutions they distrust or by promoting the interpretations of actors with scientific credentials who share their critical stance toward government policies aimed at mitigating the pandemic's effects. Nevertheless, negative posts outnumbered positive ones.

Sentiment analysis reveals that Telegram posts about academic institutions were predominantly negative or neutral, with a notable increase during policy debates. Mentions of scientists remained largely neutral, exhibiting brief bursts of criticism or praise during the height of containment disputes. Academic publications likewise drew mostly neutral reactions, though a small but visible share were strongly negative.

6.2 ▪ *Implications*

Communication practices in German corona-protest Telegram channels illustrate the politicisation of science [Scheufele, 2014]. By citing and then scrutinising mainstream research and institutions, these actors engage with the dominant public transcript [Scott, 1990] while advancing an oppositional narrative. Consistent with research on motivated reasoning, such selective curation plausibly helps sustain messages aligned with followers' prior beliefs and may reinforce anti-establishment sentiments, both political and academic. Although we do not directly measure prior beliefs, the observed patterns are compatible with this mechanism. These dynamics can contribute to diminished trust in scientific and governmental authorities and greater polarisation of public opinion [Schulze et al., 2022].

Not all corona-protesters reject science outright [Berg, 2025]. Rather, they show selective scepticism toward government and mainstream scientific bodies, especially when official findings contradict their prior beliefs. Our data reveal that Telegram channels frequently cite studies or expert opinions that appear to support their stance, signalling a nuanced, though instrumental, engagement with science. They question institutions that are perceived as extensions of political or economic power. This pattern contrasts with segments of the U.S. far right, which have been characterised as consistently anti-scientific [Walter et al., 2023], yet it aligns with evidence that American anti-lockdown activists also appropriated data-driven narratives when it served their goals [Lee et al., 2021].

Our findings also align with research on politicisation and radicalisation during COVID-19, as well as how alt-tech and dark platforms sustain counterpublics. Across this ecology — from the conspiracy and wellness nexus [Demuru, 2022] to "dark platform" affordances [Dehghan

& Nagappa, 2022; Zeng & Schäfer, 2021] — Telegram functions as a backstage where official expertise is blended into counternarratives, consistent with our hidden transcripts lens. Moreover, COVID-19 news polarised and conspiracy beliefs predicted threat perceptions and susceptibility to misinformation [Hart et al., 2020; Allington et al., 2021; Calvillo et al., 2020], consistent with motivated reasoning and selective exposure. Together, politicisation and platform logics channel scientific content into oppositional backstage talk that intermittently leaks into the public transcript.

The study highlights an actionable agenda for science communication practitioners and scholars. Rather than waiting to rebut selectively quoted studies after they spread, communicators should lead with the uncertainties they know exist (e.g., the rare risks of vaccination) and explain how evidence is revised over time. Framing science as an iterative, ongoing process, rather than a final verdict, may help prevent cherry-picking. Tailoring messages to the specific concerns of anti-establishment audiences is equally important. Addressing fears in the language and value frames of those communities opens space for dialogue, reduces reflexive polarisation, and builds credibility. By combining early transparency (including open-science practices) with respectful engagement, science communicators can strengthen public trust and keep evidence-based reasoning at the centre of contentious policy debates.

6.3 ▪ *Limitations and future research*

We presented an aggregate assessment of science-related discourse in the universe of German corona-protesters without paying attention to their ideological division (far-right groups, conspiracists, anti-vaccination activists, etc.). While our current approach offers a broad overview, it also entails several limitations. First, by not differentiating between ideological groups, our analysis may obscure nuances in how specific political actors employ scientific discourse to advance their narratives. Second, our reliance on sentiment analysis as the primary metric for the text content may not fully capture the complexity and multifaceted nature of the language used, particularly in contexts involving sarcasm, coded language, or intricate rhetorical strategies [Sen et al., 2021].

Future research should address these limitations by incorporating more granular analyses that distinguish among ideological groups and by employing advanced natural language processing methods. The application of open-source large language models with sufficient computational capacity for reasonable inference time offers promising avenues for detecting more sophisticated linguistic features (e.g. nuanced argumentation, topic shifts, and semantic subtleties) beyond mere sentiment detection. Such methodological advancements could provide deeper insights into the ways in which science is instrumentalised within diverse political discourses, thereby enriching our understanding of political communication in protest movements.

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Data availability statement
R scripts, data, and appendix are available: https://osf.io/q4jad/.

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Supplementary material

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Appendix A. Identification of scientifically framed discussions about COVID-19
Appendix B. Sentiment change overtime
Appendix C. Examples of Telegram posts

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