Media and Communication
Open Access Journal | ISSN: 2183-2439
Volume 8, Issue 2 (2020)

Health and Science Controversies in the Digital World: News, Mis/Disinformation and Public Engagement

Editors

An Nguyen and Daniel Catalan

COGITATIO

Media and Communication, 2020, Volume 8, Issue 2
Health and Science Controversies in the Digital World: News, Mis/Disinformation and Public Engagement

Published by Cogitatio Press
Rua Fialho de Almeida 14, 2º Esq.,
1070-129 Lisbon
Portugal

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Available online at: www.cogitatiopress.com/mediaandcommunication

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COGITATIO

Media and Communication (ISSN: 2183–2439)
2020, Volume 8, Issue 2, Pages 323–328
DOI: 10.17645/mac.v8i2.3352

Editorial

Digital Mis/Disinformation and Public Engagement with Health and Science Controversies: Fresh Perspectives from Covid-19

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Submitted: 15 June 2020 | Published: 26 June 2020

Abstract
Digital media, while opening a vast array of avenues for lay people to effectively engage with news, information and debates about important science and health issues, have become a fertile land for various stakeholders to spread misinformation and disinformation, stimulate uncivil discussions and engender ill-informed, dangerous public decisions. Recent developments of the Covid-19 infodemic might just be the tipping point of a process that has been long simmering in controversial areas of health and science (e.g., climate-change denial, anti-vaccination, anti-5G, Flat Earth doctrines). We bring together a wide range of fresh data and perspectives from four continents to help media scholars, journalists, science communicators, scientists, health professionals and policy-makers to better undersand these developments and what can be done to mitigate their impacts on public engagement with health and science controversies.

Keywords
anti-5G; anti-vaccination; Covid-19; conspiracy theories; disinformation; healh controversies; infodemic; misinformation; science controversies

Issue
This editorial is part of the issue "Health and Science Controversies in the Digital World: News, Mis/Disinformation and Public Engagement" edited by An Nguyen (Bournemouth University, UK) and Daniel Catalan (University Carlos III of Madrid, Spain).

1. "The First True Social-Media Infodemic"

Anyone with basic school education and in their right mind would be able to laugh at the bizarre idea of a biological virus spreading through mobile phone networks. Things might become a little more complicated with the claim that radiation from such networks suppresses the immune system against the virus, but it takes only a few clicks to find a reputable health advice source to refute it. Yet, as the novel coronavirus takes hold and wreaks havocs across the world, these two unfounded claims have been able to convince many people to break lockdown rules, pouring onto the street to smash and torch hundreds of 5G phone masts in many countries—from Australia and New Zealand to the UK, Ireland, Finland, Sweden, Belgium, the Netherlands and Italy (Cerulus, 2020; Lewis, 2020). The World Health Organisation (WHO) had to urgently place the 5G conspiracy theories on top of its coronavirus myth-busting page.

Much research needs to be done before a full answer can be found regarding why and how something seemingly unthinkable like that could happen. But most observations and analyses have so far pointed to one crucial factor: the powerful role of digital media, especially online social networks, in facilitating and fostering mis/disinformation about health and science. These platforms—especially Facebook with 2.5 billion users and YouTube with two billion as of April 2020 (Clement,

2020)—allow information to be used, produced, saved and shared at one's discretion, without any hindering or fear (Vestergaard & Nielsen, 2019). While they open new avenues for lay publics to engage with news, information and debates about health and science issues that shape their private and public lives, these media blur the line between the good and the bad, the scientific and the unscientific, and the true and the false. The link between 5G and coronavirus, with its ensuing arson attacks, is the culmination of this information chaos in a time of an unprecedented crisis. As profound uncertainty rises, limited scientific knowledge and understanding about the new virus is at odds with a panicked public's thirst for information and advice, creating a void for unchecked news, unsubstantiated claims and fabricated stories to fill.

Needless to say, the 5G–coronavirus link is only one of numerous pieces of mis/disinformation fueled by digital social media during this pandemic. As the threats to other countries from the outbreak in China began to loom large in January 2020, observers quickly witnessed the global surge of all sorts of coronavirus-related mis/disinformation—from mere rumours and misleading interpretations of facts to fabricated videos and conspiracy theories—around its origin, symptoms, development, prevention and treatment measures, government responses/strategies and so on. Just to name a few:

- The virus is a secret attempt by the global elite to reduce overpopulation;
- The virus is a bioweapon by the Chinese state to control the world;
- The virus is a plan by greedy "big pharma" firms to make money from vaccines;
- Eating garlic, drinking hot water, avoiding ice creams or wearing salt-coated facemasks will keep the virus at bay;
- Drinking bleach, chlorine dioxide, colloidal silver or one's own urine can help kill the virus.

Amidst extreme uncertainty, such false, life-threatening information—sadly with the help of many politicians, celebrities, online influencers and key opinion leaders—escalated and spread faster than the virus itself in digital media. By mid-February, WHO had to declare the situation as an 'infodemic' that must be fought alongside the fight against the virus itself. As an *MIT Technology Review* article on Febrary 12 calls it, "the coronavirus is the first true social-media infodemic" (Hao & Basu, 2020).

Social media giants such as Twitter, YouTube, Facebook and WhatsApp have since expanded their operations in fact-checking, labelling and limiting the sharing of misleading information, including removing fake news, although a study (Brennen, Felix, Howart, & Nielsen, 2020) found that quite a substantial proportion of such content remains active on their platforms. Further, they work with WHO and national health authorities to prominently feature correct information about the virus and make it easily accessible on their platforms (e.g., Facebook sets up a Covid-19 Information Centre in the news feed of every user or features reputable health sources on top of Covid-19 search results).

2. A Long-Simmering Crisis

Such technical interventions might be effective to mitigate the crisis for the time being, but one needs to step back from the Covid-19 pandemic to realise that the ongoing infodemic is not a unique development. Many of the above conspiracy theories are in fact the same old stories being renewed and refashioned in the name of the coronavirus. The 5G mast attacks, for instance, are just the latest escalation of the anti-5G activist movement that has been spearheaded by Stop 5G groups around the world. The immune-system suppression claim that leads to recent vandalism is just an extension of the basic theory that anti-5G groups have promoted for years—namely the idea that electro-magnetic radiation from 5G networks has adverse effects on various organs of the human body. Similarly, claims that the new coronavirus is a product of the big pharma's greed or the global elite's effort to control population growth are familiar stories told by anti-vaccination movements in the past decades. Despite being repeatedly discredited and dismissed by national and international health authorities, such claims have featured in every recent international outbreak—such as SARS (2002–2004), H1N1 (2009–2010), MERS (2012–2013), Ebola (2014–2015) and Zika (2015)—and have shown no sign of stopping their contagion soon. What we are witnessing in the current coronavirus infodemic, it seems, is the tipping point of a long-simmering process that facilitates the stubborn refusal to retreat of such false theories—and many other anti-science ones such as climate change denial, Flat Earth and creationism.

In that context, it is important to recognise that the Covid-19 infodemic is not trigged by technological affordances alone. It is true that digital platforms—with their omnipresent algorithm and ability to afford emotional support and bias confirmation—make it so easy for mis/disinformation to travel and to engender ill-informed public debates and dangerous decisions (Catalan-Matamoros, 2017; Nguyen & Vu, 2019; Warren & Wen, 2016). It would be vastly oversimplified, however, to attribute everything to digital technologies. One, for instance, does not believe that the earth is flat, or deny that anthropogenic global warming exists, or dismiss vaccination as ineffective or dangerous, just because these theories are widely promoted on social media. The fundamental issue remains that many people are still willing to believe in things that, by normal intellectual standards, are unmistakably unscientific or counterintuitive. This is a deep-rooted socio-political problem that has a longer history than the Internet itself. It entails a variety of human factors that can easily cloud public reasoning and/or be skillfully exploited for political, economic and/or religious gains. Among these are existing

values and beliefs, insufficient health and science literacy, STEM vocation crisis, inadequate news and media literacy, low emotional intelligence, and/or weak ability to be open to different sides of the argument (Coleman, 2018; Rowe & Alexander, 2017). For instance, prior beliefs can make it very difficult for people to modify false perceptions (Kuklinski, Quirk, Jerit, Schwieder, & Rich, 2000; Nyhan & Reifler, 2015). One study even shows that explicit attempts to correct false beliefs with scientific data and facts can backfire, leading individuals to more strongly endorse initial beliefs (Betsch, Renkewitz, & Haase, 2013).

In other words, digital media act more like an acute catalyst for mis/disinformation to surface in an environment where factual knowledge and evidence-based reasonsing do not always rule. The fight against mis/disinformation about health and science in the digital space, therefore, needs to start from recognising that scientific facts and perspectives—thereby factchecking and correcting information—are far from enough. It needs to put itself in the contemporary socio-cultural contexts in which mis/disinformation thrives—including recent troublesome developments such as the decline of expertise and experts or the rise of post-truth populist politics—and to go deeply into, inter alia, the social psychology of emotions, values and beliefs. Effective dealing with the expanding influx of health and science mis/disinformation, of which the Covid-19 infodemic is the tipping point, requires communication strategies that are "responsive to the needs and attitudes of audiences" and account for the fact that humans are not always logical, calculating or rational (George & Selzer, 2007, p. 125).

That, in turn, requires deeper understanding of how digital media facilitate or hinder the interaction between rational factual knowledge on one hand and emotions, values and beliefs on the other, and how it shapes public engagement with the health and science issues at stake. Many questions can be asked here. How exactly is mis/disinformation around health and science controversies produced, distributed and redistributed in digital environments? Do—and how do—digital platforms contribute to the decline of the authority of scientific expertise that is already seen in other environments? What techniques and strategies can science journalism and communication employ to tackle the dark sides—and promote the bright sides—of digital media in public communication of science controversies? What are the potential mechanisms for the media, technology firms, the science establishment and the civil society to cooperate in the fight against health and science mis/disinformation?

3. This Thematic Issue

The 18 works in this thematic issue contribute to the literature a set of new empirical and theoretical perspectives on the above—including nine full articles around some prominent health and science controversies of our time, as well as nine commentaries based on observations from the first few months of the ongoing Covid-19 crisis.

The first three articles examine anti-science content in digital spaces in three different ways. María Carmen Erviti, Mónica Codina, and Bienvenido León (2020) conducted a content analysis of 826 Google Video search results on three controversial science issues: Climate change, vaccines and nanotechnology. Among the key findings, most returned clips were pro-science or neutral, with only 4% taking an anti-science stance, and that anti-science videos were more frequent among those produced by ordinary users than by the news media, science institutions, non-science organisations and companies. Quite suprisingly, the presence of scientists does not differ between pro-science, anti-science and neutral clips.

Torben E. Agergaard, Màiri E. Smith, and Kristian H. Nielsen (2020) developed an original qualitative coding framework to analyse prevalent topics and intertextual material (links and shares) in posts generated by the administrators of three Danish Facebook pages that are critical of Human Papillomavirus (HPV) vaccination. They found that these posts assembled different sources (mainstream media, personal anecdotes, political assertions and scientific sources) to construct the messages with a focus on adverse events of HPV vaccination and what posters perceived as inadequate responses of healthcare systems. These Facebook pages, however, are not uniform: they are heterogenous and contextual, responding to and exchanging information and misinformation "within the communication environment in which they are embedded" (Agergaard et al., 2020, p. 339).

Next, Jan Buts (2020) presents two in-depth case studies of a peculiar type of visual content on social media: two popular anti-vaccination memes—namely lists of vaccine ingredients containing mercury, which has been depicted in conspiracy theories as a harmful component of vaccines, and quotes attributed to Mahatma Gandhi, who is known for his condemnation of immunisation. The analysis focuses how the memes moved from the imageboard 4chan to the search engine Google Images, shedding light on how "the repurposed, often ironic use of visual tropes can either undermine or strengthen the claims that accompany them" (Buts, 2020, p. 353). It also pinpoints the intersections of conspiracy theory, visual rhetoric and digital communication—particularly how the ambiguity of memes might serve as vehicles for the dissemination of health mis/disinformation.

The next three articles examine anti- and pro-science communication on social media from user-centred perspectives. Elena Milani, Emma Weitkamp, and Peter Webb (2020) conducted a social network analysis of visual images in Twitter conversations about vaccination. One of their notable findings is that "pro- and anti-vaccination users formed two polarised networks that hardly interacted with each other." Not less im-

portantly, while anti-vaccination users (primarily parents and activists) "frequently retweeted each other, strengthening their relationships…and confirming their beliefs against immunisation," pro-vaccine users (primarily non-government organisations or health professionals) "formed a fragmented network, with loose but strategic connections" (Milani et al., 2020, p. 364).

Joachim Allgaier (2020) presents an online ethnographic case study of a pre-election YouTube video that attacked the climate change policy of Germany's ruling party, Christian Democratic Union (CDU), and unleashed a heated national online and offline debate. Employing the perspectives of networked forms of expertise and ethno-epistemic assemblages, the author provides a detailed telling account of how a single YouTuber invited fierce attacks from the political establishment, generated strong support from top scientists, networked with other popular German YouTubers into an alliance against CDU or climate-unfriendly far-right parties, and stimulated several months of widespread climate policy debates on other social platforms, mainstream media as well as at schools, churches, arts events and so on.

Asheley R. Landrum and Alex Olshansky (2020) explored why people supported calls for censorship of Flat Earth videos on YouTube, despite the fact that they are believed by few. Their theoretical framework is built around third-person perceptions (people are worried that others, not themselves, are being influenced by such videos) and third-person effects (these worries lead people to support censorship of Flat Earth content on YouTube). In three experiments with American users, they found that third-person perceptions existed and varried strongly with how religious people are and which political party they belong to. However, there was only mixed evidence for whether third-person perceptions predict public support for censoring Flat Earth videos on YouTube.

The last three full articles explore the effects of digital content about health and science controversies on users. Friederike Hendriks and Regina Jucks (2020) investigated whether epistemic uncertainty—which is an essential and integral part of science but has been abused by anti-science activists to cast doubt on whatever they want to dismiss—can influence public perceptions of and attitudes to controversial science issues. In two experiments, they found that introducing epistemic uncertainty about scientific processes into online news articles about climate change did not have a large effect on trust in climate science and scientists or climate decision-making. The presence of uncertainty in the articles, however, did affect the style in which readers reasoned.

Turning attention to framing, a central technique used by science communicators to influence users' perceptions, Sarah Kohler and Isabell Koinig (2020) asked a fundamental turnaround question: As users are fixated to many socio-psychological factors in their background, would they even recognise frames intended by producers? Combining eye-tracking, content analysis and online experiments, they found that users did recognise the health and scientific frames in articles on an Austrian website about Tick-Borne Encephalitis and health frames, being more emotional and less neutral, are more frequently recognised than scientific frames. Moreover, health frame recognition was influenced by most health antecedentes included in their research—including confidence in vacines, health literacy, health consciousness, and health information-seeking behaviours and calculation. The implication, the authors argued, is that health frames can be served as a "fruitful strategy" to create awareness of vaccination and other health issues (Kohler & Koinig, 2020).

In the last full article, Kaisu Koivumäki, Timo Koivumäki, and Erkki Karvonen (2020) interviewed 17 tweeting and blogging Finnish researchers in the potentially controversial area of renewable energy to investigate what content practices and functions scientists need to adopt online in order to close the science-society gap. The interviewees, they found, were of the general view that scientists as digital science communicators must broaden their trajectories of expertise and communication. More particularly, they should move beyond traditional functions of informing and anchoring facts to adopt "more progressively adjusted practices" such as luring and manoeuvring, including common content tactics by other professional communicators such as buzzwords and clickbait (Koivumäki et al., 2020).

The second part of this thematic issue is a series of nine rapid-response commentaries on the still evolving situation with the Covid-19 pandemic. George Ogola (2020) starts with this an African overview, outlining how mutiple actors—the state, the Church, civil society and the public—generate, in their fight for legitimacy, "a competing mix" of framings, interpretations and narratives about the pandemic, with the consequence being the birth of a new crisis in its own right (Ogola, 2020, p. 440).

Turning to Asia, three national perspectives are presented. Hoa Nguyen and An Nguyen (2020) detail how a chaotic sphere of "the good, the bad and the ugly"—especially rumours, hoaxes and digital incivility—in Vietnam works in a rather strange way to keep its one-party system on toes and force it to be unusually transparent. Jamie Matthews (2020) reviews a different type of misleading information in Japan: the myth of its cultural exceptionalism, which has been dispersed across the networked public sphere as a factor that helps the country to succeed with the virus. From China, Xin Zhao (2020) observes how its state actors have been using global social platforms as a geo-political battleground during the pandemic, in which they deliberately create a tit-for-tat "Us vs US" narrative with information that is questionable but might nevertheless have gained some influences over users by the time it is scrutinised.

From Italy, the first European country with Covid-19, Alessandro Lovari (2020) focuses on how an erosion of trust in public institutions and the politicization of health and science issues have combined to foster the spread of pandemic misinformation on social media and how the

Italian Ministry of Health used its official Facebook page to mitigate, to some extent, such spread. In Spain, where science and the media are often treated as properties of the state, Carlos Elías and Daniel Catalan-Matamoros (2020) see two unexpected forces emerging to tell a different truth from that of official sources and media: social networks, especially WhatsApp, and mystery and esotericism TV programmes. From Germany, Holger Wormer (2020), observing a number of atypical short-term examples, argues that the Covid-19 and its accompanying infodemic have, above all, "accelerated and made more visible existing developments and deficits as well as an increased need for funding of science journalism" (Wormer, 2020, p. 467).

That leads us two the last two perspectives from the US. Sharon Dunwoody (2020) provides a thoughtful analysis of how "copious amounts of uncertainty" associated with Covid-19 can "confuse and mislead publics" (p. 471)—especially with the aid of social media—and how science journalism might play an essential role by privileging scientific sources, fact-checking and doing analytical stories that concentrates on context and promotes understanding. Finally, Emily K. Vraga, Melissa Tully, and Leticia Bode (2020) review recent research to argue that enhancing science literacy and news literacy—especially equipping social media users with the tools to identify, consume and share high-quality information—is a foundational stone to combat Covid-19 mis/disinformation and beyond.

Taken together, this thematic issue sheds some important new light on both the bright and dark sides of digital communication of health and science controversies and offers useful ideas as to how to go from here to mitigate its negatives and foster its positives. We hope that it will invite many questions for future research into an increasingly crucial area that not only safeguards science and improves humanities but also can ultimately save lives.

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COGITATIO

Media and Communication (ISSN: 2183–2439)
2020, Volume 8, Issue 2, Pages 329–338
DOI: 10.17645/mac.v8i2.2937

Article

Pro-Science, Anti-Science and Neutral Science in Online Videos on Climate Change, Vaccines and Nanotechnology

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Submitted: 20 February 2020 | Accepted: 19 May 2020 | Published: 26 June 2020

Abstract
Online video has become a relevant tool to disseminate scientific information to the public. However, in this arena, science coexists with non-scientific or pseudoscientific beliefs that can influence people's knowledge, attitudes, and behavior. Our research sets out to find empirical evidence of the representation of pro-science, anti-science and neutral stances in online videos. From a search on Google videos, we conducted content analysis of a sample of videos about climate change, vaccines and nanotechnology (n = 826). Results indicate that a search through Google videos provides a relatively small representation of videos with an anti-science stance, which can be regarded as positive, given the high potential influence of this search engine in spreading scientific information among the public. Our research also provides empirical evidence of the fact that an anti-science stance is more frequent in user-generated content than in videos disseminated by other types of producers.

Keywords
climate change; Google; nanotechnology; science communication; user-generated content; vaccines; video production

Issue
This article is part of the issue "Health and Science Controversies in the Digital World: News, Mis/Disinformation and Public Engagement" edited by An Nguyen (Bournemouth University, UK) and Daniel Catalan (University Carlos III of Madrid, Spain).

1. Introduction

In recent years, terminology seeking to classify messages that are favorable or contrary to established scientific knowledge have proliferated. In relation to anti-science stance messages, terms such as 'misinformation,' 'disinformation,' 'fake news' and 'denialism' are applied. On the other hand, 'science advocacy' and 'pro-science' are employed to promote a stronger role of science in society. Neither positive nor negative, 'neutral science' and related words are simply descriptive and explanatory. It is not our intention to discuss or delimit these terms. Prior work has been done by other authors in this regard (e.g., Gerasimova, 2018; Lazer et al., 2018; Scheufele & Krause, 2019).

In this article, we use the terms 'pro-science,' 'anti-science,' and 'neutral science' broadly, covering all related words. We use 'pro-science' to express active support for established scientific knowledge; 'neutral science' as an expression neither in support or against established scientific knowledge, and 'anti-science' as contrary to established scientific knowledge.

Our goal is to better understand how much pro-science, anti-science and neutral science messages circulate in videos returned by Google search results and who exactly are the people responsible for producing these videos in relation to three selected topics: climate change, vaccines, and nanotechnology. Finally, we analyze scientists' voices in a sample of videos.

2. Literature Review

2.1. Pro-Science vs. Anti-Science

Science coexists with non-scientific or pseudoscientific beliefs that influence people's knowledge, attitudes, and behavior. In the Internet era, citizens' search for scientific information based on preexisting beliefs and values (Yeo, Cacciatore, & Scheufele, 2015), plus the difficulty of recognizing inaccurate information (Lazer et al., 2018), may result in an increasing number of misinformed citizens.

According to Schmid and Betsch (2019), anti-science messages resort to false experts, appeal to conspiracies, ask for the impossible (e.g., 100% vaccine safety), create false dilemmas or biased selections of data. In these cases, the authors point out that, in order to avoid misleading information, it is necessary to fight back with immediate responses. We argue that this can be applied to respond to anti-science with pro-science claims.

Non-scientific and beliefs do not arise from all scientific topics. Consequently, there are some topics that cause hardly any anti-science messages to be produced while other topics provoke manifold and widely spread anti-science messages. It is precisely those scientific issues polarizing society that generate a large number of anti-science and pro-science messages. Climate change is a perfect example.

There is overwhelming scientific consensus on climate change (Carlton, Perry-Hill, Huber, & Prokopy, 2015; Cook et al., 2013). However, the discussion about its very existence, causes and consequences, remains within the purview of non-scientific forums. Petersen, Vincent and Westerling (2019) found that the visibility in press articles of those who deny climate change was 49% higher than that of those who believe in it. Even in *The New York Times*, *The Guardian* or *The Wall Street Journal*, contrarians were cited slightly more often than those who represented scientific consensus. The role of media in the journalistic coverage of climate change has been studied from the perspective of balance, a journalistic routine that seeks neutrality regarding controversial issues, but one that in this case has led to greater visibility of anti-science positions (Boykoff, 2007).

In online media, during the US presidential campaign and subsequent election, Donald Trump was the top influencer on global warming, significantly increasing the presence of skeptical discourse on climate change (Swain, 2017). Conversely, the youth movement initiated by Greta Thunberg, namely Fridays for Future, has contributed to a call to action to address climate change in worldwide media (Boykoff et al., 2019).

Although less present in the global political arena, vaccines are yet another scientific topic that produces a vast number of both anti-science and pro-science messages. Vaccines have largely been shown to be effective. Nevertheless, some parents still refuse to have their children vaccinated, basing their decision on different reasons: religious/philosophical or personal beliefs, safety concerns, and a desire for further information (McKee & Bohannon, 2016).

The most emblematic case of anti-science stance in the field of vaccines was that of the measles–mumps–rubella vaccine. A study published in the late 1990s hypothesizing a link between measles–mumps–rubella vaccination and autism (Wakefield et al., 1998) contributed to a significant boost of the anti-vaccination movement. Though the medical journal that published this article later retracted, the idea had already penetrated many people's minds through the media, which for many years have continued to spread this supposed relationship between measles–mumps–rubella, vaccination and autism (Dixon & Clarke, 2013). Indeed, Hoffman et al. (2019, p. 2216) have recently found that "social media outlets may facilitate anti-vaccination connections and organization by facilitating the diffusion of centuries old arguments and techniques.''

Many papers analyze anti-vaccine movements, but the literature on pro-vaccine activism is sparse. In fact, a variety of pro-vaccine activism groups have been shown to focus, to a greater or lesser extent, and in diverse ways, on the political and media debate (Vanderslott, 2019).

Pro- or anti-nanotechnology movements exist but they do not have a prominent social impact. Little evidence is found of political or religious polarization regarding nanotechnology (Drummond & Fischhoff, 2017). This young science is controversial on issues such as stem-cell research and genetic modification of human beings; impacts on human life, family and social structures; or the creation of artificial intelligences (Sandler, 2009; Scheufele & Lewenstein, 2005). However, in the public sphere, nanotechnology is currently not as questioned as climate change or vaccines (Erviti, Azevedo, & Codina, 2018). Fragmented and ambiguous media portrayals of nanotechnology may actually mitigate its risks (Boholm & Larsson, 2019).

2.2. Online Videos

One of the types of content that grows faster in Internet traffic is video (Cisco, 2019). Editing a scientific video implies a greater effort than publishing a post or a tweet, and can also imply greater intentionality; besides, its high potential impact has made video a key tool to distribute scientific information to the public (León & Bourk, 2018). The problem is that the dynamics of online circulation of videos may be favoring misinformation, even more so when, in topics such as climate change, deniers and skeptics participate more actively than pro-science people in social media (Arlt, Hoppe, Schmitt, De Silva-Schmidt, & Brüggemann, 2018).

The video platform most analyzed by academics is YouTube. It was created in 2005 and it was purchased by Google the following year, 2006. Unfortunately, different studies on YouTube's recommendation algorithm indicate that it promotes what we call anti-science. For

the selected topics for this research, we find the following conclusions:

In relation to climate change, YouTube videos support worldviews that to a large extent oppose scientific consensus (Allgaier, 2019). This platform promotes and recommends denialist and anti-scientific videos, including conspiracies and false theories about climate change. Some of these videos accumulate hundreds of thousands of views (Avaaz, 2020).

Vaccine videos have been more frequently studied than climate change videos. Venkatraman, Garg, and Kumar (2015, p. 1422) claimed that "online communities with greater freedom of speech lead to a dominance of anti-vaccine voices," so the level of freedom of online speech correlates with the level of misinformation about vaccines. According to their results, support for a link between vaccines and autism is most prominent on YouTube, followed by Google search results. Other authors confirm this view with their studies on YouTube videos: Song and Gruzd (2017), for example, concluded that 65.02% of the videos were anti-vaccine, 20.87% were pro-vaccine, and 14.11% were neutral. Ekram, Debiec, Pumper, and Moreno (2019) discovered that the anti-vaccine ideology was prevalent in video content and commentary, containing erroneous and incomplete information. Moreover, anti-immunization content is generally favored over pro-immunization content (Yiannakoulias, Slavik, & Chase, 2019).

There are no published studies regarding nanotechnology on YouTube. In any case, the good news is that YouTube video platform recommendations leading to content with conspiracy theories have been reduced by 40% as of April 2019, due to changes in its algorithm (Faddoul, Chaslot, & Farid, 2020).

While YouTube amplifies "sensational content because of its tendency to generate more engagement" (Faddoul et al., 2020, p. 1), Google is a different search engine that prioritizes quality (DiSilvestro, 2017) and tries to avoid misinformation (Del Vicario et al., 2016). Unlike YouTube, Google is not a video platform, so searches on Google videos display links to websites which algorithm detects a hosted video. In the case of YouTube, search results directly show videos. For these reasons, the use of YouTube and Google is usually for different purposes: Google is most often used as a tool for finding information, YouTube for entertainment. However, many Google search results link to YouTube videos (DiSilvestro, 2017), somehow unsettling this canonical divide.

Previous studies on the results of video searches on Google have not been found. Regarding the scientific topics for our present undertaking, there are only a few precedents about vaccine webpages. A study carried out in 2002 on Google concluded that 43% of the first 10 websites in search results were anti-vaccination (Davies, Chapman, & Leask, 2002). More recently, Arif et al. (2018) found that most vaccine webpages returned in Google searches in 6 different languages were pro-vaccine (43%–70%, with diverging results depending on the language).

Various forms of scientific content dissemination have been widely studied, however extant literature on promoters and drivers of this information is limited. In digital communication, the term 'user' designates a natural or legal person using a computer or network service. Growing access to information and communication technologies has facilitated the transformation of some users into producers. We focus on the different producers that create and disseminate online scientific content: professionals and amateurs, organizations and individual users. In this sense, the work of Burgess and Green (2013) on YouTube suggests that all users have become 'participants' in the same scenario, but the differences between content producers persists and varies depending on their range and motivations. Delving further into this aspect is vital, so this article provides a classification of video producers.

2.3. Scientists' Voices

Traditionally, two kinds of video content have been distinguished: user-generated content (UGC) and professionally generated content (PGC). UGC used to be amateur but widespread on social media, while PGC occurred mainly in video marketing or media communication, in other words, it was mostly employed to create institutional content (Kim, 2012). Currently, there are amateur users called 'YouTubers' who have become professionalized, while some professionally-produced content imitate amateurism (León & Bourk, 2018). A previous study indicates that UGC deals with scientific controversy more often than PGC (Erviti et al., 2018), which could be a predictor that this type of users might be more likely to produce anti-science videos.

Beyond the differentiations between UGC and PGC, it is interesting to note in what proportion some actors, such as scientific institutions, media, business, or citizens are producers of scientific videos. Besides, it might lead to improving the existing knowledge about the presence of scientific voices in online videos in relation to pro-science and anti-science attitudes.

Previously, we explained the prevalence of anti-science voices in press articles on climate change. In Petersen et al. (2019), the voices of 386 prominent contrarians (academics, scientists, politicians, and business people) gained far more visibility than the 386 highest cited climate scientists. The authors "demonstrate why climate scientists should increasingly exert their authority in scientific and public discourse, and why professional journalists and editors should adjust the disproportionate attention given to contrarians" (p. 1).

On social media, scientists should also be prominent voices, but only 2% of Twitter content and 3% of Facebook posts on climate change come from scientific work (Grouverman, Kollanyi, Howard, Barash, & Lederer, 2018). As producers of online video on this issue, scientific institutions are seemingly overcome by the media (Erviti, 2018). Meanwhile, calls are made for scientists

to become climate activists (Gardner & Wordley, 2019) and the role of academic climate advocacy is discussed (Boykoff & Oonk, 2018).

Regarding vaccines, Orr and Baram-Tsabari (2018) concluded that the virtual dialogue on the polio vaccination debate on Facebook had become more political than scientific. Finally, the few studies about the online conversation on nanotechnology conclude that the most active users appear to be individuals rather than the official channels of scientific institutions, although the retweets of news from *Nature*, *Scientific American*, NASA, etc., stand out (Veltri, 2012). Even Runge et al. (2013, p. 1) discovered that, in the US, tweets were "more likely to originate from states with a federally funded National Nanotechnology Initiative center or network."

3. Research Questions and Hypotheses

The research questions of this research are the following:

RQ1. To what extent do scientific videos obtained through the Google search engine have a neutral orientation, or are positioned in favor or against established scientific knowledge?

RQ2. Which video producers are more likely to launch neutral messages, for, or against established scientific knowledge?

RQ3. To what extent are the voices of scientists used in neutral videos, in favor, and against established scientific knowledge?

In addition, three hypotheses are formulated in relation to RQ2 and RQ3. RQ1 seeks a first approximation to the positioning of science videos, so we do not have a previous hypothesis.

H1. In our classification of producers, the positioning against established scientific knowledge is greater in videos produced by users (UGC) than in videos produced by other actors.

H2. Neutrality is more frequent in videos produced by news media than in videos produced by other actors.

H3. The presence of scientists is more frequent in videos positioned in favor of established scientific knowledge than in those against it.

H1 is based on previous research that provides conclusions to support this hypothesis (Song & Gruzd, 2017; Venkatraman et al., 2015). H2 is supported by the traditional journalistic principles of objectivity and balance (e.g., Boykoff, 2007). Finally, regarding H3, since the majority of the scientific community supports the existence of an anthropogenic climate change, the efficiency of vaccination and the benefits of nanotechnology, we assume that those videos in favor of established scientific knowledge could portray more scientists than those videos against science.

4. Methodology

The sample of videos that we selected for this research comes from a comprehensive research project that has produced a number of results, some of which were published in a collective work (León & Bourk, 2018).

This project conducted content analysis of online videos about three topics: climate change, vaccines, and nanotechnology. The selection of these three scientific topics is related to contemporary disciplines—in Environment, Health, and Technology—receiving public and academic attention, however noticing marked differences among them as explained in the introductory section.

The sample was selected by searching for the English terms 'climate change,' 'vaccines' and 'nanotechnology' on the videos section of Google. This search engine was used because it was the most frequently tool employed by users, and it would therefore yield videos with the largest potential projection.

The search was conducted in Spain on October 16, 2015. An incognito window was opened on Google to conduct anonymous searches, all cookies were deactivated and the cache memory cleaned, factors which might have interfered with the reliability of the results. The system returned 600 webpage links for each search term, which were conditioned by the search engine algorithm. The results were filtered, excluding those videos that were not accessible due to technical problems, did not cover the subject matter as the main topic, or were repeated. Videos that exceeded 20 minutes in length were also excluded due to limited resources for their analysis, due to operational reasons (e.g., including videos over 20 minutes in the sample would have made coding analysis unfeasible). Following this filtering process, our sample resulted in 300 videos on climate change, 268 on vaccines, and 258 on nanotechnology ($n = 826$).

An initial coding proposal was discussed in three meetings of the research team, resulting in a code book that was designed to carry out the analysis. Before starting this process, a pre-test of the questionnaire was carried out, in which two coders applied the code to 5% of the sample, aimed at detecting problems of comprehension and making the necessary adjustments. Following the testing phase, the final code book was reached. Once the coding of the videos was completed, a reliability test was carried out. The test consisted in taking 10% of the coded sample and comparing whether the coding carried out by the coders matched. The agreement between the two coders that performed the task was higher than 85% for each variable used in this study.

Table 1 lists the variables and questions of the code book.

Table 1. Code book

Topic	Climate change; Vaccines; Nanotechnology.
Video title/Host webpage	(title/name of the host webpage).
Type of author	Scientific institution (research/technology center, university, etc.); Company (excluding media companies); Media (newspaper, radio, television, digital media, etc.; Non-scientific institution (NGO/Association); UGC, understood as non-institutional videos on platforms like YouTube; Other.
Does the video take a position in favor (pro-science) or against (anti-science) established scientific knowledge?	No (neutral); Yes.
In case it does, it takes a position:	Against established scientific knowledge (anti-science). E.g., against vaccination/nanotechnology or denying anthropogenic climate change; According to established scientific knowledge (pro-science).
Do scientists speak in the video?	No; Yes; Unclear whether they are scientists or not.

The data and information collected were quantitatively analyzed and the three hypotheses of the study statistically contrasted through a chi square test.

5. Results

5.1. Research Question 1

Most videos in the sample (55.4%) take a pro-science stance, while 40.4% are neutral, and only 4.1% take a stance against science. The pro-science or neutral positions are predominant in the three topics of our study. Climate change is shown as the topic in which the pro-science stance is most frequent (68.3%) and least neutral (28.3%).

Vaccines turn out to be the scientific issue that generates most controversy, with 8.2% of videos positioned against established scientific knowledge. Climate change follows those results, with 3.3% of videos against established scientific knowledge. Finally, nanotechnology is by far the least controversial (0.78% of videos against) and often addressed from a neutral stance (49.6%; Table 2).

5.2. Research Question 2

Results indicate the predominance of online and offline media as producers of video with scientific content (52.7%). Behind the mass media, we find scientific institutions (15.7%), UGC (12.1%), non-scientific institutions (10%), companies (6%), and other producers (3.2%). We tested whether these frequencies are significantly different and they are on the whole (X^2 (5) = 113.41; $p < 0.001$), but not compared with scientific institutions and UGC (X^2 (1) = 1.96; $p > 0.05$), or UGC and non-scientific institutions ($X^2 = 1.58$; $p > 0.05$).

Surprisingly, non-scientific institutions are the producer that stands out in favor of established scientific knowledge (71%), even ahead of scientific institutions (65.3%; Table 3). Examples of non-scientific institutions are the World Wildlife Fund (*The Arctic: Our First Sign of Climate Change* | *Ocean Today*), the TED

Table 2. Positioning of videos.

	Pro-science	Anti-science	Neutral
Climate change (%, n = 300)	68.3	3.3	28.3
Vaccines (%, n = 268)	46.6	8.2	45.1
Nanotechnology (%, n = 258)	49.6	0.7	49.6
Total (%, n = 826)	55.4	4.1	40.4

Table 3. Video producers.

	Pro-science	Neutral	Anti-science
Media (%, n = 436)	54.3	42.2	3.4
Scientific institution (%, n = 130)	65.3	33	1.5
Non-scientific institution (%, n = 83)	71	25.3	3.6
User (UGC; %, n = 100)	46	41	13
Company (%, n = 50)	44	56	0
Other/unknown (%, n = 27)	33.3	62.9	3.7
Total (%, n = 826)	55.4%	40.4%	4.1%
H1: X^2 (1) = 22.75; $p < 0.001$			
H2: X^2 (1) = 1.19; $p > 0.05$			

Foundation (*The Reality of Climate Change | David Puttnam*, TEDxDublin, 2014) and the UN (Our *Future | Narrated by Morgan Freeman*, 2014).

Media take a pro-science stance much more frequently than a neutral stance, which situates communication companies in an intermediate position (54.3%). Meanwhile, less than 50% of videos produced by users (46%), companies (44%) and other producers (33.3%) are in favor of established scientific knowledge. In the last two cases, producers tend to offer neutral videos: companies, 56% of videos; other producers, 62.96%. If we disregard the media, the weighted percentage of neutral videos is 32%.

The most outstanding percentage of videos positioned against established scientific knowledge is the one corresponding to users (13%). This is relevant because it clearly exceeds the categories of other producers (3.7%), non-scientific institutions (3.6%) and media (3.4%). If we disregard UGC, the weighted percentage of anti-science videos is 2.8%.

On the other hand, scientific institutions hardly offer videos that contradict science (1.5%). Companies in the sample did not produce videos against established scientific knowledge but mostly neutral videos (apart from the 'others' category).

Next, we checked whether hypotheses 1 and 2 are fulfilled. The contrast of hypotheses through the chi square test confirms H1 (X^2 (1) = 22.75; $p < 0.001$; the parameters 'users' and 'videos against' are interdependent). Therefore, it is confirmed that, in the videos produced by users, the percentage against established scientific knowledge is higher than the percentage against science in the videos by the rest of producers.

Our second hypothesis (H2) was that, among the videos produced by media, the percentage of neutral videos would be higher than among the videos by other producers. However, this hypothesis is not confirmed by the chi square test (X^2 (1) = 1.19; $p > 0.05$). Therefore, it cannot be stated that the media take a more neutral stance than the rest of producers.

Among 34 videos that took an anti-science stance, 18 (52.9%) were linked to YouTube and one of them to Facebook. The remaining 15 were linked to several online news media—either legacy media like *The Guardian* or *ABC News*, or newcomers like *The Huffington Post*. Although these media are not detractors of science, in some cases they produced videos giving exclusive voice to those who denied established science (e.g., "US climate change deniers," 2015) and provided links to videos of other anti-science producers (e.g., "Sarah Palin compares climate change 'hysteria' to eugenics," Relly, 2014).

Who are, then, the dissonant voices in our sample? In climate change videos, we find several American conservative politicians, like Sarah Palin, Ben Carson and Carly Fiorina, as well as the Prime Minister of India, ultranationalist Narendra Modi. The list also includes several controversial people, like the author of *The Skeptical Environmentalist* (2001), Bjorn Lomborg, and the nuclear industry consultant and former president of Greenpeace Canada, Patrick Moore. The denialist think tank Heartland Institute is also included in the sample.

As far as vaccine videos are concerned, dissonant voices came from candidates for the Republican nomination to the Presidency of the US, Donald Trump and Rand Paul; YouTube channels (Experimental Vaccines; Hear this well; Autism media channel); Facebook celebrity Dr. Tenpenny on vaccines and current events; Irish broadcaster and politician Paschal Mooney; and radio show host and conspiracy theorist Alex Jones.

Only two videos take an anti-nanotechnology stance and no relevant voices from public opinion are included.

5.3. Research Question 3

Voices of scientists are more frequently represented in videos about vaccines (53%), followed by videos on nanotechnology (46.5%) and climate change (27%). As seen in Table 4, scientists are more likely to be present in pro-science videos (46.5%) than anti-science clips (35.3%) or neutral ones (35.3%). Similarly, videos without scientists make up 53.5% of pro-science videos, compared with 64.7% of anti-science and neutral ones. However, the differences are not statistically significant (X^2 (1) = 1.60; $p > 0.05$). Therefore, H3 is not supported: scientists have no statistically significantly stronger presence in videos favoring established scientific knowledge than in videos against or neutral about such knowledge.

Table 4. Scientists' voices.

	Pro-science (%, n = 458)	Anti-science (%, n = 34)	Neutral (%, n = 334)
Videos with scientists	46.5	35.3	35.3
Videos without scientists	53.5	64.7	64.7
H3: X^2 (1) = 1.60; p > 0.05			

6. Discussion

We have asked to what extent scientific videos obtained through the Google search engine have a neutral orientation, or are positioned in favor or against established scientific knowledge. Our results show that the videos obtained through the Google search engine are mainly positioned in favor of established scientific knowledge or display a neutral stance. Only a few videos were found to question the established scientific knowledge on climate change, vaccines, and nanotechnology. This result does not necessarily mean that this is also the case for the whole Internet universe, since it is known that the algorithms that the Google search engine uses to numerically assign the relevance of the documents that are indexed (called PageRank) give priority to videos from relevant sources, thus potentially minimizing the presence of videos from sources that take an anti-science stance.

Our results contradict those of other studies that found a more prominent representation of videos with an anti-science stance on YouTube, as explained in the introductory section (Allgaier, 2019; Avaaz, 2020; Ekram et al., 2019; Song & Gruzd, 2017; Venkatraman et al., 2015; Yiannakoulias et al., 2019). The differences in search results on Google and YouTube have been empirically verified in the present study. This indicates that Google is a safer search engine when it comes to finding reliable information, while YouTube video recommendations remain controversial.

We asked which video producers are more likely to launch neutral messages, for, or against established scientific knowledge. The videos produced by non-scientific institutions are more frequently in favor of pro-science than those produced by other types of producers, including scientific institutions. This may be explained by considering that among non-scientific institutions there are national and international institutions, as well as NGOs that support science. Researchers have discussed the role of NGOs in science communication (e.g., Doyle, 2007, on climate change; Vanderslott, 2019, on vaccines). Here empirical evidence of its weight in pro-science videos is provided.

Some videos with an anti-science stance have been produced by news media, as part of their information about opinions of outsiders (groups or individuals). In such cases, it cannot be stated that the media play against established scientific knowledge, since they fulfill the informative mission of offering a varied set of opinions on a given topic, trying to strike a balance among several sources.

