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Article

"You Can Do Better Than That!": Tweeting Scientists Addressing Politics on Climate Change and Covid-19

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Abstract
Climate change and the Covid-19 pandemic are global challenges in which scientists play a crucial role, and immediate political actions are necessary. However, in contrast to climate change, strong governmental actions have been taken during the pandemic. While climate change has been on the public agenda for several decades, the pandemic is a rather new issue. In such cases, social media offer scientists the potential to disseminate scientific results to the public and express calls to action and their personal views towards politics. Thus far, little is known about the extent to which scientists make use of this option. In this study, we investigated the similarities and differences between visible German climate experts and visible German Covid-19 experts regarding advocacy and assessments of policies and political actors on Twitter. We conducted a manual content analysis of tweets (*N* = 5,915) from 2021 of the most visible climate experts (*N* = 5) and the most visible Covid-19 experts (*N* = 5). The results show that climate experts addressed politics more often than Covid-19 experts in their tweets. The selected climate experts more often expressed negative evaluations, the degradation of competence and blaming. The Covid-19 experts, however, made more political calls for action. We assume that an issue's history and context will affect scientists' public assessments of politics. Our comparative study provides insight into the interrelations between science and politics in digital communication environments and elucidates visible scientists' communication behaviours towards different socio-scientific issues.

Keywords
climate change; Covid-19; digital communication; science communication; science–politics interrelations; Twitter; visible scientists

Issue
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1. Introduction

The Covid-19 pandemic and climate change are global threats, with both having high relevance for the entire population and high levels of public attention and politicisation. They represent so-called socio-scientific issues (Sadler et al., 2007), which are "controversial, socially relevant, real-world problems that are informed by science" (Taddicken & Krämer, 2021, p. 7). Although these two socio-scientific issues should not be conflated, as crucial differences exist (e.g., how long the topic has been the subject of public discussions), there is one highly relevant commonality: Scientists have become key actors in public discourses around both issues.

During the pandemic, scientists were at the centre of public discussions on Covid-19 (Leidecker-Sandmann et al., 2022; Safford et al., 2021), giving practical implications of their research for both the public and policymakers (Post et al., 2021). It is stated that the relevance of scientists in informing policy decisions has never been more noticeable than during the pandemic (Scheufele, 2022). While scientific knowledge only emerged gradually, the Covid-19 pandemic caused a high need for information (Lu et al., 2021), and the enormous impact of

the pandemic prompted scientists to communicate their expertise publicly (Leidecker-Sandmann et al., 2022). Regarding the issue of climate change, scientists had already succeeded in bringing climate change to the policy agenda in the 1980s (Schäfer, 2016).

The crucial role of scientists in both socio-scientific issues can serve as examples of the "political implications of scientific expertise" (Peters, 2021, p. 114). The close intertwining of politics and science in socio-scientific issues raises questions on how science could and should inform policymaking and public debate (Post et al., 2021). Scientific debates in modern societies often blur the lines between scientific issues being debated and the societal and moral implications of their societal applications (Scheufele, 2014). Thus, scientists become involved in politicised scientific fields (Post & Ramirez, 2018; Scheufele, 2014) where they are facing a new challenge. When engaging in politicised discourses, scientists operate in contexts determined by factors outside of science (Schmid-Petri et al., 2022). Here, scientists can be expected to not only assert established scientific knowledge and justify particular lines of policy (Pielke, 2004; Post & Ramirez, 2018; Scheufele, 2014).

At the same time, engaging has never been as easy as it is today. New digital communication environments have radically changed the communicative landscape for science communication, leading to new opportunities for scientists to communicate publicly (Taddicken & Reif, 2016). Nowadays, scientists engage in online discourses more often and can thus increase their public visibility (Metag, 2021). For instance, during the pandemic, the popularity of virologists grew very quickly, which was also reflected in their increasing number of Twitter followers (Utz et al., 2022). In general, scientists progressively use their own social media channels to communicate directly with the public (Della Giusta et al., 2021). On social media, different online public arenas intermingle (Lörcher & Taddicken, 2017), offering scientists the opportunity to communicate beyond the scientific community and directly address politics. In particular, Twitter has become a popular intersection for scientists where other scientists and science-affiliated actors, science journalists, and politicians meet (Brossard & Scheufele, 2022).

