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How Science Influencers Polarize Supportive and Skeptical Communities Around Politicized Science: A Cross-Platform and Over-Time Comparison

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ABSTRACT

Contention over COVID-19 is only a recent example of increasing social division around science in the U.S. Many blame these divisions on actors who have strategically sowed doubt and distrust around expert supported positions and policies. However, this overlooks how scientists have fueled narratives of social and political conflict around science. This study explores how science influencers on social media have used group identity language in ways that may perpetuate narratives of intergroup conflict around science. Using computer-assisted content analytic methods, we examine how science influencers' use of group identity language has changed in response to recent events (Trump presidency, COVID-19 pandemic) and across different social media platforms (Twitter, Facebook, Instagram). While there are slight increases in group identity language between 2016 and 2021, different patterns across platforms suggest that science influencers use different platforms to perform multiple roles of engaging diverse audiences, building ingroup solidarity, and defending against outgroup criticism.

KEYWORDS

Group identity; politicization of science; social media; influencers; computational social science; cross-platform

Introduction

Contention over COVID-19 is only a recent example of increasing politicization and social division around science in the U.S (Hart et al., 2020). There is concern that public consternation over issues like climate change, stem cells, and vaccination will inhibit the ability of the scientific community to respond to novel challenges and advise policy. Many have blamed public mistrust and social divisions around science on political actors for strategically sowing doubt and distrust around expert supported positions and policies (e.g., McCright & Dunlap, 2010). However, this overlooks how scientific experts have fueled narratives of social and political conflict around science (Motta, 2018). These divisive narratives are elevated on digital media in ways that further polarize science and policy issues (K. Chen et al., 2020).

Given that the internet is a dominant and growing source of science information (National Science Board, 2016), it is vital to attend to social media science influencers as

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sources who may build constructive relationships among diverse audiences or unintentionally amplify narratives of social division around science. Science influencers are often very popular actors on social media whose engaging content centers on science communication, but these actors' roles in polarization around science is neither clear nor well researched. On the one hand, science influencers may seek to be ambassadors of the scientific community by educating and building relationships with diverse audiences. On the other hand, science influencers may aim to build solidarity within their own community and defend against perceived attacks on scientists' credibility and resources from outside social groups. In their capacity as engaging educators of wide audiences, science influencers may avoid drawing lines between experts and other social groups in their social media content. When building solidarity, science influencers may reinforce narratives of social divisions to affirm in-group identity and build support for collective actions.

This computer-assisted content analysis investigates whether science influencers use group identity language their social media content in ways that may contribute to or attenuate political polarization and social divisions around science. We focus on two comparisons; first, we explore how the prevalence of group identity language by science influencers changed between 2016 and 2021. During this time, some members of the scientific community became increasingly concerned about perceived political threats to the scientific community (e.g., Druckman, 2017) in response to critical events that thrusted contentious science in the public limelight (e.g., the COVID-19 pandemic). Second, we investigate how social media platform affordances shape science influencers' use of group identity language by comparing content across three platforms where the public seeks and discusses politicized science: Twitter, Facebook, and Instagram. Here we investigate the role that platform architecture plays in amplifying or attenuating contentious social discourses. In doing so, this study examines social media science influencers as a possible source of social division around science which has, to date, been overlooked. It also sheds light on the importance of inclusive science communication, particularly during contentious times, so experts, publics, and elites can constructively address emergent and ongoing social challenges.

Background

While extensive scholarship in political communication have studied how politicians use digital platforms to strengthen connections with their constituencies (Howard, 2005) and to broadcast policy stances during political campaigns (Bossetta, 2018), much less is understood about why and how science influencers communicate information across social media. By science influencers, we refer to broadly to popular social media users with a range of occupations (e.g., scientists, media personalities, journalists) who communicate about scientific topics on social media platforms. While interested audiences have long sought science information on social media (Brossard & Scheufele, 2013), the recent COVID-19 pandemic has grown public attention in emergent scientific research and preprints (Fraser et al., 2021), shifting the landscape of science communication toward greater public engagement. Against this backdrop of the increasing dissemination of science knowledge on social media and the rise of "science influencers" across social media platforms, the role of these actors in amplifying or mitigating politicization of science is paramount to uncover.

Yet this raises a fundamental puzzle about the role of science influencers on social media: *do science influencers seek to educate diverse audiences with inclusive social media content or to build online communities with ingroup solidarity to defend against outgroup attacks?* While some scholars hope that digital platforms might allow scientists to take on roles as public intellectuals or communicators to educate broad audiences (Costa & Murphy, 2020; Dudo et al., 2016; Peters, 2013) in order to decrease group divisions, others have cautioned that social media might replicate and amplify offline inequalities around science knowledge and participation (K. Chen et al., 2021). In this way, science influencers might emphasize social divisions as they use social media to build ingroup solidarity and defend against skeptical communities.

In this paper, we use a social identity approach to theorize how this entangled motivation between public outreach and ingroup solidarity building might be embodied in the use of group identity language by the science influencers in digital content. We draw from recent theory on platform affordances and the nature of contentious digital landscape to explain how the use of group identity language in science communication is associated with platform affordances and critical social events.

Politicization of Science and Science Influencers

Concerns over public skepticism and politicization of science have been growing in the scientific community over the several decades (Druckman, 2017). Indeed, we have some evidence of social divides around science knowledge (Pew Research Center, 2018) and trust in science (Gauchat, 2012; NORC, 2021; Pew Research Center, 2019). Many blame these social divisions on strategic political actors exploiting inherent scientific uncertainties to sow doubt and distrust around expert supported positions and policies on issues like climate change over the last thirty years (McCright & Dunlap, 2010). More recently, there has been increased attention to the role social media influencers play in promoting scientific misinformation and mistrust. Analyses recently linked 65% of anti-vaccine misinformation on social media to accounts run by 12 influencers, deemed the "disinformation dozen" (CCDF, 2021). Other recent work has explored how networks of "alternative influencers" spread misinformation on YouTube (Lewis, 2018) and promote COVID-19 misinformation across multiple platforms (Hiaeshutter-Rice et al., 2021). In sum, there is a large and growing body of work investigating how strategic actors intentionally promote narratives of social divisions, spread misinformation, and amplify mistrust in science.