In addition, the context in which the aforementioned videos were published should be taken into account. Even though we only analyzed the video content, in many cases videos are part of a news site where each video is contextualized with accompanying text. Moreover, some other videos had previously been broadcast on television, where a presenter introduces the video providing some contextual information.

In general, results indicate that the media are pro-science. It cannot be stated that they take a more neutral stance than the rest of video producers (H2) and the number of anti-science videos produced by media is low. However, research on climate change conducted by Petersen et al. (2019) found that, even in prestigious news media like *The New York Times*, *The Guardian* and *The Wall Street Journal*, 'climate skeptics' were cited slightly more often than voices supporting scientific consensus. This raises the question whether points of view against scientific consensus are used too often, perhaps because they are regarded by journalists as being more interesting for the public.

Only one of the three hypotheses that we posed has been corroborated: In the videos produced by users (UGC), the positioning against science is greater than in the videos produced by other actors (H1). Most UGC videos were distributed via YouTube, which confirms previous research linking this platform and anti-science videos (Allgaier, 2019; Song & Gruzd, 2017; Venkatraman et al., 2015).

Quite surprisingly, H3 has not been demonstrated. Contrary to what we hypothesized, scientists are evenly represented both in videos with a pro-science stance and in videos with an anti-science stance. The reason might be that the sample of anti-science videos was small. In any case, it is likely that detractors include scientists in their videos to provide an image of epistemological authority.

7. Conclusions and Limitations

Our research has provided the first empirical evidence showing that the characteristics of videos obtained through the Google search engine may differ significantly from those of YouTube. In particular, we have demonstrated that, compared to YouTube videos, the videos obtained through the Google search engine display a differ-

ent position regarding the support of established scientific knowledge.

Furthermore, among the videos obtained through the Google search engine, an anti-science stance is more frequent in UGC than in other types of content. Our research has also demonstrated that non-scientific institutions play a notable role in the diffusion of reliable scientific information, since the videos they produce often support established scientific knowledge.

The relatively small representation of videos with an anti-science stance in the results provided by Google videos can be regarded as positive. After all, this search engine provides results that usually support established science, thus minimizing the possible impact of misinformation that results from spreading information that contradicts established scientific knowledge.

We have also confirmed that the neutral stance is no more frequent in videos produced by news media when compared to other producers. In general, the media tend to support established scientific knowledge, though still lending space to the representation of anti-science videos. Even if this result is consistent with the journalistic principle of balance, it can have a worrying potential contribution to the public's misinformation about certain scientific disciplines.

Since science detractors frequently give voice to scientists in videos that contradict established scientific knowledge, it is advisable for science advocates to counter that trend and reinforce the presentation of scientists' voices in their productions as well. It is also recommended that scientists who support established scientific knowledge should play a more active role in spreading science through online video, which has become a most relevant source of scientific information for the public.

The results of our research are admittedly limited to a specific search through Google videos. However, we consider that it is possible to generalize some relevant conclusions, based also on the contrast of our results with previous studies. It provides a starting point for future research on science communication through online videos.

Acknowledgments

This work was funded by the Spanish Ministry of Economy and Competitiveness (COS 2013–45301-P). Special thanks are due to the reviewers of *Media and Communication* for their invaluable suggestions.

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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COGITATIO

Media and Communication (ISSN: 2183–2439)
2020, Volume 8, Issue 2, Pages 339–352
DOI: 10.17645/mac.v8i2.2858

Article

Vaccine Assemblages on Three HPV Vaccine-Critical Facebook Pages in Denmark from 2012 to 2019

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Submitted: 31 January 2020 | Accepted: 6 April 2020 | Published: 26 June 2020

Abstract
Misinformation about vaccines on social media is a growing concern among healthcare professionals, medical experts, and researchers. Although such concerns often relate to the total sum of information flows generated online by many groups of stakeholders, vaccination controversies tend to vary across time, place, and the vaccine at issue. We studied content generated by administrators on three Facebook pages in Denmark established to promote critical debate about Human Papillomavirus (HPV) vaccination. We developed a qualitative coding frame allowing us to analyze administrators' posts in terms of prevalent topics and intertextual material incorporated by linking and sharing. We coded more than a third of the posts (n = 699) occurring in the period from November 2012, when the first page was founded, to May 2019. We found that the pages mainly addressed the reports of adverse events following HPV vaccination and the (perceived) inadequate response of healthcare systems. To construct their central message, the pages assembled different sources, mostly reporting from Danish news media, but also personal narratives, scientific information, political assertions, and more. We conclude that HPV vaccination assemblages such as these pages are heterogeneous and contextual. They are not uniform sites of vaccine criticism, but rather seem to respond to and exchange information and misinformation within the communication environment in which they are embedded.

Keywords
controversy; Denmark; Facebook; Human Papillomavirus; misinformation; qualitative content analysis; social media; vaccination

Issue
This article is part of the issue "Health and Science Controversies in the Digital World: News, Mis/Disinformation and Public Engagement" edited by An Nguyen (Bournemouth University, UK) and Daniel Catalan (University Carlos III of Madrid, Spain).

1. Introduction

Misinformation about vaccines is a widespread concern among researchers and healthcare professionals. The term misinformation usually means wrong or faulty information, and often the point of reference is scientific information. Medical authorities, expert groups, and individual researchers worry that vaccine misinformation flourishing in media environments may lead to vaccine hesitancy and ill-informed political or juridical decisions (e.g., Burki, 2019; Ghebreyesus, 2019; Larson, 2018). The affordances of the internet and social media enable users to contribute to the global flow of vaccine information in unprecedented ways, while building relations across geographical and institutional borders, forming shared narratives, and possibly affecting actions (Bucher & Helmond, 2017). The sources of vaccine misinformation on the web range from small, but often well-organized interest groups, which deliberately spread false information about vaccines, to well-meaning individuals who take it upon themselves to act as "nonprofessional risk communicators" (Kahan, 2017). Medical authorities around the

world are concerned about the total effects of such communicative efforts.

Partly in response to concerns over the intensification and diversification of vaccine information, scholars have advanced our understanding of online vaccine criticism. Some studies have focused on homepages and blogs (Bean, 2011; Kata, 2012; Moran, Lucas, Everhart, Morgan, & Prickett, 2016; Okuhara, Ishikawa, Okada, Kato, & Kiuchi, 2018; Ward, Peretti-Watel, Larson, Raude, & Verger, 2015; Wolfe, Sharp, & Lipsky, 2002). Others have analyzed vaccine-related content on popular social media platforms such as Twitter, Pinterest, YouTube, Instagram, and Facebook (see, for example, Basch & MacLean, 2019; Guidry, Carlyle, Messner, & Jin, 2015; Hoffman et al., 2019; Ma & Stahl, 2017; Schmidt, Zollo, Scala, Betsch, & Quattrociocchi, 2018; Smith & Graham, 2017; Tomeny, Vargo, & El-Toukhy, 2017; Yiannakoulias, Slavik, & Chase, 2019). Though concepts such as the 'anti-vaccination movement' and 'anti-vaxxers' are often evoked in the public and in academic debate, studies tend to show that vaccine-critical groups and individuals are in fact heterogeneous, and that the discourses they employ vary from one context to another (see also Ortiz, Smith, & Coyne-Beasley, 2019).

These findings underscore the importance of paying closer attention to the differentiated nature of vaccine-criticism and vaccine-critical information. In his study of the swine flu vaccine controversy in France, Ward (2016) concluded that a minority of critical groups and individuals mobilized against vaccination in general while most were only occasionally active and only critical of a given vaccine based on particular arguments. Ward's (2016) study shows that the prevalence of concerns, topics, and discourses often rely upon the contextual nature of the communication environment in which vaccine controversies take place and therefore vary across time, geographical settings, and the vaccine(s) at issue (see also Leach & Fairhead, 2007). This means that cultural and political issues beyond vaccines themselves affect information and communication about vaccination (Kahan, 2017; Ward, Peretti-Watel, & Verger, 2016).

Kahan (2017) coined the notion of the vaccine communication environment to designate the "sum total of practices and cues that orient individuals in relation to what is known by science." The vaccine communication environment is 'safe' as long as everyone communicating about vaccines recognizes what counts as best available scientific evidence about vaccine efficiency and safety. The environment becomes 'polluted' when information with no or little relevance to the scientific risk assessment is being introduced into the environment, thus making it more difficult for parents and others to discern what is known by science. In the US, the Human Papillomavirus (HPV) vaccine debate became polluted by terms such as the 'promiscuity vaccine' or the 'virgin vaccine,' which implied that the female-only vaccine would lead to increased and unprotected sex among vaccinated girls and young women. Kahan, Braman, Cohen, Gastil, and Slovic (2010) found that, as a result, cultural values affected people's processing of scientific information about the vaccine.

We follow Ward (2016) in addressing the contextual nature of vaccine criticism as well as Kahan (2017) in trying to probe the conflation of scientific and non-scientific information in the vaccine communication environment. Thus, we are not interested in sorting information from misinformation. Rather, our aim is to study what we, inspired by Latour's (2005) work on the assembling of the social, will refer to as 'vaccine assemblages.' In a multimodal communicative context such as social media, vaccine assemblages result from combining many pieces of information and different modes of communication about vaccination into a heterogeneous, shifting and contextual whole. Thus, vaccine assemblages relate to Leach and Fairhead's (2007) concept of vaccine anxiety, which implies that streams of content on social media platforms, much like mothers' talk about vaccination, assembles scientific information about vaccines, personal narratives related to vaccination, objective reporting, value assertions about healthcare, and much more. To study vaccine assemblages on Facebook, we identified three Facebook pages in Denmark established to facilitate and promote critical debate about the HPV vaccine. The content provided by pages such as these has been a particularly critical part of the Danish HPV vaccine communication environment, where scientific information provided by the health authorities met other types of information and other modes of communication from other sources.

2. Background

HPV is a group of common viruses, mainly transmitted through sexual contact. Some high-risk types, including HPV-16 and HPV-18, are known to cause cancers, such as cervical cancer. In 2007, a working group commissioned by The Danish Health Authority (Sundhedsstyrelsen) carried out a medical technology assessment. Based on available empirical evidence, they estimated that around 70% of all cervical cancer cases, accountable for approximately 175 deaths annually in Denmark, could be prevented by offering Danish girls the quadrivalent HPV vaccine Gardasil through the childhood immunization program (Sundhedsstyrelsen, 2007). The Danish parliament unanimously approved to introduce the vaccine by January 2009, targeting girls at the age of 12 years.

Within the first years after the introduction, the support for the HPV vaccination program in Denmark was relatively high compared to other developed countries (European Centre for Disease Prevention and Control, 2012). In 2013, however, the vaccine began to receive negative media coverage. First, a journalist on the broadsheet newspaper *Politiken* reported on possible conflicts of interest among some general practitioners who were receiving support from Sanofi Pasteur, the multinational pharmaceutical company involved in the manufacturing and promotion of Gardasil in Denmark. A few weeks later,

the same journalist wrote about a named girl suffering from a serious illness after receiving the second dose of the HPV vaccine. The journalist used Facebook to search for other girls with suspected adverse events, and the request soon circulated on Danish social media and blogosphere. Similar stories appeared in national and local media with girls, their families, and a few health professionals as sources (Smith, 2018; Suppli et al., 2018).

On March 26, 2015, the national public-service broadcaster TV2 screened the documentary *The Vaccinated Girls—Sick and Betrayed*. The documentary and subsequent news items revolved around 47 Danish girls suffering from headaches, cramps, syncope, and extreme fatigue. Some of them had been diagnosed with Postural Orthostatic Tachycardia Syndrome (POTS) or Complex Regional Pain Syndrome (CRPS). They all reported that the symptoms first appeared or significantly worsened following HPV vaccination. About 500,000 (out of a total population of 5.7 million in 2015) persons viewed the documentary, and it was widely discussed in the news and on social media. Suppli et al. (2018, p. 2) note that the documentary accelerated the negative coverage of the HPV vaccine, which "was followed by a marked decline in HPV-vaccination and an increased rate of reported suspected adverse events."

Due to the increased amount of reporting on potential adverse events, the Danish Health Authority requested a review of HPV vaccines by the European Medicines Agency (EMA). In November 2015, EMA concluded that evidence did not support that HPV vaccines cause POTS or CRPS, and that reports about suspected adverse events after HPV vaccination were consistent with what would be expected in this demographic group (EMA, 2015). However, the EMA report did not bring the controversy to a close. The media continued to report cases of suspected adverse events, and the report became subject to debate about the evidential support of its claims. Around the same time as the publication of the EMA report, the free newspaper *metroxpress* initiated its critical HPV campaign that drew on information from groups supporting the afflicted girls and their families. The number of girls who received HPV-vaccination continued to decline.

In May 2017, the Danish Health Authority, in collaboration with the Danish Medical Association and the patient advocacy organization the Danish Cancer Society, launched the Stop HPV campaign. Consultant to the Society, Louise Hougaard Jakobsen, explained that "[much] of the debate about the HPV vaccine takes place on Facebook, and this is where many parents get their information" (as cited in World Health Organization, 2018). Jakobsen herself had conducted a survey in 2016 among 1,053 parents of girls aged 10–13 years. It showed that more than 80% of the respondents who reported having actively sought information about the vaccine had used the internet as a source of information (Jakobsen, 2016).

The Stop HPV campaign generally received positive coverage. Most news media began cautioning against the decline in HPV vaccination uptake. Reporters, editors, and others blamed the 2015 TV2 documentary for excessive emotionalism and for failing to report the facts about HPV vaccination. Commentators from academia and the health authorities interpreted the whole HPV controversy in the light of fake news and the spread of misinformation on social media (Smith, 2018). In 2017 and 2018, HPV vaccination rates rose (Statens Serum Institut, 2019).

3. Materials and Methods

Facebook content seems to have played an important role in the HPV controversy in Denmark where the vaccine information environment became 'polluted' as news media and social media increasingly reported on adverse events following HPV vaccination that were not substantiated by scientific evidence. We were interested in studying content provided by vaccine-critical Facebook pages (henceforth pages). We, therefore, searched Facebook using search string such as 'hpv,' 'hpv vaccine,' and 'hpv vaccine bivirkning*' ('hpv vaccine adverse event*'). Based on the results, we identified the most popular HPV-critical pages in Denmark in terms of likes and followers. In the following sections, we present the three pages and our analytic approach.

3.1. Three Vaccine-Critical Groups and Their Pages

The three pages were established by the following social groups, which for the sake of brevity we will refer to as Group A, B, and C, and to their pages as Page A, B, and C (see list below). We last accessed the three pages in the middle of December 2019, when they were all still active. Here, some 5,900 Facebook users liked Page A, while Page B and C had around 8,100 and 1,800 likes, respectively.

- Group A: HPV Vaccine Info—Fighting for Fair Information about The HPV Vaccine (HPV Vaccine Info—Til kamp for retfærdig oplysning om HPV-vaccinen)
- Group B: HPV Update (HPV-update)
- Group C: The National Organization for Those Afflicted by HPV Adverse Events (Landsforeningen HPV-Bivirkningsramte)

Group A consists of an unknown number of "passionate writers," who created the page in November 2012 (HPV Vaccine Info, 2020). Groups B and C are both patient support groups, established to support patients suspecting their symptoms to be caused by HPV vaccination. Group B is a special group under The Danish Association of the Physically Disabled, which is an NGO aiming to ensure equal rights and accessibility for persons with physical disabilities. Group C is an independent organization. Page B dates from November 2014, Page C from May 2015. Each of the three groups also hosted

their own website, and two of them were moderately active on other social media platforms such as Twitter and YouTube. We found that the groups' Facebook pages were the most important channels for public outreach.

Group B considers themselves "neither for nor against the HPV vaccine" (HPV-update, 2017). The two others do not specify a particular attitude towards HPV vaccination. On their respective pages, the three groups provide information on critical issues related to HPV vaccination, and they are most often critical of the information provided by the health authorities and organizations in support of the vaccine.

3.2. Sampling Strategy

We accessed all posts on all three pages from November 2012 (when Page A was established) to May 2019 (when the activity level on Pages A and B had dropped to nearly zero). We collected information about the total number of monthly posts on all three pages and then decided to construct a sample corpus of about one-third of all posts. We wanted the number and distribution of posts in our sample corpus to be as representative of the full corpus of posts as possible. We also wanted to make sure that months with a low level of activity were represented in our sample corpus. So, we sampled for each month post number one, four, seven, etc. This resulted in a sample corpus consisting of 699 posts.

3.3. Qualitative Content Analysis

In order to collect systematic information about the content provided on the three pages, we chose to conduct a qualitative content analysis of all posts in our sample corpus. Following Schreier (2012), we constructed our coding frame around two main categories: topic and source. This frame nicely captured the two basic elements of posts, namely content authored by administrators (topic) and the optional linking to other sites on the internet or sharing of material from other sites (source). The full coding frame, including definitions and examples, is available by request from the authors.

We generated subcategories for the topic category in our coding frame through a data-driven, iterative process, relying on the interrelated strategies of summarization and subsumption (Schreier, 2012, p. 88). Reading the content of the posts, we first summarized the material by paraphrasing content in short sentences or keywords and then used the paraphrases to generate potential subcategory names. We subsumed different potential subcategories under one, if possible, to achieve the lowest number of operational subcategories that describe the material in fullest detail (see Table 1).

As regards to the source category, we employed a combined concept and data-driven strategy (Schreier, 2012, pp. 89–90). We relied on Fairclough's (2003, pp. 47–55) notion of intertextuality to alert us to additional meanings generated by the presence of links to external sources in posts. Based on the material available in our sample corpus, we then operationalized intertextuality in our coding scheme by expanding the source category to include three main categories: language, linked items (for example, videos, images, tweets, or other Facebook posts), and source of information (namely the actors, i.e., a person, group, or organization that has authored or published the external source). Each of these categories has a number of subcategories (see Table 1).

It should be noted that posts often incorporated sources from more than one external platform. For practical reasons, we coded only one source per post in the following way: If a link was highlighted in the header of the post, we coded the highlighted link. If no link was highlighted, we coded the first link in the post (from top to bottom). Even if a post has no links, the post still may incorporate external items in another way, for example by sharing images or Facebook content from other profiles or pages, or by copy-pasting full-length texts or elements of texts from external sources. If this was the case, we located the original item and coded it in accordance with our categories.

Table 1. Coding frame with categories and subcategories.

Categories	Example
Topic	Adverse events, effect of vaccine on cancer, healthcare system (local), healthcare system (national), healthcare system (international), vaccines in general, alternative healthcare, news media, political actors, no topic, no administrator content
Language	Danish, English, Norwegian or Swedish, other, unknown or N/A, no external element
Linked item	Website article, Facebook content, other social media content, audio or video, blog post, scientific publication, open letter or public statement (e.g., press release or reader's letter), shared picture or meme, event, other, unknown, no external element
Source of information	Group's own homepage, content provided by the two other groups in this study, Danish news media, non-Danish news media, other vaccine group, patient group, other organization or company, health authority or institution, journal, private person, other, unknown, no external element

3.4. Reliability

For an initial assessment of the reliability of our topic category and the included subcategories, we compared it to categories found in previous studies of vaccine criticism online (Bean, 2011; Moran et al., 2016; Okuhara et al., 2018; Ward et al., 2015). We found what we think is a reasonable agreement between our subcategories and those employed in other studies.

We then constructed and assessed the reliability of our entire coding frame through an iterative process. Initially, all three authors discussed the coding frame and agreed on all subcategory names, definitions, and examples. Two authors then independently coded a random selection of around 10% of the 699 posts.

In order to validate our coding of the 'language' and the 'source of information' categories, where categories are disjoint, we used Cohen's κ to measure inter-coder reliability (Cohen, 1960). For the 'linked item' category, where posts occasionally were coded in more than one of the subcategories, which makes the risk of agreement by chance very low, we checked for agreement between coder and co-coder on all co-coded posts and, as a measure of inter-coder reliability, we calculated the percentage of agreement. For the 'topic' category, where posts could fall into one or more sub-categories, we assessed the applicability and reproducibility of each of the suggested subcategories. We then compared coding results one by one via Cohen's κ.

We aimed for inter-coder reliability indices above 0.8 as this is often considered to be acceptable (Lombard, Snyder-Duch, & Bracken, 2002). If we were unable to reach an acceptable agreement, we stabilized the coding frame by removing problematic subcategories or clarifying coding instructions. After the reliability of our categories and subcategories had been established, one author proceeded to code all remaining posts.

4. Results

4.1. Coding Frame

Our coding frame is, in principle, our first result (see Table 1). It defines what we believe are the most prevalent and thus most important categories and subcategories for analyzing content on the three pages.

4.2. Post Frequency

The frequency of posts per month is shown in Figure 1. The activity level differs greatly between pages and between months. Page A has 4.1 monthly posts on average, whereas the corresponding numbers for Page B and C are 10.0 and 21.1, respectively. The maximum numbers of

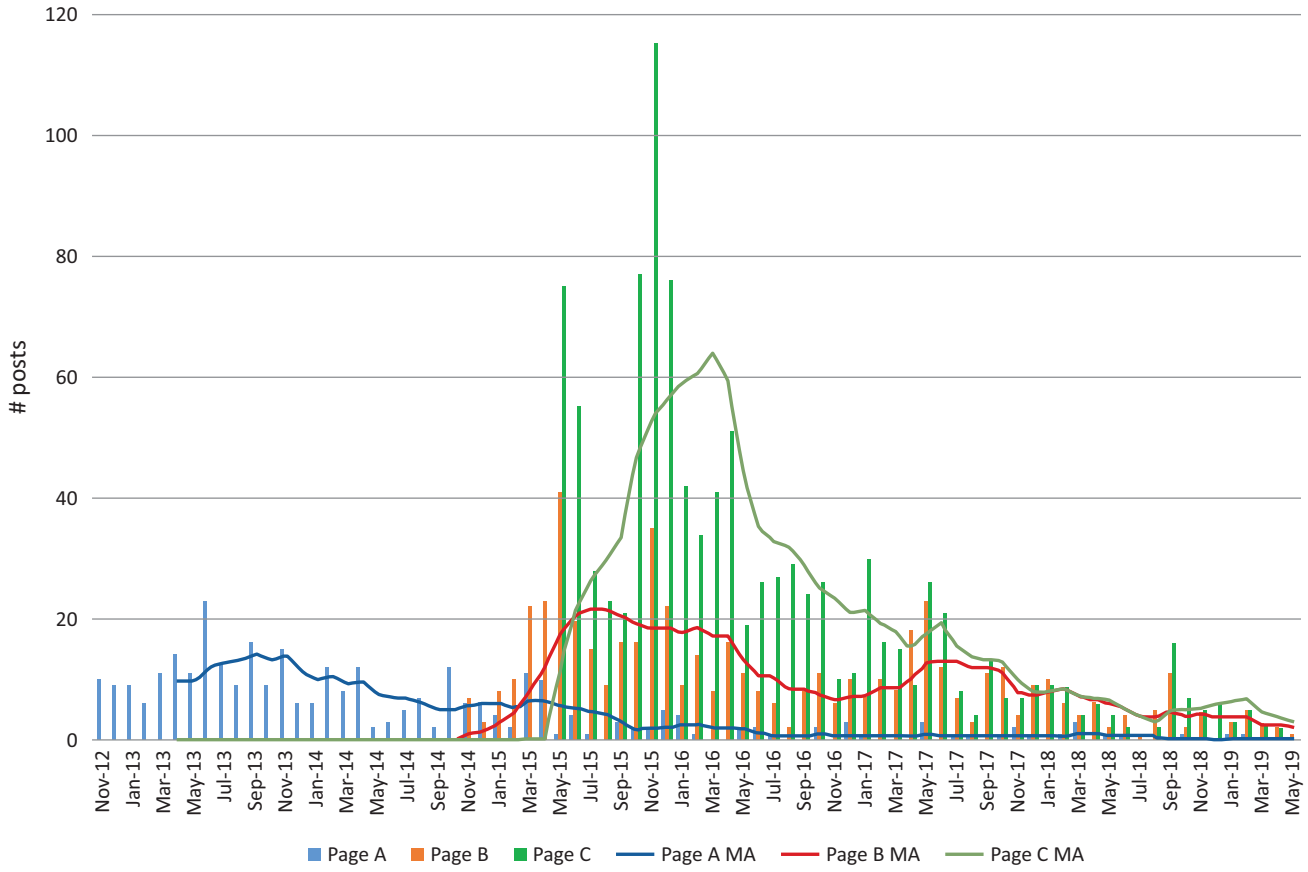

Figure 1. Frequency of posts from November 2012 to May 2019 with corresponding six month simple moving averages. Note: Our count was last updated on December 13, 2019.

posts in a particular month are 23 posts for Page A in June 2013, 41 posts for Page B in May 2015 and 115 posts for Page C in November 2015. All three pages were most active in the first 1.5 years, and the activity level on all three pages reached a peak between six and eight months after their establishment. Moreover, local peaks in activity level on all pages often coincided with central events in the Danish HPV debate. Figure 1 has four peaks corresponding to important events in the Danish HPV controversy (cf. background above):

1. Summer of 2013 (Page A only): First media coverage of reported adverse events
2. April–May 2015: After the screening of "The Vaccinated Girls" on TV2
3. November 2015: Publication of the EMA report and critical HPV coverage in the free newspaper *metroxpress*
4. May 2017: Launch of Stop HPV campaign

4.3. Topics

Our coding of topics featured in the content provided by administrators appears in Figure 2. The two most prominent topics on all three pages were adverse events following HPV vaccination and healthcare systems, which were also the prominent topics in the general public debate as described earlier (Amdisen, Kristensen, Rytter, Mølbak, & Valentiner-Branth, 2018; Suppli et al., 2018). Our results show that the three HPV vaccine-critical groups on their respective pages responded to the ongoing controversy by focusing on the safety of HPV vaccination (adverse events) and the actions of health authorities.

In Figure 2, the healthcare system subcategory subsumes the three levels of healthcare systems presented in Table 1. We can add that across all three pages the national healthcare system featured most frequently in the content provided by administrators. In particular, the three institutions that in 2017 were behind the Stop HPV campaign received most mentions, and, almost exclusively, administrators' posts were critical of the campaign.

Figure 2 also shows important differences between the three pages. Compared to Page A, Page B and C had a more narrow focus on potential adverse events. The administrators on Page A more frequently posted content relating to the effect of HPV vaccination on cancer,

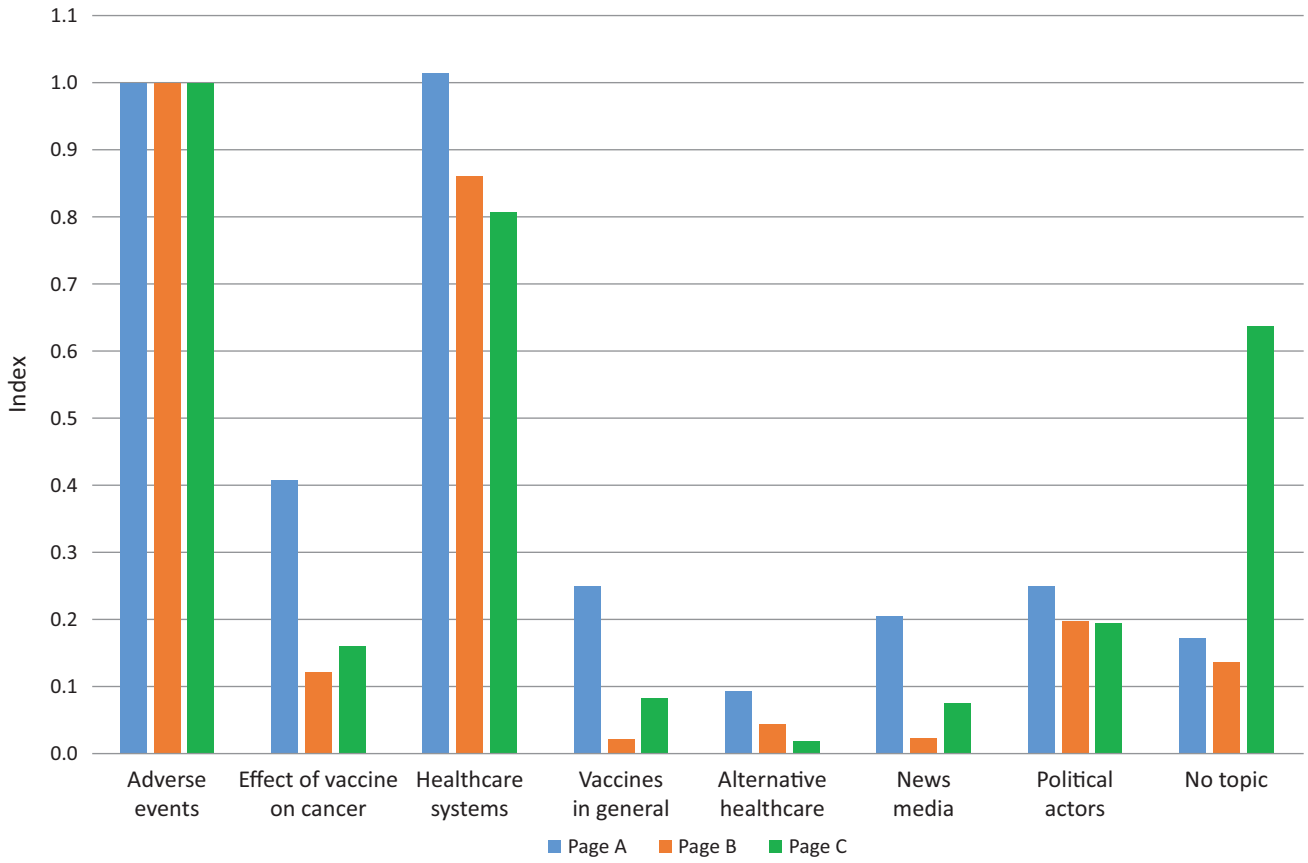

Figure 2. Relative frequencies of topics normalized by the frequency of 'adverse events' (1.0) for each page. Notes: The healthcare systems category in this figure subsumes the three levels in the healthcare system subcategory presented in Table 1 (local, national, and international). We explain the high rate of 'no topic' posts on Page C by the fact that posts may refer to more than one topic, and lengthy posts therefore tend to produce more topics in the coding process compared to shorter ones. Page C posts tended to be shorter compared to posts on Page A and B, and shorter posts tended to be topicless.

vaccines in general, alternative healthcare, and the news media. We would explain this observation by the fact that Page A was administered by a group of writers more broadly interested in many topics relating to HPV vaccination, whereas Page B and C belonged to patient groups.

Relatively few posts pertained to vaccines in general or to alternative treatments. News media and political actors, i.e., institutions or individuals that have some measure of political power or authority when it comes to policymaking, also featured relatively infrequently in the content provided by administrators. So did the effect of HPV vaccines on cancers associated with HPV, most typically cervical cancer. The administrators of Page A, however, did cover this topic about 40% of the times they mentioned adverse events. All of their comments on the effects of HPV vaccines were skeptical about studies or comments indicating that HPV vaccination would tend to decrease the number of new cervical cancer cases.

4.4. Intertextuality on Page A

The administrators of Page A, in their posts from November 2012 to June 2013, most frequently provided links to international news media (see Figure 3). Some of these links referred to national news outlets such as CNN (primarily USA) or the Australian tabloid media *The Daily Telegraph*. Others, more typically, shared material from media with a more limited circulation. For example, one post on Page A shared an article from *Idaho Mountain Express*, headlined "HPV vaccine is not the right solution," while other posts linked to American right-wing news outlets such as Alex Jones' *Prison Planet* and *USA.RightWingAmerica*, known to publish anti-vaccination material. In addition, media outlets advocating 'natural' alternatives to conventional healthcare such as the website *Natural News* recurred as a source of information on the page in its early stages.

However, the international element was not a stable feature of Page A's information stream. During 2013, links to Danish news media began to dominate. The linked news items included stories about individual concerns over the safety of the vaccine with headlines such as "Simone received the HPV vaccine: I feel pain every single day," and "Rebecca wanted to protect herself against cancer: Crippled by the vaccine." Yet, the administrators also found a reason to criticize media coverage. A post from late June 2013 contained a collage of media headlines, all of which referred to the HPV vaccine as a "cervical cancer vaccine" (HPV Vaccine Info, 2013a, authors' translation). The administrators supplied the collage with a red-letter stamp stating "it is not a vaccine against cancer" (HPV Vaccine Info, 2013a, authors' trans-

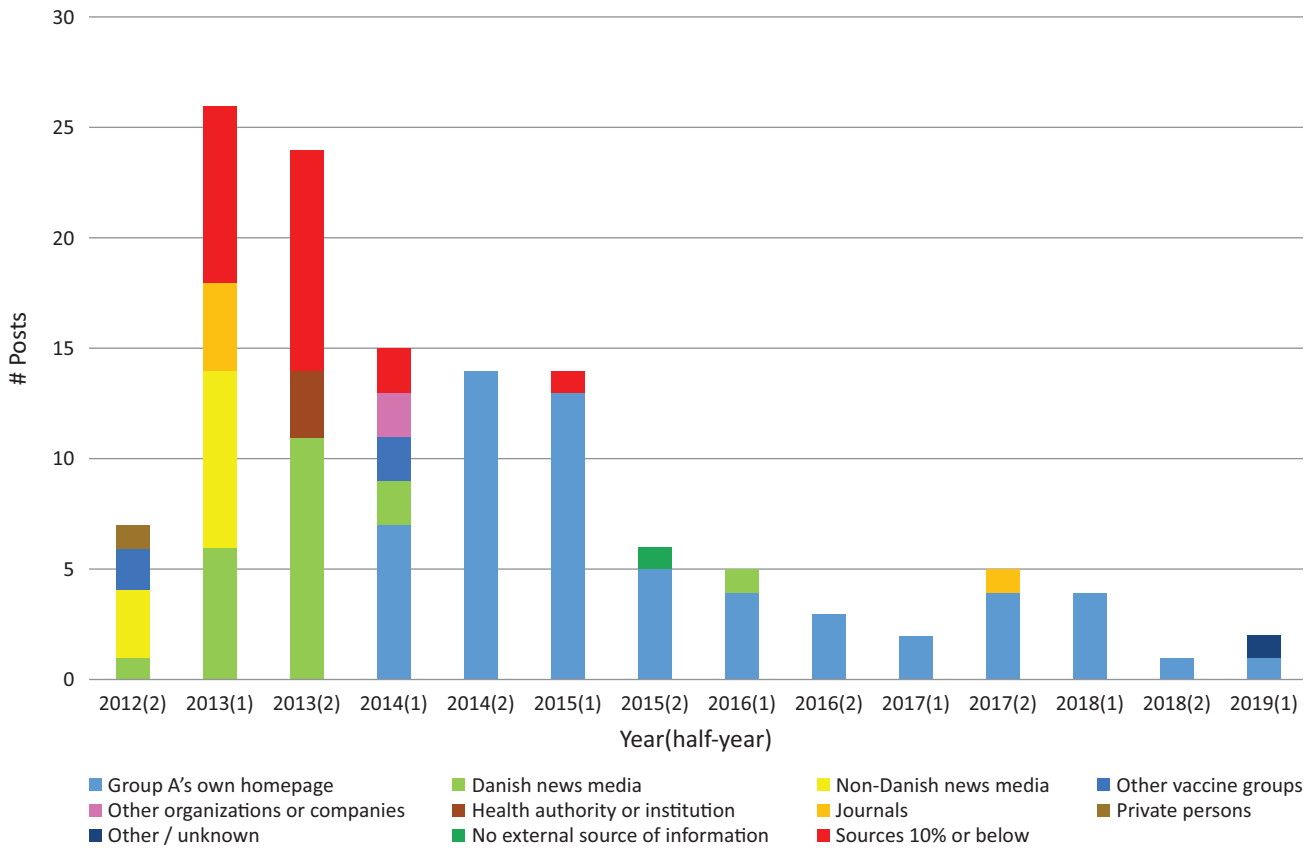

Figure 3. Sources of information on Page A until May 2019. Notes: In order to optimize data visualization, all sub-categories with relative frequencies of 10% or below have been merged into one (red section). For the same reason, we merged sub-categories 'other' and 'unknown.' The same applies to Figure 4 and 5.

lation), and suggested that the media coverage was misinformation staged by the Danish Cancer Society.

From 2014 onwards, the posts on Page A almost exclusively linked to articles published by Group A on its homepage. These posts served as short introductions to Group A's own information and often provided sensational or curious headlines such as "Gardasil will be the biggest medical scandal in history" (April 2014, authors' translation) and "The Cancer Society's dirty secret" (December 2015, authors' translation). Group A's articles on their homepage often were lengthy comments on topics of current interest, including recent events, news stories, research articles, or stakeholders' statements in the ongoing debate. In particular, Group A's writers were adamant about the role of the Danish Cancer Society in promoting HPV vaccination, more often than not insinuating that the Society conspired with pharmaceutical companies and the health authorities. One of the tags on Group A's homepage was "misinformation from the Cancer Society."

Group A was originally established because of alleged censorship on the Danish Cancer Society's Facebook pages (HPV Vaccine Info, 2020). Whether this is directly connected to the fact that the administrators of Page A seemed particularly concerned with exposing conflicts of interest in the established healthcare system, locally, nationally, and internationally, we, of course, cannot say for sure.

However, we did find that the dominant topic of the administrators' supplementary text in posts was healthcare systems. The national healthcare system featured in 33.3% of all posts, and the international health care system in 26.2%. The administrators often expressed general mistrust of key actors in Danish healthcare, such as The Danish Health Authority, The State Serum Institute (Statens Serum Institut), and general practitioners, and often hinted at possible conflicts of interest due to close ties to international pharmaceutical companies. In September 2013, the administrators compiled a list of Danish news items about possible conflicts of interests, and the administrators remarked: "It is difficult to have faith in the system in Denmark. There are numerous examples of the industry influencing every corner of it" (HPV Vaccine Info, 2013b, authors' translation).

4.5. Intertextuality on Page B

Page B most frequently used Danish media as sources (see Figure 4). Established as a platform for public outreach for a group of patients seeking to gain recognition of symptoms that they associate with HPV vaccination, Page B provided meta-coverage of the ongoing debate, with emphasis on political issues. The linked items generally served to promote the claim that the politicians and healthcare actors were not paying enough attention to this problem nor responding appropriately to issues

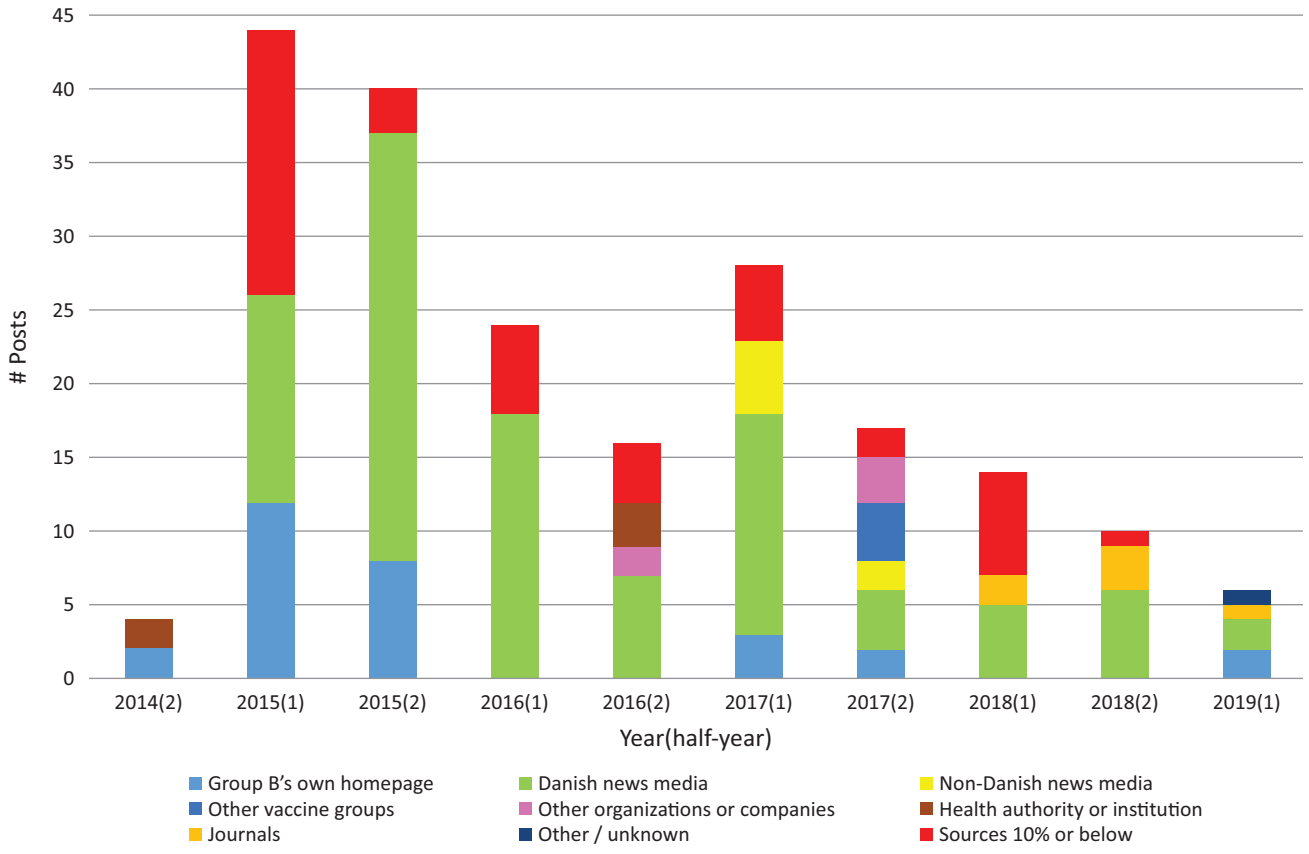

Figure 4. Sources of information on Page B until May 2019. Note: See also additional information in caption to Figure 3.

brought forth by patients. Headlines such as "Minister: We ought not to forget the ill girls" (authors' translation) and "HPV girls have to receive faster and better help" (authors' translation) support this claim.

It thus makes sense to understand Page B not only as outreach but also as part of Group B's struggle to obtain public visibility and political representation. This is perhaps most clearly seen in the 'we' that the administrators often used in their accompanying text to indicate that they are speaking on behalf of many patients. They expressed an urgent wish for better treatments, more research on the relation between their symptoms and HPV vaccination, increased visibility, and dialogue with politicians. Many posts, particularly in 2015 and early 2016, dealt with Group B's work to attain these goals. In May 2015, for example, administrators reported on the audience of Group B representatives with the Danish parliament's health care committee. Other posts shared news items with reporters interviewing Group B spokespersons.

Posts on Page B tied political issues to ontological and epistemological questions regarding the scale, frequency, and cause of the symptoms of Group B's patients. These questions were particularly prominent in the period after November 2015, where first the EMA report appeared and soon after other epidemiological studies on the relation between HPV vaccination and symptoms affiliated with other medical conditions such as Chronic Fatigue Syndrome/Myalgic Encephalomyelitis (CFS/ME), POTS, and CRPS (Arbyn, Xu, Simoens, & Martin-Hirsch, 2018; EMA, 2015; Feiring et al., 2017).