Therefore, how visible scientists communicate in digital environments is a significant question in the field of science communication. While studies have examined scientists' motives and reasons for public and policy engagement (e.g., Cologna et al., 2021; Sharman & Howarth, 2017), research on the question of whether and how scientists address politics on social media is in its infancy (e.g., Walter et al., 2017). When scientists engage in politicised controversies, their communication can serve to influence policy (Pielke, 2004; Post & Ramirez, 2018). Moreover, comparative studies in the context of scientists as public communicators are limited to comparisons between scientists and actors from other fields, such as economics (Della Giusta et al., 2021). However, it is important to better understand how visible scientists from different research areas communicate directly with the public, particularly, how they address politics. Thus, it can be assumed that these scientists may not only address but also assess and criticise policies and political actors to attract public attention.

In this study, we aim to shed light on these questions by investigating how the visible German climate experts and the visible German Covid-19 experts address politics in public discourses on Twitter. These socio-scientific issues have distinct histories in public discourses and were managed differently by politics, which may cause differences between climate experts' and Covid-19 experts' communication behaviours. The comparison is particularly interesting because Covid-19 experts had to suddenly transgress their role as researchers and deal with the public and politicians all at once (Peters, 2021), while climate experts have been dealing with the public and politics already for decades (Schäfer, 2016). Findings may help to understand the diverse communication requirements of different topics and highlight strategies of science communicators that deal with these requirements.

2. Comparing Climate Change and Covid-19

The Covid-19 pandemic and climate change can both be described as major societal challenges that have to be met with science. Thus, scientists and their communication behaviours play a decisive role. Although it is argued that the pandemic "provides a lens into how to deal with many other slow-burning crises such as the…climate crises" (van der Voorn et al., 2021, p. 8), both challenges provide a very specific context for science communication.

Climate change is a "complex and multifaceted issue with substantial policy ramifications" (Sharman & Howarth, 2017, p. 826). There is consensus among scientists that anthropogenic climate change is a major threat to humanity (Powell, 2017). While its consequences become increasingly visible, the topic remains unapproachable for most of the public due to its complexity and perceived distance (Chen et al., 2022). In Germany, climate change has been widely accepted as a "rather certain and serious societal problem" (Schäfer et al., 2014, p. 156). The challenges posed by it have received public and media attention since the 1980s (Schäfer, 2016). However, previous content analyses have shown that media coverage of climate change is driven by political events and is increasingly politicised (Chinn et al., 2020; Schäfer et al., 2014). Anthropogenic climate change is mainly portrayed as a definite threat in German news media coverage (Maurer, 2011; Schäfer, 2016). Overall, scientists in Germany are thus operating in an environment characterised by a high degree of agreement on anthropogenic climate change. A study conducted by Post and Ramirez (2018) on German climate scientists' view on climate change news coverage found that most scientists do not believe that the news media understate the issue.

The upcoming of the Fridays for Future movement in 2018 brought a new dynamic to public discourses on climate change (Rauchfleisch et al., 2021). While the movement might have led to greater visibility, the claims are not new. For decades, scientists have "sounded the alarm about global warming" (Weingart et al., 2000, p. 261). Although political actors have known of the threat for a long time, only gradual efforts have been made, and political actions have often been postponed (Grundmann, 2021). These measures, which are perceived as insufficient for coping with climate change, have created frustration among climate scientists (Pidgeon & Fischhoff, 2011). In 2020, the issue of climate change was displaced by Covid-19 in the news media and on social media (Rauchfleisch et al., 2021), which might have prompted scientists to put climate change back on the media and political agenda themselves.