However, this body of work frequently overlooks the ways in which scientific experts have at times fueled narratives of social and political conflict around science in the U.S. For example, efforts to mobilize support for scientists and scientific research (e.g., the March for Science) backfired by increasing perceptions of conflict between scientists and other social groups (Motta, 2018). In line with this, messages by science influencers emphasizing social group conflicts between the scientific community may also have unintended polarizing effects (e.g., "Show me a Nation with a science-hostile government, and I'll show you a society with failing health, wealth, & security." in deGrasse Tyson, 2017). It is important to investigate whether science influencers amplify messages of political contention around science as they often have large followings of interested audiences on social media, where people are increasingly seeking science information (Pew Research Center, 2017; Southwell & White, 2022). As influential messengers and

opinion leaders on scientific topics, science influencers may play a role in shaping both public knowledge about science and public perceptions about the role of scientific experts and institutions in society and politics. When science influencers use language defining social ingroups and outgroups, they may inadvertently amplify narratives of social and political divisions around science.

Use of Group Identity Language in Contentious Times

Social identity theory provides a useful framework to theorize how people use group identity languages in digital spaces when discussing contentious topics. Social identity theory points out the tendency for individuals to view themselves and others as members of social groups or categories (Tajfel & Turner, 1979). People are motivated to make positive contrasts between ingroups they identify as a part of and distinctive outgroups from whom they see themselves as separate. That is, individuals sort themselves and others into salient social groups and they often view members of their own ingroups more positively than members of social outgroups.

Different social categories become salient at different times, often in response to perceived threats or criticism from outgroup members. Criticism of the ingroup by outgroup members can spark defensive reactions in which individuals derogate the outgroup while affirming and celebrating the ingroup identity (Hornsey & Imani, 2004; Hornsey et al., 2002; Klein et al., 2007; Reicher & Levine, 1994). Threatened ingroups may also seek to affirm identities by persuading others of their views and positive image of their group (Klein et al., 2007; S. Chen et al., 2004). These behaviors may be particularly true of ingroup members who perceive that an audience is watching their performance of a social identity whose status is insecure in the present context (Klein et al., 2007). In a climate of increasing apprehension about the status and role of scientific expertise in public life (e.g., President Trump's selection of a climate denier to lead the EPA, public hostility toward COVID-19 social distancing recommendations), science influencers may have been motivated to affirm science-related group identities and persuade the public of a positive image of scientists by making positive contrasts with other social groups (Tajfel & Turner, 1979).

One way they might have done so is with increased use of ingroup and outgroup language to define social group boundaries. Use of in and outgroup pronouns is one way of evoking ingroup solidarity and identifying outgroups who are implied to be inferior (Li & Su, 2020). Group pronouns such as "we," "our," "they," and "their" signify group membership and create boundaries between different social groups (Íñigo-Mora, 2004). By implying different levels of distance between the speaker and others, these group pronouns indicate group membership, represent power struggles between groups, and convey information about which groups are good or bad (Pennycook, 1994; Chilton, 2017; Íñigo-Mora, 2004). Indeed, prior research has noted that in contentious contexts, the use of these group pronouns increases. Li and Su (2020) found increasing frequency of ingroup and outgroup pronouns in Twitter discussions mentioning "fake news" between 2016 and 2018 and that the two defined groups (conservative vs liberal) formed a close retweet network that circulated ingroup languages. In sum, people use ingroup pronouns to affirm group identity and solidarity while using outgroup pronouns to represent distance with other, inferior, social groups (Klein et al., 2007), and use of intergroup language may increase as group identities become more salient in contentious contexts.

Many in the scientific community have expressed increasing concerns about public divisions over the role that scientific knowledge and expertise should play in society and policy making. There are increasing partisan divisions surrounding trust in science (Gauchat, 2012), with conservatives reporting less trust in science than liberals, though in general trust in science remains high (Pew Research Center, 2020). In the context of increasing social sorting along partisan lines (Mason, 2016), the association of science with one party over another may limit the ability of experts to advise on and participate in policy making (Sarewitz, 2009). Members of the scientific community have warned about the declining authority of science, particularly in response to actions by the Trump administration and public response to the COVID-19 pandemic (Tollefson, 2020).

In sum, the social divisions about perceptions of experts and the role that scientists should play in policy making have become increasingly salient in recent years, and for this reason we may expect science influencers to increasingly use group identity language. As members of the scientific community responding to increasing scrutiny from outgroups, they may have been motivated to reaffirm positive self-concept of the scientific community by delineating ingroups from outgroups with positive comparisons in their digital content. Yet because science influencers play public roles in communicating science, engaging audiences, and as visible opinion leaders in within and without the community, increased use of group identity language may have amplified narratives of social divisions around science in unhelpful ways. We therefore make the following hypothesis concerning the prevalence of intergroup language.

H1: The frequency with which science influencers used ingroup and outgroup pronouns in social media content increased between 2016 and 2022.

Social Media Platforms and Group Identity Language

Effective social media influencers tailor content to platforms to maximize engagement. This tailoring is influenced by the technical features and user affordances of each platform, which shape influencers' perceptions of their audience and reach. Together, the features and affordances of platforms affect two important characteristics by which we can define and compare media platforms: audience and channel (Hiaeshutter-Rice et al., 2021).

A platform's *audience* can range across a spectrum from broad to narrow, referring to the degree of heterogeneity of its audience (or users). Television is a relatively broad audience platform both because of the nature of a television broadcast reaching anyone with a set but also because there are very limited ways for content producers to limit who could see their content. Conversely, while Instagram may have a huge volume of heterogenous users, its audience is considered narrow because users exposed to an influencer's content are typically followers of the influencer or their content's hashtags. Note here that we are discussing both the technical features of the platforms (broadcasting, followers, and hashtags) but also the nature of how content creators view their audience and the purpose of the platform.