The administrators repeatedly challenged the scientific results by stating that the epidemiological and clinical studies were unable to take into account the lifeworlds of real patients. In September 2017, the page shared a link to the Med Science Research website, which claimed that "[t]here are thousands of scientific studies in the medical literature on the dangers of vaccine" (Med Science Research, 2017). The link referred to a series of studies, mainly case studies, reporting on individuals who have all experienced symptoms after HPV vaccination with Gardasil. By such means, the page refuted a pure epidemiological framing of the controversy and pertained instead to the promoting of research that aimed to explain the bodily experiences of individuals.

4.6. Intertextuality on Page C

Administered by representatives of the same patient group as Page B, Page C has some of the same features, including repeated links to media stories regarding the safety of the vaccine (see Figure 5). Compared to Page B, however, we observed that Page C more consistently incorporated personal stories of individual persons suffering from suspected adverse events. We are able to support this observation by noting that there were substan-

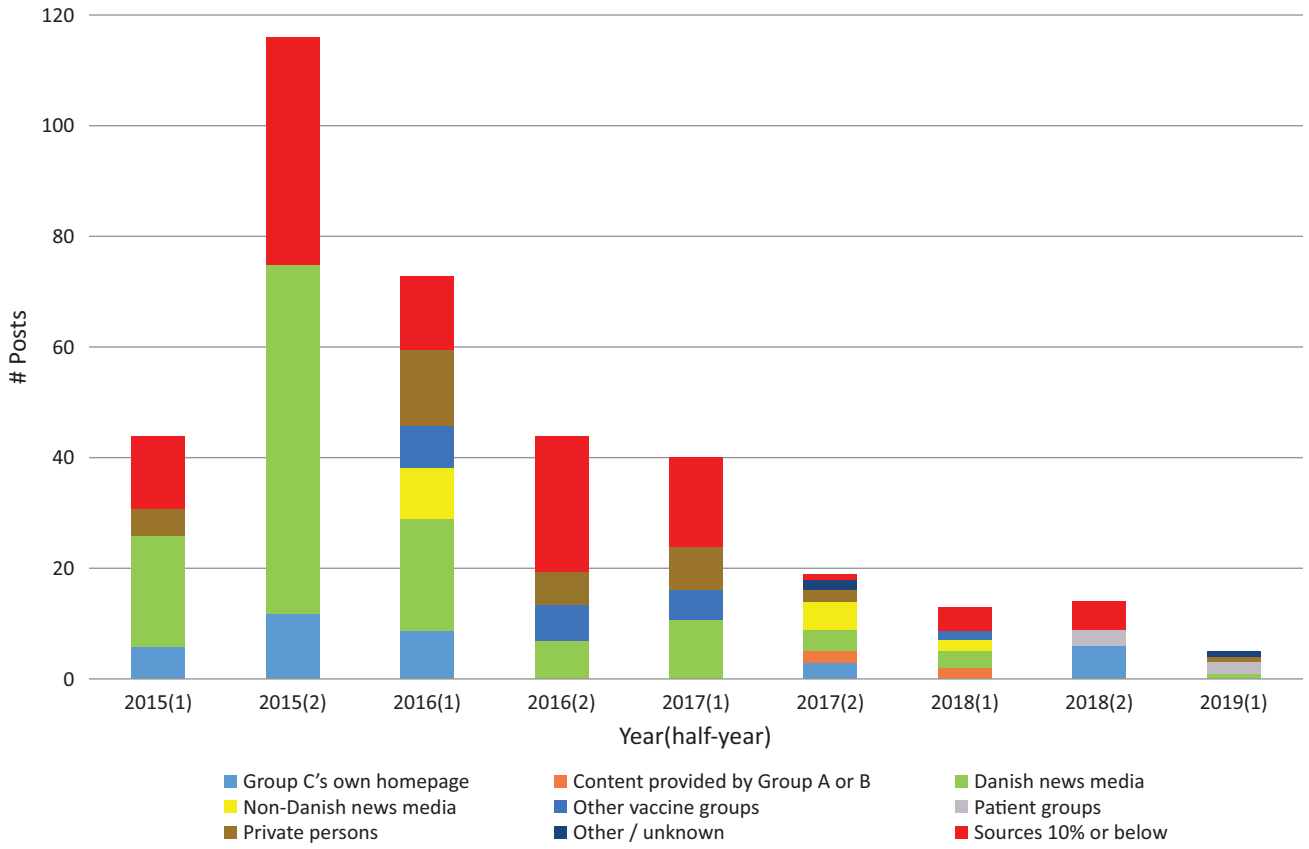

Figure 5. Sources of information on Page C until May 2019. Note: See also additional information in caption to Figure 3.

tially more links to private persons (13.0%) on Page C compared to Page A (1.6%) and Page B (2.0%).

The sources for the 'private person' category were individuals, typically patients or their relatives, telling personal, often emotional, stories about suspected adverse events or complaining about the lack of recognition from the established medical authorities. The linked items included written accounts, images, videos, open letters, or poems or songs. For example, videos depicted girls who were visibly suffering from cramps, seizures, or syncope. Written accounts provided further details about the girls' medical condition, often reporting on lack of support or even disrespect from healthcare professionals and politicians. "Let's be honest. You haven't done a lot to help us," stated an open letter in January 2016 (Landsforeningen Hpv-bivirkningsramte, 2016a, author's translation). It was written by a named woman addressing the health minister at the time. Another letter reported on a meeting between a female patient and a general practitioner who called the woman "an 'attention hore [*sic*]"' (Landsforeningen Hpv-bivirkningsramte, 2016b, authors' translation).

The stories and visual materials served to create common visibility and shared understandings. One of the first videos posted in May 2015 was followed by a statement from the administrators expressing hope that the videos posted on their page would help open the eyes of everyone to the adverse events following HPV vaccination. Such statements might also be interpreted in terms of community-building as the posts were trying to tell everyone, including patients who could be unsure about the real cause of their symptoms, that there is a coherent but somewhat overlooked community of 'the afflicted' girls and their families.

Administrators of Page C used the term 'afflicted' (in Danish, 'ramt') as a shorthand for all those afflicted by adverse events after HPV vaccination, building a common identity and community. For example, the cover photo of Page C, as of December 2019, showed around 50 people standing in front of the Danish Parliament, most of them holding a red balloon. The photo was taken in December 2015 when the group had an audience with the Parliament's Health Committee. According to the accompanying content provided by the administrators, the balloons were meant to symbolize all the afflicted who at the time were unable to attend the meeting. While images and content such as this mainly spoke to the national community of the afflicted, several posts on Page C also emphasized that the community was international in scope. "The patient group for HPV-injured [*sic*] in Ireland, R.E.G.R.E.T. is struggling as well. The HPV scandal is global" (Landsforeningen Hpv-bivirkningsramte, 2016c, authors' translation), an August 2016 post remarked.

The idea of an overlooked or even marginalized community became even more pronounced later on. In 2017 and 2018, administrator texts were generally longer, and the number of posts decreased. We also found in this period more references to the healthcare system. In 2017, for example, more than half of the posts referred to national healthcare actors such as the Danish Health Authority, the Danish Medicines Agency, or the Danish Cancer Society. These posts were often explicit in their critique of the established healthcare system and in positioning the community of the afflicted in opposition to the healthcare system.

From September 2017 and onwards, the administrators captured the oppositional stance of the community by adding this message to almost all posts:

> We are not supported by the pharmaceutical industry, so with a budget of 1/1000 of what The Cancer Society and the National Board of Health spend on their propaganda program, we are engaged in an uneven fight for equity for our many seriously ill young persons. (Landsforeningen Hpv-bivirkningsramte, 2017, authors' translation)

Like Page B administrators, Page C administrators used 'we' to build a separate identity for the afflicted. The notion of "an uneven fight for equity" suggests that 'we' are in a disadvantageous position compared to others with more resources and more impact (Landsforeningen Hpv-bivirkningsramte, 2017, authors' translation). There is also the implied corollary that the 'others' intentionally wanted to oppress or silence 'us.' "This lack of debate and focus on the many young people invalidated after their injection of Gardasil seems to be the greatest collective societal betrayal in newer time" (Landsforeningen Hpv-bivirkningsramte, 2018, authors' translation), the administrators lamented in January 2018.

5. Conclusion

We have explored how three Danish Facebook pages dedicated to critical debate about HPV vaccination assemble different topics and sources. The three pages have ranked among the most prominent and most active social media sites in the Danish HPV controversy from 2012 to 2019. We find that they all form a complex and shifting assemblage of information, assertions, expressions of community, and more. Our results are limited to topics and sources that appeared on the administrators' posts in the context of the ongoing controversy where media attention to HPV vaccination was relatively high. We were not able to address visitors' comments in order to see how they entered into the assemblage, nor have we been able to gain access to the administrators to hear about their motives. Such topics might be of interest for further studies.

Our most important specific findings include:

- All three pages focused on adverse events following HPV vaccination and the national healthcare system. The administrators across all three pages agreed that there was—is—a connection between HPV vaccination and the appearance or worsen-

ing of certain symptoms. They also agreed that the healthcare system responded inadequately to patients reporting adverse events from HPV vaccination. Often, conflicts of interest were evoked to explain why healthcare providers were reluctant to address adverse events from the point of view of those who claimed to be suffering;

- All three pages were closely linked to the public debate in Denmark as Danish news media were the most frequently used sources of information. We estimate that at least 36% of our 699 posts referred to stories reported by Danish journalists. We also found that news stories adopting a critical attitude towards HPV vaccination, for example by reporting on 'afflicted girls,' were shared more often than news stories reporting on scientific studies showing that HPV vaccination is safe;
- Beyond their common preference for sharing and commenting on stories in Danish news media, the three pages differed in their intertextual approaches. Page A mostly shared news stories and links to Group A's own homepage, where members of Group A claimed that the pharmaceutical companies have been a major force behind the introduction and promotion of HPV vaccination in Denmark. Page B administrators used their links to express concern about the lack of political and epistemic representation of the patients suffering from suspected adverse events. Page C administrators shared this concern to which they added personal narratives and content portraying the afflicted as an overlooked, yet strong community that deserves recognition and respect.

What the list above shows is that making HPV vaccine assemblages can be a daunting task. It proceeds from the premise that HPV vaccination is a moving target that can be approached from many perspectives and not only based on scientific knowledge. With their intimate relationship with the public debate that goes on in the traditional news media, the HPV vaccine assemblages that we have studied were contextual and contingent in nature. In the early stages of the controversy, we found a near-symbiotic relationship with the news media's reporting of new cases of adverse events following HPV vaccination. In the later stages where the news media aligned with health authorities, assembling the HPV vaccine on the three pages seemed to become more difficult. The administrators met this challenge in different ways. Page A became more introvert, referring mainly to its own contributions. Page B questioned the epistemic basis of epidemiological studies by pointing out that such studies failed to account for the actual life-worlds of patients. Page C focused more narrowly on the community of patients that felt betrayed by politicians, the media, and the healthcare system.

As already mentioned, the concept of vaccine assemblages is the social media counterpart to 'vaccine anxiety' discussed by Leach and Fairhead (2007). They studied parents, mostly mothers, who weighed different kinds of information from different dimensions, scientific as well as personal, social, cultural, financial, and political information, to reach a final decision about whether to have one's child vaccinated or not. We propose seeing the construction of HPV vaccine assemblages that was carried out on the three vaccine-critical pages as somewhat equivalent to this complex and anxious process of making up one's mind. The information that appeared on the pages embraced all the dimensions mentioned by Leach and Fairhead (2007). As the assembling process continued, it became harder for visitors—and analysts—to take the different dimensions apart and assess them independently of each other. And if the pages were 'taken apart' in the sense that their different streams of information were sorted in analytic categories, then maybe also the meanings that they would convey to specific persons at a specific time and place were rendered obsolete.

The vaccine assemblages metaphor is also relevant to understanding the vaccine communication environment discussed by Kahan (2017). As Kahan (2017) observes, the vaccine communication environment is 'protected' unless other antagonistic discussions become associated with the vaccine in question. Unlike the HPV vaccination controversy in the United States where strong opinions about teenage sexuality 'polluted' the debate, the Danish controversy brought together uncertainties over HPV vaccination safety and the proper treatment of medical conditions such as POTS, CRPS, and CFS/ME. Protecting the HPV vaccination environment in the Danish context, we believe, is not about designating certain vaccine assemblages as pollution, but rather of reassembling HPV vaccination in a way that addresses the sum total of what has become associated with the vaccine. In other words, protection and pollution are not neatly separated processes but rather different aspects of the process of building vaccine assemblages.

Vaccine criticism and misinformation on social media are growing concerns, and rightly so. How we address these issues depends on how we understand them. We contribute to our understanding of vaccine-critical pages by placing their criticism firmly in the national context in which it occurs and by portraying the patchwork of online vaccination criticism as vaccine assemblages. The three pages, as we have already indicated, thrived on media attention to HPV vaccination, combining found bits and pieces from the media debate with other sources to form complex and fluid assemblages around adverse events and the health care system (perceived as failed and corrupt). Vaccine assemblages reflect, but also affect the debate. What really counts for vaccine assemblages is not so much getting the scientific facts about HPV vaccination straight but gaining recognition, getting fair treatment, expressing doubts and anxieties, making value assertions, exposing conflicts of interest in the medical establishment, and much more.

Acknowledgments

We are grateful to the three anonymous reviewers, the thematic issue guest editors, and the journal editors for useful comments. We would like to thank Cogitatio's editing service for English language editing and the Novo Nordisk Foundation for financial support (Grant No. NNF17SA0031308).

Conflict of Interests

The authors declare no conflict of interests.

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COGITATIO

Media and Communication (ISSN: 2183–2439)
2020, Volume 8, Issue 2, Pages 353–363
DOI: 10.17645/mac.v8i2.2852

Article

Memes of Gandhi and Mercury in Anti-Vaccination Discourse

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Submitted: 30 January 2020 | Accepted: 11 May 2020 | Published: 26 June 2020

Abstract
This study focuses on two widely circulating memes in the anti-vaccination movement, namely lists of vaccine ingredients containing mercury, and quotes attributed to Mahatma Gandhi. Mercury has been identified by conspiracy theorists as one of the most harmful components of vaccines, and Gandhi, who has condemned vaccination practices, has been celebrated as a significant source of authority. Quotes attributed to Gandhi against vaccination, complete with picture and embellished font, circulate across various popular platforms, as do intimidating images of syringes dipped in poison coupled with a list of seemingly occult or dangerous ingredients. This article analyses both memes, moving from the imageboard 4chan to the search engine Google Images, and illustrates how the repurposed, often ironic use of visual tropes can either undermine or strengthen the claims that accompany them. The aim is to explore the intersections of conspiracy theory, visual rhetoric, and digital communication in order to elucidate the ambiguity of memes as vehicles for the spread of controversial health-related information.

Keywords
conspiracy theories; memes; misinformation; vaccination

Issue
This article is part of the issue "Health and Science Controversies in the Digital World: News, Mis/Disinformation and Public Engagement" edited by An Nguyen (Bournemouth University, UK) and Daniel Catalan (University Carlos III of Madrid, Spain).

1. Introduction

The development of the Internet has significantly facilitated the production, exchange, and consumption of information (Chadwick, 2006, p. 53). In this regard, dreams of global democracy and informed citizenship have been offset by increased fears of extensive manipulation and propaganda, as well as by the sheer overload of available information (Curran, 2012, p. 3). The kaleidoscopic clash of viewpoints generated through this medium has not inaugurated a novel period of enlightenment, but rather eroded trust in mechanisms of representation and the authority of expert discourse. In this climate, conspiracy theories perpetuating "stigmatized knowledge" not accepted by "mainstream institutions" have surfaced as a major force of social contestation (Barkun, 2013, p. 12). Conspiracy theories, or narratives of secret and evil-minded social machinations, are not a new phenomenon. They have for centuries sustained the vilification of secret societies and of Jews (Aupers, 2012, pp. 24–26). The period immediately before the Internet era saw well-documented examples such as the stories surrounding the murder of John F. Kennedy and the alleged extraterrestrial presence at Area 51. Yet currently conspiracy theories are rapidly multiplying and are often supported by a worldwide activist base. Consequently, political and media authorities have taken extensive measures to silence dissenting voices. Infowars' Alex Jones for instance, a known contributor to a variety of stigmatized narratives, was banned from Facebook, Spotify, Apple and YouTube for supposedly promoting violence and hate speech (Hern, 2018). On the other hand, Jones was reported to be an influential figure in the Trump campaign (Corn, 2017). In the medical sphere, the World Health Organization has recently declared 'vaccine hesitancy' as one of its major health concerns, in response to the growing rise of the anti-vaccination movement, a loose-knit community of people who believe that vacci-

nation is dangerous and conducted for sinister purposes (World Health Organization, 2019). In short, conspiracy theories are a major force in today's political and scientific debates.

Conspiracy theories have been extensively studied from philosophical, psychological, and sociological perspectives (e.g., Douglas, Sutton, & Cichocka, 2017; Harambam & Aupers, 2015; Keeley, 1999). Descriptive and explanatory efforts in this regard often proceed from the assumption that if the genesis and patterns of spread of conspiratorial thought can be understood, instances of misinformation can be effectively combatted. Kata (2011, p. 3785), for example, provides an in-depth analysis of discursive strategies used by online proponents of alternative health rhetoric, arguing that "truly informed choices" can only proceed from the recognition of "tactics and tropes" employed by the anti-vaccination movement. However, recognition is often a reciprocal process, and proponents of misinformation have no trouble mimicking the tactics and tropes of general medical or governmental discourse. In January 2020, for instance, the Australian Involuntary Medication Objectors Party, which campaigns against compulsory vaccination, announced its plans to be known, from then on, as the Informed Medical Options Party (Mourad, 2020). Keeping the same acronym, the organisation thus co-opts the rhetoric of informed choice. This example suggests that cultural antagonism may result in the imitation or replication of discursive characteristics. The present article argues that one of the main challenges for identifying and consequently combatting misinformation in the medical sphere is the fact that there are often no distinguishing features between the visual and textual means used by proponents and opponents of, in this case, vaccination.

The argument is supported through the analysis of examples drawn from 4chan's discussion forum /pol/, a popular anonymous imageboard and a hotbed of meme culture. Previous studies have researched the influence of 4chan on other online platforms from a large-scale quantitative perspective (Hine et al., 2017; Zannettou et al., 2017). The present article initially presents a platform-internal, qualitative study of two memes found in a single thread on /pol/. The thread was selected from the 4plebs archive. The original poster explicitly mentions his distrust of information provided by the media and the government regarding a possible link between autism and vaccines, and thus refers to a central node of contention in the broader vaccination debate. Furthermore, the thread was markedly more popular than the average thread on /pol/ and contains a relatively high number of images. In addition, the images in the thread can be divided into distinct categories, such as graphs, frogs, quotations and lists of ingredients. I focus on the latter two categories. The analysis is partly textual and partly visual, as the quotation format in the thread typically includes the outline of a famous face and lists of ingredients are often coupled with the image of a syringe. Both formats constitute image macros, a category of Internet memes composed of variable text superimposed upon a recurrent image.

The analysis proceeds from the observation that a meme, rather than being a solid and static entity, primarily consists of an iterable "contour organized around certain visual characteristics" (Pelletier-Gagnon & Diniz, 2018, p. 9). In other words, a meme is defined by its shape or outline, and not by its informational content. I illustrate the dispersion of the memetic outlines or contours encountered on 4chan by using Google Images. This procedure illustrates how, outside of 4chan, the same image of a syringe occurs across various social media platforms, although each time for different communicative purposes. In the case of quotations, it is shown how the authority of Gandhi, a popular source of inspiration on the Internet, has in recent years been subverted by online actors using his image for humorous purposes. I demonstrate that while meme culture may initially facilitate the rapid spread of disinformation, the fast-paced ironic replication of semiotic elements ultimately voids the argumentative consistency of the memetic artefacts involved. The article thus puts forward the hypothesis that, within the discursive universe of the online anti-vaccination movement, the disease and the cure seemingly constitute two sides of the same coin: the propagation and demise of memetic templates and the content they accompany constitute one process. As a meme adapts to serve a variety of communicative purposes and in the process undergoes a series of ironic reversals, it becomes more visible but less suitable for (mis-)informational purposes.

2. Memes and /pol/

Recognizable and iterable symbols govern social interaction on the Internet, as is evident from the rising significance of Internet memes. Internet memes are units of cultural replication that are often humorous and highly derivative. Most memes take the form of a simple combination of image and text. Before the term 'meme' became popularized in this sense, its scholarly definition included "tunes, ideas, catch-phrases, clothes fashions" and even "ways of making pots or of building arches" (Dawkins, 2003, p. 192). The rather specific meaning attached to the term today reveals how ironic templates circulating on fora such as Reddit and 4chan have left the periphery to occupy a position of central cultural importance. In this regard, the rapid spread and demise of memetic formats is symptomatic of an ever more "accelerative culture" steeped in a process of ongoing "bricolage" (Urban, 2001, pp. 18, 127). Often short but intense, a successful meme's life tends to be full of reversals of fate.

The highly visible meme Pepe the Frog, for instance, was created in 2005 by Matt Furie as an animal expression of contentment. Online, the frog was welcomed by various artistic communities, yet a decade after its cre-

ation it came to be perceived as an 'alt-right' symbol. After an unsuccessful reclamation campaign on social media, the frog, by then on the Anti-Defamation League's list of hate symbols, was vainly declared dead by its creator (Hunt, 2017). In 2019, Pepe, seemingly out of nothing, reappeared in the streets of Hong Kong as a symbol of anti-authoritarianism (Ellis, 2019). Each reiteration of the meme seems to arise in disregard of the intentions of its previous users. Today, Internet memes simultaneously "constitute the cultural backbone of online communities" and thrive most when they can be continuously "altered and repurposed" (Pelletier-Gagnon & Diniz, 2018, pp. 3–4). Indeed, it could be argued that the value of a meme is equal to its capacity to have its meaning radically transformed, and in this sense irony, both as a humorous strategy and as reversal of intent, governs much of today's cultural production.

The trajectory of Pepe the Frog was heavily influenced by its use on the imageboard 4chan, where the association with Trump supporters, and eventually the 'alt-right,' took hold. The subversion of innocent or ideologically loaded imagery is a common source of amusement on 4chan. For instance, the forum regularly hosts calls for repurposing the rainbow flag as a symbol of ethnonationalism, accompanied by slogans such as "defend diversity—a separate place for every race" (Anonymous, 2020a). Once such memes circulate beyond the confines of 4chan, they contaminate the broader realms of social and traditional media, and the original symbolic connection, in this case between the rainbow flag and the LGBTQ+ community, becomes tainted. The goal of parasitic cultural artefacts like the repurposed rainbow flag is not quite the actual establishment of ethnic nation states, but rather working contrary to the progressive calls for diversity that govern much of today's political discourse. Such efforts exemplify the practice of 'trolling'—generating the maximum amount of polemic and agitation with the least amount of investment. Trolls often seek to create the impression "that nothing should be taken seriously" (Phillips, 2012, p. 499). In this respect, they find fertile ground in the discourse of conspiracy theory. The rise of the Flat Earth theory, for instance, evokes in a large part of the populace a deep sense of doubt, not about the shape of the earth but about their interlocutor's true intentions: Are you being serious? In short, a cultural milieu of irony may come to erode the foundations of interpersonal trust and epistemological reasoning. In that respect, memes do not have to be taken seriously by their users to have serious consequences.

The adaptations, iterations and reversals of the memescape take place in a cross-platform environment, and the origin and spread of memes is being meticulously documented on websites such as knowyourmeme.com. Increasingly, scholars are turning to the question of measuring the impact of certain fora on the production and dissemination of memes or related Internet content. 4chan, while understudied if compared to platforms such as Twitter or YouTube, is assuming an increasingly important place in this burgeoning field of study. On 4chan, people post threads on a board that suits their interests. The first post consists of an image and text. Those responding to the original post can choose whether to include an image. Boards are focused on topics such as 'literature' or 'fitness,' but may be more open, as in the case of the 'random' board. Phillips (2012, p. 496) characterised the 'random' board, or /b/, as "arguably *the* epicenter of online trolling activity." On 4chan, users typically post anonymously, and their posts are ephemeral, as threads are regularly removed from the boards. A great number of threads receive no replies at all before disappearing from the board (Bernstein et al., 2011, p. 54). These characteristics make 4chan relatively difficult to study in any sort of comprehensive way, yet studies such as Hine et al. (2017) and Zannettou et al. (2017) indicate the usefulness of a quantitative methodology for analysing 4chan as part of the broader hyperlinked media ecosystem. Both these studies are focused on /pol/, or the 'politically incorrect' board, a board "for the discussion of news, world events, political issues, and other related topics" (Anonymous, 2017). /Pol/ has been described as "subscribing to the alt-right and exhibiting characteristics of xenophobia, social conservatism and, generally speaking, hate" (Hine et al., 2017, p. 92).

Although 4chan's lack of a direct archival function has been addressed as a distinctive characteristic of the platform (Nissenbaum & Shifman, 2017), consistent documentation efforts have been ongoing at least since 2013. A number of boards, among them /pol/, are archived on the 4plebs website, accompanied by useful statistics (4plebs, 2020). The website reveals, for instance, that the two most popular archived threads on /pol/ concern the 2016 presidential election and the 2016 EU referendum, with more than 73,000 and 58,000 posts respectively. Among the images that have been reposted the most are innumerable frogs, several versions of Donald Trump, and many variations on the stereotype of the evil hand-wringing Jew, reminiscent of Dickens's Fagin or Shakespeare's Shylock. On /pol/, Jews are held responsible, with what appear to be varying degrees of genuine conviction, for a host of calamities. A recurrent 'Jewish trick' discussed on the board is effecting the degeneration of the white race and its culture through enforced migration and multiculturalism, while the Jews supposedly keep their own bloodline 'pure'. The growing influence of LGBTQ+ culture is also presented as part of a Jewish conspiracy to undermine the strength of Western civilization. Jews are further said not to vaccinate themselves, while globally promoting compulsory vaccination programs. This study deals with the vaccination debate and does not further address the hatred and suspicion towards Jews on 4chan. Jokingly or otherwise, the expression of this hatred is highly diffuse and evident in almost every discussion on the board. Vaccination, on the other hand, is a specific topic with a persistent presence on /pol/ as a concern in itself, rather than as an addendum to any other issue. The 4plebs archive features several

threads concerned with vaccination for each month of every year for the last half decade. Some of these threads do not receive any responses, yet some generate considerable debate.

In what follows, I will focus on one recent, quite successful thread (200 replies) in which several central characteristics of online vaccination hesitancy converge. All quotes from this thread will be referenced as 'Anonymous, 2019', and a link to the archived thread is provided in the reference list. The original post, dated 23 May 2019 and accompanied by what seems to be an unrelated image of a female athlete, reads as follows:

> Just had a long fight with my fiance and her mom about vaccines. I just dont trust the government and media to be telling me the truth, and when theyre in lockstep telling me to do something and offering it for free I just assume malicious intent….Can I get some redpills on vaccines? am i being a retard or are they legitimately going to give our kids autism? (Anonymous, 2019)

The post reveals a broad distrust of the government and the media, and articulates the supposed link between vaccines and autism, a major point of contention in the information wars about vaccine safety. In the thread that follows in response to the post, opinions on vaccination are varied and sometimes opposed. Across the spectrum, a considerable amount of external information is referenced. Posts direct others towards sources that support their authors' stances, from folk documentaries to alleged specialist literature. Titles such as 'Dr.' are explicitly used on a board otherwise unconcerned with verbal etiquette. A recurrent figure is Dr. Wakefield, whose study on MMR vaccination and autism, although condemned by the scientific community and long retracted by *The Lancet*, remains hugely influential in anti-vaccination discourse (Wakefield et al., 1998). While the authority of the scientific community as a whole is thus rejected by those contesting vaccination, the authority of a single 'Dr.' is asserted with great conviction. At work here is a peculiar phenomenon where expertise as a general value is discarded, except when it supports a single seemingly predetermined viewpoint.

A "profound distrust in elites and experts" is intimately associated with populist politics, and it has been suggested that vaccine hesitancy and support for populist politicians in Western Europe tend to co-occur (Kennedy, 2019, p. 515). In the United States, too, anti-intellectual attitudes have had political consequences. The Trump campaign, for instance, is very suspicious of 'climate scientists,' and Trump has questioned the safety of vaccines before (Motta, 2018, p. 466). Thus, opinions on vaccination are often heavily politicised and culturally dependent, and they may change rapidly as alliances shift. As research on the long and global history of the phenomenon illustrates, resistance to vaccination has existed since Edward Jenner, now more than 200 years ago, used the method to induce immunity against smallpox in a patient (Holberg, Blume, & Greenough, 2017). Resistance has come in many forms, from official societies to personal abstentions, and the 'anti-vaccination movement' is not a uniform body, but rather a label that includes anyone sceptical about vaccination practices. However, throughout the history of the 'movement,' one finds a number of recurring characteristics uniting expressions of suspicion by otherwise unaffiliated individuals. Two such characteristics, namely distrust of chemical elements and selective reliance upon figures of authority, are discussed in the two following sections with reference 4chan's /pol/. The analysis illustrates that Internet memes may contribute to the promotion of anti-vaccination discourse but may also undermine the credibility of its message.

3. Quoting Gandhi

One of the functions of quotation is to invoke authority. A quote may contribute to what Atkins and Finlayson (2016, p. 164), drawing on the Western rhetorical tradition's modes of persuasion, term the 'logos', the 'pathos' and the 'ethos' of an argument. Logos is the locus where "evidence for claims" is provided, while pathos relates to sentiment, humour, and the use of "elevated language" (Atkins & Finlayson, 2016, p. 164). Ethos, finally, establishes a speaker's character, "including their identification with a particular community or cultural milieu" (Atkins & Finlayson, 2016, p. 164). In a hyperlinked environment, there are various means available to fulfil such functions, but quotation is remarkably common on 4chan. Quite often, quotes appear in the form of an image of the speaker's face, accompanied by a stretch of text and the attribution. People quoted in this manner in the thread under consideration are Robert F. Kennedy Jr., William W. Thompson, Mahatma Gandhi, Dr. Ron Paul, Mark Twain, Bill Gates, Søren Kierkegaard, Nikola Tesla, George Orwell, and Georg Wilhelm Friedrich Hegel. A general ethos or cultural milieu cannot immediately be derived from such a varied list, and it is remarkable that not many of those listed are referenced specifically for their views on vaccination. Indeed, some, such as Hegel, predate the invention of the practice. In one response to the initial post, Mark Twain is (potentially incorrectly) attributed the quote "It's easier to fool people than to convince them they have been fooled" (Anonymous, 2019). Kierkegaard too, is referenced in the broad context of being fooled, and Orwell is invoked regarding "times of universal deceit" (Anonymous, 2019). Tesla is simply referenced regarding the possibility of an endless supply of energy. The quote is not further contextualized but its inclusion suggests that vaccines are just one of the domains in which the powerful are holding back information that might deliver the general populace from toil and evil.

The case of Bill Gates is more complicated, as the quote refers to a TED Talk on climate change in which he suggested that vaccines may help bring down the

population. Gates's remarks are initially surprising yet unremarkable in the context of his talk—general improvements in healthcare can be associated with limited population growth. However, they are interpreted on the board as if he let slip the murderous motivations of humanity's governing order. At the time of writing, similar suspicions are arising around Event 201, a 2019 event hosted by the Gates Foundation involving the simulation of a coronavirus pandemic and thus eerily prefigurative of the COVID-19 outbreak (Fichera, 2020). Of the remainder of people who are quoted on vaccination proper, Kennedy, nephew of the former president, appears first, with the argument that vaccination is a burden on the taxpayer. William W. Thompson is presented as a scientist turned whistle-blower who uncovered a hidden study that once again linked vaccines and autism. Dr. Ron Paul is presented as condemning the totalitarian characteristics of "mandatory and forced vaccination" (Anonymous, 2019). The image of Mahatma Gandhi, finally, is accompanied by the following quote: "Vaccination is a barbarous practice and one of the most fatal of all the delusions current in our time. Conscientious objectors to vaccination should stand alone, if need be, against the whole world, in defence of their conviction" (Anonymous, 2019).

Gandhi often appears on 4chan, across several boards, as well as on a host of other platforms, accompanied by faux quotes such as "bitches ain't shit but hoes and tricks" (e.g. u/dchubbs, 2013), lyrics that should properly be attributed to the musician Dr Dre. Attributing false quotes to Gandhi, as well as, for instance, to Albert Einstein and Abraham Lincoln, is a popular practice on the Internet, partly deriving its iconoclastic, humorous quality from the fact that sharing actual Gandhi quotations online is also a widespread phenomenon: the popular website BrainyQuote (2020) features Gandhi on its short 'authors to explore' list , and AZ Quotes (2020) features him among its 'popular authors.' His image is part of the latter website's background. On Goodreads (2020), his "be the change you want to see in the world" is one of the 10 most popular quotes, boasting more than 100,000 likes. In most online instances, Gandhi quotes are accompanied by his familiar bespectacled image (Figure 1).

When uploaded into the Google Images search box, the Gandhi image from the 4chan thread returns dozens of similar images and associated quotes (with limited influence from search history across browsers and machines). About one fourth of the quotes tends to be false, with examples ranging from the parodical "you must be the meme you want to see in the world" (Me.me, n.d.) to the more absurd "it's just a prank bro" (Know Your Meme, 2016). While Google Images search is never neutral and by no means a tool that easily allows for experimental control, it is an accurate pathway for mimicking people's day-to-day encounter with online material, as Google remains the most visited website in the world. Furthermore, Google Images search tends to return images with a similar composition, and is therefore highly effective in tracing memes, which are primarily determined by their contour, or the shape that contains the message. Following Dennett (2017), Pelletier-Gagnon and Diniz (2018, p. 2) argue that memes are primarily a "design worth copying," and that they do "not necessarily transmit reliable information." The specific usage of Gandhi as a vessel for carrying inaccurate quotes confirms this perspective. The sheer quantity of quotes falsely attributed to Gandhi, often in a trolling context, make it likely for 4chan users to be primed not to take Gandhi quotations seriously. In other words, while his appearance contributes to the comic pathos and ironic ethos that define the imageboard's community, Gandhi is by default not expected to contribute to the logos of an argument by introducing support or proof for one's stance.

Nevertheless, the Gandhi quote on vaccination cited above is correctly attributed, and can be found in Gandhi's *A Guide to Health* (1921, pp. 105–112). Gandhi, "a vocal opponent to western medicine," believed that vaccination "hindered discipline over the body and control over the mind" (Brimnes, 2017, pp. 57–58). In rejecting vaccination, Gandhi used his power as a member of the cultural elite to question scientific expertise, and thus combatted authority with authority. The argument he presents in the book features logical fallacies and favours anecdotal accounts over scientific evidence, but the primary mechanism Gandhi mobilizes is that of emotion, and more specifically, disgust. He manages to cast aside the opinion of specialists in the field by zooming in on the abject qualities of microscopic medicine. In his book, a vaccine is said to be "a filthy substance" and vaccination is described as "injecting into the skin the liquid that is obtained by applying the discharge from the body of a small-pox patient to the udder of a cow" (Gandhi, 1921, p. 105). The latter sentence does not

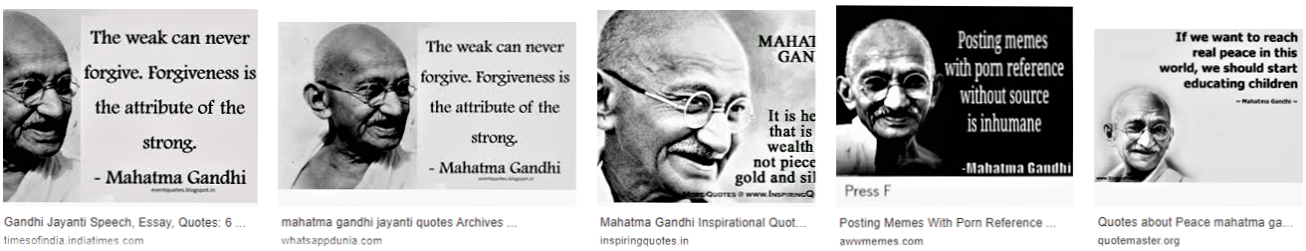

Figure 1. Various instances of typical Gandhi quotation format. Source: Google Images (2019).

read easily in translation, but there is no need for it to be fully transparent. The result, a list of disgusting procedures and objects, should be enough to conjure up the image of a poisonous, or at least repulsive concoction. Furthermore, Gandhi profits from the fact that vaccination is a fundamentally counter-intuitive operation. Breaching the integrity of the body is usually associated with harm rather than healing. In rejecting vaccination, one's instincts about protection thus lead to its lack. For Gandhi and those who agree with him on the subject, it is of relatively little importance whether vaccines are necessary, but of great importance that they are frightening and disgusting, and thus evoke a response of refusal. On 4chan, however, Gandhi has no power to wield, as his online identity has already fallen victim to extensive memetic repurposing. His image is not associated with truth and seriousness, and an encounter with his face is likely to bring mere anticipation of the absurd. His argumentative strategies, however, which include the listing of ingredients for instigating fear and disgust, are more abiding, as the next section illustrates.

4. Mentioning Mercury

Apart from the talking heads discussed in the previous section, two outlines or contours stand out among the four dozen images that occur within the /pol/ thread under scrutiny. The first contour is that of the graph. Typically, the graph serves to indicate the rising incidence of a plethora of pathological conditions, associated with either the rising number of specific vaccines, or the rising number of people who are vaccinated. The second contour is that of the syringe. Given the previous discussion of intuitive resistance to needles entering one's body, the needle is a far from innocent representative artefact. Indeed, the *Diagnostic and Statistical Manual of Mental Disorders*, in its discussion of phobias, prominently features a separate coding for the fear of "needles" and "invasive medical procedures" (American Psychiatric Association, 2013, p. 198).

In the thread under discussion, the image of a needle typically co-occurs with a list of vaccine ingredients. Mercury and aluminium feature most frequently. One of the images explains that a single flu vaccine contains more mercury parts per billion than does hazardous waste, with the image of the needle printed twice as large as that of a barrel with a radioactivity warning sign. Another image features an apple surrounded by needles that carry the following inscriptions: "Mercury (a known neurotoxin), Aluminium (a known neurotoxin), Polysorbate 80 (a known carcinogen), aborted fetal cells, GMO Bacteria & DNA, Formaldehyde" (Anonymous, 2019). The suggestion is that nobody would eat an apple injected with those substances. The question, then, is why we allow them in our bloodstream. Interestingly, the first three elements listed carry some sort of medical explanation of harm, involving cancer or the neural system. The other three elements seem not to require such an explanation; the absence of an explanation, one could argue, can be ascribed to the fact that the elements are considered disgusting in and of themselves. Formaldehyde carries a revolting smell, bacteria are the enemy of sanitized society, and the suggested consumption of "aborted fetal cells" goes, for some, against all that is good and holy. From this perspective, it is far from surprising that Gandhi would associate Western medicine and its vaccination practice with black magic (Brimnes, 2017, p. 58). Variations on this theme are present in the /pol/ thread not only in the images posted, but also in the text:

> Read the ingredients here on the CDC [Centers for Disease Control and Prevention] site and see that aborted human fetal tissue, aluminium (lots of it), bovine serum, chicken serum, eagle serum, monkey liver, polysorbate 80, formaldehyde and many other carcinogens and preservatives are injected straight into the blood stream. (Anonymous, 2019)

The Centers for Disease Control and Prevention is a leading public health body, and by no means a fringe society for alternative medicine. The link the anonymous poster provides genuinely directs there, and all the ingredients mentioned, in some form or another, do form part of particular vaccines. It is, however, the cumulative effect imparted by the poster that transforms these individual ingredients from technical accessories into components of a witch's brew. As observed by Eco (2009, p. 133), the figure of the list is often one of "accumulation," meaning that "the sequence and juxtaposition of linguistic terms" suggest that they belong "to the same conceptual sphere." A well-known feature of language use discussed in corpus-based studies—namely, semantic prosody—further demonstrates that habitual co-occurrence of lexical items results in evaluative association (Louw, 1993, p. 159). Both these observations together suggest that "chicken serum," while perhaps relatively unproblematic on its own, takes on a quite occult appearance as part of a contextual bestiary. As such, the expanding list continually reinforces its own abject qualities.

Rhetorical listing practices, however, do not constitute lies, and it is important to note that mercury is not included in the list above, despite being the central element of condemnation in the majority of posts in the thread. Presumably, this is because mercury also does not appear in the Centers for Disease Control and Prevention document referred to. Thus, the spread of medical misinformation can in part be attributed to discursive agents, like the poster of the list above, whose output suggest at least a partial commitment to truth. Similar conclusions can be drawn from the pseudo-scientific discussion in the /pol/ thread about which form of mercury is most harmful, and whether the mode of contact matters. Initial agreement that people eat fish, and fish is said to contain higher concentrations of mercury than vaccines, leads to the following hypothe-

ses: There is a difference between methylmercury (fish) and ethylmercury (vaccines), and injection is intrinsically more dangerous than ingestion. On this issue, the anonymous posters institute a micro-community of amateur researchers, each contributing pieces of the puzzle as to where exactly the dangerous qualities of a particular chemical element reside. However, the discussion, as well as the arguments developed, remain fragmented. Before consensus can be reached on any topic, new links and materials are constantly introduced, as in the following post:

> RFK jr/mercury/thimerisol is a big rabbit hole. Also can look int fluoridation levels in brain. MMR/Brian Hooker FOIA. And there was a woman in Utah IIRC, Markwitz or similar. Who found a link between vaccines and autism, caused by contamination from LABORATORY RATS that gave tens of millions of Americans autism via vaccine. The feds locked her up after a Russian scientist wrote a follow up to her paper, and told her they'd ruin her if she didn't tell everyone she made it up (which they did). This was around 2010. Before this she was a leading scientist and researcher of penicillin in the 80s….I hope that helps, They're making it hard to find this stuff. (Anonymous, 2019)

In this fragment, listing has a very different effect from that observed in the list of ingredients discussed above. Listing may indicate "an imprecise image of the universe" for speakers who are yet to decide upon the exact relation among the variety of concepts and entities that populate their mental and physical world (Eco, 2009, p. 18). The juxtaposed abbreviations in the quote above signal frustration in terms of the ability to produce a coherent mental picture of the relation between various factors in anti-vaccination discourse. Yet, rather than reflecting upon the disorder within the mind, the poster projects confusion outward, and proposes a conspiracy: "They're making it hard to find this stuff." A malevolent entity is out there, consciously making it difficult for humans to process important information.