During the largest public health crisis in recent history, information about Covid-19 was widely disseminated by various sources (Taddicken & Krämer, 2021). In contrast to the long history of climate change, the current pandemic only emerged at the beginning of 2020 and has had an immediate impact on societies worldwide, for example, through lockdown measures. Since Covid-19 has posed an imminent and severe threat to individuals, the issue is perceived as more urgent and less abstract than climate change (Rauchfleisch et al., 2021). The Covid-19 pandemic caused a high need for information (Lu et al., 2021). A huge reliance on scientific experts existed during the pandemic as they could explain the pandemic's cause and effects to the public and policymakers (Leidecker-Sandmann et al., 2022). This was accompanied by the increased popularity of scientists from the field of virology in Germany (Utz et al., 2022).

At the time of the pandemic outbreak, policymakers were quick to take far-reaching measures to combat the spread of Covid-19 (Lidskog et al., 2020). In Germany, extensive political decisions were also taken to prevent and contain the transmission of the virus (Sell et al., 2021). Many scientists were surprised by the speed and scale of such responses, particularly when compared to the responses to climate change (van der Ven & Sun, 2021). Especially at the beginning of the pandemic, there was a high degree of agreement between science and politics about what societal actions should be taken (Metcalfe et al., 2020).

In contrast to measures on the long-term problem of climate change, responses to the Covid-19 pandemic tended to be short-term; the two issues thus vary enormously in terms of temporality (Grundmann, 2021). However, initial content analyses have revealed a high degree of politicisation in news media coverage of Covid-19, which is similar to that of climate change (Hart et al., 2020). The political nature of scientific issues is thus visible in public discourses on both issues (Metcalfe et al., 2020).

In politicised scientific fields, different actors try to make their voices heard and pursue particular political goals, which is also assumed for scientists (Schmid-Petri et al., 2022). Research has shown that some climate scientists advocate for certain political outcomes (Pielke, 2004; Post & Ramirez, 2018). A comparative study of visible climate experts and visible Covid-19 experts holds promise because the two global challenges have aspects in common, such as their societal relevance and the dominance of scientific voices in their discourses. Still, they also differ in their perceived immediacy and political responses. Regarding the involved scientists, most Covid-19 experts have only been in the public eye for a short time; therefore, they most likely have less experience in communicating with the public than climate experts (Peters, 2021). This likely results in different communication behaviours, particularly on social media. Here, the different strategies of science communicators that deal with different communication requirements resulting from the different histories of the two socio-scientific topics may particularly become visible.

Moreover, as strong governmental responses have been taken during the pandemic, lacking to the extent of climate change (Lidskog et al., 2020), the level of frustration among climate scientists has presumedly increased. Climate scientists have long been described as "frustrated by the limited response to what they see as the greatest threat facing our planet" (Pidgeon & Fischhoff, 2011, p. 40). We suspect that these differences in the political handling of the two global threats result in different communication behaviours of climate experts and Covid-19 experts towards politics and the public.

3. Visible Scientists Addressing Politics on Social Media

While scientists often remain invisible to the public, in some situations such as climate change and the Covid-19 pandemic, they have become important public communicators acting as policy advisors to the public (Peters, 2021). During the pandemic, individual scientists played an unprecedentedly prominent role in traditional and social media (Utz et al., 2022; Wormer, 2020). The term "visible scientist" originally referred to scientists who were prominent in the mass media and distinguished by activities in "the tumultuous world of politics and controversy" (Goodell, 1977, p. 6). Visible scientists tried to influence policy through the mass media, putting issues on the media agenda while knowing that policymakers were watching (Fahy, 2017; Goodell, 1977). Therefore, visible scientists "hold some form of power" (Metag, 2021, p. 130).