In addition, a platform can be defined by its *channel*, which refers to the degree of competition or independence that an influencer's message may expect. Traditional platforms like television and newspapers are relatively more independent channel

platforms than social media platforms, as audiences have very limited opportunities to interrupt or contradict the message (e.g., calling into a radio program). In contrast, other platforms allow for a high degree of visible engagement, such as Twitter. User norms reflect this, as well. Publicly engaging with followers and other users is a common practice and is frequently done with people on different sides of an issue or campaign (e.g., Hillary Clinton tweeting at Donald Trump to "delete your account" or the frequent back and forth conversations between Elon Musk and various public figures after his purchase of Twitter). However, just as with audiences, channel is not a binary but should be thought of as a continuum. While the structures of Twitter allow for a great deal of engagement, in contrast, Instagram is a relatively more independent channel (though less so than others like television). The technical structures of Instagram do not allow for users to directly share another user's content to their own account, for instance.[1]

For the purposes of this study, we view Twitter, Facebook, and Instagram as all some degree of narrow-audience platforms (most of a user's audience are their followers). Of course there are interesting differences in audiences that can be investigated, but we are primarily concerned with the varying levels of channel competition and independence among them. Twitter has a very competitive channel, Facebook less so, and Instagram has the most independent channel of the platforms under investigation.

Defining platforms by their audience and channel allows us to make hypotheses about the likely content and effects of existing and future communications platforms. For example, "alternative" influencers who spread misinformation systematically post more divisive and conflictual content on platforms with more competitive channels (Twitter, Facebook) than those with more independent channels (e.g., YouTube) (Hiaeshutter-Rice et al., 2021). On competitive channel platforms, in which counter-messages and messengers may be more visible, science influencers may be more likely to use group identity language to address anticipated and real-time criticism from others. Science influencers may feel a need to address different groups and delineate group boundaries in spaces where messages from outgroups may be more visible on one's own content (Hornsey & Imani, 2004; Hornsey et al., 2002; Klein et al., 2007; Reicher & Levine, 1994). However, it may also be the case that science influencers strategically seek to avoid perpetuating divisive and potentially inflammatory content on competitive channel platforms, using little outgroup language to maintain an inclusive messaging style. Independent channel platforms may also present opportunities to affirm ingroup identities in spaces that influencers may anticipate less conflict (Klein et al., 2007; Reicher et al., 1998). This mirrors similar findings in the political campaign context that found that content on broad audience and noncompetitive platforms tends to be far more negative in tone than others. (Hiaeshutter-Rice, 2020). These findings suggest that platform structure matters and that there are testable and predictable differences in content based on these structures.

While all platforms under investigation are defined as narrow-audience platforms, the degree of competition in the platform's channel may affect science influencers' use of ingroup and outgroup language. Given extant research about divisive messages in competitive channel platforms, we expect that science influencers may use more group identity language on Twitter and Facebook than Instagram. However, we also expect that science influencers may use group identity language on more narrow platforms where they are likely to engage in identity-affirming behaviors. Therefore, we ask a research question

concerning on which platform in- and out-group pronouns appear most frequently in science influencers' content.

RQ1: Do ingroup and outgroup pronouns appear more frequently in science influencers' content on competitive channel (Twitter, Facebook) or independent channel platforms (Instagram)?

The degree of competition in the platform's channel may further influence the sentiment of science influencers' posts using ingroup and outgroup pronouns, which reflect positive contrasts made between in and outgroup members. On one hand, science influencers may make stronger contrasts on more competitive channel platforms when they cheerlead ingroup identities and defend against outgroup criticism, resulting in greater difference ingroup and outgroup sentiment competitive channel versus independent channel platforms. This hypothesis is supported by evidence that influencers use more emotional narratives to capture audience attention on digital platforms where they need to compete for clicks (Kim & Chen, 2022). On the other hand, as some scholars argued, scientists might take on roles as ambassadors who educate and engage with diverse audiences on competitive digital platforms like Twitter (Costa & Murphy, 2020; Dudo et al., 2016; Peters, 2013). This might motivate them to avoid contrasting social ingroups on more competitive and interactive platforms, perhaps reserving these contrasts for more independent channel platforms on which their message may face less criticism and interruption. Indeed, when ingroup members are known to one another in communication channels, they are more likely to affirm and empower ingroup identities and norms (Klein et al., 2007; Reicher et al., 1998), and as such independent-channel platforms (e.g., Instagram) may present an opportunity for science influencers to affirm and celebrate positive group identity. To uncover the sentiment associated with ingroup and outgroup posts in science influencers' content across platforms, we raised our second research question:

RQ2: How does sentiment associated with ingroup and outgroup pronouns in science influencers' content differ between competitive channel (Twitter, Facebook) or independent channel platforms (Instagram)?

Engagement with Group Identity Language

The prevalence of group identity language is important to investigate because digital discourses using group identity language receive more social media engagement. This engagement is explained by the economic model of social media, which conceptualizes attention is a scarce and competitive resource (Webster, 2014). When a social media post clearly supports or opposes a particular group, that clarity of group alignment attracts greater attention, reposts, and discussions. This is because individuals tend to engage more with identity narratives to build solidarity and defend themselves against other communities (Kahan, 2017). For instance, in a study of posts by U.S. conservative and liberal news media on Facebook and Twitter, posts using hostile language toward outgroups received

more shares and angry reactions (Rathje et al., 2021). As a result, the voices of moderates and nonpartisans are often drowned out, receiving far less attention than strong partisan discourse (Bail, 2021). In the context of science communication, the use of ingroup and outgroup identity language in posts about science attitudes boosted digital votes and shares (K. Chen et al., 2022). In sum, issues are often presented in polarizing ways to attract attention on social media and there is a strong body of evidence showing that group identity language in posts, especially outgroup hostility, leads to more attention and engagement online. Driven by this evidence, we propose our second hypothesis to examine this relationship in science influencers' social media posts.

H2: Use of ingroup and outgroup pronouns will be positively associated with social media engagement metrics (reactions, shares, comments) in science influencers' social media content.