The metaphor the poster starts out with presents the image of an inherently confusing, alternative reality: 'a big rabbit hole.' The origins of this idiom, as is well known, lie with Lewis Carroll's *Alice In Wonderland* (1865). This novel boasts a character named the Mad Hatter. It is widely assumed that this character was inspired by the prevalence of psychotic symptoms among hatters in Victorian Britain, directly related to the introduction of mercury in the process of manufacturing hats (Waldron, 1983, p. 1961). There is evidence to suggest, however, that the Mad Hatter character was simply based on a hat-donning eccentric known to Carroll (Waldron, 1983, p. 1961). Such curious co-occurrences illustrate that there will always be further investigative alleys for the chemically suspicious to explore. Consciously or not, language rephrases language, and correspondences across utterances, be they written or oral, reveal that "any text is constructed as a mosaic of quotations; any text is the absorption and transformation of another" (Kristeva, 1986, p. 37). In the time of search engines and hyperlinked media ecosystems, intertextuality is not a hidden phenomenon to be foregrounded, but the default mode of information processing. The Mad Hatter example reveals how the Internet facilitates a descent into rabbit hole upon rabbit hole for those who are so inclined. One is also confronted, in this regard, with the close affiliation between the conspiracy theorist and the researcher: Both establish links and patterns while seeking to unearth the truth, and both may fall victim to apophenia—the perception of patterns where perhaps none can be said to exist (Dixon, 2012, p. 195).

In humans, "pattern recognition can be seen as matching the incoming visual stimuli to existing mental models" (Dixon, 2012, p. 194). Thus, recognizing a pattern reinforces the expectation of the pattern, and the ability to perceive connections and correspondences is a process that fundamentally relies on repetition. In order to see whether there are repeated visual elements on the surface of the Internet that are strongly associated with the practice of listing vaccine ingredients, I queried Google Images for the terms 'vaccinations ingredients.' One repeated image stood out, as the first page of results contained a number of very similar iterations (Figure 2): The first variant, directing to Pinterest, consists of a syringe with its needle inside a small container bearing the inscription 'poison,' as well as the image of a skull . Above this shape one reads "Do you know what's in a vaccine?" (Gorski, n.d.) Around the syringe are listed ingredients and their supposed effects: "Mercury [thimerosal]: One of the most poisonous substances known. Has an affinity for the brain, gut, liver, bone marrow and kidneys. Minute amounts can cause nerve damage. Symptoms of mercury toxicity are similar to those of AUTISM" (Gorksi, n.d.).

A nearly identical image, sourced from a Facebook group, follows closely in Google Images (the third variant in Figure 2), with the heading reading: "Do you know if these are contained in vaccines and why?" (Refutations to Anti-Vaccine Memes, 2013). Instead of being dipped in poison, however, the syringe is dipped in a container labelled 'refutations to anti-vaccine memes.' This inscription is clearly and amateurishly pasted over the previous label, making it obvious that the figure of the syringe was copied to explicitly disrupt an earlier anti-vaccination variant. A similar list of ingredients appears around the syringe, with examples such as the following: "Mercury [thimerosal]: These are not the same thing. There is no pure mercury in vaccines. Thimerosal is used in some multi-dose influenza vials as a preservative, but no other vaccines contain it" (Refutations to Anti-Vaccine Memes, 2013).

A final almost identical image (the middle variant in Figure 2), taken from a website dedicated to combatting disinformation on vaccines, presents the syringe with its

Figure 2. Template of the syringe used for conflicting purposes. Source: Google Images (2019).

needle in a container labelled "extra spicy" beneath a red pepper (Babe, 2019). Among the ingredients listed are 'Autismiam,' and also the following:

> Mercury [thimerosal] THIMEROSAL thimerosal thimerosal thimerosal thimerosal thimerosal thimerosal thimerosal thimerosal thimerosal thimerosal thimerosal thimerosal thimerosal TOXINS!!!!!!!1111!!1!!!1!!!1! 1!!!!!!!!!11!!11. (Babe, 2019)

The purpose of this iteration of the meme is to ridicule people who are suspicious about vaccines. Textual incoherence and frustration, elements also observed in conspiratorial posts on the 4chan thread, provide ample material for ironic treatment. This version of the meme also lists several animal parts and explicitly belittles people who react to science emotionally. Google presented the three variants near each other, and only upon clicking the image does the text become readable, presented in its proper environment. As mentioned, the first image discussed appeared on a Pinterest page, the third one on a Facebook page, and the middle one a website dedicated to expelling anti-vaccination myths. Instantiations of the template mocking anti-vaccination discourse are numerically dominant on Google Images. However, the template itself may suit the spread of vaccine hesitancy. Mockery does not change the fact that lists of unfamiliar ingredients, whether explained or not, may inspire fear or suspicion. Huntington (2016) has made the case for memes as rhetorically reliant upon synecdoche: a part comes to represent the whole. The shape of the syringe as a representation of vaccination practice in general, even if it used to debunk health misinformation, is likely to reinforce anti-vaccine sentiment, regardless of where it occurs, regardless of which arguments accompany it, and regardless of the intentions of the person sharing the image. Gandhi's memetic insertion into the vaccination debate, on the other hand, is unlikely to spread misinformation because of his association with the absurd. The pattern of irony overrides his potential argumentative force. The meme, in short, is self-effacing.

5. Conclusion

Memes contribute to the spread of health misinformation, but assessing their ultimate impact is not a straightforward procedure. 4chan, and more specifically /pol/, served as a starting point for the discussion above and led to the identification of two templates with a distinctive contour that circulate across platforms as part of the vaccine debate: the quoted head and the syringe. I exemplified, with reference to the syringe and the list of ingredients, how templates used by anti-vaccination campaigners are copied by their adversaries. While the template was thus transformed into a meme signalling irony rather than (mis)information, I suggested that the strategy is not necessarily effective due to general aversion to the needle's contour. A meme's reception, regardless of its textual content, may be heavily determined by the affective response to its visual outline. I also aimed to show that, as memes are replicated, ironic repurposing tends to develop into purely self-reflective iterations of the template, making any content associated with a particular image macro easily dismissible. In this regard, I discussed the expectation of unbelief that the profile of Gandhi inspires, and the way this neutralizes his authority and potential impact in the vaccine debate. In the introduction I argued that the success of a meme depends upon its capacity to have its meaning radically transformed. As the cases discussed illustrate, transformative potential supports a meme's proliferation but also contributes to the demise of its constative value. Popular memes are often short-lived, as they are quickly exhausted by endless iterations. From this perspective, one could argue that memetic content spreading misinformation should be subjected to an accelerative treatment: If a considerable amount of memes citing anti-

vaccination activists is circulated in a limited time span, the textual and visual rhetoric associated with these replicators will become ineffective.

This stance would find tentative support in the fact that on 4chan the term 'meme' is used not just with reference to semiotic templates, but also to label broad cultural phenomena, in which case the term usually has the connotation of 'worthless,' 'untrue,' or 'outdated.' The 4plebs /pol/ archive is rich in discussions on 'meme ideologies.' Proposing for instance, that communism is a meme ideology is equivalent to suggesting that it is a mere discursive position not corresponding to any potential state of affairs. The verb 'to meme' occurs as well, as in the following post on a thread that discusses a reported case of hantavirus in the context of the global COVID-19 outbreak: "Are we gonna meme hanta chan into a global pandemic too?" (Anonymous, 2020b).

In this context, 'to meme' means to inflate something's impact beyond correct proportion, or to escalate a situation through misinformation. Here, agency is claimed on the part of the poster and his peers, but often 4chan presents cultural memes as being produced by external agents, as an example from the thread discussed above illustrates: "What about vaccines without aluminium, carcinogens, human and animal tissues? Can I get that? No I didn't think so. Vaccines are a meme" (Anonymous, 2019).

In the above statements, memes are framed as cultural phenomena that are fundamentally without substance, despite circulating widely. In other words, ongoing semantic changes suggest that once a set of ideas becomes the target of a large number of cultural replicators, independent of whether they are or are not supportive of the ideas in question, the suspicion of an absence of substance is raised. Or, in short: The more memes a topic inspires, the more the topic will be considered 'a meme.' On first sight, this would strengthen the case for accelerating and thereby exhausting the rapid spread of potentially dangerous memes. However, the post labelling vaccines as 'a meme' bears witness not just to a lack of belief in their value, but also to conspiratorial agency: If something circulates widely despite lacking necessity or truth, someone must be behind the successful process of dissemination. In the final analysis, then, spreading memes to subvert them may result in increased pathways for conspiratorial thinking, and should be avoided after all. As memes lose their connection to any identifiable origin, an origin is invented. The levels of suspicion one can create in this manner are endless, as the following response from the thread discussed above illustrates:

> They want to feel like they are in on a gigantic secret, to expose the 'man,' the sneering scientist using dem big words with their good ol' honest down to earth wisdom…it is a wonderful chaff to misdirect discourse from actual topics into an endless vortex of shitposting and dumb memes. (Anonymous, 2019)

The post aims to provide insight into the motivations of anti-vaccine proponents. It argues that conspiratorial thought opposes common sense to expertise, and that felicitous self-aggrandizement depends upon an imaginary conflict with evil forces. The poster's final reflection, however, imitates the procedure he derides: anti-vaccination discourse is presented as a bait conspiracy drawing away attention from the actual evil machinations of powerful forces behind the memetic scene. This attitude is a reminder that conflicts of information in anti-vaccination discourse are but a single instance of a much broader tendency to suspect a malevolent agent behind a variety of social practices and conventions. As with image macros, the content is variable but the template is set.

Acknowledgments

The author acknowledges the support of the Genealogies of Knowledge Research Network, and would like to thank Mona Baker and Henry Jones for commenting on earlier versions of this article. Further thanks go out to the anonymous reviewers for their balanced and insightful comments.

Conflict of Interests

The author declares no conflict of interests.

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COGITATIO

Media and Communication (ISSN: 2183–2439)
2020, Volume 8, Issue 2, Pages 364–375
DOI: 10.17645/mac.v8i2.2847

Article

The Visual Vaccine Debate on Twitter: A Social Network Analysis

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Submitted: 29 January 2020 | Accepted: 18 April 2020 | Published: 26 June 2020

Abstract
Pro- and anti-vaccination users use social media outlets, such as Twitter, to join conversations about vaccines, disseminate information or misinformation about immunization, and advocate in favour or against vaccinations. These users not only share textual content, but also images to emphasise their messages and influence their audiences. Though previous studies investigated the content of vaccine images, there is little research on how these visuals are distributed in digital environments. Therefore, this study explored how images related to vaccination are shared on Twitter to gain insight into the communities and networks formed around their dissemination. Moreover, this research also investigated who influences the distribution of vaccine images, and could be potential gatekeepers of vaccination information. We conducted a social network analysis on samples of tweets with images collected in June, September and October 2016. In each dataset, pro- and anti-vaccination users formed two polarised networks that hardly interacted with each other, and disseminated images among their members differently. The anti-vaccination users frequently retweeted each other, strengthening their relationships, making the information redundant within their community, and confirming their beliefs against immunisation. The pro-vaccine users, instead, formed a fragmented network, with loose but strategic connections that facilitated networking and the distribution of new vaccine information. Moreover, while the pro-vaccine gatekeepers were non-governmental organisations or health professionals, the anti-vaccine ones were activists and/or parents. Activists and parents could potentially be considered as alternative but trustworthy sources of information enabling them to disseminate misinformation about vaccinations.

Keywords
activism; misinformation; social media; social network analysis; Twitter; vaccination

Issue
This article is part of the issue "Health and Science Controversies in the Digital World: News, Mis/Disinformation and Public Engagement" edited by An Nguyen (Bournemouth University, UK) and Daniel Catalan (University Carlos III of Madrid, Spain).

1. Introduction

This study explored the dynamics of the dissemination of vaccination images on Twitter to gain insights into the pro- and anti-vaccine networks sharing them. Online images can increase the sharing rate and visibility of tweets (Chen & Dredze, 2018) and can be used to articulate the messages in the text of the tweet or to elicit emotive response (Giglietto & Lee, 2017). Moreover, images can convey health messages effectively (Houts, Doak, Doak, & Loscalzo, 2006) and influence public opinion toward health issues (Apollonio & Malone, 2009). Previous studies on vaccine images analysed their sentiment and content (Chen & Dredze, 2018; Guidry, Carlyle, Messner, & Jin, 2015; Lama et al., 2018); however, none of them investigated how this visual information is disseminated

online. Therefore, this study explored whether vaccination images flow within or between insular communities, how they are shared within the same network, and who the most influential anti- and pro-vaccine actors are. These actors could influence the distribution of vaccine images and could be potential gatekeepers of vaccination information.

This research focuses on Twitter since it is a news feed where most users' profiles and their messages are public and thus accessible for research purposes (Kumar, Morstatter, & Liu, 2013; Kwak, Lee, Park, & Moon, 2010). Moreover, Twitter allows thematic conversations to emerge between either friends or strangers by sharing tweets, which are short textual messages of 280 characters that can include multimedia content such as pictures, gifs, videos, URLs, and geotags. The voluntary sharing of information and personal opinions online by Internet users provides the opportunity to understand more deeply audiences' understanding, attitudes, and beliefs towards specific topics, such as health (Scanfeld, Scanfeld, & Larson, 2010; Wilson, Atkinson, & Deeks, 2014) and scientific controversies, including vaccines (Love, Himelboim, Holton, & Stewart, 2013).

The information posted on Twitter is not necessarily filtered by traditional gatekeepers (e.g., journalists, press officers), thus giving the opportunity to scientists, activists, and other individuals to reach their audience directly. For example, a health practitioner could engage with their public informally and directly on Twitter instead of using official channels (e.g., health organisation's website; Schmidt, 2014). By bypassing the information gatekeeping system, Twitter and other social media outlets allowed access to a variety of traditional and alternative sources of information (Murthy, 2012). However, this also facilitated the dissemination of misinformation online. False news items are found to spread faster and more widely on Twitter than true news, especially those about politics (Vosoughi, Roy, & Aral, 2018). However, most political exposure is still from reliable sources of information, and only a small fraction of users shares news from disinformation sources (Grinberg, Joseph, Friedland, Swire-Thompson, & Lazer, 2019). In the case of vaccinations, anti-vaccine users were also found to be a minority on Twitter (Bello-Orgaz, Hernandez-Castro, & Camacho, 2017) that share alternative sources of information rather than traditional ones (Himelboim, Xiao, Lee, Wang, & Borah, 2019). These actors may use social media to disseminate information (and misinformation) about vaccines and sensationalise objections to vaccinations (Witteman & Zikmund-Fisher, 2012). This enables them to reach their target audience directly and potentially influence their risk perception toward vaccines, thus persuading them not to vaccinate themselves and/or their children (Betsch, Renkewitz, Betsch, & Ulshöfer, 2010).

2. Literature Review

2.1. 'Alternative' Experts and Disseminating (Mis)Information

The Internet and social media outlets allow easy access to information; any Internet user can consume and produce textual and visual content and potentially reach their target audience online. Hence, these actors can communicate with their public directly on digital media, bypassing the traditional gatekeeping system of news media and journalists (Schmidt, 2014). They can reach blog readers or social media followers, who already know about them and are interested in their content. They can also reach organic or ad hoc publics, who come across their content by searching Google or following Twitter hashtags (Bruns & Moe, 2014). Either way, Internet users that regularly contribute to a conversation on a topic with high quality information tend to be acknowledged as 'experts' by the other participants (Bruns, 2008). For example, a parent sharing good content about vaccinations frequently with a vaccine group online could be considered an alternative expert about vaccinations by the other members of the group. On Twitter, conversations formed around hashtags can become communities. In this case, every user tweeting with a certain hashtag regularly can be considered a member of that community (Bruns & Burgess, 2015). Some of these users may become experts, and even opinion leaders if they have several followers and strategic connections within the community that allow them to control the flow of information. Opinion leaders would be able to decide what content to share (or not) with the members, thus potentially influencing the community's common opinion (Murthy, 2012).

The type of content valued may differ among communities. For example, in polarised communities, members do not share information that does not support the beliefs of the community. This can reinforce their confirmation bias and misconceptions or misunderstandings of scientific content (All Europe Academies, 2019), as in the case of anti-vaccine communities that only share information supporting their claims while excluding any scientific evidence claiming the opposite (Kata, 2012). By filtering content that favours a certain perspective, polarised communities can facilitate the spreading of misinformation and conspiracy theories among their members (Del Vicario et al., 2016). In these groups, experts and gatekeepers may not be scientists and journalists, and the quality of their contributions may not be valued based on scientific accuracy, but on agreement with the members' opinions. Moreover, members of polarised communities tend to have a negative perception of outsiders, and do not acknowledge the authority of external experts, even those whose expertise is recognised by the scientific community (Bruns, 2008; Southwell, 2013).

2.2. Anti-Vaccine Activism and Misinformation on Twitter

Though vaccines have eradicated or significantly reduced vaccine-preventable diseases, and are considered one of the most effective public health interventions, they have aroused public concerns about their safety and effectiveness since first proposed. Moreover, the vaccine controversy has been recently stimulated by a range of factors (e.g., occurrence of vaccine side effects, scepticism or non-acceptance of scientific evidence; Larson, Cooper, Eskola, Katz, & Ratzan, 2011), which have been highlighted by anti-vaccine movements (Dubé, Vivion, & MacDonald, 2015).

Anti-vaccine movements disseminate their alternative information on the Internet and social media. Previous research on Twitter found that most of the anti-vaccination messages claim that vaccines are dangerous and encourage vaccine refusal. These tweets share personal stories, anecdotes, opinions, misinformation, and conspiracy theories (Dunn, Leask, Zhou, Mandl, & Coiera, 2015; Mitra, Counts, & Pennebaker, 2016); moreover, they tend to share links to emerging/alternative news websites rather than traditional ones (Meadows, Tang, & Liu, 2019). Though anti-vaccination tweets are only a minority in the vaccine debate on Twitter (Love et al., 2013) and their volume has decreased since 2015 while that of pro-vaccine messages has increased, the number of anti-vaccine users has doubled (Gunaratne, Coomes, & Haghbayan, 2019). Anti-vaccine activists tend to be alternative sources of information (Himelboim et al., 2019) and believe conspiracy theories related to vaccination (Mitra et al., 2016). These actors form a polarised and tight community that does not interact with outsiders and does not engage with pro-vaccine users (Bello-Orgaz et al., 2017; Yuan & Crooks, 2018). Anti-vaccine actors do not share only text and hyperlinks, but images too. Though image sharing is a popular activity online (Duggan, 2013), there is little research on vaccine images disseminated on social media (Chen & Dredze, 2018; Guidry et al., 2015) and none of these previous studies considered how these images are distributed on Twitter, by who and to whom.

2.3. Social Media Network Analysis

Social media network analysis can be an effective method to study the dissemination of vaccine images on Twitter, as it investigates the distribution of tweets and retweets among and within networks and the actors that could affect this distribution (Himelboim, 2017). A Twitter network can be formed by users conversing about the same topic, using the same hashtags, and the tweets and retweets they share with each other (i.e., their connections; Kumar et al., 2013). Retweets can be reciprocal or not, thus their reciprocity and direction can provide insights on the connectivity and attitudes of a network. For example, a network could be formed by two polarised groups, highly connected within but barely connected between them. These two groups could be formed by like-minded people around opposite perspectives on the same topic, e.g., in favour or against vaccination (Smith, Rainie, Shneiderman, & Himelboim, 2014). Another example could be a network formed by one central actor highly retweeted by the other members; in this case the central member broadcasts their message to the others, like a hub, but does not engage with them (Himelboim, Smith, Rainie, Shneiderman, & Espina, 2017).

The connectivity of a network can also provide other insights: In a network where members frequently retweet each other but not outsiders, information will be disseminated more efficiently but it will also become redundant (Kadushin, 2011). Moreover, the dense connectivity could give a sense of trust, safety, and support to its members, but also reinforce their common beliefs and increase their negative perception of outsiders (Southwell, 2013). In a loose network, instead, the sense of support may not be strong but there would be better access to and diffusion of new information (Kadushin, 2011). Social network analysis can also be an effective means of identifying actors exerting influence on the information flow within a network (Himelboim, 2017). The central actor mentioned before, the hub, could be one of these; they regulate the types of messages and images circulating within the group. A key actor could also be a broker connecting groups that otherwise would not be linked. For example, these actors could retweet or be retweeted by different groups, thus influencing their access to new information (Kadushin, 2011; Kumar et al., 2013). In this study, we distinguish actors as individuals that can potentially control the information flow in a network, and users as generic Twitter users or members of a network.

3. Aims and Objectives

The aim of this study is to fill a gap in our knowledge of how vaccine images are shared on Twitter. As such, the study takes an exploratory approach to gain insights into the diversity of networks, communities, and actors involved. Specifically, the study seeks to explore how vaccine visual information (and misinformation) circulates within and among Twitter networks and to identify actors that could potentially influence the flow of vaccination images. These actors may be the same as those participating in health conversations—advocates and health professionals (Xu, Chiu, Chen, & Mukherjee, 2015)—or may include a wide range of other actors, such as Governmental Health Agencies, NGOs, charities, the media, academics, and parents. Since the types of actor participating in the sharing of visual material may differ between anti- and pro-vaccine communities, identifying these differences will provide insights into the types of 'gatekeepers' and 'experts' that are acknowledged by each community. This has practical relevance for those seeking to participate in the visual vaccine discourse on

Twitter. Therefore, this study focused on:

- The pro- and anti-vaccine actors that are most influential in their respective communities, identifying the types of groups they represent;
- How these actors share information within their networks.

Sharing practices may differ between actor types and the networks within which they operate. Moreover, sharing patterns can vary depending on the network structure (Himelboim et al., 2017). Therefore, analysing the dynamics of information flow within and between anti- and pro-vaccine networks may provide information on how (mis)information circulates. Hence, this research also analyses:

- Whether anti- and pro-vaccine communities share visual information between each other;
- How anti- and pro-vaccine communities share images with their members.

4. Methods

4.1. Data Collection, Preparation, and Classification

This study undertakes a qualitative comparison between the dissemination of anti- and pro-vaccine images within and between Twitter networks. To explore vaccine Twitter networks and identify recurrent influential actors, we collected tweets posted in June (from 26th to 30th), September (from 9th to 13th), and October (from 4th to 11th) 2016 using the software NodeXL Pro, developed by the Social Media Research Foundation. We gathered only tweets written in English, having an image uploaded on Twitter originally and at least one of the following hashtags: #vaccine(s), #vaccination(s), #immunization, #vaccineswork, #whyIvax, #antivax, #CDCwhistleblower, #vaccineinjury, #vaxxed, and #hearus. Hashtags are words preceded by the # sign that label specific conversations on Twitter. To select the hashtags for the collection criteria, we first consulted the online services Symplur.com and Hashtagify.me to identify those relevant to vaccines, and then we checked on Twitter how often these hashtags were used during June 2016. We finally selected the twelve most tweeted hashtags: four generic, four anti-vaccine, and four pro-vaccine. We did not include words (e.g., vaccine[s]) in the collection criteria since hashtags, not words, are usually used to find all published tweets with those keywords and to join the respective conversations (Bruns & Stieglitz, 2014). Moreover, users tend to include hashtags in their posts to reach audiences interested in the topic that are not yet their followers (Bruns & Moe, 2014). For these reasons, in this study we preferred to focus on ongoing visual conversations around hashtags.

We gathered 4480 tweets in June, 2658 tweets in September, and 5262 tweets in October. Since we were interested in how images are shared (retweeted) among vaccine networks, we considered only retweets and mentions in the social network analysis (Kumar et al., 2013). We removed tweets that were not relevant to vaccinations and tweets that were replies, obtaining final samples of 3573, 1932, and 3778 tweets, respectively. Then, to distinguish different conversations about immunisation, and therefore the networks participating in these conversations, we classified the tweets as follows:

- Anti-vaccine: Tweets strongly against vaccinations, claiming conspiracy theories, disseminating misinformation about vaccines, or opposing pro-vaccine messages; e.g., 'the CDC will never admit that #vaccines cause autism';
- Pro-vaccine: Tweets strongly in favour of vaccinations, promoting immunisation campaigns, providing medical advice regarding vaccinations, or mocking anti-vaccine claims; e.g., '#VaccinesWork—one step forward to end polio';
- Pro-safe vaccine: Tweets expressing concerns about vaccinations, i.e., the need for more controls and ethical considerations in vaccine production, administration, and business; e.g., 'Vaccinations should be administered only after being tested';
- News: News tweets that included text, web links, hashtags, or images that referred to newspaper, webzine or magazine news articles (opinion articles were excluded) about vaccinations, outbreaks, immunisation campaigns, vaccine research and development; e.g., 'the clinical trial for Zika vaccines has started';
- Academic: Tweets about journal papers, academic job applications, patient recruitment, or medical/academic conferences, lectures, seminars.

We followed the guidelines suggested by Braun and Clarke (2013) to code the tweets. We identified potential categories during the preliminary analysis of the tweets from the first collection (June 2016), considering tweets' content, images, hashtags, embedded links, and Twitter users. Photos, URLs, and other tweets' attachments were also considered, following LeFebvre and Armstrong's (2018) directions for content and sentiment analysis. Once we defined the classification system it was applied to all three datasets, including the first one.

4.2. Social Network Analysis

To analyse the sharing patterns of vaccine images, for each data collection we plotted the networks of retweets and mentions in clusters by the Clauset-Newman-Moore algorithm (Clauset, Newman, & Moore, 2004). First, we focused on the overall networks, then we explored the anti- and pro-vaccine groups separately. For each network and group, we analysed the size of network and its connectivity (Kumar et al., 2013). For example, we considered parameters such as density (the ratio between

the number of observed retweets and the number of possible retweets in the network) and modularity (which ranges from 0 = the users in a network are highly connected, to 1 = they are not connected; Newman, 2010). Density and modularity can provide insights into the connectivity within the same group and among different communities and clusters. These two values must be considered together since high density can indicate a strongly connected network, which might be unified or divided depending on its low or high modularity, respectively (Himelboim, 2017). We used these four parameters to explore how the visual information flows within and among groups and clusters and its reach.

4.3. Analysis of Key Actors

In this research, we defined 'gatekeepers' as those Twitter actors that could potentially control the information flowing into and within a network. Moreover, we defined 'hubs' as Twitter actors that broadcast their messages to a wide audience. Both hubs and gatekeepers were considered 'key actors' within the network. Actors that could act as gatekeepers or hubs were identified by their values of betweenness centrality (i.e., how many actors belonging to different groups a user connects) and in-degree centrality (i.e., how many times a user's posts were retweeted; Himelboim, 2017) since the number of followers is not a good indicator of influence (Cha, Haddadi, Benevenuto, & Gummadi, 2010; Kwak et al., 2010). Actors meeting these two criteria were more likely to reach diverse audiences and conversations (high betweenness centrality) and to have a high visibility within the network (high in-degree). We did not consider users having high betweenness centrality but in-degree centrality equal to zero and low out-degree centrality (i.e., how many retweets a user made) as key actors, since they were unlikely to have an impact on the conversations.

For each data collection, we identify the top 50 actors having the highest betweenness centrality and/or having an in-degree centrality higher than 20 retweets. Then we excluded from each sample users that had a high centrality value but did not tweet (i.e., they were mentioned in a highly shared tweet), and individuals having high betweenness centrality for interacting with users having a different opinion on vaccinations (e.g., a pro-vaccine user engaged by anti-vaccine actors) or retweeting both anti- and pro-vaccine messages. We identified 48, 46, and 50 key actors in the June, September, and October dataset, respectively.

After identifying these actors, we classified them based on their vaccine sentiment (e.g., pro-vaccine, anti-vaccine) and type of actor (e.g., activist, parent, health professional). For both classifications we followed Braun and Clarke's (2013) guidelines: We ran a preliminary analysis on the key actors from the first collection (June 2016) to identify potential types of actor and their vaccine sentiment, and we subsequently refined our coding and applied it to all three datasets. To categorise actors into types of actor, we considered the words they had used to describe themselves in their Twitter biography or in the website linked to their profiles. Thus, to classify their vaccine sentiment we evaluated: Twitter biography, names and handles, webpage links, profile and/or background pictures, tweets' content, and hashtags.

We then conducted a small qualitative analysis of the images shared by two anti-vaccine key actors and two pro-vaccine ones to explore the types of images and relative messages that could have the highest popularity within each community. We chose the most retweeted five images for each actor since retweeting can be considered a Twitter practice that shows endorsement of or support for a message (Boyd, Golder, & Lotan, 2010).

This study received ethical approval by the Faculty Research Ethics Committee of the University of the West of England.

5. Results and Discussion

To explore the dissemination of vaccine images on Twitter, we collected tweets having specific parameters three times. We found that, in each collection, most of the tweets were anti-vaccine, whereas only a few tweets reported news, and an even smaller number of tweets were pro-safe vaccine (see Figures 1 and 2). The number of pro-vaccine tweets and academic tweets varied significantly across datasets likely due to the occurrence of specific events, such as conferences or immunisation campaigns. Our results differ from those obtained by previous research. For example, Love et al. (2013) found that the majority of tweets related to vaccinations were neutral, and only a small proportion were anti-vaccine. These differences were likely due to different collection criteria, since we limited the sample of tweets to those having specific hashtags and images, and/or to different coding criteria because we coded the tweets based not only on their textual content but also on their image, hashtag, and embedded links as well.

Twitter users who retweeted anti-vaccine tweets also retweeted pro-safe vaccine messages, whereas actors who shared pro-vaccine posts also shared academic content and news. Hence, we could distinguish two main communities in the overall network: one against vaccination and one in favour. This separation was emphasised by the poor interaction between the two groups—only one or two actors shared both anti- and pro-vaccine tweets and a few users occasionally engaged with those having a different point of view, though aggressively (see Figure 1). This suggests that vaccine images were mainly shared within insular communities, rather than between them (Himelboim et al., 2017). Moreover, the dissemination of images differed within anti- and pro-vaccine groups. The members of the anti-vaccine group were consistently more connected than the pro-vaccine group: They often retweeted and mentioned each other and did not share outsiders' images. The pro-vaccine network, in-

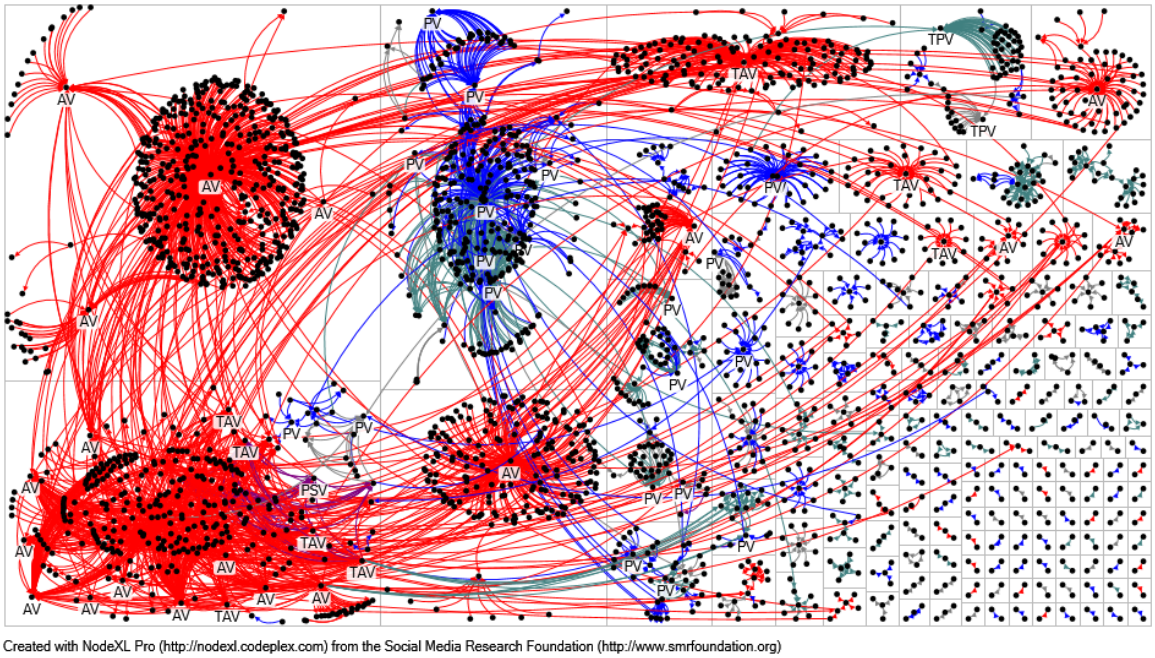

Figure 1. Overall network in October 2016. Notes: The arrows indicate the tweets, the dots indicate the users, and the letters indicate the key actors. Red arrows: anti-vaccine tweets; blue arrows: pro-vaccine tweets; grey arrows: news; green arrows: academic tweets; purple arrows: pro-safe vaccine tweets; AV: anti-vaccine actor; PV: pro-vaccine actor; TAV: tendentially anti-vaccine actor; TPV: tendentially pro-vaccine actor.

stead, was always fragmented into several loosely connected clusters, which could favour access to outsiders and new information. Similar results were found by Bello-Orgaz et al. (2017) and Yuan and Crooks (2018), who did not find interactions between anti- and pro-vaccine groups on Twitter.

The two communities also had different key actors. In all three datasets, most of these actors belonged to the anti-vaccine group, though in October the number of pro-vaccine actors increased (see Figure 3). This could be due to the high number of academic tweets in that dataset, related to the occurrence of a meeting between an NGO and the Islamic Development Bank. This finding contrasts with previous research which observed more pro-vaccine influencers than anti-vaccine on Twitter, though it did not look only at images (Bello-Orgaz et al., 2017). This discrepancy is likely related to both the higher number of anti-vaccine images collected in this study and the criteria used to define key actors. In the next sections, each community and its actors are discussed in detail.

5.1. The Anti-Vaccine Community

The anti-vaccine community always had more tweets than the pro-vaccine group, even when it had fewer members; hence, its users likely retweeted anti-vaccination images more often and were more connected. However, the density and modularity of the community and the dissemination pattern of its images indicate that most of the anti-vaccine users did not retweet

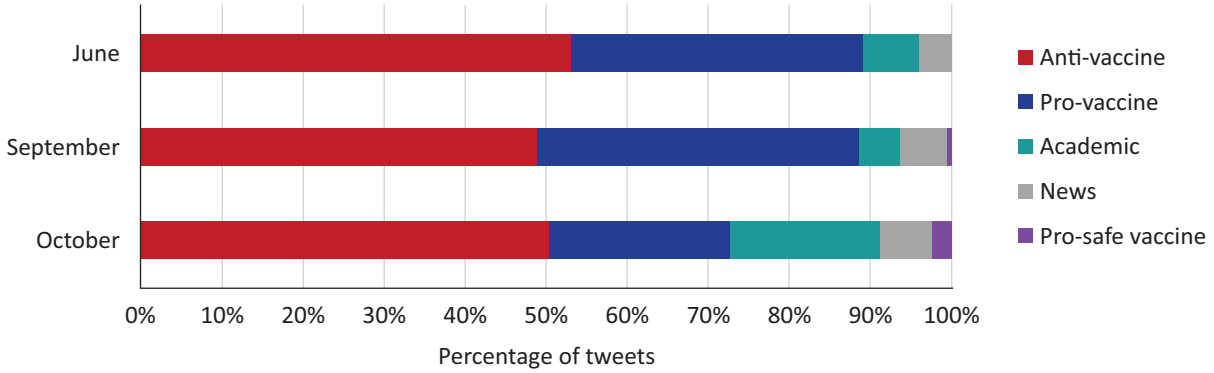

Figure 2. Percentage of tweets for each data collection and each category. Note: The total number of tweets analysed for each collection was 3573 in June, 1932 in September, and 3778 in October.

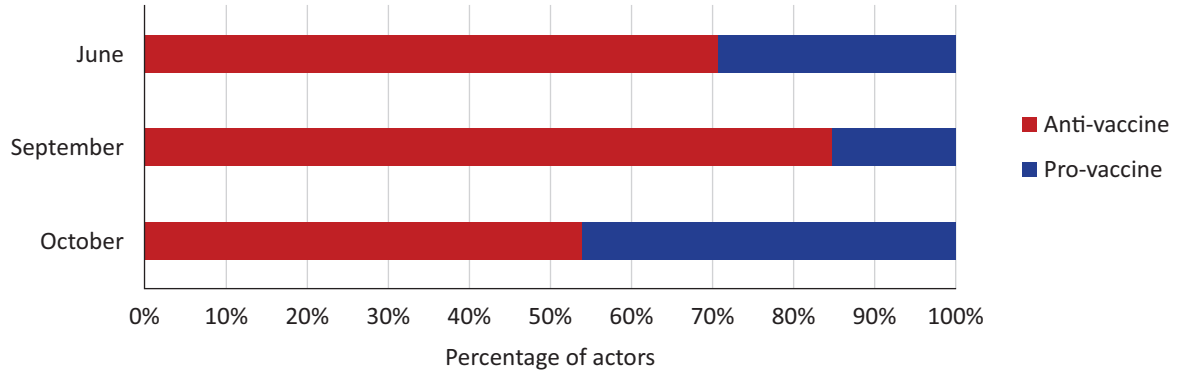

Figure 3. Percentage of anti- and pro-vaccine key actors identified in each dataset. Note: Total number of actors: 48 in June, 46 in September, 50 in October.

each other reciprocally, but clustered around different groups of people (see Table 1 and Figure 1). Therefore, the anti-vaccine visual information was shared mostly within multiple sources and groups (Himelboim et al., 2017). These groups were not disconnected from each other; their members also retweeted other groups' content. The connectivity within and between clusters may indicate that anti-vaccine users valued the information shared by the other members of the network (Himelboim, 2017). Moreover, this connectivity can provide a sense of trust, safety and support to the members of the community (Kadushin, 2011). Previous studies also found that the anti-vaccine community barely engage with outsiders and only re-share its members' tweets (Bello-Orgaz et al., 2017; Himelboim et al., 2019; Yuan & Crooks, 2018).

Most of the anti-vaccine key actors were activists, parents, parent-activists, and journalist-activists. There were no journalists who were not activists as well. A few of these actors were general users who did not provide any information about themselves (i.e., uncategorised), and even fewer were alternative-health practitioners (see Table 2). As also found by Himelboim et al. (2019), most of the key actors were alternative and non-academic sources of vaccine visual information. Among them, a journalist-activist and an activist constituted the source of two clusters recurrent in all three datasets (see top-left quadrant and second-to-left bottom quadrant in Figure 1). Several parent-activists, activists, and uncategorised users, instead, dominated the flow of visual messages of a third recurrent cluster (see bottom-left quadrant in Figure 1).

These three clusters formed a conspicuous part of the anti-vaccine community. Two of them were broadcasting networks where the actor/hub at their centre (the activist and the activist-journalist) was highly retweeted by the users around them but did not retweet other members of the community (Smith et al., 2014). These two actors disseminated images to their audiences, and they could act as opinion leaders by deciding what visual information to share. Moreover, they may be acknowledged as 'experts' by their audiences who valued and re-shared their content (Murthy, 2012). The other recurrent cluster included most of the other key actors, which frequently retweeted each other thus potentially forming friendship relations and strong ties (Huberman, Romero, & Wu, 2008). In addition to interacting among themselves, they also retweeted and were retweeted by users belonging to other clusters. This behaviour meant that the shared images reached other groups within the wider anti-vaccine network. Thus, they acted as gatekeepers; they could control the flow of visual information within the anti-vaccine community by choosing the images to share to their audience from other clusters. Moreover, they increased the visibility and redundancy of anti-vaccination images within the whole network, and at the same time, induced social contagion (Harrigan, Achananuparp, & Lim, 2012). This

Table 1. Number of users and tweets forming the anti- and pro-vaccine networks.

	June		September		October	
Graphic metrics	Anti-vaccine	Pro-vaccine	Anti-vaccine	Pro-vaccine	Anti-vaccine	Pro-vaccine
Users	944	1056	925	469	1393	1135
Tweets	1896	1677	1397	535	2141	1637
Density	0.0021	0.0015	0.0016	0.0024	0.0011	0.0013
Modularity	0.49	0.72	0.71	0.92	0.66	0.80

Notes: The anti-vaccine network includes anti-vaccine and pro-safe vaccine conversations. While tweets were classified into exclusive categories, users were not. The pro-vaccine network includes pro-vaccine, academic tweets, and news. Since a few users were mentioned by, engaged with, or shared content from both anti- and pro-vaccine groups, they were counted in both networks.

Table 2. Anti- and pro-vaccine key actors classified by type of actor.

Type of actors	June		September		October	
	Anti-vaccine (n = 34)	Pro-vaccine (n = 14)	Anti-vaccine (n = 39)	Pro-vaccine (n = 7)	Anti-vaccine (n = 27)	Pro-vaccine (n = 23)
Activists	32%	0%	23%	0%	33%	4%
Parents	12%	0%	8%	0%	7%	0%
Parent-Activists	15%	0%	10%	0%	15%	0%
Journalist-Activists	6%	0%	5%	0%	4%	0%
Alternative Health practitioners	3%	0%	5%	0%	4%	0%
Uncategorised	24%	0%	26%	0%	19%	0%
NGOs	0%	43%	0%	14%	4%	39%
Chief-Executives, Managers of NGOs	0%	7%	0%	14%	0%	13%
Health professionals/Academics	0%	21%	3%	57%	4%	35%
Other	9%	29%	21%	14%	11%	9%
Total	100%	100%	100%	100%	100%	100%

Notes: The category 'Other' includes types of actor that appeared occasionally and not in all three collections (e.g., writer, journalist, public health organization, research centre, pharmaceutical company). Each group (e.g., anti-vaccine) was divided into several categories to show the diversity of type of actors. Hence, the percentages refer to small frequencies.

mechanism might reinforce the echo-chamber effect by excluding information that comes from outside the well-connected network and reinforcing the messages shared by like-minded members of the community (Southwell, 2013; Yardi & Boyd, 2010).

We explored the five most retweeted images shared by the two hubs (the activist and the journalist-activist) to gain insights into the messages they conveyed. The activist posted photos saying that vaccines are unsafe. Three of these images included doctors' or medical associations' testimonials supporting these claims, whereas two of them mentioned *Vaxxed* (documentary) as a reliable source of vaccine information or as a growing anti-vaccination movement in the US. The journalist–activist shared photos or pictures with only textual elements that claimed conspiracy theories behind mandatory vaccinations, suggesting that vaccines are unsafe and cause autism. Both these two hubs shared vaccine misinformation and pseudoscientific evidence. Vaccine safety and conspiracy theories were two common topics of anti-vaccine images shared on Pinterest as well (Guidry et al., 2015).