Nowadays, there are many new forms to gain public visibility, especially via social media (Olesk, 2021). Scientists can become visible to the public, address political problems of society at large by warning about climate change or provide advice on health issues (Peters, 2021). However, this "boundary role" at the interface of science and media is only taken by a minority of scientists (Rödder, 2012). In this study, we operationalise the

analytical concept of visibility as scientists who are visible in digital communication environments.

The rise of digital communication environments has radically changed the communicative landscape for science communication (Taddicken & Reif, 2016), leading to "an intermingling and integration of the different partial public spheres" (Lörcher & Taddicken, 2017, p. 4). This is especially true for Twitter, where actors from different arenas intertwine, share various content and connect it via the hashtag function. This phenomenon of flattening multiple audiences into one is also known as "context collapse" (Marwick & boyd, 2011). The platform enables scientists to distribute, consume, and discuss scientific issues in a new way (Büchi, 2017). While Twitter primarily serves as a platform for many researchers to share their research findings and connect with their scientific network (Collins et al., 2016; Costas et al., 2020), Twitter's architecture enables scientists to engage in broader public discussions (Brossard & Scheufele, 2022; Della Giusta et al., 2021). Hence, the rise of social media platforms such as Twitter has changed how scientists communicate with different non-scientific actors (Roedema et al., 2021) since social media facilitate exchanges between science and politics, and media and the public (Walter et al., 2019). While in the past, scientists had to turn to the public and political actors via traditional mass media (Weingart, 2001), nowadays, they can directly address politics using their own accounts on social media platforms (Della Giusta et al., 2021).

It is important to emphasize that scientists—like other societal actors—might be motivated by their political preferences to communicate the facts and include personal preferences in their professional recommendations (Scheufele, 2022). The political dimension of science communication can become visible in scientists' engagement in public discourses on social media (Nisbet & Markowitz, 2015). Previous work has shown that scientists also use Twitter to express their own personal views, especially in highly politicised fields (e.g., Jahng & Lee, 2018; Walter et al., 2017). Digital media can even be seen as drivers of politicisation (Schmid-Petri et al., 2022). The 280-character limit on platforms like Twitter is said to create a "temptation for scientists" to communicate beyond the presentation of evidence-based information (Brossard & Scheufele, 2022, p. 614).

Since science, politics and the public are in a "continuous communication process influencing each other" (Schrögel & Humm, 2020, p. 504), scientists can participate directly in public discussions and potentially engage in stealth advocacy. So-called "informal policy advice"—formerly given by scientists through mass media coverage (Petersen et al., 2010)—might have become significantly more present on social media. This has the potential to reshape interactions between scientists and political actors, leading to a political impact (Peters, 2021).

Particularly in politicised scientific fields, the distinction between science and policy is often blurred (Post et al., 2021). Since the demand for advice from scientists has increased, they are increasingly expected to speak out in public debates (Schmid-Petri et al., 2022). Scientists might attempt to reach political actors through the general public (Tøsse, 2013). Different typologies of the roles of scientists in politics exist (e.g., Pielke, 2007), and the normative question of scientists' public policy advice has been addressed (e.g., Bray & von Storch, 2017; Donner, 2014; Lackey, 2007). Research in the early stages of the pandemic on the public's perception of the relationship between science and policy has shown that especially people who have a need for clear information, see scientific knowledge as stable and want certain scientists to dominate policymaking (Post et al., 2021). A study examining UK-based climate scientists' views on policy engagement showed that they are divided on the extent to which they should engage in policy debates and make policy recommendations (Sharman & Howarth, 2017). However, they consider a certain level of advocacy to be warranted (Sharman & Howarth, 2017). A recent study by Cologna et al. (2021) found that both climate scientists and the public in Germany believe that scientists should actively advocate for policies. While open support for climate policy affects the perception of the objectivity of scientists, it does not affect their perceived trustworthiness (Cologna et al., 2021). While the general perceptions of scientists' role in public discourses have often been discussed, if and how scientists include advice in their direct public communications has raised little scholarly attention so far (Schrögel & Humm, 2020).