Methods

Data

There is no universally agreed-upon strategy for identifying what constitutes an "influencer," nor was this a conceptualization the authors wanted to make arbitrarily. We aimed to identify a broad range of popular social media profiles who post about diverse scientific topics on different platforms, and so searched online for science influencers identified by a range of academic and popular media sources to best reflect a contemporary definition of science influencers, rather than selecting accounts by domain, occupation, or following. In this way, we aimed to collect data from influential accounts whose focus was science communication, rather than popular accounts that occasionally posted about scientific topics. Some science influencers have been identified by previous research due to their large followings on social media (Pew Research Center, 2018). However, other sources with interest in science and medicine on social media have also identified science influencers and publicized them online where interested parties may encounter them. We therefore added to our list of influencers by drawing on four lists of "top" science influencers to follow on social media from publications like Science Magazine and Business Insider (Beall & Bradley, 2017; MacArthur, 2021; Stanger & Robinson, 2014; You, 2014). We also included science and medical influencers interviewed in two journalistic articles (Ellis, 2019; Ohlheiser, 2020). Finally, we included science and medical influencers recognized in two marketing sources listing top influencers (Bushak, 2022; IZEA, 2020). These online articles and research reports identifying influencers were all published between 2014 and 2022 (see Table S1 in Supplemental Information for further information). To be included in our dataset, influencers mentioned in these sources needed to be based in the United States (to the best of our knowledge), have identifiable accounts (no anonymous influencers), and have an account on at least one of the platforms under investigation that represents their own views (not an organization, company, or group account). During the identification process, we only included science influencers who met these criteria.

This resulting list included a diverse group of science influencers. Some were popular and reputable (e.g., Bill Nye, Neil DeGrasse Tyson) while others have sometimes been known to spread inaccurate health claims (e.g., Dr. Oz; Stecula et al., 2022) or intolerant views (e.g., Sam Harris; Lewis, 2018). Some influencers were practicing scientists or astronauts (e.g., Katie Mack, Erik Klemetti), or medical professionals (e.g., Dr. Austin Chiang). Others worked in science communication as photographers (e.g., Cory Richards), science journalists (e.g., Alan Boyle), and media creators (e.g., Hank Green). We chose to retain all influencers identified by this strategy rather than making ad hoc evaluations of the quality of their messages as a basis for inclusion.

This identification strategy yielded 108 science influencers. From this list, 3 Instagram accounts, 10 Facebook pages, and 6 Twitter accounts were unavailable for data collection (common reasons were that the account was not public, or it had been deactivated or suspended). Finally, we collected data from 64 Instagram accounts, 47 Facebook pages, and 99 Twitter accounts (see Table 1, as well as Table S2 in Supplemental Information for full list of influencers).

Instagram and Facebook posts were collected via CrowdTangle, an API owned by Meta which claims to allow researchers access to all public historical data for Facebook pages, groups, and Instagram accounts. Content which has been removed or made private is not available through CrowdTangle. We downloaded all publicly available posts from science influencers' Facebook pages and Instagram accounts between January 2016 and early April 2022. The downloaded data included the text of the post, date the post was made, post URL, unique post ID, and engagement metrics such as number of followers at time of

Table 1. Data Description.

Platform	Date Range	Number of Accounts/Pages	Total Number of Posts Collected
Twitter	January 1, 2017 – March 31, 2022	99	1,852,914
Facebook	April 13, 2017 – April 12, 2022	47	79,437
Instagram	April 9, 2017 – April 8, 2022	64	43,472

Table 2. Group identity language use and social media engagement: results from negative binomial regression.

	Instagram	Facebook	Twitter
(Intercept)	4.3146***	2.7169***	0.6200***
	(0.1657)	(0.0805)	(0.0239)
In Group	0.0706***	−0.0296**	0.1393***
	(0.0083)	(0.0092)	(0.0041)
Out Group	0.1087***	0.2443***	0.3251***
	(0.0119)	(0.0152)	(0.0078)
Sentiment	0.0004	0.0076***	−0.0004***
	(0.0005)	(0.0004)	(0.0001)
Platform control (included)			
User-level control (included)			
Num.Obs.	42765	76304	1832172
AIC	681872.9	990264.8	10744395.4
BIC	682462.0	990736.2	10745662.3
Log.Lik.	−340868.453	−495081.411	−5372095.691
F	4572.508		
RMSE	1.05	1.08	0.96

posting and the number of reactions, shares, and comments, as well as other metrics not used here.

Twitter data from the same time-period was collected via the Twitter Academic Researcher API. This service allows for a similar data collection as CrowdTangle, that is full public post history (excluding deleted content) from the time the account was established. Data for each post includes the date and time it was posted, the text of the post, any relevant links, hashtags, or user tags, and engagement data (retweets, likes, number of comments). Data was collected from January 2017 through March 2022. The Twitter dataset is significantly larger than the other corpora are. This is because a) the Twitter dataset contains more users, b) users tweet more than they post on Facebook and Instagram, and c) the Twitter data includes retweets (~700,000 tweets are retweets).

As a final check before we move into the analyses, we looked at the degree to which content was cross-posted between the platforms. This is an important step to evaluate the degree to which we are looking at data driven by the structures of the platform and not cross-contamination. We did so by looking at the URLs in each post. If there is a great deal of cross-platform posting, we should see high levels of Twitter and Instagram links in Facebook content (for example). This is a blunt approach that will overstate the effect. An influencer linking to a Twitter thread they were not involved in on their Facebook is not the same as them sharing their own Twitter content. Instead of a lot of cross-posing, we find the opposite. There is very little cross-platform linking going on, with only 481 Facebook posts linked to Twitter and 22 linked to Instagram and of Twitter's 1,832,216 posts, 861 linked to Facebook and 4,566 linked to Instagram. There was no cross posting on Instagram.