5.2. The Pro-Vaccine Network

The pro-vaccine network had a completely different structure from the anti-vaccine community: It was formed by several loosely connected clusters and it was variable across the three datasets (see Table 1 and Figure 1). However, two clusters that were recurrent across the three datasets linked most of the biggest groups of the pro-vaccine network. These two clusters acted as brokers, reaching out to other groups discussing vaccinations from a slightly different angle (Himelboim et al., 2017). The structure of the pro-vaccine network facilitated access to and diffusion of new or different visual messages, thus avoiding redundancy of information; it also favoured networking, especially among NGOs and foundations who were often key actors (Kadushin, 2011). Previous research found that the pro-vaccine network was better connected, and as in this case, tended to be more open to outsiders than the anti-vaccination community (Bello-Orgaz et al., 2017; Yuan & Crooks, 2018). The anti- and pro-vaccination communities did not only have a different network structure, but also different types of key actors. The pro-vaccine ones were mainly NGOs, foundations, health professionals, academics, and Chief Executive Officers (CEOs) of NGOs (see Table 2). These actors were more credible sources of information, as also found by Himelboim et al. (2019).

NGOs dominated the flow of visual information in favour of immunisation. Many of them acted as hubs broadcasting their messages to their audiences (Smith et al., 2014). Moreover, an NGO and its CEO were at the centre of two clusters recurrent across the three datasets. These two actors acted as brokers, connecting the other organisations and charities involved in immunisation campaigns; hence, they acted as gatekeepers controlling the dissemination of information among them (Kadushin, 2011). Consistent with a one-way communication flow, it is possible that NGOs saw Twitter primarily as a means to persuade the public of their point of view (Auger, 2013), to create networks of supporters, and for "public education" rather than for mobilisation activities (Guo & Saxton, 2014). This attitude emerged in the most retweeted images shared by two key pro-vaccine actors: the NGO and its CEO. The NGO shared photos about immunisation campaigns and activities they run, and their partnerships with other non-profit organisations. Their messages did not focus on vaccine safety, but on their efficacy. The images posted by the CEO were photos about the NGO's achievements or charts and in-

fographics about vaccine efficacy. This actor also shared two infographics related to news about research on vaccine development.

6. Conclusion

This study is the first to explore how visual information is disseminated within and among anti- and pro-vaccination networks on Twitter and who the potential gatekeepers are in each community. This research reinforces previous work (Bello-Orgaz et al., 2017) by showing that pro- and anti-vaccine communities do not share images with each other on Twitter. Moreover, the few images explored in this study emphasised the polarisation of these two communities. While the most retweeted anti-vaccine images focused on vaccine safety, vaccine conspiracies, and provided pseudoscientific evidence to support their claims, the pro-vaccine images were about immunisation campaigns, vaccine efficacy, and development. We also found that the pro-vaccine network sharing images split into several loosely connected groups and had NGOs, foundations, healthcare practitioners, and academics as key actors and experts. The structure of this group facilitated networking among non-profit organisations and the exchange of new information about immunisation campaigns and research (Southwell, 2013). The anti-vaccine key actors sharing images were mainly activists or parents or both and were well connected within the network. The high connectivity of this community may reinforce the ties between members and increase their distrust towards non-members. It may also encourage intentions to avoid vaccinating and campaigning against vaccinations (Southwell, 2013). One cluster in particular may have increased the redundancy of visual information within the anti-vaccine network (Harrigan et al., 2012). This redundancy of visual messages, combined with high level of interactions among the members of this cluster, might reinforce the network ties and indirectly encourage those on the margins of the network, who have doubts about vaccinations, to become anti-vaccine as well (Southwell, 2013).

6.1. Practical Implications

Anti-vaccine images were predominant. By retweeting each other, anti-vaccination users increased the visibility of their images, enabling them to appear in followers' timelines and the vaccine hashtag streams more often. Hence, these images could potentially reach a broader audience than the pro-vaccine ones (Kumar et al., 2013). Moreover, these images could influence the public not to vaccinate, especially because they were retweeted by activists and parents who may become popular alternative sources of vaccine information (Szomszor, Kostkova, & Louis, 2011). This could be particularly problematic, as parents using social media to search for vaccine information may place more trust in them than in health professionals (Freed, Clark, Butchart, Singer, & Davis, 2011).

Pro-vaccine images may not reach as many conversations around hashtags as those against vaccinations do; hence they may not reach as many users who seek vaccine information by searching Twitter hashtags (Bruns & Burgess, 2015). For visual communication about vaccinations, we suggest targeting those users searching for hashtags such as #vaccines and #vaccinations, rather than anti-vaccine actors, as they may be more open to information about immunisation. The World Health Organisation (WHO) has given similar guidance (to target a broad lay public, rather than seek to engage anti-vaccine groups) when speaking at public debates about vaccinations (WHO, 2017). They also suggest correcting vaccine misinformation and unmasking the techniques deniers use to advocate against vaccinations (WHO, 2017).

Trying to persuade anti-vaccine users to vaccinate may not be an effective strategy, as their community is closed and possibly hostile to outsiders (Yuan & Crooks, 2018). Moreover, they may oppose any content produced by traditional experts and sources of information as they tend to believe in conspiracy theories (Mitra et al., 2016). An alternative approach could be that suggested by Lutkenhaus, Jansz, and Bouman (2019), who mapped vaccine conversations and communities on Twitter and identified their opinion leaders and gatekeepers, in a manner similar to our study. They contacted opinion leaders and gatekeepers at the border of the anti-vaccine communities, who were not deniers nor strong supporters of vaccinations. By engaging with them, and providing correct scientific information and data about vaccines, they were able to reach closed communities who do not trust traditional experts, but will consider pro-vaccine messages discussed by influencers from within the community. Lutkenhaus et al. (2019) also suggested studying the content shared by the target communities. This could include the content and symbols used in images shared by the anti- and pro-vaccine actors (Guidry et al., 2015).

6.2. Limitations and Future Studies

The results of this study differ from those of previous research on vaccination networks on Twitter. For example, while we found that most Twitter communities were anti-vaccine, Love et al. (2013) saw that pro-vaccine tweets comprised the majority of the conversation. The high number of anti-vaccine tweets and users we found might be due to our collection criteria. We collected only tweets having pictures, and at least one of ten popular hashtags highly relevant to vaccine discussions, thus excluding tweets having only words such as 'vaccine' that related them to the topic. We took this approach because hashtags, rather than words, are used to actively follow and join a Twitter conversation (Bruns & Burgess, 2012). Moreover, we considered hashtags such as #CDCwhistleblower, #vaxxed, and #hearus in our collection criteria, which do not contain the word

'vaccine' but label niche discussions against vaccination. Nevertheless, ten hashtags might not include all the popular conversations on vaccinations. Though the data were collected in 2016, more recent studies have also reported polarisation in vaccine networks (Bello-Orgaz et al., 2017; Yuan & Crooks, 2018) and observed that the closed nature of the anti-vaccine community could make it difficult to penetrate (Gunaratne et al., 2019). Together with our study, this suggests there may be particular challenges for those undertaking vaccination campaigns on Twitter.

This research contributes to understanding how images about vaccinations flow on Twitter. Further studies are needed to investigate the dynamics within the Twitter anti-vaccine community and the textual and visual content they share since Twitter messages may influence readers not to vaccinate (Dunn et al., 2017). Future research should also focus on vaccine pictures shared on social media in relation to the communities that diffuse them. Moreover, it would be interesting to analyse the differences between network patterns around vaccine hashtags and those around words. Such research would facilitate design of effective Twitter immunisation campaigns, and address the sentiment spread by the anti-vaccine movement online and offline (Leask, 2015).

Conflict of Interests

The authors declare no conflict of interests.

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COGITATIO

Media and Communication (ISSN: 2183–2439)
2020, Volume 8, Issue 2, Pages 376–386
DOI: 10.17645/mac.v8i2.2862

Article

Rezo and German Climate Change Policy: The Influence of Networked Expertise on YouTube and Beyond

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Submitted: 31 January 2020 | Accepted: 20 May 2020 | Published: 26 June 2020

Abstract
Just before the European election in May 2019 a YouTube video titled *The Destruction of the CDU* (Rezo, 2019a) caused political controversy in Germany. The video by the popular German YouTuber Rezo attacked the conservative Government party CDU (*Christlich Demokratische Union Deutschlands*) mainly for climate inaction. As a reaction to the subsequent attacks on Rezo and his video from the political establishment an alliance of popular German YouTubers formed to release a second video. In this video, the YouTubers asked their followers not to vote for the Government or the far-right parties, because they would ignore the expertise of scientists and the scientific consensus on anthropogenic climate change and therefore be unable to provide sustainable solutions for the future. This debate started as a YouTube phenomenon but quickly evolved into a national public discussion that took place across various social media channels, blogs, newspapers, and TV news, but also e.g., in discussions in schools, churches, as well as arts and cultural events. The focus of this contribution is on the formation of the heterogeneous coalition that emerged to defend and support the YouTubers. It prominently involved scientists and scientific expertise, but other forms of expertise and 'worlds of relevance' were also part of this coalition. The conceptual tools of 'networked expertise' and 'ethno-epistemic assemblages' are employed to explore expertise and credibility as well as the associations and networks of actors involved which illuminate how a single YouTuber was able to contribute to the unleashing of a national debate on climate change policy.

Keywords
climate change; controversy; Germany, global warming; influencers; networks; science communication; YouTube

Issue
This article is part of the issue "Health and Science Controversies in the Digital World: News, Mis/Disinformation and Public Engagement," edited by An Nguyen (Bournemouth University, UK) and Daniel Catalan (University Carlos III of Madrid, Spain).

1. Introduction

Scientific and other forms of expertise are key resources in public health and science controversies. However, in general, there are various forms of relevant expertise in public controversies. Often they oppose one another and the way in which credibility and trustworthiness are assigned varies among the public. For a better understanding of this matter, Limoges (1993) offers a processual understanding of expertise in controversy contexts. Limoges describes controversies as 'controversist spaces' in which various actors and experts with completely different 'worlds of relevance' meet. For Limoges, all participating groups are fully-fledged actors in this space thus expertise per se does not count more than the view of any of the other involved actors and in most cases, expertise is provided in plural and often contradictory. In media coverage of debates, journalists generally mediate controversies and select the (expert) voices they think should be represented. This process, however, is less straightforward for public science and health controversies in the digital world as there are no gatekeepers and a great variety of new actors and experts struggling to have their voices heard.

Limoges asserts that the actual issue during a controversy is the negotiation of the associations established between the different 'worlds of relevance' mobilized by different participants. Such associations are not defined a priori but emerge as outcomes of the interactions between the participants. In other words, the representation of expertise develops through the course of controversies. How powerful and credible experts become in a controversy depends, in this view, on their ability to network and form associations.

In this view, the credibility of expertise needs to be developed within a controversy context and it is therefore not an individual but collective process. For Limoges, the credibility of expertise stems from the strengths of the networks that actors are associated with in the controversy. Expertise is, therefore, a collective learning process which provides actors and experts with credibility if they are successful in addressing the articulations of various 'worlds of relevance.' In this sense, expertise is a public process which creates the conditions of credibility of expert performance (Limoges, 1993).

This understanding of networked and collective forms of expertise in controversy contexts was further developed by Irwin and Michael (2003). They proposed the notion of ethno-epistemic assemblages as a heuristic tool with which heterogeneous groupings could be analysed. 'Epistemic' here refers to the production of truth or truth claims; 'ethno' connotes the idea of locality and situated-ness of knowledge; and the concept of 'assemblage' is used to grasp the interweaving of laypeople and experts (Irwin & Michael, 2003, pp. 119–120). These assemblages are not static, they are dynamic and processual, and different actors with a variety of background knowledge, expertise, and experience can join such groups. This concept is proposed for a better understanding of the way in which controversy, debate, and negotiation are played out in public. Instead of struggles conducted between experts and (lay) publics, Irwin and Michael (2003) propose that struggles over truth claims are conducted between assemblages made up of different combinations of experts and publics. The concept of ethno-epistemic assemblages, therefore, blurs the boundaries between experts and non-experts but also between public, government and governance, as well as between science and society.

In this contribution, I offer a close reading of a public controversy about climate change policy that was initiated by, and mainly revolved around, a YouTube video released by the popular German YouTuber Rezo in May 2019 (Rezo, 2019a). This video mainly attacks the failing climate policy of the German government and has received national and international attention. In this interpretative account, I use the perspective of networked forms of expertise and ethno-epistemic assemblages as introduced by Limoges (1993) and Irwin and Michael (2003) to analyse the 'controversist space' of the public debate and how various forms of expertise formed networks and worlds of relevance which became enrolled and connected in the unfolding debate. My account is based on an online ethnographical approach following the Rezo video and the subsequent debate through various digital spaces (social media platforms such as YouTube and Twitter, online news sites and blogs) from May 18, 2019, to January 31, 2020. In this process, key documents of the debate were selected and archived for further analysis and a chronological archive of YouTube videos and comments, Tweets, blog entries, and news articles were created, which serve as the basis of my interpretative account.

2. YouTube and Science Communication

YouTube is extremely popular in Germany. A representative study (Rat für kulturelle Bildung, 2019) among young citizens in Germany has found that 86% of youths between 12 and 19 years use YouTube and that 93% of youths between 18 and 19 years in Germany use YouTube for entertainment, information, and education. 91% of young people questioned said that it is very important what their friends recommend watching on YouTube. 65% of the young people questioned also follow recommendations from YouTube influencers. Such influencers are particularly influential among the 12–15 age group (Rat für kulturelle Bildung, 2019).

Another representative study on the use of online media among young people in Germany has found that the use of YouTube has further increased in recent years (Medienpädagogischer Forschungsverbund Südwest, 2019). While in 2016, 42% of young people questioned said that they used YouTube daily or almost daily in 2018, 60% of the respondents said that they used the site daily or at least several times a week. YouTube has become one of the most popular Internet sites in Germany for all age groups. The study also investigated information and knowledge seeking behaviour online and found that YouTube is the second most popular site for acquiring knowledge and information after Google. Also, more young people search for things they want to know via YouTube rather than the online encyclopaedia Wikipedia (Medienpädagogischer Forschungsverbund Südwest, 2019).

This is also the case when it comes to science, technology, and research—not just among young people. A German representative study on science and research in society (Wissenschaft im Dialog, 2015) found that more than two thirds (69%) of young people questioned between 14 and 29 years said they use YouTube (and other online video platforms) to get information about science and research. Among those between 30 and 39 years, still more than half (55%) said the same and among those between 40 and 49 years, it is almost half (46%) who are informed via YouTube.

So far, little research has been done to systematically investigate science and research topics on YouTube (Allgaier, 2018; León & Bourk, 2018). There are some methodological problems that need to be overcome. For

instance, the algorithmic curation and personalization of search results (e.g., Rieder, Matamoros-Fernandez, & Coromina, 2018) make reliably sampling video content difficult. However, there is a great deal of potential for public science and health communication via the online video format, since it allows for the use of lots of different audiovisual elements as well as text, and subtitles in different languages (e.g., Allgaier & Svalastog, 2015; Körkel & Hoppenhaus, 2016; León & Bourk, 2018). Luzon (2019, p. 170) asserts that "online science videos are multimodal texts which draw on several modes or semiotic resources (e.g., non-verbal sound, spoken and written language, image) to re-contextualize scientific discourse." This re-contextualization can be used to bridge knowledge gaps between scientific experts and the general public (Erviti & Stengler, 2016; Luzon, 2019). But there is also a dark side. Analyses of scientific video content on YouTube have found that users are directed to biased and defective video content and conspiracy theories when they are searching for biomedical or scientific information. Some examples are topics such as vaccines (Basch & Basch, 2020; Basch, Basch, Zybert, & Reeves, 2017; Venkatraman, Garg, & Kumar, 2015), Ebola (Allgaier & Svalastog, 2015; Basch, Basch, Ruggles, & Hammond, 2015), the Zika Virus (Basch, Fung et al., 2017), climate change and geoengineering (Allgaier, 2019), and the question of whether the Earth is flat (Landrum, Olshansky, & Richards, 2019).

Another gap in the literature concerns the production of content. Very little is known so far about who is successfully communicating science and research on these sites and with what intentions various actors use YouTube to communicate science (Flores & de Medeiros, 2019). In social media research, it has been a convention to differentiate between professionally generated content and user-generated content (e.g., Kim, 2012). Research by Welbourne and Grant (2016) has shown that science videos made by professional media organizations outnumbered the videos made by users when the research was conducted. However, it was also found that the content produced by the users is more popular and has been viewed much more often than the videos created by professional media organizations (Welbourne & Grant, 2016).

Morcillo, Czurda, and Robertson-von Trotha (2016) described how science videos created and shared by the users are made of high cinematographic quality and are also immensely creative. The 'amateur users' created new visual languages and also new genres and formats for the successful public communication of science. In their videos, charismatic hosts present science in innovative and creative new ways and have also developed science-related storytelling that is enjoyed by large audiences. They often use humour and emotion in their science videos and the contents are often heavily personalized. Science and other YouTubers generally present themselves as authentic and amenable persons who avoid jargon and often use vernacular language. By that, they often want to show that they are close to their viewers and everyday people and make the experience of watching a YouTube video more relatable (Holland, 2017).

Recent research from Germany has found that Science YouTubers produced and shared the majority of the science videos in a sample of 400 science videos on YouTube in German language (Bucher, Boy, & Christ, 2019). These independent science communicators outnumbered the contributions coming from research institutions and universities and also received far more views than the contributions of scientific organizations and institutions. The most successful science YouTubers now have many millions of subscribers.

Video-sharing via YouTube, in general, has become far more professionalized and commercial in recent years. Most content creators on YouTube try to monetize their video content and many of them are organized in multichannel networks that help them with marketing, potential advertisers, and sponsors (Frühbrodt & Floren, 2019). All successful creators on YouTube need to play along with the platform-specific rules in order to be visible. How YouTube's ranking and curating algorithms highlight some contents and neglect others is not transparent and also changes with time (e.g., Geipel, 2018). Further research is needed to fully understand the platform-specific logics and laws, but Van Es (2019) describes the operating logic of YouTube as being commercially driven, for instance by selling personally targeted advertising space. Here, the YouTube algorithms have different functions: They control what is allowed on the platform, they determine the extent to which a video is integrated into the recommendation system, and the algorithmic control also decides whether a video is eligible for remuneration for advertising. In this sense, the black-boxed YouTube algorithms have a strong influence on the communications and work of YouTubers, and they also act on the relationships among users, creators, advertisers, and the platform itself (Arthurs, Drakopoulou, & Gandini, 2018; Bishop, 2018). However, YouTubers who create science videos have the advantage that videos about science topics generally do not depend strongly on real-world events in contrast to, for instance, current or political affairs topics and videos.

A simple dichotomous distinction between user-generated content and professionally created content is no longer adequate to explain what is happening on YouTube today. Previous amateurs, such as the (science) YouTubers, have now become more successful on YouTube than many of the previous media and communication experts from traditional media organizations by reaching wider audiences (Morcillo, Czurda, Geipel, & Robertson-von Trotha, 2019). To be successful on YouTube also means elaborate community management (e.g., Erviti & Stengler, 2016). Successful YouTubers, therefore, spend a significant amount of time with parasocial interactions; they respond to comments, engage in dialogue with their viewers and personally deal with

requests, ideas, and suggestions (Rihl & Wegener, 2019). In this way, they are often quite service-oriented, for instance when they ask their viewers what the next video should be about. In this sense, they use a very dialogic approach and also encourage their viewers to comment on their videos and to discuss them.

Breuer (2012) argues that 'authenticity' is an important if not the central currency on platforms such as YouTube and is often linked to credibility. To be authentic also means to be perceived as a real, honest, and tangible person whom users can relate to. Authenticity is often linked with amenability, which increases if the users feel that they are taken seriously by the content creators. This can involve, for instance, personal replies to their questions or comments or being personally mentioned in videos. Research on social media influencers has stressed the importance of authenticity (e.g., Abidin & Ots, 2016) and also the role of emotion (e.g., Sampson, Maddison, & Ellis, 2018) in social media communications. Recent research by Reif, Kneisel, Schäfer, and Taddicken (2020) highlights the importance of considering emotions when studying trustworthiness, especially in the context of public science communication. In the community of YouTube users, dialogue and interaction are highly valued. Individuals, organizations and institutions that are not responsive on YouTube are often not perceived as being trustworthy or authentic and therefore not of interest to many YouTube users. Transparency is another important issue for many science and other YouTubers, e.g., for establishing trust. This means, for instance, making the sources used in videos transparent and directly linking to relevant sources and materials in the videos' descriptions (e.g., Delattre, 2017).

3. The Public Debate about Rezo and His *The Destruction of the CDU* Video

3.1. The Rezo Video on YouTube

Rezo is a popular German YouTuber based in the university town Aachen. The male YouTuber has a degree in computer science, is known for his trademark blue hair and withholds his official name from the public (Wikipedia, 2020a). By posting funny clips and videos about music on his two YouTube channels he has built himself a large base of followers and subscribers and has gained a reputation in the German YouTube scene. On May 18, 2019, he posted an unusually long video which lasted almost an hour (54 minutes and 57 seconds). The video is titled *The Destruction of the CDU* (Rezo, 2019a). The CDU (*Christlich Demokratische Union Deutschlands*) is the conservative governing party of Germany's Chancellor Angela Merkel. Right at the beginning of the video, the YouTuber makes it clear that destruction in this sense is only meant metaphorically. He moves on to explain that it is the purpose of the video to present reasons and proof why the governing party actually de-legitimizes itself with its own politics, or in other words that it does not practice the values it claims to uphold. He does not exclusively take a swipe at the conservative governing party, but also at the party of the Social Democrats (SPD, *Sozialdemokratische Partei Deutschlands*), which forms a coalition government with the CDU in Germany.

In the video, Rezo attacks various policies of the governing parties, but the largest and main part of the video criticises the government's climate policy. He explains that there is a consensus among scientists that humans are the cause of climate change and describes his frustration and disappointment that the government does not act according to the advice of climate scientists concerning climate change. He portrays climate change as a serious threat to the wellbeing of humanity and all other forms of life on the planet. Rezo describes some of the scenarios of what is likely to happen, if climate emissions are not curbed very soon based on scientific assessments, such as the ones from the Intergovernmental Panel on Climate Change and stresses that, according to the scientists, there is no going back once certain levels of climate change have been reached. Among others, he explains global warming and the global consequences of rising temperatures and he also portrays likely consequences of the loss of biodiversity through climate change, harmful effects on public health, food security, and increased global migration as a result of climate change.

The video is a complaint, an arraignment, and a manifesto for curbing climate emission, the transition to sustainable energy systems, carbon taxing, and a plea for a scientific assessment of the climate crisis. In order to make his sources transparent, there is a link in the description of the video to a 13-page Google document (Rezo, 2019b) listing all the sources he refers to in the video (99 of the references in the document refer to the debate around climate change). In the section concerning climate change, he mainly refers to scientific publications in scientific journals such as *Science*, *Nature*, *Environmental Research Letters*, *Atmospheric Chemistry and Physics*, *Nature Climate Change*, *The Lancet*, *Proceedings of the National Academy of Science*, or *The Royal Society (Philosophical Transactions A*), and scientific assessment reports, for instance, by the Intergovernmental Panel on Climate Change or the Intergovernmental Platform on Biodiversity and Ecosystem Services.

In the video, Rezo (2019a) is seen talking, filmed from the front, wearing an orange hoodie, and while he is talking subtitles refer to the sources laid out in the appendix document. Occasionally a graph or an image appears on the screen to visualize what he is explaining. The way he is talking differentiates him from a news anchor or academic expert; he is using a youthful and vernacular language that other people of his age use when they have conversations among friends in a pub. His language is not neutral in tone, he also shows verbally and by facial expressions and gestures that he is shocked about the gloomy scenarios put forth by the scientists and angry

that the government is not reacting appropriately, given the advice coming from scientific experts. However, Rezo follows a structured argumentation line and points out in detail how the government is failing in addressing the climate crisis (before he moves on to talk about social policy issues).

3.2. The Social and Political Context

The video was posted on YouTube roughly a week before the European elections took place in Germany on May 26, 2019. In the video, he calls on his predominantly young followers to participate in the European elections, but to vote for neither the CDU nor the SPD and particularly not the far-right AfD (*Alternative für Deutschland*). From his point of view, none of the three parties would provide any real sustainable solution for dealing with climate change—and the AfD would not even acknowledge that anthropogenic climate change is happening. In the description of the video it reads in German:

> The European election is taking place very soon. In this video, I try to answer the question of whether the CDU, SPD, or AfD are good parties that are in harmony with science and logic. In any case: Go to vote next weekend. If not, pensioners will decide on your future and that is not cool at all. (Rezo, 2019a, author's translation)

Within a day, the video had more than one million views and all major German news outlets reported on it over the following days. By election day, Rezo's video had been viewed more than 11 million times and reviewed in international news outlets such as *Le Figaro*, *The Guardian*, and *The New York Times*. Meanwhile, a German Wikipedia entry was also made (Wikipedia, 2020b) about the impactful video and its reception in politics, media, science, and society, which also linked to key documents. By the end of the year, *The Destruction of the CDU* video was the most-watched German online video of 2019, receiving more than 16 million views (Wikipedia, 2020b).

Immediately after the video had been reported in the news, politicians of the conservative governing party heavily attacked the YouTuber for spreading false information and fake news (e.g., "Germany's CDU slams YouTuber Rezo," 2019). CDU then announced that it would react in the form of their own response video. However, shortly after that, the conservative party then announced on its website (CDU, 2019) that a response video would not be the communicative style of a grand national party and instead released an 11-page document, in which it tried to refute Rezo's claims.

3.3. Aftermath of the Video

Soon after the video was released, various scientists entered the scene, such as the influential female science communicator Mai Thi Nguyen-Kim. She quickly produced a video (maiLab, 2019a) on her YouTube channel 'maiLab' to check the scientific facts presented in Rezo's work. Apart from some minor inaccuracies she scientifically approved the content of Rezo's video as well as his call for immediate action. The maiLab video also features the comedian and physician Eckhard von Hirschhausen, who is very popular and well-known for hosting various health and science programs on German television and other public events. In the video, he is also supportive of Rezo's claims.

Some days later Stefan Rahmstorf (2019), Professor for Physics of the Oceans at the University of Potsdam and Head of Earth System Analysis at the Potsdam Institute for Climate Impact Research, and Volker Quaschning (2019), Professor for Regenerative Energy Systems at HTW Berlin University of Applied Sciences checked the scientific facts presented in the Rezo video, as well as in the written response of the CDU and both also backed the claims that Rezo made in the video. Quaschning writes that he did not find any proofs in the response of the CDU that would substantially disprove the claims made in Rezo's video concerning climate change. Physicist Christian Thomsen, President of the Technical University of Berlin, also backed Rezo's claims and states in an opinion piece (Thomsen, 2019) that Rezo (and other involved YouTubers) had cited references more correctly and transparently than many of the Federal Ministers and professional politicians who were attacking him. Rezo not only received backing from scientists and other experts, but also from many citizens, religious institutions (Oster, 2019), and influential people from the arts and culture community, such as the director Thomas Oberender (2019).

Meanwhile, Rezo had teamed up with further influential players in the German YouTube scene. On May 24, 2019, two days before election day, an alliance of over 70 highly popular German YouTubers released another video (Rezo, 2019c), which they simply named *A Statement of 70+ YouTubers*. This video was less than three minutes long and contained a single statement issued by a very diverse set of YouTubers. The YouTubers featured in this video normally have differing points of foci, such as music, beauty, fashion, gaming, as well as a range of other subjects. Very few of them had been making videos about science-related topics up until that point. A statement posted underneath the video was later signed by more than 90 highly popular German YouTubers.

In their video statement, the YouTubers called on their followers to vote in the European elections, but not to vote for the governing parties or the right-wing AfD, because none of them would follow scientific advice on climate change. The YouTube creators explicitly aligned themselves with the scientific experts and also referred to the work of the Intergovernmental Panel on Climate Change (Rezo, 2019c) and a statement signed by over 26,000 scientists and scholars from Germany, Austria,

and Switzerland (Scientists for Future, 2019). This statement explained that the governments of the three countries were not doing enough to limit global warming, to halt the mass extinction of animal and plant species, or to preserve the natural world upon which life depends. Taken together, this group of YouTubers has millions of followers. This video also made national headlines (e.g., "German YouTubers," 2019) and was viewed almost 3 million times just within the first two days.

This alliance of YouTubers was also heavily attacked and criticized by various members of the conservative governing party. The biggest winner in the German election was the Green Party (Wikipedia, 2020b), receiving more than a third of first-time voters votes. The governing coalition experienced massive losses and the German public-service television suggested that the 'Rezo-effect' had helped the Green party; with this, climate protection had become a major topic in the EU elections (Wikipedia, 2020b).

The massive gain in the share of votes by the Green Party in the European election was not a result of the YouTube videos alone. There is no data-based evidence that a 'Rezo-effect' had taken place in the election. Nonetheless, various news articles and blogs claimed that the two videos had influenced the results of the election. Conspiracy theories emerged on the web suggesting that the Rezo video had been instigated by the Green party—although this was later disproved by journalists (Wikipedia, 2020b). Rezo claimed in various interviews that he made the video himself and had spent hundreds of hours working through the scientific material. He felt that it was his duty as an informed citizen to criticize the Government for its inaction and he also de-monetized the video to show that he was not aiming to profit financially from it. To understand the potential impact of the video it is important to have a look at the wider social and political context, in which the video emerged: Many young voters in Germany already held grudges against the government because their protests against Article 13 of the draft EU Copyright Directive (which would require Internet platforms like YouTube to filter out copyrighted video content) were ridiculed by some conservative politicians shortly before the video (e.g., Stojanovski, 2019). Also, the enduring wave of nation-wide Fridays for Future demonstrations, inspired by the climate protection activist Greta Thunberg, had not been taken seriously by the government (e.g., "EU election," 2019). Instead of responding to the questions and concerns raised by young people about climate protection and sustainable plans for the future, Annegret Kramp-Karrenbauer, leader of the conservatives, proposed having a debate on the regulation of political views on the Internet during election campaigns (e.g., "Germany's AKK," 2019). This led to further furious debates and a petition campaign against the censorship of free speech on the Internet ("YouTubers petition," 2019).

German Chancellor Angela Merkel remained silent during this debate. Almost a month passed until she first spoke out on the issue, on June 19, 2019. In a discussion (Tagesschau, 2019) with about 200 teenagers in Goslar, she said that she was not happy with the defensive reaction of her party when the Rezo video first appeared. When the young people asked her if she thought there were points that Rezo got right in his video she responded that he was right that the government had indeed broken its promise on climate protection. The government then promised to assemble a task force on climate change in the autumn.

Five days before the newly assembled climate expert commission of the German government met and the third global climate strike took place on September 20, 2019, YouTube scientist Mai Thi Nguyen-Kim and Rezo together released another video (maiLab, 2019b) in order to mobilize people for the climate strike and to influence politicians' decision on pricing carbon. The 26-minute video presented scientifically approved solutions about how CO_2 emission pricing could help to solve the climate crisis. The video prominently featured economics professor Ottmar Edenhofer and engineer Klaus Russell-Wells, who runs a YouTube channel focused on energy transition and sustainability (Joul, 2020).

When the 'climate cabinet' of the government had presented a working plan about carbon pricing that scientific commentators described as a disappointment, Mai Thi Nguyen-Kim quickly produced another video (maiLab, 2019c), published September 23, 2019, in which she explained in drastic words why the proposed solutions would not be effective from a scientific point of view and why the government had still failed to address the climate crisis in a sustainable manner. This video also featured a rant about the government's failure by Harald Lesch, professor of astrophysics at the University of Munich, a public intellectual and popular German science communicator on TV, radio, and on various online platforms.

From October 24, 2019, onwards, Rezo has had a regular column in the elite weekly newspaper *Die Zeit*, in which he writes about social and political topics (Wikipedia, 2020a). He has been invited to join panels, talk shows and discussion forums, and in November 2019 he won, among other awards, the environmental media award for his *The Destruction of the CDU* video (Rezo, 2019a; Wikipedia, 2020a). In an interview in the weekly news magazine *Der Spiegel*, he was asked about the new government legislation about climate protection and he said: "It does not matter if I think it is sufficient. I am not an expert. It is important what the scientists say. And they say: The new legislation is not sufficient" (Kühn, 2020, author's translation). In April 2020, Rezo was also awarded the Nannen Award in the web project category for his YouTube video *The Destruction of the CDU*. The Nannen Award is the most prestigious prize for journalism in Germany, although the decision was considered controversial among journalists (e.g., Singer, 2020).

4. Discussion

4.1. Rezo, Networked Expertise and Ethno-Epistemic Assemblages

The perspectives of networked expertise (Limoges, 1993) and ethno-epistemic assemblages (Irwin & Michael, 2003) are helpful conceptual tools to better understand how a young blue-haired person could contribute to the unleashing of a societal debate over climate protection and anthropogenic climate change which went on for many months. The content of Rezo's video was not only discussed in journalistic media and social media platforms but e.g., also in schools, where many teachers showed the video in class and discussed climate change and politics with their students (e.g., Rezo, 2019d).

Over the years, Rezo was able to develop specific expertise concerning successful social media communication and interaction (not only on YouTube but also via other social media channels). An important resource is his large base of followers that he is able to address and also his very good contacts and connections in the German YouTube scene (Ziewiecki & Schwemmer, 2019). Rezo had received academic training at a technical university so he is able to actually process information from scientific sources himself (Wikipedia, 2020a). Over the years, he has learned how to present himself successfully on YouTube, but also how information needs to be presented so that it reaches an audience on this platform. He mentioned in various interviews how important it was for him to make all sources transparent that he used and that it took him a lot of time to work through all the material himself. The main achievement of the video is that it was able to translate and present the scientific content so that its target audience could personally relate to it. This is where scientists and institutional science communicators had failed. None of the content presented in the video was new—it was *how* it was presented that made it so impactful. Here, the use of a jargon-free colloquial language was very important, but also the fact that he was emotionally and wholeheartedly engaged in talking about an issue that was obviously a personal matter of concern. A certain amount of rage and indignation towards the government in the video together with the provocative call for all his followers to not vote for the established government parties were also very helpful in this regard. Reif et al. (2020) have highlighted the importance of considering emotions for the perception of trustworthiness, particularly in the science communication context.

Many of his followers most likely already perceived him as an authentic, relatable, and credible person, which might have been an important reason why so many young people watched his video in the first place. At some point, the YouTube algorithm also became an ally (although it is not entirely transparent how it functions). In May 2019, the Rezo video was trending and recommended to German users on YouTube. Soon after that, it was also recommended by the algorithms of other social media platforms, such as Facebook, Instagram, and Twitter, since many users had used these platforms to share or discuss the video. Various additional factors then further amplified the video, such as the fact that the general news media reported it and politicians had reacted to it, making it even more newsworthy in journalistic outlets, adding further 'worlds of relevance.'

When Rezo teamed up with the heterogeneous network of YouTubers his statement also reached many young people who had not been following his channel but those of the other YouTubers, channels with entirely different target audiences than Rezo's. Very quickly scientists jumped on the bandwagon and further helped to make the video known within their spheres of influence. This association lent scientific credibility to the network that had formed around the Rezo video. The videos from maiLab were particularly important for adding credibility in various further 'worlds of relevance' and her connections with other YouTubers, journalistic media, and celebrity science communicators further amplified the reach of the videos. Various other YouTubers, who had not been involved until that point, then also pushed Rezo's videos via their own channels. In addition, a variety of further actors from entirely different social spheres and 'worlds of relevance,' such as schools, churches, or arts and culture organisations also engaged with and commented on the video, making the debate even more newsworthy and relatable to many different social worlds. The video also came in conjunction with the already popular Fridays for Future protest movement initiated by Greta Thunberg. The direct relation to the European election gave it a high value of actuality. This did not stop when the official results of the election came in. Many had the subjective feeling that the Rezo video was at least partly responsible for the losses of the government parties in the election because the video had received so much attention, but there is no scientific evidence to back up this claim.

What is especially interesting is the relationship between the YouTubers and their followers and the scientific experts. Rezo and the other YouTubers never claimed to be authorities in science, but rather backed up the scientists and demanded that their voices be heard in the political debate and that the politicians from then on had to listen to the scientific experts and follow their recommendations. This is the same argument that climate change activist Greta Thunberg put forth on various occasions, 'listen to the scientists!' So in this particular instance, this specific YouTube movement had greatly amplified and supported scientific authority and expertise. However, Henriksen and Hoelting (2017, p. 34) propose that new forms of expertise emerge on platforms such as YouTube:

> The artists who find great success on YouTube are becoming a new form of expert. These experts are

> content creators who can now bypass the standard gatekeepers of genres before distributing their work. Bereiter and Scardamalia's (1993) definition of expertise notes that it is not only determined by knowledge or tenure in an area, but by how the knowledge is adapted to unique contexts and new challenges. There are still experts in traditional domains that may pose valid questions…. However, emerging and popular artists on YouTube are reframing their domain and its context of how creative systems operate and the communities that participate in them.

In this sense, professional YouTubers have become experts at being seen and heard on this specific online platform (Morcillo et al., 2019), an environment in which scientists and research organizations are struggling (e.g., Bucher et al., 2019) as well as journalists, political parties and many other organisations. The YouTubers have learnt to develop communication styles and formats that work and that are popular, they network among each other and create connections with different spheres of society. Many YouTubers make their sources transparent and link up to them in the video descriptions in order to enhance credibility and trust. They have managed to engage the community of their followers and also learnt how to deal with the platform-specific rules of YouTube and especially the curation (mainly by algorithms) that is crucial to maintain the visibility needed to survive on the platform. The success of the ethno-epistemic assemblage supporting Rezo and his video is the result of connecting and addressing various 'worlds of relevance,' the inclusion of various experts and diverse forms of expertise, but also of the development of platform-specific forms of expertise in order to reach and connect people with a variety of backgrounds and interests. This was a successful association of heterogeneous actors such as beauty, gaming, comedy, music, and other YouTube creators, with not just science and scientists but also with teachers and students, senior citizens, artists, and clergy, as well as many other members of society. This diverse group of actors managed to turn this specific ethno-epistemic assemblage into an entity embodying various forms of expertise and which was able to develop its credibility over the course of the debate, blurring the boundaries between laypeople and experts, and thus became an influential civil society actor within German political discourse.

4.2. Limitations and Outlook

A methodological limitation of this contribution is that it is based on the conceptual interpretation of selected documents and not on a systematic data collection and analysis. For instance, further research could compare the Rezo debate in various social media platforms and journalistic formats. Furthermore, it focused on only one of the evolving assemblages in the debate—the one supporting Rezo. A symmetrical account of this debate could entail studying further entities, for instancing those opposing Rezo and rejecting his claims and how they relate to each other. Another neglected aspect concerns the reception of the debate (Paßmann, 2019). Here the analysis of the hundreds of thousands of comments to the Rezo video would be an interesting starting point that could be complemented with focus groups of YouTube audiences and interviews with the actors involved in the debate. Nonetheless, the Rezo debate demonstrates, in my opinion, that YouTube as a platform and YouTubers as platform-specific experts have become crucial factors in the public science communication landscape which should be taken more seriously both by society as well as in academic discussion. Analyses of the science–society relationship should therefore also focus on the contents and various networks and associations that form around specific science-related content on YouTube and how they are publicly assessed. The investigation of controversially discussed science and health-related topics, such as climate change or COVID-19, will strongly benefit from the inclusion and consideration of these elements.

Acknowledgments

I would like to thank the anonymous reviewers and the Academic Editors for their helpful and productive comments. I also want to thank my colleagues in Aachen and elsewhere for stimulating discussions and helpful hints as well as my students for sharing their views, thoughts, and insights with me.

Conflict of Interests

The author declares no conflict of interests.

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COGITATIO

Media and Communication (ISSN: 2183–2439)
2020, Volume 8, Issue 2, Pages 387–400
DOI: 10.17645/mac.v8i2.2853

Article

Third-Person Perceptions and Calls for Censorship of Flat Earth Videos on YouTube

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Submitted: 30 January 2020 | Accepted: 22 March 2020 | Published: 26 June 2020

Abstract
Calls for censorship have been made in response to the proliferation of flat Earth videos on YouTube, but these videos are likely convincing to very few. Instead, people may worry these videos are brainwashing others. That individuals believe other people will be more influenced by media messages than themselves is called third-person perception (TPP), and the consequences from those perceptions, such as calls for censorship, are called third-person effects (TPE). Here, we conduct three studies that examine the flat Earth phenomenon using TPP and TPE as a theoretical framework. We first measured participants' own perceptions of the convincingness of flat Earth arguments presented in YouTube videos and compared these to participants' perceptions of how convincing others might find the arguments. Instead of merely looking at ratings of one's self vs. a general 'other,' however, we asked people to consider a variety of identity groups who differ based on political party, religiosity, educational attainment, and area of residence (e.g., rural, urban). We found that participants' religiosity and political party were the strongest predictors of TPP across the different identity groups. In our second and third pre-registered studies, we found support for our first study's conclusions, and we found mixed evidence for whether TPP predict support for censoring YouTube among the public.

Keywords
censorship; conspiracy theories; fake news; flat Earth; third-person effects; third-person perceptions; YouTube

Issue
This article is part of the issue "Health and Science Controversies in the Digital World: News, Mis/Disinformation and Public Engagement" edited by An Nguyen (Bournemouth University, UK) and Daniel Catalan (University Carlos III of Madrid, Spain).

1. Introduction

Flat Earth ideology resurfaced from obscurity due to a proliferation of misinformation on YouTube (Landrum & Olshansky, 2019; Paolillo, 2018). True believers, though, are rare. Despite the videos' presence on YouTube and the widespread media coverage the movement has received, a 2018 poll reports only 5% of the U.S. public say they doubt the true shape of Earth, and only 2% are certain that Earth is flat (YouGov, 2018a). A greater proportion of the U.S. public, for example, believe they have seen a ghost (15%; YouGov, 2018b).

While most do not find the arguments made in flat Earth videos persuasive, at least at first exposure (Landrum, Olshansky, & Richards, 2019), a barrage of news articles highlight calls for YouTube to crack down on the spread of misinformation; and YouTube has responded by updating its recommendation algorithm (e.g., Binder, 2019; YouTube, 2019). People's strong negative reactions are not likely due to fears that *they*, themselves, will be persuaded, but fears that the videos will brainwash *others* (Scott, 2019). Indeed, research finds that individuals often overestimate the effects media have on others (and generally underestimate the effects

on themselves), a phenomenon called third-person perception (TPP; Gunther, 1995; Perloff, 1993, 2009; Salwen, 1998). TPP, then, is thought to lead to certain attitudes and/or actions, such as support for censorship; and this is called third-person effects (TPE; Davison, 1983; Gunther, 1991; Perloff, 1993).

In three studies, we examine the flat Earth YouTube phenomenon using TPP and TPE as a theoretical framework. In these studies, we asked participants how convincing *they* found flat Earth arguments from YouTube videos and compared this to their expectations for how convincing *others* might find the arguments. Instead of merely looking at ratings of one's self vs. a general 'other,' however, we ask about a variety of groups who differ based on political party, religiosity, educational attainment, and area of residence (rural, urban).