In the case of climate change, a group of scientists founded Scientists for Future, in which scientists often engage as "knowledge suppliers for FFF [Fridays for Future]"—a role that can be seen as close to political activism (Merkel, 2022, p. 270). When scientists address policy advice, they transgress their role as "pure scientists" who mainly focus on their own research and do not actively engage in public discourses (Pielke, 2007). Scientists advocating for a particular policy are defined as "issue advocates" (Post et al., 2021; Schmid-Petri et al., 2022). They contribute to the politicisation of science (Schmid-Petri et al., 2022). On social media, the attempts of visible scientists to address politics are more easily documented. However, only a few studies have directly considered visible scientists' online communications in terms of advocating policies in controversial political contexts using content analysis. When investigating the role of scientists as issue advocates (Pielke, 2007), we must focus on scientists' public communication practices. Thus, it is necessary to analyse the extent to which visible scientists address politics in their tweets to gain an overview of their online communicative practices outside their scientific communities. Here, we ask whether and to what extent visible climate experts and visible Covid-19 experts publicly give political calls to action:

> RQ1: How do visible German climate experts compared to visible German Covid-19 experts advocate policies in public discourses on Twitter?

Moreover, scientists' public addressing of politics may include advocacy and assessments of policies and political actors. We can assume that scientists who publicly advocate policies may want to attract attention towards their own issues and thus increase their visibility further. When adapting to media logics, greater visibility might be reached more easily (Metag, 2021). Social media offer scientists the opportunity to take a public stand on politically relevant issues (Jahng & Lee, 2018) and to publicly criticise political actors and their policies since they can bypass traditional gatekeepers (Peters, 2013). By applying the news values of negativity and conflict (Galtung & Ruge, 1965), scientists may attract public and political attention. Scientists have been found to be interested in providing knowledge to the public and using their reach to put pressure on policymakers (McCormick, 2009). Initial research suggests that while climate scientists address other scientists more often than political actors on Twitter, their tone towards political actors is more negative than their tone towards their peers (Walter et al., 2019). However, there is a lack of more profound insight into how they assess policies and political actors in their social media communications. Thus, we pose a second research question:

> RQ2: How do visible German climate experts compared to visible German Covid-19 experts assess policies and politics in public discourses on Twitter?

In order to answer this research question, we investigate various aspects of assessment. First, we focus on negative evaluations. This is because negativity as a news value attracts attention and it has been presumedly adopted by media-experienced scientists (Peters, 2013). Climate experts have observed that, in contrast to climate change, strong governmental responses have been possible during the pandemic. This might have reinforced their concerns about politicians acting against or neglecting scientific evidence regarding climate change. Visible scientists might address this by degrading politicians' competence on social media. With the opportunity to bypass traditional gatekeepers on social media (Roedema et al., 2021), scientists' communication may become less filtered. Therefore, scientists may attract public attention by engaging in conflict. They may attribute causal responsibility to political actors for their past actions by blaming them. Research on blaming so far has focused mainly on political communication (e.g., Hameleers et al., 2016); if or to what extent visible scientists publicly blame political actors has yet to be studied.

4. Methods

In order to investigate different communication behaviours of visible climate experts and visible Covid-19 experts regarding advocating and assessing politics and policies, we conducted a manual content analysis of all tweets (original tweets, quotes, and replies) from the year 2021 that were posted by 10 visible scientists (N = 5,915). Since climate change and Covid-19 are not sciences in their own right, we use the term "visible experts" instead of visible scientists when referring to both scientist groups.