Analytical Approach

To identify the prevalence of group identity language and the sentiment of posts, we employed computer-assisted dictionary methods, which search the posts for a list of provided keywords. We used the keywords previously employed by Li and Su (2020) to identify group identity language ("we," "our," "they," and "their") and the Lexicoder Sentiment Dictionary (LSD; Young & Soroka, 2012) to measure the positive or negative sentiment in posts. For sentiment, we counted the number of positive words (such as love or heartwarming) and subtracted number of negative words (such as destroy or broke), divided that by the total number of words in the post, the multiplied by 100. This number is the tone of each post. A high positive post would be something like: "These are the best vegan breakfast bars packed with quinoa and sweet potato that make them naturally gluten free and healthy for kids!" from Facebook whereas a negative post might look like: "What a sad week for planet Earth! The Amazon rainforest (the lung of our planet) is burning at a record rate!" There are a variety of different ways to measure sentiment, of course. Supervised machine learning methods have shown great promise in this area (Van Atteveldt et al., 2021). However, as what we are interested in aggregated tone, our argument is that a dictionary shows similar results to human coders (e.g., Dun et al., 2021), thus the LSD is an appropriate tool to use here as it has been often in the past on similar corpora (Hiaeshutter-Rice & Hawkins, 2022; Sabel & Cin, 2016; Soroka et al., 2018). To provide additional context about the actors, organizations, and groups associated with ingroup and outgroup language, we used the Name Entity Recognition method from Natural Language Processing with Python (spaCy package) which allows us to identify the major entities in

each of our posts that use identity pronouns (n = 3,524,398), including person, organization, and the nationality groups. Finally, we used negative binomial regressions to examine how group identity language was associated with engagement with science influencers' social media posts (Table 2).

Results

How Science Influencers Use Group Pronouns Across Platforms and Over Time

Following Li and Su's (2020) methodology, we identified the prevalence of group pronouns between 2016 and 2022 (H1) and across different platforms (RQ1) in science influencers' posts. Each panel in Figure 1 presents the proportion of posts that used each pronoun ("we," "our," "they," and "their"). The x-axis represents the time span from January 1st 2017 to April 30th 2022. Each line in the panel represents a platform.

We found that, in general, science influencers slightly increased their use of outgroup language over time across all platforms. There were no significant changes in usage of "we"

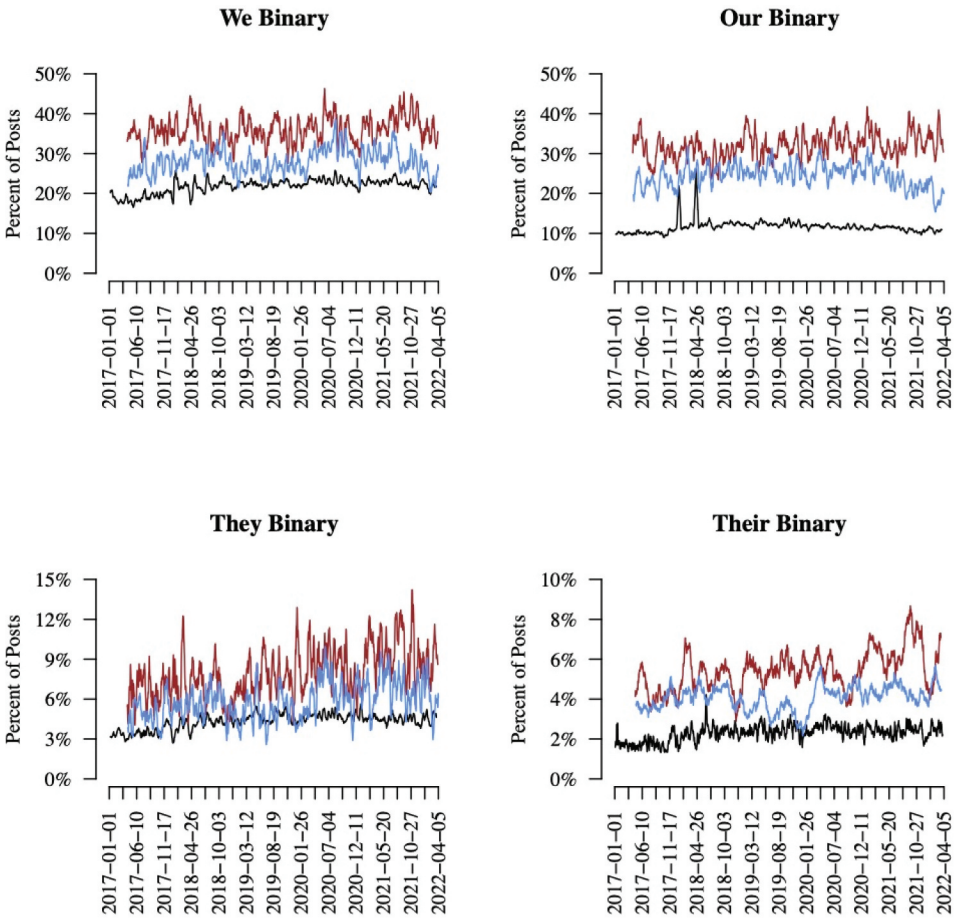

Figure 1. Group Affective Pronoun Use by Platforms and over Time (2016–2020). *Note.* red represents Instagram, blue represents Facebook, black represents Twitter

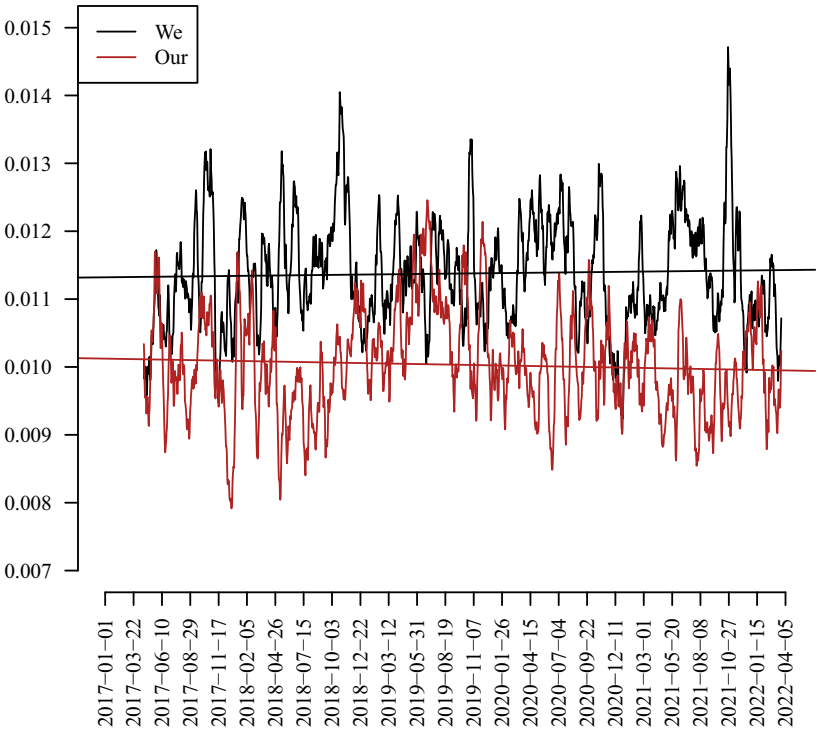

Figure 2. Prevalence of Ingroup Pronoun Use over Time.

and a slight negative relationship between time and the usage of "our." We show these findings in Figures 2 and 3 below. In addition to the mean usage of each group language word, these figures also show the prediction line of their usage by date.