We had two aims for this research. First, we aimed to determine which identity groups our participants believe are more susceptible than themselves to the arguments presented in flat Earth videos, and whether these TPP are conditional on participants' own characteristics (e.g., political party, religiosity). Second, we aimed to determine the extent to which TPP predict support for censoring YouTube compared to other participant characteristics (e.g., political party, conspiracy mentality, YouTube use).

1.1. TPP vs. TPE

The expectation that others will be more influenced by media messages than oneself is referred to as TPP, whereas the attitudes or behaviors that stem from TPP, such as calling for censorship of those messages, are referred to as TPE (Davison, 1983). The TPP and TPE model takes a meta-perspective, looking not at the direct effects of media but at the effects that result from people's beliefs about media effects (Perloff, 2009).

1.2. TPP of Conspiracy Theories

Although TPP and TPE are well researched in areas such as advertisements (e.g., Huh, Delorme, & Reid, 2004), violent media (e.g., Hoffner & Buchanan, 2002; Innes & Zeitz, 1988), and pornography (e.g., Gunther, 1995; Rojas, Shah, & Faber, 1996; Zhao & Cai, 2008), very little work examines TPP of conspiracy theories.

Douglas and Sutton conducted one such study with a U.K. student sample in the 2000s, asking about conspiracy theories surrounding the death of Princess Diana (Douglas & Sutton, 2008). Besides asking participants how much they and others would agree with the conspiracy statements (i.e., current selves, current others), they also asked participants to speculate how much they and others would have agreed with the statements prior to having read the material (i.e., retrospective selves, retrospective others). Inconsistent with prior work on TPP, collapsed across current and retrospective ratings, participants did not expect others to agree with the conspiracy statements more than themselves. However, participants did expect others to exhibit greater attitude change (Douglas & Sutton, 2008).

Our study differs from Douglas and Sutton (2008) in a number of ways, but a central difference is who the 'others' are. Whereas Douglas and Sutton asked participants to rate their own classmates—a group of 'others' whom the participants might have seen as similar to themselves, we asked about several identity groups that could range from very similar to very different from our participants. We expected that participants' TPP would vary based on perceived social distance (the 'social distance corollary,' Cohen, Mutz, Price, & Gunther, 1988).

1.3. Social Distance and TPP

Social distance has been at the center of much research on TPP (e.g., Cohen et al., 1988; Eveland, Nathanson, Detenber, & McLeod, 1999; Paek, 2009; Shen & Huggins, 2013). Cohen et al. (1988), for example, demonstrated that TPE magnify as the 'other' group becomes more abstract. These researchers asked Stanford University undergraduates to consider the effects of negative political ads on themselves, on other Stanford students, on other Californians, and on public opinion at large (Cohen et al., 1988). As social distances between an individual and 'others' increase, the individuals' perceptions of the others become more abstract; and the more abstract others are to us, the greater we believe they are susceptible to negative media effects (Meirick, 2004).

Social distance can also be conceptualized as psychological distance, or the degree of (dis)similarity between the self and the other (Perloff, 1993), with the resulting perception exemplifying in-group/out-group bias (e.g., David, Morrison, Johnson, & Ross, 2002; Gardikiotis, 2008; Lo & Wei, 2002; Wei, Chia, & Lo, 2011). Jang and Kim (2018), for example, found strong TPP based on political party affiliation: Republicans believed Democratic voters would be more susceptible to so-called 'fake news,' whereas Democrats believed Republican voters would be more susceptible.

1.4. Current Article

Three studies examine our research aims. The first study explores associations between YouTube users' individual characteristics (e.g., their political party affiliation and religiosity) and their expectations for how convincing other people would find YouTube clips arguing Earth is flat. These 'other people' included people described as Democrats, Republicans, biblical literalists, atheists, rural dwellers, urban dwellers, those who did not go to college, and those who attended graduate school. The second study examines the relationships between YouTube users' individual characteristics, third-person ratings, and their support for censoring such content on YouTube. The third study attempts to replicate study 2 with a larger and more nationally representative sample that was not limited to YouTube users.

2. Study 1

2.1. Participants

We recruited 397 U.S. participants who regularly use YouTube via TurkPrime, a service of Amazon's Mechanical Turk. We requested a naïve sample: The top 2% of most active MTurkers were not eligible for our study. Overall, 57% of the participants were female, and racial/ethnic breakdowns were as follows: 76% White, 11% Black/African American, 7% Hispanic/Latino, 6% Asian, and 2% other. The average age of participants was 38.39 years (median = 36, *SD* = 12.29). 11% completed only high school, 38% attended some college, 35% received some degree from college, and 16% completed graduate school. About 43% identify as Democrat, 37% identify as independent, and only 21% identify as Republican.

MTurk samples tend to be higher educated and hold more politically liberal views compared to U.S. nationally representative populations, and this was true of our sample. They also tend to have a higher number of atheists and agnostics compared to the U.S. population (Burnham, Le, & Piedmont, 2018), which appears to be the case for our sample. Over 41% of our study 1 participants said that they are not religious and never pray.

2.2. Study Design and Procedures

Data for study 1 were collected as part of a study examining susceptibility to flat Earth arguments on YouTube (see Landrum et al., 2019). Participants were randomly assigned to one of four conditions that determined which 30-second video clip they saw. Participants then answered questions about the video, including how convincing they and others were likely to find it. Lastly, participants answered standard demographic questions which were followed by a fact check statement explaining why the argument was misinformative. Participants received $2 upon survey completion.

2.3. Stimulus Materials

As stated above, participants were randomly assigned into one of four conditions which presented different flat Earth arguments: (1) a science-based argument, (2) a conspiracy-based argument, (3) a religious-based argument, or (4) a sensory-based argument. See the Supplementary File for descriptions of the videos. The clips were cut from a YouTube video well known within the flat Earth community, *200 Proofs the Earth Is Not a Spinning Ball* (Dubay, 2018). The following text preceded each of the videos: "In the video, *200 Proofs the Earth Is Flat* the narrator makes the following argument." A transcription of the narration and the embedded video followed.

2.4. Measures

Only the measures used for this study are described here. For more information, see the Supplementary File and our project page at https://osf.io/h92y5.

2.4.1. Convincingness

After watching the video, participants were reminded of the argument made and were asked to report how convincing they found it using a slider scale ranging from 0 (not convincing) to 100 (extremely convincing). Later, participants were asked to rate how convincing they think other types of people might find the video using the same scale. These other groups were described as follows: Republicans, Democrats, people who think the Bible should be interpreted literally, people who do not believe God exists (atheists), people who live in rural areas (country), people who live in urban areas (cities), people who did not go to college, and people who attended graduate school.

2.4.2. TPP Scores

The dependent variable for this study was the difference in perceived susceptibility (i.e., TPP score), which was obtained by subtracting one's own rating of the argument's convincingness from one's expectations of how convincing each of the other identity groups would find the argument (e.g., TPP = Other group – Self rating; see Jang & Kim, 2018; Wei et al., 2011). Therefore, TPP scores could range from +100 (indicating that the participant thinks the 'other' would be completely convinced whereas the participant is not at all convinced) to −100 (indicating that the participant is completely convinced and thinks that the other would not be convinced at all) for each of the eight different identity groups (e.g., TPP_rural = rating for people who live in rural areas – rating for the 'self'; TPP_biblit = rating for people who believe the Bible should be interpreted literally – rating for the 'self'; Figure 1).

2.4.3. Religiosity

Participants were asked two questions to gauge their religiosity: (1) how much guidance does your faith, religion, or spirituality provide in your day-to-day life on a 6-point scale (not religious to a great deal), and (2) do you pray, and if so, how often, on a 5-point scale (I do not pray to at least daily). These two items were centered and scaled before being averaged together and rescaled; religiosity scores ranged from −1.02 to 1.51 (*M* = 0, *SD* = 1, Median = −0.19).

2.4.4. Political Party Affiliation

Political party affiliation was measured with 6 categories: strong Democrat (n = 58), Democrat (n = 106),

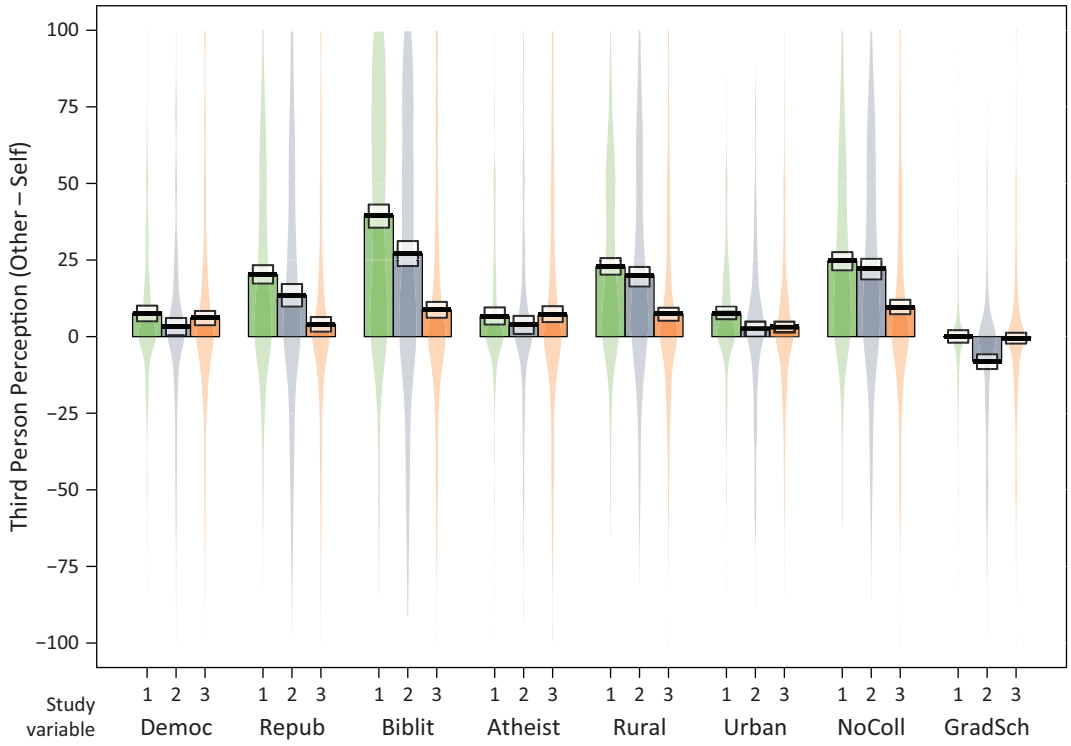

Figure 1. TPP scores for each identity group across the three studies.

Independent (n = 142), Republican (n = 60), and strong Republican (n = 20), with an additional option of 'I choose not to answer' (n = 11). To reduce the number of comparison groups, strong Democrat and Democrat were combined into one response level, 'Democrat' (n = 164), and strong Republican and Republican were combined into one response level, 'Republican' (n = 80). Independent was kept as its own response level, and the 11 people who said they prefer not to answer were coded as missing. This variable was treated as categorical with Democrat as the referent in all analyses.

2.4.5. Conspiracy Mentality

Conspiracy mentality was measured using the 5-item generalized conspiracy mentality scale by Bruder, Haffke, Neave, Nouripanah, and Imhoff (2013). Participants were shown each statement, such as 'many important things happen in the world, which the public is never informed about,' and asked whether the statement is (1) definitely false to (4) definitely true. The five items perform well as a scale, predict belief in specific conspiracy theories (see project page), and have acceptable inter-item reliability (Cronbach's alpha = .75, 95% CI[.72, .79]). Participants scores on the conspiracy mentality scale were approximately normally distributed (M = 2.79, Median = 2.8, SD = 0.52).

2.4.6. Demographics

We also asked a series of demographic questions including participants' age, gender, whether they live in rural (23%), urban (26%), or suburban (52%) areas, level of education, and race/ethnicity. The descriptives for these variables are reported in Section 2.1.

2.5. Results

2.5.1. Rating the 'Self' vs. Rating the 'Other'

First, we ask whether participants rate others as more convinced by the flat Earth videos than themselves. To examine this, we conducted a within-subjects ANOVA to test for a difference based on group rated, $F(8, 3160) = 149.9$, $p < .001$. Then, we conducted planned contrasts, comparing participants' ratings of how convincing they thought each of the identity groups would find the video compared to how convincing they found it. Study 1 participants reported that each identity group would be more convinced by the video than themselves, except when rating those who attended graduate school (see Table 1).

2.5.2. Predicting TPP Scores

Next, we aimed to determine whether participants' own characteristics (e.g., political party, religiosity) predicted their TPP for the different identity groups. To examine this, we conducted regression analyses predicting TPP scores from condition (video watched) and participants' political affiliation, religiosity, conspiracy mentality, income, gender, age, area of residence (rural, suburban, urban), and education level (see Table 2). To determine the relative importance of the predictors, we conducted

Table 1. Planned comparisons between 'self' and 'other' identity groups for how convincing each will find the flat Earth video across the three studies.

	Study 1		Study 2		Study 3	
	Estimate	Cohen's *d*	Estimate	Cohen's *d*	Estimate	Cohen's *d*
Self vs. Democrats	7.63***	0.35	3.31	0.11	5.90***	0.19
Self vs. Republicans	20.26***	0.63	13.43***	0.35	3.76*	0.11
Self vs. Bib literalists	39.51***	1.00	26.99***	0.62	8.52***	0.23
Self vs. Atheists	6.72***	0.25	3.88^{T}	0.13	7.04***	0.19
Self vs. Rural	22.87***	0.77	19.77***	0.58	7.34***	0.24
Self vs. Urban	7.51***	0.34	2.72	0.11	3.17*	0.12
Self vs. No College	24.74***	0.82	22.03***	0.63	9.37***	0.28
Self vs. Grad School	−0.03	0.00	−8.07***	−0.32	−0.67	0.02

Notes: $^{T}p < .10$, $*p < .05$, $**p < .01$, $***p < .001$.

lmg tests (Grömping, 2006; Lindeman, Merenda, & Gold, 1980), which partitions R^2 by averaging sequential sums of squares (Type I) across all orderings of predictors.

When predicting TPP, where the 'other' is described as a Democrat or Republican, participants' own religiosity and political affiliation were the strongest influencers. Among our participants, the greater one's religiosity, the less they believe Republicans will be more convinced than themselves by flat Earth videos ($b = -6.08$, $p < .001$)—that is, the TPP score for Republicans decreases with increasing religiosity. On the other hand, greater religiosity marginally predicts believing that Democrats will be more convinced than themselves by flat Earth videos ($b = 2.86$, $p = .049$)—that is, the TPP score for Democrats slightly increases with increasing religiosity (see Figure 2).

Participants' own political affiliation also influenced TPP of Democrats and Republicans. Independents expected larger gaps between Democrats and themselves (that is, a TPP score greater than 0; $M_{TPP\_Democ} = 12.83$, $SD = 25.76$) and between Republicans and themselves ($M_{TPP\_Repub} = 19.99$, $SD = 30.86$). Republican participants, reasonably, expected smaller gaps between Republicans and themselves (that is, a TPP score closer to 0; $M_{TPP\_Repub} = 3.62$, $SD = 33.13$) than Democrat participants expected when rating Republicans ($M_{TPP\_Repub} = 29.76$, $SD = 32.94$). Notably, however, Republican participants and Democrat participants did not vary significantly when rating Democrats (Republicans rating Democrats: $M_{TPP\_Democ} = 9.91$, $SD = 33.13$; Democrats rating Democrats: $M_{TPP\_Democ} = 3.05$, $SD = 17.00$).

When predicting TPP where the 'other' is described as living in urban or rural areas, participants' own political party affiliation was the strongest influencer. Most notably, Republicans expected smaller gaps—TPP scores closer to 0—between rural dwellers and themselves ($M_{TPP\_Rural} = 7.58$, $SD = 26.0$) than Democrats expected ($M_{TPP\_Rural} = 29.7$, $SD = 29.5$, $p < .001$). Furthermore, independents expected larger differences between themselves and urban dwellers ($M_{TPP\_Urban} = 12.0$, $SD = 21.99$) than Democrats expected ($M_{TPP\_Urban} = 6.19$, $SD = 19.32$; $p = .013$). However, Republicans' expectations ($M_{TPP\_Urban} = 4.38$, $SD = 24.22$) did not significantly differ from Democrats' expectations ($p = .609$)

There was also an influence of conspiracy mentality: People with greater conspiracy mentality expected smaller gaps between rural dwellers and themselves than those with lower conspiracy mentality expected ($b = -6.59$, $p = .033$).

More factors significantly predicted TPP where the 'other' is described as a biblical literalist, and the strongest predictors were the participant's religiosity and political party, as well as whether the participant saw the religious appeal. Understandably, participants who saw the clip appealing to scripture as evidence of a flat Earth expected much larger gaps between biblical literalists and themselves ($M_{TPP\_Biblit} = 61.17$, $SD = 34.42$) than people who saw the conspiracy appeal ($M_{TPP\_Biblit} = 29.04$, $SD = 36.24$, $p < .001$; see Table 2).

Moreover, participants' religiosity played a significant role when rating atheists and biblical literalists. Greater religiosity predicted smaller gaps between participants' ratings of themselves and biblical literalists ($b = -10.55$, $p < .001$) and greater gaps between themselves and atheists ($b = 5.52$, $p < .001$).

Participants' political affiliations also influenced their ratings of biblical literalists. Republicans expected smaller gaps between biblical literalists and themselves ($M_{TPP\_Biblit} = 19.09$, $SD = 37.95$) than Democrats expected ($M_{TPP\_Biblit} = 51.74$, $SD = 37.5$, $p < .001$). Independents also expected smaller gaps between biblical literalists and themselves ($M_{TPP\_Biblit} = 38.84$, $SD = 37.67$) than Democrats expected ($p = .010$).

When predicting TPP where the 'other' did not attend college, participant's own political affiliation was the only significant influencer. Republicans expected smaller gaps between themselves and people who did not attend college ($M_{TPP\_NoCollege} = 10.91$, SD = 28.09) than Democrats expected ($M_{TPP\_NoCollege} = 30.04$, $SD = 30.13$; $b = -15.61$, $p < .001$). Moreover, no factors were significant when predicting TPP scores for those who attended graduate school. However, as noted ear-

Table 2. GLM analyses for each identity group. Non-standardized regression coefficients are shown.

	Characteristic defining the 'other'							
	Political identity		Area of residence		Religiosity		Education	
	Dem	Repub	Urban	Rural	Atheist	BibLit	Grad	No College
Condition (ref = Conspiracy appeal)								
Religious	3.64	6.37	0.63	3.70	−4.59	31.60***	1.51	0.83
Science	1.85	5.82	1.42	2.76	−3.34	7.05	−1.59	3.34
Sensory 1	1.96	0.42	4.79	1.35	−2.94	−0.09	4.00	2.15
Sensory 2	3.12	2.60	3.95	3.89	−1.02	−0.25	0.55	1.46
Participant Characteristics								
Political Party (ref = Democrat)								
Independent	9.47**	−6.16^{T}	6.52*	−0.88	1.81	−10.64*	3.06	0.61
Republican	4.07	−18.81***	−1.64	−17.59***	0.28	−23.74***	0.76	−15.61***
Religiosity	2.86*	−6.08***	0.65	−2.43	6.40***	−11.39***	0.73	−1.54
Conspiracy Mentality	−4.28	−5.38^{T}	−4.37^{T}	−6.59*	−3.87	−0.33	−0.82	−4.63
Income	−0.80	−0.65	−0.16	−0.08	−0.64	−0.19	−0.53	0.59
Gender	−2.10	0.70	−2.54	2.35	−6.44*	1.74	−0.35	3.30
Age	−0.12	−0.03	−0.08	−0.15	−0.04	0.33*	0.05	−0.14
Area (ref = Urban)								
Rural	6.65^{T}	0.84	6.18^{T}	−5.10	0.31	3.13	−0.18	−0.53
Suburban	−1.20	−0.14	1.23	−0.65	−1.26	2.85	−3.90	−0.37
Education	0.50	3.03	0.57	1.26	−0.46	1.23	−0.46	2.52^{T}

Notes: $^{T}p < .10$, $*p < .05$, $**p < .01$, $***p < .001$.

lier, this was the one group participants rated as no more likely to be convinced than themselves (see Figure 1).

2.6. Discussion

Study 1 was exploratory, aiming to examine which identity groups YouTube users believe are more susceptible than themselves to the arguments presented in flat Earth videos and whether these beliefs are conditional on participants' own characteristics (aim 1). Supporting prior TPP work, we found that participants exhibited a 'self'–'other' bias, believing that the 'other' groups (with the exception of those who attended graduate school) would be more convinced by flat Earth videos than themselves. Participants believed biblical literalists, in particular, would be the most susceptible to flat Earth arguments in YouTube videos, especially when those arguments appeal to religious texts. In addition to biblical literalists, participants also expected people who did not go to college, people who live in rural areas, and

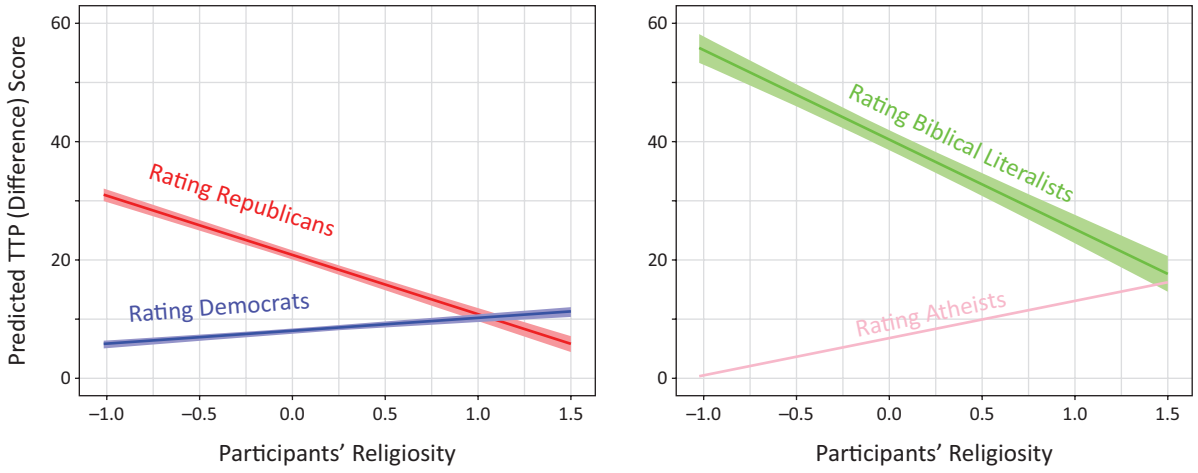

Figure 2. Predicted TPP scores ('other' minus 'self,' i.e., difference score) when rating how much more convincing Democrats and Republicans will find the flat Earth videos compared to oneself, and how this predicted difference score varies based on the participants' religiosity.

people who vote Republican to be more susceptible to flat Earth videos. Notably, these TPP were predicted by participants' own religiosity and political affiliation. The strongest biases were expressed by those with lower religiosity. These non-religious individuals may have been more prevalent in our sample as we recruited participants from MTurk.

3. Studies 2 and 3

Studies 2 and 3 aimed to replicate the findings from study 1 that (1) supported prior literature by elucidating a 'self'–'other' bias (here, in perceived susceptibility to flat Earth YouTube videos), (2) suggested that respondents believe biblical literalists would be the most susceptible to flat Earth videos, and (3) showed that participants' TPP were primarily driven by their own (lack of) religiosity and their political party affiliations (aim 1). Moreover, studies 2 and 3 aimed to examine the extent to which perceptions of social distance predict TPP (aim 1) and the extent to which TPP predict support for censoring YouTube (aim 2). Whereas study 2 included a participant sample similar to study 1 (YouTube users recruited from MTurk), study 3 included a larger and more diverse participant sample, recruited by Qualtrics Research Services to match census, and not restricted based on YouTube use (as YouTube users may be less likely to want to censor the platform).

3.1. Study 2 Participants

We recruited 404 U.S. participants, who regularly use YouTube, in the summer of 2019 via TurkPrime. Overall, 53% of the participants were female, and racial/ethnic breakdowns were as follows: 72% White, 8% Black/African American, 2% Hispanic/Latino, 6% Asian, and 1% Other. The average age of participants in this sample was 35.82 years (*median* = 33, *SD* = 11.63). As with study 1, this sample was highly educated: 12% only completed high school, 33% attended some college, 38% received a four-year college degree, and 15% stated that they completed graduate school. This sample was also predominantly liberal leaning: about 54% report voting Democrat, 10% report voting independent, 21% report voting Republican, and 15% report not voting.

3.2. Study 3 Participants

A sample of 1,005 participants were recruited in winter 2019 by Qualtrics Research Services to match U.S. census on gender, age, education, household income, region, and race/ethnicity. The final sample was 56% female, and racial/ethnic breakdowns were as follows: 61% White, 14% Black/African American, 4.5% Hispanic/Latino, 4.5% Asian, and 2% Other. The average age of participants in this sample was 44.12 years (*median* = 42, *SD* = 17.03). Regarding education, 13% did not finish high school, 25% completed only high school, 21% attended some college, 20% received a four-year college degree, and 12% stated that they completed graduate school. About 40% report typically voting Democrat, 9% report voting Independent, 29% report voting Republican, and 22% report not voting. Also, unlike study 2, we did not limit this study to YouTube users, but use of the platform was still high. Almost half of the sample reported using it daily, 25% at least weekly, 9% at least monthly, 7% less often than monthly, and 11% report never using it.

3.3. Study Design and Procedures

Study design and hypotheses for studies 2 and 3 were pre-registered prior to data collection. The full pre-registered analyses can be found at https://osf.io/h92y5.

Unlike study 1, participants in studies 2 and 3 were not randomized into different video conditions (though 202 participants in Study 3 were not shown any video to serve as a control sample). Instead, participants were shown the same 5-minute video called *flat Earth in 5 Minutes* produced by ODD TV and posted on the ODD Reality YouTube channel. The video was originally posted in 2017, and, at the time of data collection, had over 1.2 million views. Participants could skip the video after one minute. Study 2 participants were on the page an average of 5.65 minutes (*median* = 5.2, *SD* = 5.14), and study 3 participants were on the page an average of 4.75 minutes (*median* = 5.2, *SD* = 3.16).

Afterwards, participants answered questions about their perceptions of the video, about how others might view the video, about potential censorship of flat Earth videos on YouTube, how different the other groups were than themselves (i.e., social distance), and standard demographic questions, which were followed by a fact check statement that provided several ways that the viewer can test the shape of the Earth to see that it is not flat. TurkPrime participants received $2 upon completion.

3.4. Measures

The variables measured in the second study were the same as the first with a few important additions: an index for measuring beliefs that YouTube should censor flat Earth content and ratings of perceived social distance. We describe these in more detail below. Also, we asked the political affiliation question a bit differently, focusing on whom they typically vote for (e.g., the Democratic candidate, the Republican candidate) as opposed to how they categorize themselves. For the full list of measures see the Supplementary File.

3.4.1. Call for Censorship

One new component to this survey asked participants about censoring flat Earth videos on YouTube. For these items, participants were shown a series of statements and asked to what extent they agreed or disagreed

with those statements (strongly disagree = 1 to strongly agree = 6). See Table 3 for the list of items.

In our preregistration, we stated we would use an averaged index for these items, and we report that analysis in this article. The items have good inter-item reliability and a scree 'acceleration factor' test shows evidence for one factor. However, the non-graphical solutions (e.g., parallel analysis, optimal coordinates analysis) suggest a two-factor solution. This analysis is reported at https://osf.io/h92y5.

3.4.2. Social Distance

Also new to this study, we asked participants to rate how similar or dissimilar people from various groups are to themselves (e.g., Eveland et al., 1999). Participants read the following: 'For each of the following identity groups, please tell us whether you feel that the people in this group—whether you belong to the group or not—are a lot like you or not at all like you.' Like for the self-report and the third-person ratings, participants answered this question using a slider scale from 0 to 100. We reverse coded these variables so that higher values (100) reflected 'Not at all like me' and lower values (0) reflected 'A lot like me.'

Participants were asked about each of the identity groups they rated earlier in the survey, including Republicans (S2: $M = 61.15$, $SD = 31.25$; S3: $M = 52.65$, $SD = 32.97$), Democrats (S2: $M = 41.24$, $SD = 31.2$; S3: $M = 47.85$, $SD = 32.77$), biblical literalists (S2: $M = 71.94$, $SD = 32.42$; S3: $M = 56.27$, $SD = 33.32$), atheists (S2: $M = 49.77$, $SD = 32.42$; S3: $M = 64.72$, $SD = 32.58$), rural dwellers (S2: $M = 54.28$, $SD = 29.22$; S3: $M = 47.76$, $SD = 30.57$), urban dwellers (S2: $M = 37.92$, $SD = 25.27$; S3: $M = 39.10$, $SD = 28.43$), people who did not go to college (S2: $M = 58.34$, $SD = 28.91$; S3: $M = 49.87$, $SD = 31.38$), and people who attended graduate school (S2: $M = 41.09$, $SD = 28.53$; S3: $M = 46.67$, $SD = 30.87$).

Our data, code, and full pre-registered analysis are available at https://osf.io/h92y5.

3.5. Results

3.5.1. Rating the 'Self' vs. Rating the 'Other'

Based on study 1 results, our first hypothesis was that participants would rate each of the identity groups as finding the video more convincing then they, themselves, do, except when rating people who attended graduate school. This hypothesis was partially supported in study 2 and fully supported in study 3 (see Table 1). Consistent with study 1, planned contrasts between ratings for the 'self' and 'others' found that, on average, participants in study 2 expected the following groups to be *more* convinced by the flat Earth video than themselves: Republicans, biblical literalists, people who live in rural areas, and people who did not go to college. In contrast, study 2 participants, on average, expected people with graduate degrees to be *less* convinced than they were, whereas study 1 found no significant differences. Moreover, study 2 found no significant differences between 'self' vs. 'other' ratings when rating Democrats and when rating urban dwellers. In contrast, like study 1, study 3 expected each of the groups to be more convinced by the flat Earth video than themselves, except for those who attended graduate school (see Table 1).

3.5.2. Predicting TPP Scores

Our second hypothesis, based on study 1 results, was that religiosity and party affiliation would be two of the strongest predictors of TPP. We also wanted to determine whether social distance was a better predictor of TPP scores than other individual differences variables. As with study 1, we conducted regression analyses (see Table 4) and *lmg* tests of relative importance (see

Table 3. Censorship items.

	Study 2 n = 404		Study 3 n = 1,005	
YouTube should…	*M*(*SD*)	Median	*M*(*SD*)	Median
shut down or delete channels that upload flat Earth videos	1.98(1.22)	Disagree	2.61(1.51)	Disagree
ban users who upload flat Earth videos	1.93(1.17)	Disagree	2.58(1.52)	Disagree
delete videos that argue the Earth is flat	2.02(1.22)	Disagree	2.68(1.55)	Disagree
be fined for distributing flat Earth videos	1.73(1.73)	Disagree	2.37(1.48)	Disagree
demonetize channels that upload flat Earth videos	2.76(1.52)	Somewhat disagree	3.25(1.56)	Somewhat disagree
refrain from recommending flat Earth videos to other users	3.34(1.59)	Somewhat disagree	3.38(1.51)	Somewhat disagree
Cronbach's Alpha	0.86 95% CI[0.84, 0.88]		0.85 95% CI[0.84, 0.87]	
Scale Descriptives	$M = 2.29$, $SD = 1.00$		$M = 2.81$, $SD = 1.15$	

Notes: Participants were shown a series of statements and asked to what extent they agreed or disagreed with those statements on a scale from 1 (strongly disagree) to 6 (strongly agree).

Table 4. GLM analyses for each identity group.

		Characteristic defining the 'Other'							
	S	Democ	Repub	Urban	Rural	Atheist	Biblical Literalists	Grad School	No College
Perceived social distance	2	−0.03	0.39***	0.02	0.26***	0.11^{T}	0.45***	0.03	0.26***
	3	−0.18***	0.04	0.10*	0.13**	0.13**	0.13**	−0.01	0.13**
Political party (Ref = Democrat)									
Republican	2	11.76*	−5.78	1.86	−12.10**	6.15	−14.83**	−3.59	−5.03
	3	8.57*	−5.31	5.14^{T}	−5.61^{T}	5.08	−4.70	5.31*	0.41
Independent	2	2.36	0.15	−0.77	−3.32	2.66	2.31	−5.32	0.06
	3	7.87	−5.14	−2.97	−2.81	−6.02	−10.94*	2.61	−3.58
Other	2	1.50	−12.47*	0.03	−9.13^{T}	−7.10	−6.85	−10.29**	−10.90*
	3	2.44	−1.41	−0.01	−4.77	0.34	−3.01	1.29	−2.15
Religiosity	2	−1.42	−6.98**	−1.44	−8.38***	−0.84	−5.72*	−0.19	−8.47***
	3	0.66	−5.14***	1.24	−5.21***	−2.31	−4.76**	1.75	−4.51**
Conspiracy mentality	2	−3.21	−5.14	−6.11*	−5.89*	−1.85	−12.54***	−4.59^{T}	−6.12*
	3	3.23*	1.92	2.10	3.03^{T}	3.12^{T}	1.49	1.61	4.90**
Income	2	−0.23	−0.72	−0.12	−0.73	−0.48	−1.07	−0.35	−0.03
	3	−0.45	0.32	−0.98^{T}	0.13	−0.52	−0.07	−0.87	0.13
Gender (1 = Male)	2	0.52	2.10	0.84	0.60	−3.57	−0.77	−3.31	0.22
	3	−0.08	−0.06	−0.08	−1.20	−1.62	−1.35	−1.20	−0.53
Age	2	0.12	−0.10	−0.07	0.20	0.20	−0.03	0.07	−0.13
	3	−0.04	0.16^{T}	−0.08	0.01	0.04	0.13	0.06	0.05
Area (Ref = Urban)									
Rural	2	1.70	2.87	3.51	9.08^{T}	0.72	−0.18	1.15	0.15
	3	12.61***	4.56	5.80^{T}	9.94**	13.28**	7.10^{t}	9.58**	9.52**
Suburban	2	−1.38	5.15	1.04	10.78**	2.20	6.06	2.14	0.10
	3	6.75*	3.53	1.82	8.35**	3.43	6.13^{T}	0.81	8.62**
Education	2	−0.20	1.54	−0.17	1.09	−1.22	1.61	−1.45	1.61
	3	2.06*	1.23	1.32	2.19*	1.47	1.56	−0.40	1.77

$^{T}p < .10$, $*p < .05$, $**p < .01$, $***p < .001$; S column stands for study, and the numbers 2 and 3 indicate to which study sample the value belongs. Non-standardized regression coefficients are shown.

Figure 3). Supporting our hypotheses, religiosity, party affiliation, and social distance were the strongest predictors of TPP in both studies 2 and 3 (at least for the categories in which study 2 participants perceived the group to be more susceptible to the arguments made in the video than themselves). It is notable that social distance is not always the strongest predictor, and in study 3, area of residence and religiosity are also strongly predictive of TPP.

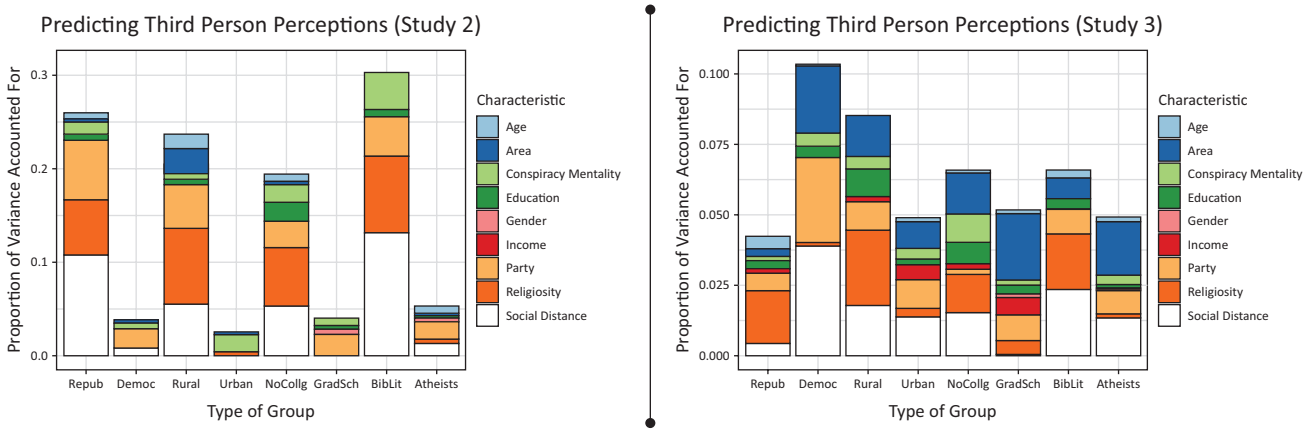

Figure 3. Relative importance of the predictors for studies 2 and 3. Please note the vertical axes differ for the two figures.

Table 5. Simple correlations between the average censorship score and the TPP scores.

	Study 2		Study 3	
Group rated	Pearson's *r*	95% CI	Pearson's *r*	95% CI
Democrats	0.10*	[0.01, 0.20]	0.00	[−0.07, 0.07]
Republicans	0.26***	[0.17, 0.35]	0.11**	[0.04, 0.17]
Urban	0.17***	[0.08, 0.27]	0.05	[−0.02, 0.12]
Rural	0.23***	[0.14, 0.32]	0.01	[−0.06, 0.08]
Atheists	0.08	[−0.02, 0.18]	−0.05	[−0.12, 0.02]
Biblical literalists	0.22***	[0.12, 0.31]	0.06^{T}	[0.00, 0.14]
Graduate school	0.12*	[0.02, 0.21]	0.10**	[0.04, 0.17]
No college	0.23***	[0.13, 0.32]	0.01	[−0.06, 0.08]

Notes: $^{T}p < .10$, *$p < .05$, **$p < .01$, ***$p < .001$.

3.5.3. Predicting Censorship of YouTube

Our third hypothesis was that TPP scores would predict support for censoring YouTube. We tested this hypothesis in two ways. First, we conducted simple correlations. There were positive associations between most of the TPP scores and the censorship scores for study 2, but not for study 3. TPP scores for Republicans and those who attended graduate school were the only two that were significantly correlated with censorship scores for both study 2 and study 3 (see Table 5).

Next, we conducted regression analyses and tests of relative importance, predicting censorship scores from the TPP scores as well as from YouTube use, conspiracy mentality, political party affiliation, religiosity, gender, income, and area of residence. It is worth noting that many of the TPP scores are correlated with one another (see Table 6).

Therefore, to avoid issues with multicollinearity, we used data reduction techniques. A parallel analysis, optimal coordinates analysis, and evaluation of eigenvalues on the study 2 sample suggest that there are two dimensions. We conducted a maximum likelihood factor analysis, extracting two factors with promax (oblique) rotation. TPP scores for Republicans (0.85), rural dwellers (0.97), biblical literalists (0.73), and people who did not attend college (0.76) loaded onto the first factor. In contrast, TPP scores for Democrats (0.95), urban dwellers (0.72), atheists (0.74), and people who attended graduate school (0.69) loaded onto the second factor.

We conducted a confirmatory factor analysis for the study 3 sample using the two-factor solution. The two factor solution was close, but not a good fit for study 3 ($\chi^2 = 138.97$, $p < .001$; SRMR = 0.037; RMSEA = 0.09, 95% CI[0.078, 0.107]; CFI = 0.963). Supplementary analyses suggest a one-factor solution would be more appropriate. Therefore, when analyzing study 3 data, we used an averaged index of the TPP scores. That a two factor solution was appropriate for study 2 but not study 3 is understandable given the differences in the samples: MTurkers, who lean more liberal and less religious than a nationally representative population, may be more likely

Table 6. Pearson correlations among TPP scores for study 2 and study 3.

	Study	DEM	REP	URB	RRL	ATH	BLT	GRD	NC
Democrat (DEM)	2	1.00	0.32***	0.68***	0.31***	0.62***	0.40***	0.62***	0.45***
	3								
Republican (REP)	2	0.35***	1.00	0.47***	0.75***	0.35***	0.68***	0.47***	0.67***
	3								
Urban (URB)	2	0.64***	0.47***	1.00	0.45***	0.54***	0.45***	0.61***	0.53***
	3								
Rural (RRL)	2	0.44***	0.65***	0.48***	1.00	0.29***	0.67***	0.38***	0.75***
	3								
Atheist (ATH)	2	0.59***	0.41***	0.54***	0.46***	1.00	0.23***	0.55***	0.39***
	3								
Bibl lit (BLT)	2	0.40***	0.64***	0.47***	0.61***	0.38***	1.00	0.41***	0.64***
	3								
Graduate sch (GRD)	2	0.56***	0.47***	0.60***	0.37***	0.42***	0.40***	1.00	0.37***
	3								
No college (NC)	2	0.50***	0.57***	0.51***	0.68***	0.56***	0.59***	0.40***	1.00
	3								

Notes: $^{T}p < .10$, *$p < .05$, **$p < .01$, ***$p < .001$.

Table 7. Predicting censorship scores. Non-standardized regression coefficients are shown.

	Study 2			Study 3		
	b	*F*	*Img*	*b*	*F*	*Img*
YouTube Use	−0.10	0.85	0.23%	−0.06	2.50	0.41%
TPP—F1	0.01*	5.11*	3.85%	0.00	1.22	0.17%
TPP—F2	0.00	1.15	1.12%	NA	NA	NA
Party (ref = Democ)		4.76**	4.79%		0.51	0.24%
Republican	−0.50***			−0.02		
Independent	-0.30^{T}			−0.19		
Other	−0.32*			0.05		
Religiosity	0.02	0.06	0.61%	0.08	2.25	0.65%
Conspiracy mentality	−0.08	0.70	0.54%	−0.12*	5.46*	0.43%
Income	0.01	0.09	0.05%	−0.05*	4.10*	0.03%
Gender	−0.01	0.01	0.05%	−0.02	0.03	0.40%
Area (ref = Urban)		0.04	0.10%		1.32	0.40%
Rural	−0.03			0.06		
Suburban	−0.03			−0.13		
Education	0.03	0.58	0.44%	0.07*	3.90*	0.24%

Notes: $^{T}p < .10$, $*p < .05$, $**p < .01$, $***p < .001$.

to see stronger divides than a more representative sample, grouping together Democrats, urban dwellers, atheists, and people who attended graduate school in one bin and Republicans, rural dwellers, biblical literalists, and people who did not go to college in another.

In study 2, we found partial support for our hypothesis that TPP scores predict censorship: Specifically, TPP scores for the dimension that captured perceptions of Republicans, biblical literalists, rural dwellers, and people who did not go to college. It is worth noting, though, that political party was a stronger predictor of censorship scores than TPP scores; participants political party affiliation explained approximately 4.76% of the response variance, whereas TPP scores (factor 1) explained approximately 3.85% of the response variance. Moreover, in study 3, however, we did not find support for our hypothesis. TPP scores did not significantly predict censorship and explained approximately only 0.24% of the response variance (see Table 7).