The 10 visible scientists are professors or postdoc researchers in the broad fields of climate change or Covid-19 and are affiliated with a German university or research institution. They were selected by applying a pyramid scheme, starting from the most visible German scientist from each field in terms of followers on Twitter. Based on that, we searched the accounts they followed and selected all scientists in the field who had at least 10,000 followers to ensure they reached a broad public. We continued searching the accounts the scientists followed and concluded the selection process when no further scientists were found. We found five German climate experts and 14 Covid-19 experts fulfilling the criteria. In order to be able to adequately compare the results, we selected the five most visible climate experts and the five most visible Covid-19 experts in terms of followings on Twitter. Since the two topics are multifaceted, the visible scientists came from different disciplines. Climate experts' backgrounds were in physics, oceanology, engineering, or economics while Covid-19 experts' backgrounds were in medicine, physics, or biology (see Supplementary Material).

Using Twitter's API, we collected the timelines of the selected scientists from the year 2021. The sample consists of all original tweets, quotes, and replies (N = 5,915). The vast majority of all tweets were German (81%). The remaining tweets were coded as either English (15.9%) or other (e.g., links, emojis; 3.1%). We chose the year 2021, as the German general election happened in September 2021 and there were also a few regional county elections. While Covid-19 was the overlaying topic in 2020 (Rauchfleisch et al., 2021), climate change as a political topic regained attention, especially surrounding the flood disaster in western Germany in July 2021. Furthermore, in the first few months of 2021, Germany had lockdown measures in place to prevent the spread of Covid-19 while also rolling out its vaccine campaign. By looking into visible scientists' Twitter communications in 2021, we can observe how they publicly addressed politics during the general election, coalition talks, and government formation afterwards.

In the content analysis, we first coded whether a tweet addressed politics. Here, statements or questions referred to measures or strategies in which politicians had decision-making authority or where a reference to politics was made. If that was the case, we coded advocating (calls to action) and aspects of assessment (evaluation, degradation of competence and blaming). "Calls to action" were coded when the experts suggested certain measures (e.g., politics should follow a certain strategy, specific measures should be set in place or demand towards politics to refrain from certain actions).

"Evaluation" was coded when the experts rated political measures or political actors in their tweets, we differentiated between positive and negative evaluations. We considered "degradation of competence" to occur when an expert either directly expressed that they did not ascribe competence to a political actor or when they expressed that political actors were acting against common knowledge; the contradiction had to be made clear in the experts' tweet (e.g., lack of understanding or questioning politicians' professional position). "Blaming" was coded when the experts claimed that a certain state or situation was a political actor's fault (e.g., political failures, reproach for a situation due to disregard for science or warning that a forthcoming situation is a politician's fault due to non-actions or wrong actions).

Climate experts' tweets and Covid-19 experts' tweets (N = 5,915) were coded by two coders to ensure reliability. Krippendorff's alpha intercoder reliability was calculated with a random sample of 10% of the tweets and ranged between 0.70 and 0.93 across all variables. At the lower end were more subjective variables, such as blaming and political calls to action, while other variables, such as addressing politics or the type of political actor, were above 0.85 and thus showed good reliability (see Supplementary Material). As this study analysed all the selected experts' tweets from 2021, no inferential statistics were used.

5. Results

In total, 5,915 original tweets, quotes, and replies by 10 visible scientists were analysed; 4,365 were tweeted by climate experts and 1,550 by Covid-19 experts. The selected Covid-19 experts tweeted between 71 and 633 times in 2021, while the climate experts tweeted between 453 and 1,681 times (see Supplementary Material). In total, almost every fifth tweet contained a form of addressing politics. Climate experts more often addressed politics than Covid-19 experts. Based on this, we can already observe differences in the communication behaviours of the most visible climate experts and the most visible Covid-19 experts on Twitter. Whereas climate experts addressed politics in 25.5% of their tweets, Covid-19 experts addressed politics less often, but still in 18.1% (Table 1).