We see some evidence of increased use of group pronouns around critical events, particularly outgroup pronouns ("they," "their") starting in early 2020 when the COVID outbreak started, and in September 2021 during the withdrawal from Afghanistan. This pattern of how science influencers use group pronouns over time to rally supportive and skeptical communities during critical moments echoes with existing literature that highlights how activists and opinion leaders seize these critical social and global movements to influence public opinions (Hussain & Howard, 2013; K. Chen et al., 2022).

Looking at the cross-platform comparison for group pronoun frequency (RQ1), we found that science influencers used an overall much higher proportion of ingroup as well as outgroup pronouns on more independent channel platforms (Instagram) than competitive channel platforms (Twitter). In particular, on Instagram there was greater use of group affirming language (i.e., "we," "our") by these science influencers than on other platforms. On Facebook, we observe an interesting pattern in which use of outgroup pronouns has increased over time, particularly since early 2020. Yet we see declines in the frequency of ingroup pronouns by science influencers on Facebook in the same time period. In general, the frequency of group all group pronouns is less on Facebook than on Instagram. Finally, concerning the most competitive channel platform under investigation (Twitter), we observed that the frequency of group pronouns is lowest in proportion.

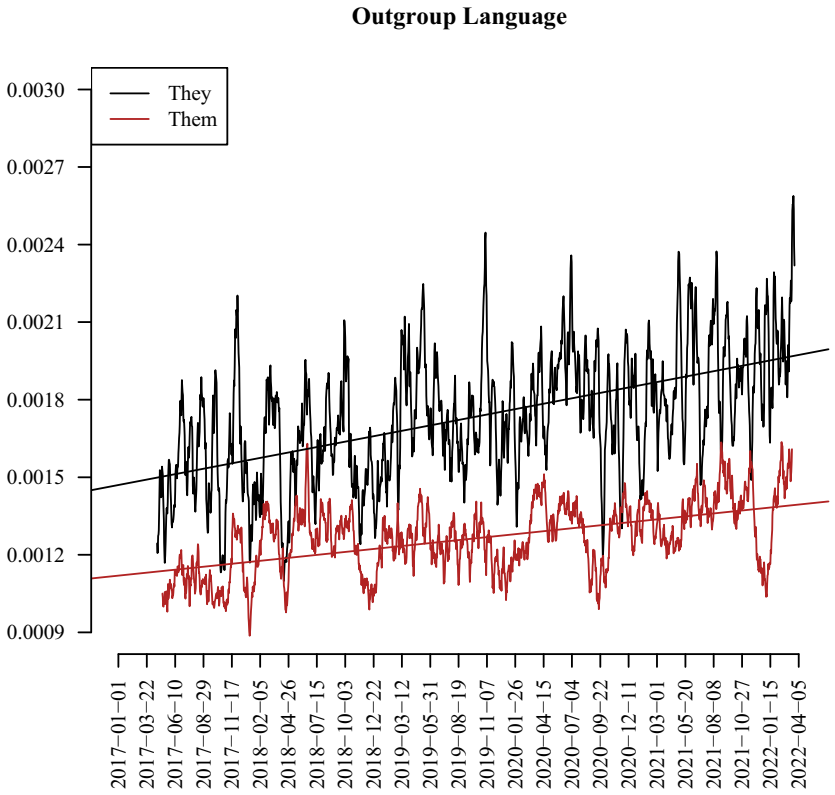

Figure 3. Prevalence of Outgroup Pronoun Use over Time.

To provide further context, we identified actors, organizations, and nationality groups associated with the use of ingroup and outgroup identity language in science influencers' posts over time and across platforms (for details, see Table S3 and S4 in Supplemental Information). In doing so, we observed differences in who ingroups and outgroups pronouns referred to between platforms. On Twitter and Facebook, political actors and organizations, as well as countries that compete politically with the U.S., were most frequently associated with and ingroup and outgroup language (e.g., Boris Johnson, Putin, Trump, GOP, Supreme Court, Russian, Republican). In contrast, the entities associated with ingroup language on Instagram were less about politics (e.g., NASA, Harvard). For instance, below are two examples, with the first used ingroup language and the second used outgroup language. Concerning over-time comparisons across the three platforms from 2017 to 2022, the most frequent entities mentioned alongside ingroup and outgroup language were largely political. While mentions of some political entities were common across the time period (e.g., the Republican party), other actors and nationalities became more common in response to contemporary events (e.g., frequent mentions of Chinese in 2020, Ukrainian in 2022).