4. Discussion

This article presents three studies examining two research aims. Our first aim was to determine which identity groups people believe are more susceptible than themselves to flat Earth videos, and whether these TPP are conditional on participants' own characteristics. For studies 1 and 2, people who believe the Bible should be interpreted literally (i.e., biblical literalists) were viewed as the most susceptible to flat Earth arguments on YouTube. This is unsurprising given the historical connection of flat Earth and its associated beliefs (e.g., geocentricism) to biblical literalism as well as the many appeals by the flat Earth community to the Bible as a source of evidence. In study 3, people without college degrees were seen as being as susceptible as biblical literalists.

Supporting prior TPP literature, our studies find a 'self'–'other' bias in which participants generally rated the 'other' groups as being more susceptible to flat Earth videos than themselves, and this is predicted by perceived social distance (supporting the social distance corollary; cf. Eveland et al., 1999). However, it is not only social distance that predicts TPP. Participants' own religiosity and political party are also strongly predictive, even when accounting for the other factors.

Our second aim was to determine the extent to which these TPP predict support for censorship of YouTube. Before discussing these results, a few points are important to note. First, support for censorship was generally low among the YouTube users who composed our sample for study 2. We thought it was possible that support for censorship would increase in a more representative sample not restricted to YouTube users (but controlling for YouTube use). However, this also was not the case. Although support for censorship was slightly higher for study 3 than for study 2, the distribution of scores were still positively skewed with a floor effect. Second, there seemed to be an effect of seeing a flat Earth video on support for censorship in the unexpected direction. In study 3, we included a sub sample of participants who did not see any video but were still asked the censorship questions. Participants who did not see the flat Earth video ($M = 3.01$ of 6, $SD = 1.05$) were more open to censoring flat Earth videos than participants who had seen the video ($M = 2.76$, $SD = 1.17$), $t(338.30) = 2.99$, $p < .003$.

We only found partial support for the hypothesis that TPP scores predict the desire for censorship. In fact, there were differences between our two samples (study 2 and study 3). In study 2, the TPP scores for most of the identity groups were correlated with censorship scores, and one of the TPP factors (i.e., the one on which Republicans,

biblical literalists, rural dwellers, and people who did not go to college loaded) predicted desire for censorship. For study 3, however, only two of the TPP scores—the ones for Republicans and people who attended graduate school—predicted censorship scores, and the TPP average score did not predict desire for censorship when accounting for other factors.

These results are not entirely inconsistent with prior work on TPE. On one hand, TPP have been shown to predict support for censorship for several socially undesirable messages, such as violence and sexual content on television (Gunther & Hwa, 1996; Rojas et al., 1996), advertising for cigarettes, alcohol, and gambling (Shah, Faber, & Youn, 1999), rap music (McLeod, Eveland, & Nathanson, 1997), and for the media in general (Rojas et al., 1996). On the other hand, several other studies failed to find associations between TPP and support for censorship. These studies included support for censoring the O. J. Simpson trial (Salwen & Driscoll, 1997) and Holocaust-denial material (Price, Tewksbury, & Huang, 1998), and for the regulation of political communications (Rucinski & Salmon, 1990). Thus, there does not seem to be a clear relationship between TPP and censorship attitudes, and message type may have a moderating effect.

5. Conclusions

Because YouTube recently announced modifications to its recommendation algorithms and specifically mentioned flat Earth in its announcement (YouTube, 2019), it is evident that the management at YouTube is concerned about the influence of these videos on the public. Undoubtedly, YouTube was facing public pressure to take some action as a result of recent issues, such as articles blaming YouTube's algorithms for the rise in flat Earthers and promotion of other conspiracies, like QAnon (Coaston, 2018). Presumably, those who support regulation of such content, as well as YouTube's upper management who implemented these regulations, hold strong TPP, and they may have overestimated the effects these videos would have on others. Though our research only partially supports the theory that the general public would support censoring flat Earth videos on YouTube based on their own TPP, such perceptions may have played a significant role in these executives' decision making.

Acknowledgments

The authors would like to thank the members of the Science Communication and Cognition Lab and the faculty and staff of the College of Media and Communication at Texas Tech University for their help and support.

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 authors (unedited).

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COGITATIO

Media and Communication (ISSN: 2183–2439)
2020, Volume 8, Issue 2, Pages 401–412
DOI: 10.17645/mac.v8i2.2824

Article

Does Scientific Uncertainty in News Articles Affect Readers' Trust and Decision-Making?

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Submitted: 23 January 2020 | Accepted: 27 April 2020 | Published: 26 June 2020

Abstract
Even though a main goal of science is to reduce the uncertainty in scientific results by applying ever-improving research methods, epistemic uncertainty is an integral part of science. As such, while uncertainty might be communicated in news articles about climate science, climate skeptics have also exploited this uncertainty to cast doubt on science itself. We performed two studies to assess whether scientific uncertainty affects laypeople's assessments of issue uncertainty, the credibility of the information, their trust in scientists and climate science, and impacts their decision-making. In addition, we addressed how these effects are influenced by further information on relevant scientific processes, because knowing that uncertainty goes along with scientific research could ease laypeople's interpretations of uncertainty around evidence and may even protect against negative impacts of such uncertainty on trust. Unexpectedly, in study 1, after participants read both a text about research methods and a news article that included scientific uncertainty, they had lower trust in the scientists' assertions than when they read the uncertain news article alone (but this did not impact trust in climate science or decision-making). In study 2, we tested whether these results occurred due to participants overestimating the scientific uncertainty at hand. Hence, we varied the framing of uncertainty in the text on scientific processes. We found that exaggerating the scientific uncertainty produced by scientific processes (vs. framing the uncertainty as something to be expected) did not negatively affect participants' trust ratings. However, the degree to which participants preferred effortful reasoning on problems (intellective epistemic style) correlated with ratings of trust in scientists and climate science and with their decision-making. In sum, there was only little evidence that the introduction of uncertainty in news articles would affect participants' ratings of trust and their decision-making, but their preferred style of reasoning did.

Keywords
fake news; procedural knowledge; readership; science communication; scientific literacy; scientific uncertainty; trust

Issue
This article is part of the issue "Health and Science Controversies in the Digital World: News, Mis/Disinformation and Public Engagement" edited by An Nguyen (Bournemouth University, UK) and Daniel Catalan (University Carlos III of Madrid, Spain).

1. Introduction

Scientific uncertainty is defined as "lack of scientific knowledge, or disagreement over the knowledge that currently exists" (Friedman, Dunwoody, & Rogers, 2012, p. xiii). While scientific processes are continuously optimized to allow only limited uncertainty, uncertainty remains an immediate outcome of scientific research (Friedman et al., 2012). Consequently, there has been debate in science communication research and practice about how and to what effect uncertainty may be communicated. Research suggests that communicated uncertainty might lead to adverse reactions by recipients (see National Academies of Sciences, Engineering, and Medicine, 2017). Also, uncertainty has been utilized to manufacture doubt about climate science among

the general public (Freudenburg, Gramling, & Davidson, 2008; Lewandowsky, Ballard, & Pancost, 2015; Oreskes, 2015; Oreskes & Conway, 2011). However, it has also been argued that transparency about uncertainty in scientific information might enhance public trust, as long as it is not overemphasized (e.g., Druckman, 2015; Zehr, 2017).

In digital media (e.g., social media and blogs), uncertainty is often expressed and explicitly discussed (Dunwoody, Hendriks, Massarani, & Peters, 2018), but it might also be exploited by climate skeptics to fuel their online attacks. In fact, a number of studies investigating climate-skeptical blogs ascertain that blog entries and comments often challenge scientific data and methods in order to establish the notion there is an active scientific controversy around climate change (Elgesem, Steskal, & Diakopoulos, 2015; Matthews, 2015; Sharman, 2014). Mercer (2018) concluded that climate skeptics may use appeals to Popper's philosophy (e.g., whether claims of climate science are falsifiable) to deconstruct climate science arguments.

In such a context, we conducted two studies to investigate how the communication of scientific uncertainty within news articles about climate science affects participants' assessment of uncertainty surrounding an issue and their trust in climate researchers and climate science. In the first study, because the scientific processes might act as a source of uncertainty but also as a way to resolve it, we investigated whether reading about scientific processes before reading news articles on climate science might mitigate the effect that communicated scientific uncertainty may have on participants' judgments about issue uncertainty and trust. In the second study, we extend our results by varying how we introduced the scientific processes. We introduced them either by emphasizing that scientific processes are optimized to achieve as much scientific certainty as possible or by exaggerating the scientific uncertainty inherent in science (as climate skeptics might do in digital media).

1.1. Scientific Uncertainty

While some uncertainty cannot be resolved (e.g., knowledge about the future), the term 'epistemic uncertainty' pertains to unknowns that can be resolved, at least in theory. Sources of epistemic uncertainty often lie within scientific processes (van der Bles et al., 2019; Walker, 1991). Even though processes and methods are continuously optimized to limit uncertainty, there is always some level of specification that cannot be reached. Walker (1991) prepared a taxonomy of such sources of uncertainty, applicable to a variety of empirical scientific disciplines: When designing research, *conceptual uncertainty* is present in the choice and conceptual definition of variables. Then, *measurement uncertainty* arises as related to how consistent and how accurate measurements are. Processes of generalization involve *sampling uncertainty*, whereas *modeling uncertainty* refers to errors in estimating mathematical relationships between variables. Next, *causal uncertainty* arises from the possibility of making false assumptions about a variable's causal relationship. Finally, Walker's taxonomy also includes uncertainty stemming from false use or assumptions of knowledge or underlying theories, which may influence all the other types of uncertainty. Following an extensive review of conceptualizations of scientific uncertainty and empirical evidence, van der Bles et al. (2019) added another source of scientific uncertainty: *expert disagreement*. Expert disagreement may arise when empirical results are new, not yet replicated, or conflicting, but also when experts have not (yet) reached consensus over accumulated evidence (see Oreskes, 2007; Zehr, 2017).

In this article, we refer to scientific uncertainty, which pertains to the status of evidence (but not uncertainty around facts or numbers; for a recent study, see van der Bles, van der Linden, Freeman, & Spiegelhalter, 2020), and we use Walker's conceptualization to describe how we manipulated scientific uncertainty in both studies. In study 1, in the news article participants read we included measurement, sampling, and modeling uncertainty around evidence on the effect of climate change on ocean life; in study 2, we further introduced participants to the uncertainty resulting from expert disagreement.

1.2. Trust and Decision-Making

Scientific uncertainty is directly linked to trust in science. While scientific knowledge is inherently uncertain and complex, this also means that a full understanding of scientific claims and evidence is not feasible for laypeople, resulting in a bounded understanding of science (Bromme & Goldman, 2014). To overcome this bounded understanding, laypeople have to defer to and depend on expert knowledge (Bromme & Goldman, 2014; Schäfer, 2016), but this does not mean they are gullible (Sperber et al., 2010). Instead, they build trust through heuristically and systematically evaluating information and information sources (Hendriks & Kienhues, 2019). In trustworthiness evaluations of experts, three dimensions are recognized: an expert's expertise, integrity and benevolence (Hendriks, Kienhues, & Bromme, 2015). Further, because people likely make similar evaluations of scientific experts and their corresponding scientific communities, people might evaluate whether experts of a particular domain hold and share expertise, follow established and acceptable norms, and act with a general goodwill toward society.

Many studies have investigated the relationship between communicated scientific uncertainty and trust in science or scientists, and results are contradictory. This might be because different studies operationalized the communicated uncertainty differently, e.g., as distributions, ranges, or verbal statements, or because different studies evaluated different sources of uncertainty. In the context of our work, below we only describe studies—

separately for different dependent variables—that have examined the influence of verbal statements about scientific uncertainty on trust in science or scientists (for a complete review, see van der Bles et al., 2019).

First, some studies have investigated how trustworthy scientists or journalists are perceived to be as information sources when they communicate scientific uncertainty. Gustafson and Rice (2019) found that when they included uncertainty frames related to consensus (i.e., experts disagree) in scientific information on climate change, this lowered the perceived credibility of the source compared to a control condition; conversely, other scientific uncertainty frames (e.g., referring to unknowns within future research) did not. Further, Jensen (2008) found that when disclosed uncertainty was attributed to an article's primary scientist, this enhanced the primary scientist's perceived trustworthiness (here: honesty and transparency) and that of the article's author (journalist). In a later study, this finding was only replicated for journalists' credibility but not for that of scientists (Ratcliff, Jensen, Christy, Crossley, & Krakow, 2018).

Second, other studies have investigated how trust in a particular scientific discipline is affected when scientific uncertainty is disclosed. For example, when an article describes the limitations (vs. recent advances) of research in a scientific field, the field is perceived to be less precise and less simple (and more so by Republicans than Democrats in a US sample; Broomell & Kane, 2017). In another study, introducing scientific uncertainty and limitations in news articles about cancer research did not increase trust in the medical profession, but introducing more experts in the article may have (Jensen et al., 2011).

Third, some studies have investigated whether scientific uncertainty affects laypeople's internal uncertainty—their psychological experience of uncertainty (Peters & Dunwoody, 2016; van der Bles et al., 2019)—which might manifest in people's decision-making (e.g., Han, Moser, & Klein, 2007). In one study, messages that included uncertainty did result in participants giving higher ratings on the objectivity and balance of the journalistic reporting (about a vaccine), but it lowered participants' ease of decision-making (Westphal, Hendriks, & Malik, 2015). Two other studies used the following variation: Uncertainty was introduced either via lexical hedges (e.g., 'probably') or by referring to other experts. In one study, hedging led participants to more easily make decisions about a health issue (Mayweg-Paus & Jucks, 2015), while in the other study, hedging in texts about an educational issue led to participants to give lower ratings on argument credibility and 'scientific-ness' of the text (Thiebach, Mayweg-Paus, & Jucks, 2015).

Taken together, the results on how uncertainty affects laypeople's trust and decision-making are rather inconclusive. Thus, here we investigated whether scientific uncertainty (pertaining to the state of evidence) in news articles affects participants' assessment of uncertainty in the research field and affects their trust in assertions made by climate scientists and their trust in climate science itself. Furthermore, we assessed whether being faced with scientific uncertainty led participants to have more uncertainty when making decisions related to the issue.

1.3. Knowledge about Scientific Processes

As mentioned above, in science's endeavor to narrow in on the 'truth,' scientific processes are continuously augmented to minimize uncertainty. However, the degree to which laypeople understand such aspects about science is central to their scientific literacy. In newer conceptions of the term, scientific literacy entails not only content knowledge (knowing a set of facts about science) but also procedural and epistemic knowledge (Organisation for Economic Co-operation and Development, 2017). Procedural knowledge means being aware of the main methods of empirical enquiry, as well as the scientific uncertainty that comes along with them, while epistemic knowledge entails, for example, understanding why such methods are used.

In this context, one open question some studies have considered is how someone's knowledge about scientific processes might affect their interpretation of scientific uncertainty. In a large survey study, people who had higher knowledge about scientific methods were also more aware of uncertainty within science (Retzbach, Otto, & Maier, 2016). In a qualitative study, participants accepted uncertainty if they also believed that uncertainty is intrinsic to science (Maxim & Mansier, 2014). Similarly, in an experimental study, Kimmerle, Flemming, Feinkohl, and Cress (2015) found that participants who believed science to be uncertain tended to perceive higher scientific uncertainty in news reports. Along these lines, when Rabinovich and Morton (2012) encouraged participants to believe that science is a debate (vs. the search for a single truth), they were more motivated to behave sustainably. Further, Flemming, Kimmerle, Cress, and Sinatra (2020) were able to reduce the negative effects of scientific uncertainty on ratings of credibility by introducing participants to the role of scientific uncertainty in research using a refutation text. All these results are in line with the theoretical and empirically tested idea (Gauchat, 2011) that the general public's trust in science is related to believing that scientific processes ('the scientific method') culturally demarcate scientific knowledge from other types of knowledge.

Given the above findings, we assumed for our studies that if, along with a text discussing the scientific uncertainties of a particular issue, participants were also given information about the direct source of the uncertainty—namely, the associated scientific research methods—this might make them more trustful and allow them to more easily make decisions. For example, it is possible that when participants are informed that scientific models are based on data and are continuously improved,

they may be able to explain and partially resolve modeling uncertainty.

2. Study 1

Overall, the empirical research is inconclusive on how communicated uncertainty affects laypeople (van der Bles et al., 2019). Specifically, it is still unclear how communicated scientific uncertainty affects laypeople's judgments of the credibility of messages and their overall trust in scientists and scientific disciplines. To explore these research questions further, we designed an experimental study with a two-factorial design. Scientific uncertainty was varied by introducing scientific uncertainty in a fictitious newspaper article on how climate change affects ocean life. This text was presented to two experimental groups (scientific uncertainty conditions). The other two groups (non-scientific uncertainty conditions) read the same text, but the information was presented as certain (e.g., 'later studies found similar results'). Furthermore, in order to enhance participants' abilities to evaluate scientific uncertainty, we aimed to activate participants' relevant knowledge about sources of uncertainty. Hence, empirical research methods (which were directly applicable to the uncertainty mentioned in the news article text) were presented to two groups (empirical research methods conditions) before they read the newspaper article with/without scientific uncertainty; the other two groups (non-empirical research methods conditions) read texts on media coverage about climate change.

We investigated whether being exposed to scientific uncertainty (scientific uncertainty conditions) and/or learning about empirical research methods (empirical research methods conditions) affected participants' (1) assessment of the issue uncertainty, (2) perception of the article's credibility, (3) trust in the scientists' assertions and trust in climate science, and (4) ease with which they were able to reach a personal decision on the issue. We expected that communicating scientific uncertainty to participants would increase their perception of the issue uncertainty and decrease their ease of making a decision but also increase their trust in scientists (e.g., Jensen, 2008; Rabinovich & Morton, 2012) and in climate science in general:

> H1: In the scientific uncertainty conditions, ratings of issue uncertainty are higher, and ratings of decision-making ease are lower, compared to the non-scientific uncertainty conditions (main effect).
>
> H2: In the scientific uncertainty conditions, ratings of information credibility and trust in climate scientists and climate science are higher, compared to the non-scientific uncertainty conditions (main effect).

We furthermore expected that providing participants with information about empirical research methods might enhance their trust in climate scientists and in climate science, as similar research found that introducing participants to the unavoidability of uncertainty in science increased credibility and trust ratings (e.g., Flemming et al., 2020).

> H3: In the empirical research methods conditions, ratings of trust in climate scientists and climate science are higher, compared to the non-empirical research methods conditions (main effect).
>
> H4: In the empirical research methods conditions, ratings of decision-making ease are higher, especially for the scientific uncertainty condition (interaction effect).

2.1. Methods

For experimental materials and measures, see the Supplementary File. This study was preregistered (Hendriks, Ilse, & Jucks, 2017). We conducted a power analysis to calculate the sample size needed to detect a small effect of partial eta square of .01 with a power of .95 and an alpha of .05, using G*power (Faul, Erdfelder, Buchner, & Lang, 2009). The determined sample size was 175.

2.1.1. Sample

We recruited university students via open Facebook groups and a university newsletter, resulting in $N = 286$ participants who finished the questionnaire and consented to data usage. After excluding those who had studied at an (applied) university for more than two semesters and those who used a mobile phone to complete the questionnaire, we were left with $N = 207$ participants. Those participants were between 18 and 41 years of age ($M = 20.34$; $SD = 2.56$), and 63.8% were female, 33.8% male, and 2.4% chose not to disclose their gender. Most (60.4%) majored in social sciences, economics, or law; 13.0% in science, technology, engineering e mathematics; 11.6% in the arts; the remaining 25% in health, nutrition or sports. One participant had not studied at a college/university.

2.1.2. Procedure and Measures

After giving information about participating in the study, we presented participants with demographical questions (age, gender, education). Next, we had them read the two texts: First, participants read about research methods (experimental methods and mathematical models) or media coverage on climate change (empirical research methods versus non-empirical research methods conditions), and then they read about ocean acidification with/without uncertainty (resulting from comparing lab and field experiments, from making generalizations, and from making predictions from mathematical models; scientific uncertainty versus non-scientific uncertainty con-

ditions). The experimental groups were randomly selected by the survey software, leaving $n = 51$ in the 'empirical research methods/scientific uncertainty' condition, $n = 50$ in the 'empirical research methods/non-scientific uncertainty' condition, $n = 56$ in the 'non-empirical research methods/scientific uncertainty condition,' and $n = 50$ participants in the 'non-empirical research methods/non-scientific uncertainty' condition.

Uncertainty assessment was then measured with four items, such as 'Climate science has not yet sufficiently researched all impacts of climate change on ocean life.' Credibility of information (three items as in Appelman & Sundar, 2016), trust in assertions by climate scientists (three items, e.g., 'I trust statements of climate scientists about the impact of climate change on the oceans'), and trust in climate science (three items related to expertise, integrity and benevolence, e.g., 'I trust climate science, because I believe that climate scientists are experts in their field'; adapted from Wissenschaft im Dialog, 2018) were measured on 5-point Likert scales (1 'I do not agree' to 5 'I agree very much'). A further measure on epistemic aims is not reported in this article. We next presented several statements of climate-friendly behavior, asking participants whether they would do these in the next month (e.g., 'use a bike, walk, or use public transport instead of taking the car,' using Likert scales from 1 'not likely' to 5 'likely'). Next, we measured participants' ease of decision-making to partake in climate-friendly behavior by asking them to choose three options from the list and indicate how ready they were to act on these for a month (from 1 'not ready' to 5 'ready'). Certainty in this decision was then measured with the two subscales uncertainty and decision effectiveness of the Decisional Conflict Scale (item 10–16; Buchholz, Hölzel, Kriston, Simon, & Härter, 2011). We also asked what could hinder participants from carrying out these behaviors in the next month (four items, such as 'lack of finances'; one optional open-ended item).

Finally, we explained that the texts were fictional and possibly simplified and asked for participants' consent to use their data.

2.2. Statistical Analyses

Using SPSS 25, we conducted analyses of variance (ANOVA) with two factors: *empirical research methods* and *scientific uncertainty*. For the scales that were expected to be positively interrelated, we conducted multivariate analyses of variance (MANOVA) to inspect general effects and limit the accumulation of Type I errors, and we followed up with ANOVA for each of the respective scales and simple effects analyses. For the full report of results, see the Supplementary File.

2.3. Results

As expected, the degree to which participants perceived issue uncertainty was higher when uncertainty was included in the text (H1): The factor scientific uncertainty ($p < .001$, $\eta_p^2 = .20$) was significant, while empirical research methods was not ($p = .123$; neither was the interaction, $p = .281$).

The texts were perceived to be of similar credibility (empirical research methods, $p = .516$; scientific uncertainty: $p = .580$; interaction: $p = .563$). A MANOVA showed an interaction effect for empirical research methods and scientific uncertainty on participants' trust judgments ($p = .007$, $\eta_p^2 = .05$), but there was no evidence for a main effect of either empirical research methods ($p = .815$) or scientific uncertainty ($p = .117$). Separate univariate ANOVAs only showed an interaction effect for trust in the assertions made by climate scientists ($p = .015$, $\eta_p^2 = .03$), which we followed up by simple effects analyses (Bonferroni corrected). These indicated that trust in assertions ratings were significantly lower in the 'empirical research methods/scientific uncertainty' condition ($M = 3.78$, $SD = 0.66$) than in the 'non-empirical research methods/scientific uncertainty' condition ($M = 4.06$, $SD = 0.67$; $F(1,203) = 4.86$, $p = .029$) and in the 'empirical research methods/non-scientific uncertainty' condition ($M = 4.11$, $SD = 0.54$; $F(1,203) = 6.57$, $p = .011$). The other two comparisons of experimental groups did not reach significance (see Supplementary File). In sum, these results do not support H2 and directly contradict H3.

Regarding the decision (committing to climate-friendly behavior), no difference between groups could be observed (empirical research methods: $p = .607$; scientific uncertainty: $p = .538$; interaction: $p = .527$). In contrast to H4, participants' ease of decision-making did not differ between the experimental conditions, as shown by a MANOVA with both scales as dependent variables (empirical research methods: $p = .801$; scientific uncertainty: $p = .431$; interaction: $p = .183$).

2.4. Intermediate Discussion of Study 1

When scientific uncertainty was communicated in the news article (about the effect of ocean acidification on ocean life), participants perceived higher issue uncertainty (confirming H1). However, this experimental variation did not lead participants to rate the credibility of the information or their trust in climate science differently (not supporting H2). When participants were given information about empirical research methods in addition to the article entailing scientific uncertainty, they gave lower ratings for trust in climate scientists' assertions, as compared to experimental conditions in which participants only read the news containing scientific uncertainty but did not read about research processes, or when participants did read about the research processes and did read the news article, but the news article contained no scientific uncertainty (contradicting H3). There was no evidence for an effect of the experimental variation on participants' decision to behave in a climate-friendly way, nor on the ease

with which this decision was made (not supporting H1 in this regard).

These findings contradict our expectation that giving participants information about the research methods would ease their interpretation of uncertainty and, thus, enhance their trust in climate scientists' assertions and in climate science generally. Possibly, as the text explaining the empirical research methods included several sources of uncertainty (measuring, sampling, and modeling), participants may have been more skeptical towards the certainty on which climate scientists' assertions rest in general.

3. Study 2

We tested this interpretation in study 2, in which we varied the text that had, in study 1, explained the empirical research methods. In study 2, participants received one of two versions of this text, which described two separate research processes, namely the empirical research methods (as in study 1) and the role of expert consensus in science (described in detail below). Regardless of the research process being considered, in the study 2 variations of this text, we either framed uncertainty in an 'expected' way, in which we emphasized that the scientific process is intended to increase certainty, or we framed uncertainty in an 'exaggerated' way, where we highlighted the uncertainty that follows from scientific processes. That is, we tested whether the framing of scientific uncertainty—either as something inherent to science or as something that fundamentally challenges making reliable conclusions from evidence—affected participants' ratings of the article's credibility, ratings about trust, and their decision-making surrounding the issue. In all conditions of study 2, the news article text presented the issue (the effect of ocean acidification on ocean life) as scientifically uncertain (as in study 1's scientific uncertainty conditions).

As briefly mentioned above, in addition to the two conditions of framing uncertainty ('expected' vs. 'exaggerated'), we varied the text on research processes to describe two different types of process, where one condition described the empirical research methods (as in study 1) and the other described the role of experts finding a consensus in science. Especially around the issue of climate change, expert consensus finding is argued to be a central scientific process for achieving certainty (Oreskes, 2007). Hence, highlighting processes of consensus finding and quality checking among experts (e.g., peer review) might help people understand that when scientific uncertainty exists in a scientific field, it is not because pertinent scientific experts cannot be trusted (as might be inferred from the results of study 1). Hence, regarding the two conditions for consensus finding, in one we framed uncertainty in an 'expected' way, where we emphasized that expert consensus plays a pivotal role in generating reliable scientific knowledge, and in the other condition we framed uncertainty in an 'exaggerated' way, where we highlighted the uncertainty that arises from expert disagreement. Similar variations were made for the two conditions concerning empirical research methods: In one condition, we framed uncertainty in an 'expected' way, in which we emphasized that empirical scientific methods are intended to increase certainty, whereas in the other condition we framed uncertainty in an 'exaggerated' way (e.g., stating that lab experiments do not allow for making conclusions about the real world). Our hypotheses for study 2 are as follows:

> H5: When uncertainty is framed in an exaggerated way, participants give higher ratings for issue uncertainty and have a lower ease of decision-making compared to when uncertainty is framed as being expected (i.e., as part of the scientific process; main effect).
>
> H6: When uncertainty is framed in an exaggerated way, participants give lower ratings for information credibility and trust in climate scientists and climate science compared to when uncertainty is framed as being expected (main effect).

Furthermore, to assess individual differences between participants, we included a measure for epistemic style (Elphinstone, Farrugia, Critchley, & Eigenberger, 2014). This inventory measures people's preferences for information processing and problem solving: One scale reflects preference for intellective style reasoning (e.g., by deep reflection on problems), and the other a default style reasoning (e.g., by finding quick solutions). This reflects a two-system approach for dealing with uncertainty that has been assumed to be useful for examining the role of scientific uncertainty in public communication of science (Patt & Weber, 2014). Since participants' epistemic style might influence their reasoning about scientific processes and scientific uncertainty, this may, in turn, also affect their judgments about credibility and trust. Hence, we investigated (as research question of the study) whether participants' epistemic style influenced their ratings on all dependent variables that followed the experimental manipulations (covariation effect).

3.1. Methods

The experimental materials can be found in the Supplementary File. This study was approved by the authors' university's ethics commission (2018-21-FH) prior to data collection.

3.1.1. Sample

We recruited participants via a university newsletter, resulting in $N = 170$ who finished the questionnaire and consented to data use (mobile phone users were not permitted to take part, but were asked to use a lap-

top/desktop computer). After excluding those who had studied at an (applied) university for more than two semesters and those who were suspected to or had self-reported as participating in the previous study, we were left with $N = 129$ participants. Those participants were between 18 and 33 years of age ($M = 20.73$; $SD = 2.65$, the entry '11' was recoded as missing), and 56.6% were female, 39.5% male, and 3.9% chose not to disclose their gender. Most (42.6%) majored in social sciences, economics, or law; 34.1% in science, technology, engineering e mathematics; 17.8% in the arts; the remaining 4.9% in health, nutrition or sports.

3.1.2. Procedure and Measures

The procedure was similar to study 1. After presenting information about participation, we asked participants demographic questions (age, gender, education). To increase relevance, students were given a cover story, namely that participants had to write an argumentation in a class (e.g., at university), and for that, had to read the two texts, where one was introduced as a background text and the other as a newspaper article (no specific source references were given).

The two texts were as follows: First, participants were to read one of four versions of the background text on research processes. In the condition 'empirical research methods/expected uncertainty framing,' participants received a background text that emphasized how experimental studies and modeling are used to achieve reliable knowledge in climate science ($n = 40$; similar to the empirical research methods conditions from study 1). In the condition 'expert consensus/expected uncertainty framing,' the background text described how experts in climate science reach consensus ($n = 31$). In the condition 'empirical research methods/exaggerated uncertainty framing' ($n = 32$) and the condition 'expert consensus/exaggerated uncertainty framing' ($n = 26$), the background texts described scientific processes by evoking the uncertainty around evidence or highlighting the disagreement between experts, respectively. All experimental groups then read the same news article on ocean acidification, similar to the scientific uncertainty text from study 1. The experimental groups were randomly selected by the survey software.

As in study 1, we measured participants' assessment of uncertainty, their perception of information credibility, and their trust in climate scientists/climate science. A questionnaire on epistemic aims, and another on strategies participants use to deal with an informational problem are not reported.

Regarding decision-making, participants were asked to make a different decision than in study 1. Imagining they had to write an argumentation for their class, they were asked which claim they would support: 'Impacts of climate change on ocean [life] are…' (see the Supplementary File for original item) followed by the options from 1 'not at all grave' to 5 'very grave.' Two further items (see the Supplementary File) measured participants' attitudes toward climate science. Then, epistemic style was measured with the two scales (intellective style, default style) of the Epistemic Preference Indicator-Revised (EPI-R; Elphinstone et al., 2014) on Likert scales from 1 'do not agree at all' to 5 'very much agree'). For neither scale was a difference between groups observed (see the Supplementary File).

Finally, we explained that the texts were fictional and possibly simplified, and then we asked whether participants were familiar with the study materials, whether they had seen news reports on predatory journals, and whether participants would give us consent to use their data.

3.2. Statistical Analyses

Using SPSS 25, we conducted analyses of covariance (ANCOVA) with two factors: the type of research processes (TRP: 'empirical research methods' and 'expert consensus') and uncertainty framing (UF: 'expected' and 'exaggerated'), using as covariates both scales of the EPI-R (centered by subtracting the variable sample mean; Schneider, Avivi-Reich, & Mozuraitis, 2015). Again, we conducted multivariate analyses of covariance (MANCOVA) for positively interrelated scales. See the Supplementary File for full results.

3.3. Results

Contrary to our H5, we found that the degree to which participants perceived uncertainty was neither a result of experimental variation nor influenced by the covariates (TRP, $p = .750$; UF, $p = .868$; interaction $p = .331$; EPI-R default style, $p = .309$; EPI-R intellective style, $p = .144$).

Regarding H6, results showed that all texts were perceived to be of similar credibility (TRP, $p = .339$; UF, $p = .506$; interaction $p = .350$; EPI-R default style, $p = .395$; EPI-R intellective style, $p = .897$). A MANOVA showed that the experimental variation did not impact participants' trust ratings (TRP, $p = .503$; UF, $p = .961$; interaction $p = .171$). However, regarding RQ1, while the EPI-R sub-scale intellective style did reach significance as a covariate ($p = .010$, $\eta_p^2 = .07$), default style did not ($p = .158$). Separate univariate ANOVAs showed that intellective style did covary significantly with both trust in assertions by climate scientists ($p = .008$, $\eta_p^2 = .06$) and trust in climate science ($p = .004$, $\eta_p^2 = .06$).

There was no evidence of an effect of experimental variations on participants' decisions (on the gravity of climate change effects on ocean life) (TRP, $p = .934$; UF, $p = .932$; i n-teraction, $p = .866$). The EPI-R sub-scale intellective style was significant as covariate ($p = .006$, $\eta_p^2 = .06$), but not default style ($p = .906$). Contradicting H5, a MANOVA for ease of decision-making showed no effects as a result of the experimental variation, but ease of decision-making did co-vary with intellective style (TRP, $p = .482$; UF, $p = .154$; interaction, $p = .073$; EPI-R in-

tellective style, $p = .036$, $\eta_p^2 = .05$; EPI-R default style, $p = .120$). Separate ANCOVAs revealed that the intellective style covariate affected ratings on both scales of the Decisional Conflict Scale (measuring ease of decision making), namely the certainty ($p = .043$, $\eta_p^2 = .03$) and the effectiveness of the decision ($p = .010$, $\eta_p^2 = .05$). We do not interpret further effects in the separate ANCOVAs, because they were not significant by MANOVA.

3.4. Intermediate Discussion of Study 2

In study 2, we did not find any significant effects that were due to experimental variations. That is, there was no evidence that either ascribing the source of uncertainty to empirical research methods vs. expert disagreement, or framing uncertainty as being expected vs. being exaggerated affected participants' ratings of perceived uncertainty and ease of decision-making (counter to H5), or their assessments of information credibility and trust (counter to H6). However (regarding the study's research question), we found that having an intellective epistemic style—an appreciation for dealing with complex issues and engaging in problem solving—was a covariate for participants' trust in the assertions of climate scientists and their trust in climate science, as well as for the decision (claim support) and ease of decision-making. Thus, a preference for deep reflection about such issues may be even more relevant for trust in science and making decisions about scientific issues than is being exposed to messages that attack the scientific processes underlying uncertainty in climate change information.

4. General Discussion

The results of study 1 showed that while the presence of scientific uncertainty in a text on ocean acidification led participants to more highly rate the uncertainty of the issue, it did not cause participants to have more uncertainty when making a decision related to the issue. Similarly, this experimental variation did not cause participants to give higher rankings on information credibility, to have greater trust in the assertions made by climate scientists, or to have greater trust in climate science. On the contrary, when participants read a text describing empirical research methods prior to reading the article containing scientific uncertainty, they had even less trust in the assertions made by climate scientists. In contrast to what we expected from previous research (e.g., Flemming et al., 2020), our study found no evidence that having participants read texts describing the role of uncertainty in scientific research would ease how they later interpreted the scientific uncertainty presented within the article.

In study 2, we tested whether this effect could be attributed to the text on empirical research methods, which introduced several sources of uncertainty and thus could have resulted in the impression that scientific processes in climate science are unreliable. However, the results of study 2 showed that this seems not to have been the case: There was no evidence that framing scientific processes (either empirical research methods or expert consensus) as the main source of scientific uncertainty would negatively impact participants' trust in climate scientists' assertions or their trust in climate science. However, the extent to which participants rated their attitude to approaching science-based problems as reflecting an intellective epistemic style did influence their trust judgments and their decision-making. Hence, how people resolve scientific uncertainty might depend more on individual information processing preferences than on how scientific uncertainty is framed in news articles.

In sum, our studies indicate that while participants did perceive the uncertainty introduced in news articles, this did not affect their decision-making, and it only slightly influenced their trust: Having information on scientific processes (empirical research methods) in combination with reading scientific uncertainty in the news article did result in participants having slightly lower trust in climate scientists' assertions (e.g., to make meaningful claims about the issue). However, there was no evidence that this would affect participants' overall trust in climate science, and neither did framing the scientific uncertainty in an exaggerated way (both regarding empirical research processes and expert disagreement). This could be due to participants' prior knowledge about and their attitude toward uncertainty in scientific information: Participants might have expected scientific results to be rather uncertain (not due to the text we introduced with this aim), thus making them unreceptive toward appeals to (sources of) scientific uncertainty.

The effects of scientific uncertainty on trust and behavioral intentions are worthwhile to study, as past studies have differed in their measured concepts (e.g., trust, emotion, behavioral intentions), and focus (e.g., uncertainty of statistical estimates vs. generalizability of experiments; see van der Bles et al., 2019, 2020). In the present work, we investigated how scientific uncertainty is interpreted when people are reminded that scientific processes act both as the source and as a resolution for uncertainty. However, the texts we used in the experiments might have been too complex or not relevant enough for participants. Further, each text referred to several sources of scientific uncertainty. We deemed this necessary to remind participants that there is fundamental scientific uncertainty in climate science but also that research processes are being continuously optimized to approximate 'truth.' Further research should address the field's yet fragmented understanding on the communication of uncertainty, making precise distinctions between different types and sources of scientific uncertainty. As such, further studies should examine consequences of different sources and types of scientific uncertainty on trust, emotion, and behavior.

Trust is a complex concept, as it can be directed at the source of knowledge, experts, or science in general. Our studies addressed only trust in climate science re-

searchers and trust in the discipline of climate science, for which we used two small scales. While in our studies both scales show acceptable internal consistency (see the Supplementary File), they should be formally tested for reliability and validity in a larger sample. Further studies should use more elaborate trust scales to further examine the effects of scientific uncertainty (in its different forms) on trust.

Another limitation of our work is that we only questioned university students. We aimed for a sample that had little formally acquired procedural knowledge, such that we excluded participants that had already completed their first year of university education. The studies should be replicated with a more diverse sample, as students could be generally aware of scientific uncertainty and might have an accepting attitude toward science. However, our studies suggest that in a population of students who do not yet possess university-level scientific literacy, adversarial information about scientific uncertainty and its sources might have little to no effect.

5. Conclusion

Our studies add to the literature on the public assessment of scientific uncertainty, which has produced conflicting results (van der Bles et al., 2019), and they are relevant to understanding how readers perceive and interpret scientific uncertainty in digital news media, for example when it is directed at weakening their trust in science. As a consequence of uncertainty being used to provoke doubt about science, uncertainty in climate change communication has often been linked with adverse responses by recipients (Lewandowsky et al., 2015). Strategic appeals regarding science's inability to achieve reliable results might be especially prevalent in attacks on climate science in digital media such as blogs (Elgesem et al., 2015; Mercer, 2018), but also in the context of anti-vaccination, advocates might use scientific evidence in digital media outlets to persuade their readers (e.g., Moran, Lucas, Everhart, Morgan, & Prickett, 2016; Schalkwyk, 2019). Our studies show that while participants' trust judgments were slightly affected by addressed scientific uncertainty in the two texts (study 1), an exaggeration of scientific uncertainty originating from empirical research or expert consensus did not lead to lower trust judgments than when uncertainty was presented as being expected (study 2). However, how scientific uncertainty can be communicated to a more general public should be carefully considered (Corner, Lewandowsky, Phillips, & Roberts, 2015; Druckman, 2015).

Especially in user comments, scientific uncertainty and the credibility of scientific research might be critically addressed (Lörcher & Taddicken, 2017). In a study investigating attacks on science in user comments (added to social media entries introducing a scientific study), expert user comments targeting thematic complexity were perceived to be more credible and reduced participants' agreement with a scientific claim, in comparison with, for example, comments targeting researcher competence (Gierth & Bromme, 2020). Similarly, 'incivility' in user comments might polarize readers' attitudes on a scientific topic (Anderson, Brossard, Scheufele, Xenos, & Ladwig, 2014), and negative user comments on a blog post may sour readers' attitudes toward a scientific topic, both when comments use scientific arguments or subjective opinions (Winter & Krämer, 2016). In sum, the mere presence of dissenting user comments might be effective in reducing reader's trust in scientific results. This means that in digital media, science communicators should not only carefully consider the extent and framing of their communication of uncertainty inherent in scientific results, but they should also be attentive of whether user comments challenge science by pointing to scientific uncertainty. While our studies did not find that giving readers information about scientific processes effectively reduced negative impacts of uncertainty on trust, this and other communicative strategies to protect against the utilization of scientific uncertainty to attack science should be further investigated.

Acknowledgments

We thank Teresa Ilse, who collected the data from study 1 as part of her master's thesis. The data were completely reanalyzed for this article. We cordially thank Celeste Brennecka for native speaker advice.

Conflict of Interests

The authors have no conflicting interests to declare.

Supplementary Material

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

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COGITATIO

Media and Communication (ISSN: 2183–2439)
2020, Volume 8, Issue 2, Pages 413–424
DOI: 10.17645/mac.v8i2.2859

Article

Health and Scientific Frames in Online Communication of Tick-Borne Encephalitis: Antecedents of Frame Recognition

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Submitted: 31 January 2020 | Accepted: 26 May 2020 | Published: 26 June 2020

Abstract
In a period characterized by vaccine hesitancy and even vaccine refusal, the way online information on vaccination is presented might affect the recipients' opinions and attitudes. While research has focused more on vaccinations against measles or influenza, and described how the framing approach can be applied to vaccination, this is not the case with tick-borne encephalitis, a potentially fatal infection induced by tick bites. This study takes one step back and seeks to investigate whether health and scientific frames in online communication are even recognized by the public. Moreover, the influence of selected health- and vaccine-related constructs on the recognition of frames is examined. Study results indicate that health frames are the most easily identified and that their use might be a fruitful strategy when raising awareness of health topics such as vaccination.

Keywords
framing; health communication; science communication; tick-borne encephalitis; vaccination

Issue
This article is part of the issue "Health and Science Controversies in the Digital World: News, Mis/Disinformation and Public Engagement" edited by An Nguyen (Bournemouth University, UK) and Daniel Catalan (University Carlos III of Madrid, Spain).

1. Introduction: Vaccination and Framing in Health Communication

In recent years, news coverage and public debates have shown that people discuss vaccination and even refuse to vaccinate themselves or their children (Schoeppe et al., 2017, p. 654). Many studies have already investigated the reasons why people do, and do not, get vaccinated (e.g., Askelson et al., 2010; Berman, Orenstein, Hinman, & Gazmararian, 2010). Online media has been found to have a particularly strong impact on people's perceptions of vaccination (Betsch, 2011; Betsch, Böhm, Korn, & Holtmann, 2017; Nyhan & Reifler, 2015). As people increasingly consult the Internet for health-related information (Din, McDaniels-Davidson, Nodora, & Madanat, 2019), vaccination is no exception to this trend (Betsch, Renkewitz, Betsch, & Ulshöfer, 2010; Kessler & Zillich, 2018) and it is likely that such Internet research will likely influence people's attitudes towards vaccination.