5.1. Advocating Policies

To elucidate the extent to which visible German climate experts and visible German Covid-19 experts advocate policies on Twitter, we continued to analyse only the tweets that address politics (n = 1,392). We saw that 29.5% of climate experts' tweets and 60% of Covid-19 experts' tweets contain calls to action (Table 2). Thus, the Covid-19 experts made more political calls to action from a relative perspective. Taking the total amount of visible scientists' tweets into account, calls to action by climate experts were much more present in our data in absolute numbers.

5.2. Assessing Policies and Political Actors

We analysed how visible German scientists assessed policies and political actors and found differences between climate experts and Covid-19 experts, with more negative assessments by climate experts overall.

The data show that most of the tweets did not evaluate policies or political actors: 66.4% of the climate tweets and 86.8% of the Covid-19 tweets that addressed politics did not contain any evaluation. However, around a quarter (25.9%) of the tweets by the climate experts contained negative evaluations, while only 10% of the Covid-19 experts' tweets contained negative evaluations (Table 3). In addition, positive evaluations of politics or policies were found in 4.2% of the climate experts' tweets and in 2.9% of the Covid-19 experts' tweets.

We also analysed how often the visible scientists degraded the competence of political actors. In most tweets, the visible scientists neither degraded nor attributed competence to political actors. However, in 14.5% of the climate experts' tweets, the competence of political actors was degraded, while such degradation occurred in only 1.4% of the Covid-19 experts' tweets (Table 3).

Table 1. Addressing of politics in experts' tweets (N = 5,915).

	Climate experts' tweets (n = 4,365)		Covid-19 experts' tweets (n = 1,550)	
Addressing politics	n	%	n	%
Not present	3,253	74.5	1,270	81.9
Present	1,112	25.5	280	18.1

Table 2. Advocating behaviour in experts' tweets addressing politics (n = 1,392).

	Climate experts' tweets (n = 1,112)		Covid-19 experts' tweets (n = 280)	
Call to actions	n	%	n	%
Not present	784	70.5	112	40.0
Present	328	29.5	168	60.0

Table 3. Assessing behaviour in experts' tweets addressing politics (*n* = 1,392).

		Climate experts' tweets		Covid-19 experts' tweets	
		n	%	*n*	%
Evaluation	Not present	738	66.4	243	86.8
	Negative	288	25.9	28	10.0
	Negative and positive	39	3.5	1	0.4
	Positive	47	4.2	8	2.9
Competence	Not present	924	83.1	275	98.2
	Degrade	161	14.5	4	1.4
	Degrade and attribute	13	1.2	0	0
	Attribute	14	1.3	1	0.4
Blaming	Not present	1,000	89.9	273	97.5
	Present	112	10.1	8	2.5

Comparing whether and to what extent visible climate experts and visible Covid-19 experts blamed political actors, our results show little blaming overall of political actors by the visible scientists. While the Covid-19 experts blamed politics in only 2.5% of their tweets that addressed politics, the climate experts blamed politics in as many as 10.1% of their tweets (Table 3). Thus, climate experts blame politics relatively more often than Covid-19 experts.

6. Discussion and Conclusion

In this study, we aimed to elucidate visible scientists' communication behaviours on different socio-scientific issues and provide insight into the interrelations between science and politics in digital environments. More specifically, our goal was to analyse how the most visible German climate experts and the most visible German Covid-19 experts advocate and assess policies and political actors in public discourses on Twitter. A manual content analysis of tweets (*N* = 5,915) was conducted to explore the similarities and differences between the two groups of visible scientists.