Sentiment Surrounding Group Identity Pronouns Across Platforms

To examine the tone associated with these pronouns, we categorized social media posts by whether they mentioned ingroup pronouns only ("we," "our") or outgroup

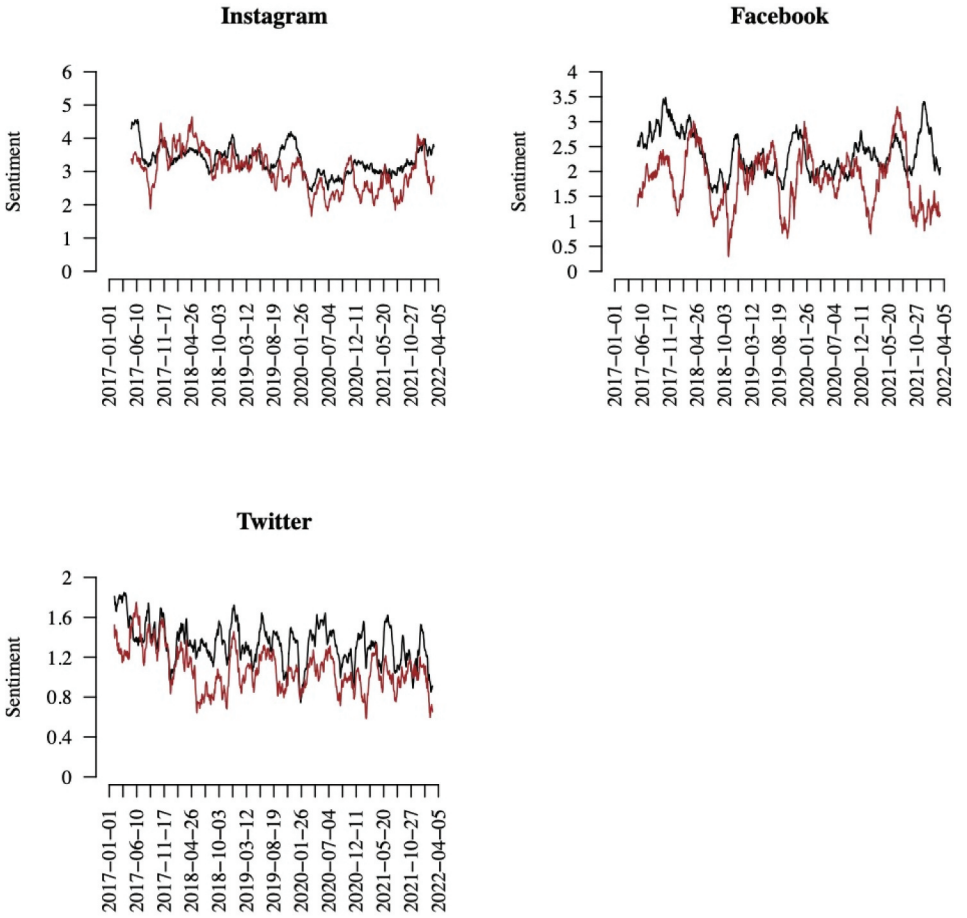

Figure 4. Sentiment used in the in-group vs out-group posts comparing the three platforms. *Note:* the black lines represent the average sentiment used in those posts that contain in-group pronouns; the red lines represent those posts that contain outgroup pronouns; means are smoothed over a 60-day window for readability.

pronouns only ("they," "their"). We then used the Lexicoder Sentiment Dictionary (LSD; Young & Soroka, 2012) to measure the positive or negative sentiment in posts and make comparisons between the tone of posts using ingroup and outgroup pronouns across platforms (RQ2).

Comparing the tones used in the in-group and out-group posts across the three platforms, we found that for Instagram, the difference in the tones of ingroup posts and outgroup posts is 3.316 vs. 2.989 (Figure 4, left panel). For Facebook, the difference is 2.298 vs. 1.755 (Figure 4, right panel). For Twitter, the difference is 1.338 vs. 1.067 (Figure 4, bottom panel). This suggests that for competitive channel platforms such as Twitter and Facebook, there is a much larger difference in sentiment when science influencers used in-group and out-group pronouns to rally skeptical vs. the supportive communities.

Group Identity Language and Social Media Engagement

Finally, we present the results of negative binomial regressions examining how group identity language was associated with engagement with science influencers' social media posts (H2). In these analyses, we compare engagement with posts using in-group language ("we," "our") vs. not using in-group language, using out-group language only ("they," "their") vs. not using out-group language. While not shown in the results for the sake of readability, the models do include controls for both the platform (through separation into three models) and the user. Our findings overall support H2. Use of out-group pronouns is associated with more engagement across all the three platforms. Use of ingroup pronouns is associated with more engagement on Twitter and Instagram, but the effect size is notably less than outgroup pronouns.

Discussion

This study investigates how influential science communicators may have amplified narratives of politicization and social conflict around science in the past five years by referring to social ingroups and outgroups in their social media content. We find some evidence of increasing use of group identity language in science influencer content over time, and in particular around the beginning of the COVID-19 pandemic in early 2020 (H1). This burst of group pronouns by the science influencers suggests that as scientific knowledge and expertise came under intense public scrutiny and scientific evidence became more uncertain (Merrifield, 2021; Scheufele et al., 2021), science influencers chose to use social identity language to rally their ingroup community members as well as to speak to outgroup members to discuss this highly controversial and politicized science issue.

We found that intergroup language is consistently political over time, where science influencers often refer to politicians, country actors, and political organizations when they communicate (science) contents. While much literature that studies social identity and public engagement on social media has examined the use of group language on a single platform, our paper takes a step further to investigate the cross-platform nuance that drives how science influencers deploy identity languages (RQ1). Our findings revealed a pattern of greater use of group pronouns by science influencers on more independent channel platforms (Instagram) than more competitive channel platforms (Twitter). In particular, these science influencers used a much larger proportion of ingroup pronouns on Instagram compared to Facebook and Twitter. As competitive platforms such as Twitter have been infused with politicized science messages (Hiaeshutter-Rice et al., 2021; Hiaeshutter-Rice, 2020), our finding suggests that science influencers may choose to avoid language reflecting intergroup conflict on these already politicized platforms. Instead, they chose to rally around supporters on more independent and narrow audience platforms such as Instagram. In contrast to the majority of research which finds evidence of polarizing discourses and social conflict on Twitter and Facebook (Li & Su, 2020; Rathje et al., 2021), this cross-platform comparison allows us to uncover that Instagram may be a space with stronger social identity discourses, as suggested by the small but growing number of recent studies that underline the contentious nature of group dynamics in science issues on visual-intensive platforms (Kim & Chen, 2022; Molder et al., 2021).

When we break down who these ingroup and outgroup are, we found political actors and organizations, as well as country actors as the major entities on the competitive channel platforms (Facebook and Twitter) than the independent channel platform (Instagram). This suggests that when science influencers tended to frame identities politically on channels where content creators need to compete for audiences' viewership and engagement. Although science influencers used group identity language more frequently on a more independent platform (Instagram), when it comes to the sentiment associated with using group language (RQ2), we found science influencers made stronger contrasts between ingroups and outgroups on more competitive channel platforms (Twitter, Facebook) than independent channel platform (Instagram), as indicated by the difference in the positive-negative tone surrounding ingroup and outgroup pronouns. Despite the lower frequency of group language on Twitter, the larger contrast in affective tone drawn between ingroups and outgroups could nevertheless contribute to polarization around science issues, as research shows that emotion plays a critical role in increasing public attention to and sharing of science information (Kim & Chen, 2022). As these science influencers couple group identity language with a larger difference in positive and negative sentiment, even their more limited use of group identity language may polarize audiences around science content, which is a research question worth exploring in future.

The differences in the frequency of group identity language on more independent versus competitive channel platforms respond to the puzzle we raised at the beginning of this paper regarding about the role(s) of science influencers on social media, which are little understood compared to political influencers. Our findings suggest that, in contemporary conditions, science influencers may focus on building online communities with ingroup solidarity to defend against outgroups over engaging with diverse audiences. First, we observe these science influencers may use digital media strategically to build online communities to strengthen in-group solidarity and to avoid inter-group conflicts. On Instagram, science influencers may seek to build ingroup solidarity and community among an interested audience, suggested by the higher frequency of group pronouns, particularly ingroup pronouns, in contrast to other platforms. In contrast, science influencers on more competitive-channel platforms (e.g., Twitter), where they are likely to receive more interaction and public criticism, chose to use less group identity language, perhaps to avoid amplifying public divisions around science and instigating group conflicts in comment threads. When science influencers use group language on Twitter and Facebook, they also made stronger positive-negative contrasts between ingroups and outgroups than on Instagram. This suggests that when science influencers create content on more competitive channel platforms, they may be defending against outgroup criticism by advocating for a more positive ingroup perception compared to a more negative perception of outgroups, which could bring unintended consequences of polarizing supportive and skeptical communities around the politicized science.

In fact, the positive association between the use of group identity language and social media engagement (H2) highlights the problem of these identity-infused communication from science influencers. As social media algorithms promote content that receives greater engagement (Davis & Graham, 2021; Gabielkov et al., 2016) and that group identity language can make social group conflicts more salient and foment collective action (Spears & Postmes, 2015; Tajfel & Turner, 2004), these findings suggest that science influencers can inadvertently amplify narratives of social divisions around science.

Strengths & Limitations

This study presents findings from a novel population of data, public social media posts made by popular science influencers across three platforms (Twitter, Facebook, Instagram). While these influencers are popular voices of science information with large followings, their role and response to public polarization around science has not been investigated to date. Using this data, we made original comparisons about how these influencers' content creation differs between platforms and has changed over time. These findings shed new light on how platform features and affordances might shape the structure of information online in ways that are likely to affect public attitudes toward politicized science. In addition, we were able to identify how science influencers have responded to critical events in ways that may further polarize public attitudes around science.

Yet there are also limitations to note. First and foremost, though we endeavored to collect data from a broad range of science influencers identified by many sources, it is possible that a different sample of science influencers would yield different results. In addition, science influencers are not homogenous in their views, and thus may refer to different social ingroup and outgroups in their content. For example, Dr. Oz, who was at time of writing a recently failed Republican senate candidate endorsed by President Trump, likely used ingroup and outgroup pronouns to refer to different groups than Neil deGrasse Tyson, who has been openly critical of the Trump administration. Though our measures of group identity language are useful for measuring trends over time and across platforms in large bodies of data, they are blunt measures intended to capture big-picture trends, and thus some interesting nuance may be obscured. Further, we do not compare our measures of ingroup and outgroup language to human-coding, which means we have likely overlooked other ways that science influencers may express ingroup solidarity and outgroup criticism. Future research should explore science influencers messages and their effects on attitudes more closely, attending in particular to the actors and ideas associated with ingroup and outgroup discourses, as well as individual differences between influencers.

Additionally, it could be the case that the trends we observe concerning increased group identity language over time are not unique to science influencers, but rather reflect broader polarization on social networks driven by algorithmic or commercial logics. We assume that science influencers increasingly used this language in response to perceived social identity threats. However, it may be that non-science influencers also use group identity language to promote engagement and algorithmic visibility, and the science influencers whose data we collected were popular *because* they were successful at using this language strategically. Finally, we only focused on the time period between 2016 and 2022. While this time frame covers a number of events about which the scientific community expressed concerns (e.g., actions by the Trump administration to restrict research activities, the COVID-19 pandemic), this does preclude us from speculating on the use of groups identity language by science influencers before this time.

Conclusions

This study investigated the use group identity language in digital media by influential science communicators to better understand how these actors could inadvertently amplify or attenuate narratives of social division around contentious science. Given

the increasing role of the Internet as a source of science communication, we must attend to the roles that influential digital communicators play shaping public attitudes toward contentious science to compliment the well-researched effects of political elites in these areas (e.g., Germani et al., 2021; Willis, 2017; Yu et al., 2021). Amid increasing partisan social sorting (Mason, 2016), there are concerns that scientists could come to be seen as a social group in conflict or cooperation with competing partisan social groups. The use of ingroup and outgroup language by science influencers in reference to political actors and groups could contribute to these perceptions, which may have implications for scientists' abilities to respond to future challenges and advise on policymaking. The findings also point to the ways in which social media platform affordances may influence science influencers to play different roles in different online spaces, notably when it comes to defending against outgroup criticism and building ingroup solidarity. In this context, it is important to conceptualize scientific skepticism and rejection as not only a cognitive process, but a result of social dynamics and intergroup conflict (Prot, 2015). Attention to the roles science influencers and nonpolitical opinion leaders play with respect to social identities is crucial, as public support for expert knowledge in policy making is vital to addressing future social, political, and public health challenges.

Note

1. It is possible to share a post through Instagram's "Story" feature. However, as we are looking at actual posting behavior instead of Stories, we consider these to be more independent.

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No potential conflict of interest was reported by the author(s).

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Data Availability Statement

The data that support the findings of this study are available from the corresponding author, SC, upon reasonable request.

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