Firstly, our findings indicate that both climate experts and Covid-19 experts use Twitter to address politics, albeit to varying degrees. The urgency of both socio-scientific issues tends to draw scientists into politics (Brüggemann et al., 2020). Our results suggest that visible scientists transgress the role of the "pure scientist" (Pielke, 2007) on social media in communicating beyond the scientific community and participating directly in public discourses. These findings align with previous research that scientists use Twitter to address politics (e.g., Walter et al., 2019). Overall, the behaviour of addressing politics was more pronounced among climate experts than that of Covid-19 experts in our sample. Climate experts have been concerned about the need to act for decades, while public and policy attention is rather new for most Covid-19 experts. However, Covid-19 experts' tweets included more political calls to action than climate experts' tweets. Accordingly, our findings suggest that Covid-19 experts often addressed politics to give informal policy advice by making calls to action. One possible explanation is that new scientific findings emerged almost daily during the pandemic; scientists then shared information about the consequences and necessary measures since decisions had to be made within days or weeks. Hence, the instant threat of the pandemic might have caused Covid-19 experts to use Twitter to advocate certain measures to combat the virus. Political calls to action in Covid-19 experts' Twitter communications highlight the relevance of scientists in informing policy decisions during the pandemic (Scheufele, 2022). Another explanation is a potential disenchantment with politics by climate scientists. They might have moved away from advising and calling for action due to their years of experience with perceived inactive politicians.

Secondly, our results highlight differences between visible Covid-19 experts' and visible climate experts' assessments of policies and political actors. Climate experts' tweets contained more negative evaluations—which is in line with the idea of a higher frustration level compared to Covid-19 experts. Negative assessments in connection with few political calls to action may be regarded as indicators of frustration or even resignation of climate experts due to the lack of responses from politicians. Moreover, since climate scientists have engaged in public communication for years, they might have adopted media strategies, such as the news values of negativity and conflict, in their communication styles in order to generate attention for the issue. Blaming and the degradation of the competence of political actors occurred more often in climate experts' tweets, suggesting that they focused more on long-term strategies, consequences, or past failures than Covid-19 experts. By degrading competence and apportioning blame, visible scientists attract public attention and thus may put pressure on policymakers.

Our results indicate that the histories of both issues might have influenced visible scientists' communications.

This study supports previous research that in highly politicised fields, scientists provide knowledge and express their own views (e.g., Walter et al., 2017). In particular, climate experts seem to use social media to assess policies and political actors. Accordingly, they perform roles that have in the past mainly been filled by journalists (Taddicken & Krämer, 2021).

Some limitations must be considered. Our sample consisted of only 10 visible scientists, five climate experts and five Covid-19 experts. Conclusions drawn from this analysis should be made cautiously as each individual may have a significant impact. However, we selected the most visible German scientists in terms of Twitter followers, as together they reach a broad public, and each may influence public perceptions of science, politics, and public perceptions of climate change respectively Covid-19. Notwithstanding, the generalizability of the findings to other cultures and domains is limited. This study is also limited to making only descriptive claims on a selection of assessment categories. Moreover, we only looked at tweets from one year. However, this study can make statements about the Twitter communication behaviours of the 10 most visible climate experts and Covid-19 experts contributing to the field of science communication by providing details about the similarities and differences of Twitter communication.

Our study highlights the importance of considering visible scientists' communication behaviours due to socio-scientific issues and the rise of digital communication environments. Since we did not analyse the interrelations between science and politics in more detail, future studies should also consider the reactions of political actors and the public to scientists addressing politics. Further research should also include visible scientists from other fields and countries when exploring scientists' communication behaviours on social media. Moreover, more qualitative research is necessary to gain insight into scientists' communication behaviours in different controversial areas. In-depth interviews can be useful for understanding the intentions of visible scientists when they address politics on social media.

This study has shown how important it is to draw more attention to empirical work on the boundaries of science communication, political communication, and public opinion research (Scheufele, 2014). Overall, this study strengthens the idea that social media offers a platform for scientists to engage in public discourse and directly address politics. However, the most visible climate experts and the most visible Covid-19 experts make different use of the possibilities online. Therefore, the differences between both visible scientist groups underline the relevance of further comparative research on socio-scientific issues.

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Conflict of Interests

The authors declare no conflict of interests.

Supplementary Material

Supplementary material for this article is available online in the format provided by the author (unedited).

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