Hence, online messages and the way websites present arguments are a key factor in shaping individual attitudes towards vaccination. In the following, we define such arguments as frames, which refer to "organizing principles that are socially shared and persistent over time, that work symbolically to meaningfully structure the social world" (Reese, 2010, p. 11). Frames are best conceptualized as "interpretation packages" (Gamson &

Modigliani, 1989, p. 1) to present a specific issue. As such, they help structure arguments and ideas (Reese, 2010). Moreover, to frame means "to select some aspects of perceived reality and make them more salient in a communicating text" (Entman, 1993, p. 52). Research has already combined framing and vaccination issues but has been mostly focused on selected aspects, single frames, or one particular research perspective (Bigman, Cappella, & Hornik, 2010; Kim, Pjesivac, & Jin, 2019; McRee, Reiter, Chantala, & Brewer, 2010; Nan, Daily, Richards, & Holt, 2019). Yet, the identification of frames as employed in health communication messages is crucial, given that the way messages are framed is likely to reflect selected health goals (Hallahan, 2015), and is likely to affect people's message perceptions subconsciously (Coleman, 2010). In this context, frames in health-related messages, such as online websites on vaccination, are expected to have positive effects on users.

2. Antecedents to Frame Recognition and Frame Perception

Apart from frames in messages, previous research has determined that health-related variables moderate responses to health messages regarding drug advertisements (e.g., Koinig, Diehl, & Mueller, 2017; Lee, Whitehill King, & Reid, 2015) We also presume individuals' attitudes to be subject to a variety of health- or vaccine-related variables (World Health Organization [WHO], 2014) just like vaccination hesitancy, which is influenced by "complacency, convenience and confidence" (WHO, 2014, p. 11).

First, confidence in vaccination is crucial for behavioral beliefs associated with vaccinations, and as such, also determines individual attitudes towards vaccinations (Shapiro et al., 2018). It includes trust "in the effectiveness and safety of vaccines, the system that delivers them, including the reliability and competence of the health services and health professionals, and the motivations of policy-makers who decide on the need of vaccines" (MacDonald, 2015, p. 2). If confidence is high, individuals regard vaccinations positively (Askelson et al., 2010). Another construct which is highly correlated with confidence in vaccination and one of the most important assets in health communication (Zagaria, 2004) is health literacy. Health literacy refers to routine practices and activities utilized by individuals as part of their illness control mechanisms (Marks, Allegrante, & Lorig, 2005). As such, health literacy "represents the cognitive and social skills which determine the motivation and ability of individuals to gain access to, understand and use information in ways which promote and maintain good health" (Nutbeam, 1998, p. 10). Additionally, collective responsibility alludes to the fact that individuals presume that through collective action, a potential health problem can be solved (Betsch et al., 2018). This suggests that individuals might decide to get vaccinated because they see the benefit for their communities, rather than their own benefit (Betsch et al., 2017). This concept is highly relevant to diseases, such as influenza and measles, which are spread widely among the unvaccinated. In this context, health consciousness might be also relevant, which is grounded in individual differences and people's inclination towards the subject matter (Dutta, Bodie, & Basu, 2008), moderating health perception (Moorman & Matulich, 1993). Individuals expressing high levels of health consciousness are expected to be more prone to, e.g., search for information conducive to their well-being or engage in health-enhancing behaviors; as such, they are also presumed to be more interested in and willing to vaccinate themselves. This leads to another set of behavioral variables which influence the perception of information as well. Health information-seeking behavior is linked to positive health attitudes, an urge to search for further information as well as a need to consult (with) different sources (Dutta-Bergman, 2004). The sources individuals consult can be either distinct media channels and/or interpersonal sources (Niederdeppe et al., 2007). As such, it is also predicted that this behavior will positively shape individuals' perceptions of health information. Besides, calculation refers to "the need for extensive elaboration and information searching" (Betsch et al., 2018, p. 3). Individuals scoring high in this dimension have been found to proactively engage in information-seeking behavior; because of their high knowledge of the individual health issues, they are expected to favor vaccination (Brewer, Cuite, Herrington, & Weinstein, 2007) and are known to behave rationally (Wiseman & Watt, 2004).

To sum up, we assume that both individual predispositions (confidence in vaccination, health literacy, collective responsibility, health consciousness), as well as individual behavior (health information seeking behavior, calculation), have an impact on how messages are perceived. Yet, research has predominantly focused on the perception of messages and frames instead of asking if such frames are even recognized. It is plausible that the behavioral antecedents might influence the recognition of frames, while the predispositions might influence the perception of frames.

3. The Relevance of Vaccination against Tick-Borne Encephalitis in Austria

While a plethora of vaccination studies have predominantly focused on vaccinations against human papillomavirus (HPV), measles, mumps, and rubella (MMR), or influenza, little research has been conducted on tick-borne encephalitis (TBE). TBE is a potentially fatal infectious disease transmitted by ticks. It occurs in most forest belted areas of Europe, including Austria (Zavadska et al., 2018), and if untreated can endanger individuals' health and life. In contrast to HPV, MMR, and influenza, TBE is only transmitted by tick bites and not by humans. Therefore, the vaccination for TBE is different, because it prevents only a single person from the disease, while

other diseases affect the entire population directly. Yet, TBE is still linked with costs for both individuals and society (Smit, 2012, p. 6301), given its long-term neurological sequelae which require long-term care and cause a loss of productivity and premature retirement (WHO, 2011, p. 254). From 1999–2000, Austria ran a large immunization campaign against TBE, which was estimated to have saved the national health care system an equivalent of $80 million (WHO, 2011, p. 254). Furthermore, climate change has influenced the spread of ticks due to the milder and shorter winters and the early arrival of spring (Lindgren & Gustafson, 2001), which has resulted in an increased number of incidents of TBE (Zavadska et al., 2018), which are expected to lead to higher health-related costs.

Amongst central European countries, Austria has been especially affected by an increasing number of tick bites in recent years with the number of hospitalizations increasing from 2015 onwards (Allianz, 2018). As of 2014, only half of the Austrian population had tried to prevent TBE infections by getting vaccinated (Österreichischer Rundfunk, 2015). The following year, protective measures increased, with 65% of respondents claiming to have been vaccinated against TBE in 2015 (Statista, 2019). Given that infections and deaths by TBE are on the rise in Austria, both the government and health care or pharmaceutical marketers have been prompted to raise awareness of the need for TBE-vaccination. While the most effective protection against tick bites are vaccinations or personal protection measures, such as long clothes or tick-repellent sprays (Driver, 2011), both measures will not be sufficient if people are not aware of the risks associated with TBE. Yet to date, most papers on the subject of TBE have rather focused on the medical or natural scientific aspects of TBE, addressing issues such as the spread of ticks (Lindgren & Gustafson, 2001) instead of informing the public of the dangers TBE poses to society and social well-being. However, informing the public about ticks and TBE is deemed necessary and insights from message framing might help educate the public on TBE. For instance, websites hosted by pharmaceutical companies, such as Pfizer and those partly supported by governmental departments, address the risks associated with tick bites. Such cooperation between government and pharmaceutical companies qualify as a form of public health communication (Bonfadelli & Friemel, 2020), which also applies to the website on TBE which relies on specific frames to communicate their messages.

4. Health Frames and Scientific Frames in TBE Communication

Vaccination against TBE tackles health communication, as well as science communication since websites on TBE include information which is directly meant to promote health-related behaviors that are, in most instances, based on scientific evidence (e.g., Cooper, Lee, Goldcare, & Sanders, 2012). As summarized above, research on framing and vaccination has rather focused on single frames or single perspectives. We would like to enhance the understanding of frames by suggesting a differentiation between health frames, which are rather emotional and scientific frames, which are rather based on neutral information.

For the first category we have chosen character frames (e.g., Dan & Coleman, 2014) which are increasingly used in the areas of health communication (e.g., Koinig et al., 2017) and science communication (e.g., Kessler, Reifegerste, & Guenther, 2016). Character frames allude to affective frames that are able to evoke emotions and reactions in recipients (Grabe & Bucy, 2009). According to Dan and Coleman (2014) and Dan (2018), four frames can be distinguished: victim frames (i.e., a person affected by the disease, who is portrayed as weak; negative disease symptoms are emphasized), survivor frames (i.e., a healthy individual or hero-like figure, who has overcome the disease; positive attributes are stressed), carrier frames (i.e., an extremely negative portrayal of the health condition, caused by deviant behavior), and normal frames, in which people are presented as both ordinary and in normal surroundings, and in a state where the disease is not perceived as a burden. These considerations apply to communication of TBE, too. We assume that scientific frames on TBE are different from health frames. While health frames are affective and likely to evoke emotional responses in recipients by focusing on individual aspects such as well-being, scientific frames are neutral and focus on scientific evidence based on robust ecological data and present information in a factual manner.

For the second category of scientific frames and following the example of Ruhrmann, Guenther, and Kessler (2015), variables related to scientific evidence such as scientific (un)certainty and progress will receive consideration (Cooper et al., 2012). Based on Entman (1993, p. 52), the four frames—problem definition, causal interpretation, moral evaluation, and treatment recommendation—are broadly applicable to neutral and factual scientific frames. Problem definition concerns identifying both relevant actors and topics involved in the discussion at hand (Bowe, Oshita, Terracina-Harman, & Chao, 2012) and it is commonly linked to scientific (un)certainty. Causal attribution involves uncovering the reasons and causes behind certain problems (Bowe et al., 2012). Moral evaluation includes a rating of the findings presented, and, as such, is often based on negative or positive judgements (Entman, Matthes, & Pellicano, 2009). Finally, in the process of treatment recommendation, solutions to the previously identified problem are formulated, which are often presented in a forward-looking, predicting manner (Matthes & Kohring, 2008).

We presume that, on the one hand, frames which we describe as health frames are affective in that they emphasize personal and emotional aspects; furthermore, they become manifest in character frames. This category is characterized by a significant research gap (Guenther,

Gaertner, & Zeitz, 2020). On the other hand, we conceptualize neutral and factual frames as scientific frames, as information is usually based on scientific reasoning and facts. We have chosen the terms 'health frames' and 'scientific frames' to emphasize their respective character. Of course, 'scientific frames' were used in health communication as well as health frames were used in science communication, too. Hence, the present study extends previous research, in which calls for a more comprehensive and categorically broader conceptualization of framing in health communication have been made (Guenther et al., 2020). As we have outlined above, behavioral variables, as well as individuals' predisposition, might influence the perception of frames. Yet, we would like to take a step back and instead investigate whether health frames and scientific frames are even recognized and whether their detection may be influenced by respondents' attitudes and behaviors. We employ a joint approach since we assume that people do not recognize both frame types in a similar manner. Therefore, our two research questions are:

RQ1: Are health or scientific frames recognized more frequently?

RQ2: Is the recognition of health and scientific frames influenced by selected health- and vaccine-related antecedents?

5. Method and Materials

5.1. Study Design

The goal of our study is to determine whether scientific frames or health frames are more frequently identified by the Austrian public and which antecedents influence the frame recognition of the study participants. We conducted an online survey and showed participants texts from an Austrian website on TBE. The texts contained five different frames. After reading the texts, participants were asked several questions as to the antecedents and if they recognized the frames.

We carefully selected our text material for the online questionnaire. First, we used eye-tracking to identify texts which were read by common users of the Austrian website on TBE. Second, we conducted a content analysis of those messages in order to identify both the scientific frames and health frames as featured in the text. Finally, these texts and identified frames were used in the online survey. Figure 1 outlines our study procedure.

5.2. Selection and Validation of Text Material

5.2.1. Eye-Tracking

We analyzed an Austrian pro-vaccination website (www.zecken.at). This website is hosted by a pharmaceutical company, but the overall initiative is a joint endeavor with the Austrian health care ministry. We used

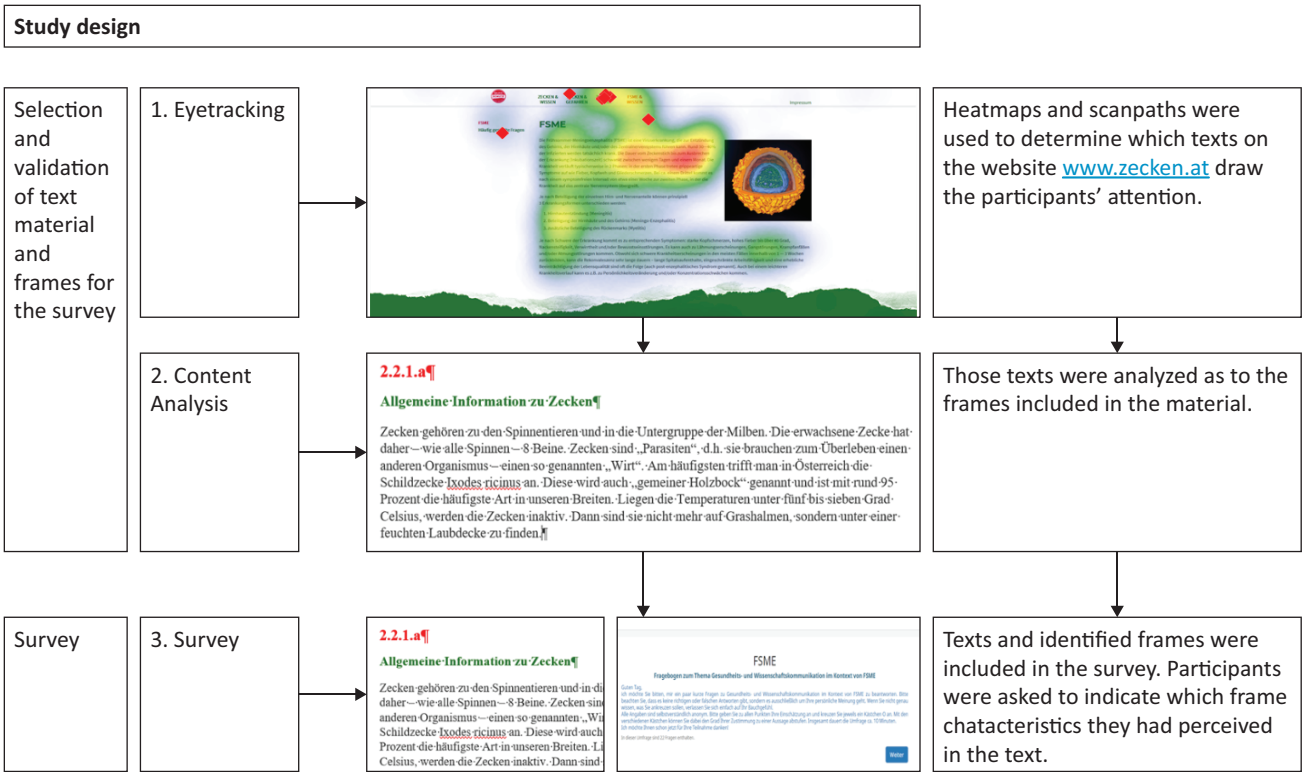

Figure 1. Study design and procedure. Source: Authors.

an eye-tracking study to identify those texts on the website that drew the reader's attention. We asked participants (n = 15) to gather information on TBE, giving them up to 10 minutes to search the website. Additionally, we controlled the experiment by asking the participants to gather information on bee-friendly gardening. Using both examples, we were able to analyze if there were significant differences between the eye movements, which was not the case. We used scan paths and heatmaps. If an area (and text) did not draw any (zero) attention in terms of looking at it or reading it (scan paths show reading patterns), the specific text was neither included in the followed-up content analysis nor the survey.

5.2.2. Content Analysis

The content analysis aimed to uncover which (health and scientific) frames the texts contained. First, we used 17 frames based on a literature review and derived definitions for each frame type including examples in a codebook. After pre-testing the codebook and some minor adjustments, a research group consisting of five students analyzed the texts. In total, five frames were identified (Table 1): two health frames, the carrier frame—which inquires whether the text addressed the negative health consequences associated with tick bites—and the victim frame, which particularly focused on the negative effects for the individual. Additionally, there were three scientific frames: problem definition—which highlighted the sources for the health issue and its public relevance—causal attribution—which listed reasons as to why a health problem is increasing in relevance—and treatment recommendation. The texts themselves, as well as the frames identified, were then employed as stimulus material in the respective question categories of the main study.

5.3. Online Survey

5.3.1. Study Description

Subjects for the study were recruited via asking students to send out the link of the online survey to friends and family members. This non-probability sampling method leads to a non-student convenience pool. While this sample does not allow us to draw conclusions for the overall Austrian population, it does, however, ensure a higher degree of heterogeneity than a sample based solely on students (Leiner, 2016, p. 216). Further, as we seek to investigate whether frames are recognized in general, we are still able to derive viable conclusions regarding potential differences in frame recognition among a more diverse sample. In total, 271 subjects participated in the structured questionnaire. Respondents were between 18 and 80 years old (M = 36.3, SD = 14.48). The largest part of the sample was made up of women (f = 65.7%; m = 34.3%).

After determining the antecedents regarding individuals' predispositions and behavioral aspects, the questionnaire ascertained respondents' familiarity with the term TBE. Regardless of their answer, individuals were presented with a definition in order to ensure an equal state of knowledge before exposing them to the stimulus texts. After reading through the text, questions related to message comprehensibility as well as the included health and scientific frames were posed. The questionnaire concluded with demographic questions.

5.3.2. Measurements

The answers to each question were reported on a 7-point Likert scale ranging from (1) 'I do not agree at all' to (7) 'I fully agree.' Factor analyses revealed the items of the all multi-item variables to load on one single factor and to have acceptable Cronbach α values, thus they were combined for analysis:

- 'Confidence in vaccination' was measured with the 5C psychological antecedents of vaccination scale (Betsch et al., 2018), utilizing three items (KMO = .500, p = .000; α = .904).
- 'Health literacy' was determined by one single item as derived from Lee, Hwang, Hawkins, and Pingree (2008).
- 'Collective responsibility' was derived from the same scale (Betsch et al., 2018) and was measured by two items (KMO = .500, p = .000; α = .721).
- 'Health consciousness' (Dutta et al., 2008) was measured via one question based on Gould (1988, 1990) and Dutta-Bergman (2004).
- 'Health information seeking behavior' was established through two questions adapted from Maibach, Weber, Massett, Hancock, and Price (2006) and Kapferer and Laurent (1985; KMO = .500, p = .000; α = .755).
- 'Calculation' was also based on the 5C psychological antecedents of vaccinations scale (Betsch

Table 1. Frame category and frame type.

Frame category	Frame type	Based on
Health frames	Carrier frame Victim frame	Dan and Coleman (2014); Dan (2018)
Scientific frames	Problem definition Causal attribution Treatment recommendation	Entman (1993)

et al., 2018) and was determined by three questions (KMO = .680, p = .000; α = .796).

In addition, we set out to determine the degree to which respondents were able to identify the previously highlighted frames. Each frame was operationalized with two statements to which the respondents were asked to answer on a 7-point Likert scale ranging from (1) 'I do not agree at all' to (7) 'I fully agree' (Table A1 in the Supplementary File). The carrier frame inquired whether the text addressed the negative (health) consequences associated with tick bites (2 questions; KMO = .500, p = .000; α = .759), while the victim frame particularly focused on the negative effects for the individual (2 questions; KMO = .500, p = .000; α = .717). Problem definition (i.e., highlighting the sources for the issue and its public relevance) was measured via two questions (KMO = .500, p = .000; α = .759). Likewise, causal attribution—listing the reasons why a (health) problem is increasing in relevance—was measured via 2 questions (KMO = .500, p = .000; α = .734), while treatment recommendation was concerned with the availability of solutions to the (health) problem (1 question). Items for the two health frame categories were based on Dan (2018), while items for the three scientific frames were based on Entman (1993).

6. Results

6.1. Health and Scientific Frames

The first research question was interested in uncovering whether health frames or scientific frames were recognized more frequently in the text passages used (Table 2). Generally, it can be noted that out of all frames featured in the text, the two health frames—namely the carrier frame (M = 6.072, SD = 1.231) and the victim frame (M = 6.055, SD = 1.181)—were detected more often by respondents. Subjects were further able to make out the scientific frames problem definition (M = 5.516, SD = 1.286) as well as determine TBE's causal attribution (M = 5.479, SD = 1.236); to a slightly lesser extent, they identified the recommended treatment (M = 4.48, SD = 1.907).

When looking at the frame categories in more detail and determining if there are significant differences between the recognition of health frames and scientific frames, the carrier frame was significantly more frequently identified than the three scientific frames: problem definition (T = 8.455, p = .000), causal attribution (T = 8.179, p = .000), and treatment recommendation (T = 12.468, p = .000). The second health frame, namely the victim frame, was also more easily discerned than the scientific frames problem definition (T = 8.727, p = .000), causal attribution (T = 8.274, p = .000), and treatment recommendation (T = 12.576, p = .000). No significant differences between the two health frames were reported (T = .453, p = .651). This means that both health frames function similarly, yet there are differences between health frames and scientific frames. Overall, the results point in the same direction and suggest that health frames are significantly more frequently identified than scientific frames (T = 15.927, p = .000).

6.2. Antecedents and Their Influence on the Recognition of Health and Scientific Frames

The second research question investigated which antecedents influenced the recognition of health frames and scientific frames. As research on framing usually tries to examine the perception of frames, this study focuses on a previous step, i.e., figuring out if antecedents might already influence frame recognition. We distinguish between antecedents which are related to individuals' attitudes (confidence in vaccination, health literacy, health consciousness, collective responsibility) and antecedents which include behavioral aspects (health information-seeking behavior, calculation). We calculated two multiple linear regressions and added the antecedents as predictors for health frame recognition or scientific frame recognition. Age and gender were included as controlling variables which allowed us to analyze whether the recognition of scientific frames or health frames is dependent on individuals' attitudes or behavioral aspects. The results of the regression analysis are presented in Tables 3 and 4. In the Supplementary File, more details on the influence of the previously identified variables on each of the two health frames and three scientific frames can be found (see Tables A2 to A6).

For health frames, the model fit turned out to be significant and accounted for almost 18% of the variance (R^2 = .175, F(8,270) = 6.928, p = .000; Table 3). The standardized regression weights beta show which of the antecedents have a higher impact on the recognition

Table 2. Mean and standard deviation of health and scientific frames.

Frame category	Frame	M	SD
Health frames	Carrier frame	6.072	1.231
	Victim frame	6.055	1.181
Scientific frames	Problem definition	5.516	1.286
	Causal attribution	5.479	1.236
	Treatment recommendation	4.480	1.907

Note: Model fit of health frames vs. scientific frames: T = 15.927, p = .000.

Table 3. Regression results using recognition of health frames as a criterion.

Predictors	B	beta	p	R^2
(Intercept)	2.915		.000	.175
Confidence in vaccination	.052	.080	.288	
Health literacy	.089	.099	.103	
Health consciousness	.122	.137	.036	
Collective responsibility	.138	.200	.006	
Health information seeking behavior	.102	.122	.058	
Calculation	.100	.138	.030	
Age	.000	.013	.221	
Gender	.020	.008	.142	

Note: 'B' represents unstandardized regression weights, 'beta' indicates the standard regression weights, and 'p' refers to significance.

of health frames. Collective responsibility (beta = .200, p = .006) and health consciousness (beta = .137, p = .036) as individuals' attitudes influence the recognition of health frames more than both behavioral variables, calculation (beta = .138, p = .030) and health information seeking behavior (beta = .122, p = .058). The latter is, unfortunately, just over the threshold of significance. The other predictors are not significant and therefore do not contribute to the recognition of health frames.

In the case of scientific frames, the model fit was also significant (R^2 = .074, F(8,270) = 2.610, p = .009; Table 4). Yet, only health information seeking behavior was found to be a useful predictor (beta = .163, p = .017), while the impact of all other antecedents was not significant. The model explained only 7% of the variance. Therefore, the variables which have a stronger effect on the recognition of scientific frames are obviously missing in this study.

The results of the regression showed that given the quite low explained variance in both models, additional analysis is required. Nevertheless, analyzing these results we note the positive relationship between health consciousness, collective responsibility, calculation, and health frames. However, only health-seeking behavior can influence the recognition of scientific frames.

7. Discussion

Our study was interested in uncovering specific health-related antecedents as formed in response to scientific (neutral) frames and health (affective) frames in TBE communication amongst the Austrian population—an area that has received very limited academic attention to date. Rather than other framing studies on vaccination, we wanted to scrutinize whether frames are even recognized before being perceived or judged. We conducted an online survey and carefully selected the stimulus material using eye-tracking and content analysis. We focused on the effects of frame recognition and tried to determine whether the recognition of frames differed, depending on whether the frame was classified as a health (character) frame or scientific (neutral) frame. Therefore, we used a convenience sample which does not allow us to draw conclusions for the Austrian population in general yet shows differences in the recognition of frames (also see limitations in Section 8).

While previous research has been able to confirm the co-existence of multiple frames (Matthes & Kohring, 2008), the present study moved beyond a pure content analysis, indicating that frames might be detected to varying degrees. Overall results suggest that health frames are recognized more often than scientific frames. One potential explanation for this tendency is that affective (and thus, emotional) frames are able to elevate respondents' personal involvement by heightening the perception of personal relevance and risk associated with tick bites and TBE. This is in line with previous research indicating that similarity can be a useful tool to increase message effectiveness (Ahn, Fox, &

Table 4. Regression results using recognition of scientific frames as a criterion.

Predictors	B	beta	p	R^2
(Intercept)	3.712		.009	.074
Confidence in vaccination	.049	.095	.237	
Health literacy	−.004	−.005	.937	
Health consciousness	.052	.073	.289	
Collective responsibility	−.009	−.017	.825	
Health information seeking behavior	.108	.163	.017	
Calculation	.062	.107	.110	
Age	.001	.098	.104	
Gender	.000	.000	.999	

Note: 'B' represents unstandardized regression weights, 'beta' indicates the standard regression weights, and 'p' refers to significance.

Hahm, 2014), whereby the perceived relevance of the message can trigger individuals to identify with message content (So & Nabi, 2013). The same was found to hold true for messages corresponding to individual preferences (Lobinger, 2012; Stark, Edmonds, & Quinn, 2007). Hence, by increasing identification and personal relevance—through the inclusion of thematic and affective frames or tailoring—negative message effects can be mitigated (Kreuter, Strecher, & Glassman, 1999; Kreuter & Wray, 2003). This is an interesting finding given that informational content devoid of any emotional element has dominated the present-day health communication debate. It seems that providing consumers information alone appears will not suffice, on the contrary, health information should involve consumers emotionally. This then suggests that when considering how to make messages appealing, the best option is to combine informative and emotional elements. For this reason, the inclusion of health and character frames could prove to be a fruitful strategy for health messages.

Besides identifying frames via two different methodological approaches and thus ensuring the robustness of results (David, Atun, Fille, & Monterola, 2011), through our study we were also able to demonstrate that selected health- and vaccine-related constructs influenced the recognition of both health frames and scientific frames. For instance, previous studies have determined that both health consciousness and health information seeking behavior are viable constructs to predict health outcomes (Shim, Kelly, & Hornik, 2006; van der Molen, 1999). In terms of message comprehension, health information seeking behavior has been positively linked to information engagement and information apprehension (Strekalova, 2014). In our study, health information-seeking behavior was only positively and significantly linked to the recognition of scientific frames. Hence, it appears that if individuals are actively seeking health information, they are looking for more neutral information and therefore recognize scientific frames more easily. When it comes to the health frames, health consciousness, collective responsibility, and calculation were predictors to explain the recognition of the two health frames. Health information seeking behavior was not significant. Health consciousness refers to individuals who are more prone to and engage in health-enhancing behaviors, such as the willingness to be vaccinated. The emotional aspects of the health frames seem to be in line with the need to take care of oneself. Presupposing a communal orientation, collective responsibility was also found to influence individuals' health frame recognition. This might be conditioned by the fact that both frame types, the carrier frame and the victim frame, presuppose some group embeddedness, whereby the contribution of the individual to collective well-being is stressed. Still, it is quite interesting that collective responsibility influences the recognition of health frames since TBE is a disease which is not spread by human beings. An explanation could be that people feel responsible for others in their immediate environment, e.g., parents who take care of their children and think about getting them vaccinated. In this case, the health frames fit quite well as the expectation of a possibly fatal course of the disease might trigger negative emotions in recipients. Yet, in this case, the relationship between cause and effect needs to be examined more thoroughly. The calculation is closely linked to the health-related construct of health consciousness, and thus individuals are pre-supposed to detect health frames more readily due to the high investment of cognitive resources. Although we distinguished between attitudes and behavioral aspects, none was more prone to affect frame recognition. As the explained variance of the second regression was even quite low, it rather suggests thinking about other variables which might affect the recognition of scientific frames.

8. Limitations and Suggestions for Future Research

According to Borah's (2011) recent literature review, framing can be either sociological or psychological in nature. In the case of sociological frame analysis (Entman, 1993), the presentation of arguments in texts is scrutinized in detail, while in the case of psychological frame analysis (Tversky & Kahneman, 1981), individual perceptions of the information retrieved are subject to analysis. The present study tried to shed light on those concepts by asking if antecedents might already influence the recognition of frames. While our explorative study was innovative in examining a research area (vaccinations against TBE), which is not yet at the center of scientific attention, there are several limitations to our study. First, our quantitative survey was based on a small convenience sample. We found effects, yet we cannot draw representative conclusions for the Austrian population. If future research intends to elucidate how the Austrian population recognizes frames, it should be replicated with a larger and more diverse sample. Likewise, as the present study only focused on texts addressing the risks associated with TBE, future studies might want to explore different content (e.g., videos or social media content). For this purpose, conducting an integrative frame analysis as proposed by Dan (2018) might be worthwhile. Additionally, the differentiation of whether content drew respondents' attention or did not draw their attention might be an interesting aspect for future research. Furthermore, this study design could not answer how the highlighted frames are actually perceived by the public. We suggest turning to qualitative methods (e.g., focus groups) to examine how health frames and scientific frames are perceived. Finally, we are aware that we are not able to determine if we have another causal relationship between the antecedents and frame recognition. It is also possible that the detection of the frames influences other factors, e.g., collective responsibility towards family members. In this case, an experimental design is needed, which can scrutinize if those

antecedents are predictors or criteria towards the recognition of frames.

Acknowledgments

We would like to thank the editors and the reviewers for their recommendations as well as the study courses of Klagenfurt and Karlsruhe for their help with conducting this study.

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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COGITATIO

Media and Communication (ISSN: 2183–2439)
2020, Volume 8, Issue 2, Pages 425–439
DOI: 10.17645/mac.v8i2.2812

Article

"On Social Media Science Seems to Be More Human": Exploring Researchers as Digital Science Communicators

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Submitted: 27 January 2020 | Accepted: 23 March 2020 | Published: 26 June 2020

Abstract
In contemporary media discourses, researchers may be perceived to communicate something they do not intend to, such as coldness or irrelevance. However, researchers are facing new responsibilities concerning how popular formats used to present science will impact science's cultural authority (Bucchi, 2017). Currently, there is limited research on the microlevel practices of digital science communication involving researchers as actors. Therefore, this qualitative study explores how digital academic discourse practices develop, using the tweeting and blogging of researchers involved in a multidisciplinary renewable energy research project as a case. The results of a thematic analysis of interviews with researchers (n = 17) suggests that the researchers' perceptions form a scale ranging from traditional to progressively adjusted practices, which are labelled 'informing,' 'anchoring,' 'luring,' and 'maneuvering.' These imply an attempt to diminish the gap between science and the public. The interviewees acknowledge that scientific facts may not be interesting and that they need captivating means that are common in the use of new media, such as buzzwords and clickbait. It appears that trials and experimentation with hybrid genres helped the researchers to distinguish the contours of digital academic discourses. The implications support suggestions to broaden the trajectories of expertise and communication, including issues of culture and identity, trust, and the relevance of science. It is argued that scientists' embrace of new media channels will refine some articulations of the mediatization processes, and these findings support recent suggestions that mediatization could also be conceptualized as a strategic resource.

Keywords
communication; media research; new media; science communication; social media

Issue
This article is part of the issue "Health and Science Controversies in the Digital World: News, Mis/Disinformation and Public Engagement" edited by An Nguyen (Bournemouth University, UK) and Daniel Catalan (University Carlos III of Madrid, Spain).

1. Introduction

Renewable energy development faces competing interests, and whilst solar power production generally has a neutral or positive public image globally (Nuortimo, Härkönen, & Karvonen, 2018), local opposition to wind and solar energy farms includes economic issues, noise and health impacts, ice and fire-related risks, and a generic 'not in my backyard' mentality (Rule, 2014).

Attitudes and behavioral intentions about such politicized scientific topics may not be about technology and facts as such, and ideology-based framing influences the acceptance of scientific information (Luong, Garrett, & Slater, 2019). Research on misinformation suggests that the post-truth malaise requires consideration of changes in wider societal contexts. This includes the long-term decline in social capital as trust, polarization and transformation of the media landscape, and political drivers that

discredit institutions as 'elitist,' leading to alternative epistemologies that erode trust in facts and science to the extent where facts no longer matter (Lewandowsky, Ecker, & Cook, 2017). A growing body of research suggests that the 'echo chamber' concept may be overrated, because the general predispositions of social media users influence their beliefs, regardless of the news source or algorithms used (Nguyen & Vu, 2019).

Acknowledging these changes, research efforts are needed to understand the influences of online communication environments on the nuances of public trust in science (Scheufele & Krause, 2019). For example, although researchers have adjusted their messaging to the media logics and address journalists and politicians on Twitter, they tend to be less addressed in return (Walter, Lörcher, & Brüggemann, 2019).

Meanwhile, the public expert role is challenging for scientists in balancing the dual expectations of providing guidance on non-scientific issues and concrete social problems whilst remaining highly objective (McKaughan & Elliott, 2018). "Being an expert means crossing the boundary of science, entering society as an actor," and as values and public controversies come into play, the credibility of science may be challenged (Peters, 2014, p. 79).

Other science communication scholars have concerns about the promotional interests that adversely affect the institution as a whole (Weingart & Guenther, 2016). Communicating to gain quantified attention through performance and impact measures is enabled by social media—channels that lack quality control and raise questions of trust in the medium where sources and genres of information merge with promotion and opinion (Weingart & Guenther, 2016).

In counterargument, science communication practices cannot be encompassed by the previous untainted idyll of science that has a one-dimensional distinction between truth-seeking and instrumental communication, according to Irwin and Horst (2016). In their view, different publics have specific values, and the relationship between changing scientific communities results in an evolving new ecology of science communication that needs to be recognized in all its richness, in order to understand the relationship between the new social media and the mechanisms of fluctuating public trust. Extending beyond the transfer of scientific information, Davies and Horst (2016) draw on cultural studies and describe science communication as a cultural phenomenon and a part of sense-making in society. Meanings are negotiated through cultural processes, such as representation that co-creates identities and images of science and scientists within and beyond academia (Davies & Horst, 2016).

To study sense-making through media, Couldry (2012) suggests analyzing media as an open-ended set of practices people perform in relation to media, including practices of representation. Actions involving digital technologies recognized by specific groups of people as ways of attaining social goals, enacting social identities, and reproducing sets of social relationships, may also be defined as 'digital practices' in discourse analytical approaches (Jones, Chik, & Hafner, 2015).

However, it may be challenging for researchers to connect abstract scientific knowledge to everyday discourses using adequate terms, metaphors, and concepts (Peters, 2014). In sum, there are important reasons to argue that the practices of researchers as organizational actors talking science as a social institution into being (Autzen & Weitkamp, 2019) are worthy of exploration, particularly in the current online context. Our aim is to increase knowledge of these emerging science communication practices. This qualitative study contributes to the public communication of science research by exploring how researchers shape the characteristics of their digital practices.

2. Literature Review

2.1. The Context

In Finland, the energy policy-making community consists of the government and the regime actors, whose main legitimatization is their importance to the Finnish economy and who are closely linked to large-scale energy generation, involving governmental research organizations (Ratinen & Lund, 2016). Researchers are also involved with niche actors comprising civil society associations, NGOs and campaigns that influence energy policies through public debate, background lobbying and social media (Haukkala, 2018).

This research focuses on the inter-disciplinary BCDC Energy Research project (2015–2021), which seeks solutions for using solar and wind power extensively and cost-effectively. The project involves five academic organizations in Finland with approximately 40 researchers, and is funded by the Academy of Finland's Strategic Research Council, which views interaction with society as being of key importance. The project's science communication activities emphasized tweeting and blogging by researchers, with the support of communication professionals in their organizations, including one of this article's authors. Finnish energy companies were involved in the project's advisory board.

2.2. Academic Discourse

Peters (2014) summarizes a common problem addressed in science communication research as difficulties in relating "the esoteric character of modern science, its incomprehensibility and detachment from everyday culture" (p. 74) to the relevance structure of the audience and common sense.

On the other hand, Bucchi (2013, 2017) has integrated ethics with aesthetics in the discussion of styles and the quality of science communication:

> It is increasingly important for our field to raise the question of which communicative processes may

> have contributed to changes in the cultural and social status of science….And what is the long-term impact of the fashionable wave of pop formats for presenting science to the public:…FameLab, 3-minute pitches, and so on? (Bucchi, 2017, pp. 891–892)

Writing is not a neutral space but an active and ideological process, where rhetorical features of the text make meaning and structure relationships between scientific, non-academic and professional industry audiences, by moving them closer or further apart and making science relevant (Szymanski, 2016). For example, the use of displaced agency or passive voice depict scientific knowledge as having epistemic authority over industry practice (Szymanski, 2016).

Therefore, alongside informing about or defending science, Dudo and Besley (2016) suggest enacting a more strategic approach, for example by building trust and excitement through tailoring messages and highlighting common ground. The aspects of strategic communication have received little attention in science communication research, which has often focused on the organizational level, critically connecting the strategic aspects to science public relations (Autzen & Weitkamp, 2019), triggering reminders that 'strategic' should not be interpreted as any form of dishonest communication (Besley, Dudo, & Yuan, 2018).

Whilst there have been few attempts to address the manifestation of strategic communication on the individual level, Besley et al. (2018, p. 712) conceptualize "strategic science communication as planned behavior" towards achieving social outcomes. However, it is unclear how strategically researchers behave in their communications, as they show tendencies to focus on serendipitous rather than strategic communication (Wilkinson & Weitkamp, 2013). For the purposes of this study, we combine this line of thought with the perspective that although communication cannot not be strategic, most strategies are automated in their acquisition, and used implicitly and unconsciously alongside intentional and thoughtful strategic communication (Kellermann, 1992). This allows us to study the level of the researchers' strategic awareness regarding their digital discourse practices.

As there is limited science communication research on the quality of communication strategies and styles (Bucchi, 2013), this study seeks to show how researchers combine quality with strategy in the digital environment.

2.3. Digital Communication Environment

Altheide and Snow's (1979) theoretical construction of the 'media logic' approach has not lost its relevance in arguing that media formats have become a framework of presentations in an automated way, to the extent that they generate media culture. Furthermore, media serves as major sources of legitimation in how reality is defined. Media technologies entail connotations of topical rationality, but the style in which the technology is used promotes affective and entertaining mood responses. In order for scholars to be heard, they must come out of the academic form, enter the media stage, and be declared competent according to media rules (Altheide & Snow, 1979).

Today the field prefers to talk about plural media logics, describing the various logics in effect, and the focal characterizations of new or social media include the selection of content with regards to attention-maximizing and individualization (Klinger & Svensson, 2015). 'Social media logic' (van Dijck & Poell, 2013) models the ways in which the platforms impact their users' social interactions, including popularity, which has been found to lead to a more informal tone of voice of public agencies on Facebook (Olsson & Eriksson, 2016). The online public sphere for discussing science has been characterized as broken, with incivility and trolling (Mendel & Riesch, 2018), calling into play carnivalesque techniques that may offer fruitful spaces for participation, and thereby build stable ethical and political positions. For example, the tactical and ironic utilization of media genres, as 'cultural jamming,' repurposes elements of mainstream culture for alternative viewpoints and societal impact (Lievrouw, 2011).

Klinger and Svensson (2015) take media logic to the micro-level of actors and the convergence of content producer and consumer roles. In their view, occupational practices and norms are merged into blogs and social media platforms, whilst the logic of new media penetrates professional organizations such as journalism. Emergent news values of instantaneity, solidarity, and ambience rival established journalistic news values and professions with specific claims of knowledge production, such as researchers, and demand embracing the logics of new media spaces (Hermida, 2019).

The concept of media logic is deeply intertwined with studies of mediatization, the key concern being how and to what extent a social system has mediatized, that is, adapted its processes to media logics. The present study's aim is not so grand, but follows Eskjær's (2018) perspective on mediatization as not determining the operations of other social systems through adaptive or reactive processes. Instead, by triggering self-regulated transformation, such as media training and changing communication tactics, mediatization may be turned into a strategic resource (Eskjær, 2018). There is little research that has addressed researchers' digital mediatization in particular, although it has been found that academics may utilize the structures of the media for their own agendas, to the extent that it is the media's autonomy that comes into question (Scheu & Olesk, 2018), and embrace the user control accompanied by online social channels (Koh, Dunwoody, Brossard, & Allgaier, 2016).

2.4. Digital Academic Discourse Practices

To distinguish distinctive types of social processes enacted in media-related practices, Couldry (2012) asks:

"*What are people* (individuals, groups, institutions) *doing in relation to media?*…How is people's media-related practice related, in turn, to their wider agency?" (p. 43, emphasis in original).

To target the micro-level of researchers' digital practices, discourse analytical and sociolinguistic research provides helpful conceptualizations, often drawing on genre analysis. Hybrid genres evolve for various purposes and different views regarding the research group's role in society and in relation to public audiences (Luzón, 2017). Compared to its analog predecessor, 'digital academic discourse' is characterized by more explicit writer-reader interaction and dialogicity, which are supported by digital academic hybrid genres, merging research blogs, tweets, wiki pages, and research social networking sites (Kuteeva & Mauranen, 2018). For the purposes of this study, the researchers' social actions as digital practices (Jones et al., 2015) are conceptualized as their 'digital academic discourse practices.'

Baram-Tsabari and Lewenstein's (2013) scientists' written skills clusters of clarity, style, and analogy precede the present study's focus on characteristics that are relevant to digital academic discourse practices, including metaphors, humor, and digital and visual means such as hashtags and pictures.

To summarize, there are many issues related to how academic discourses interact with the digital communication environment and what the perceived, underlying wider agency is, such as the role of science in society. By examining how academics harness the logics of the digital medium and merge various forms and purposes to appropriately respond to new, complex rhetorical exigencies (Luzón, 2017; Zou & Hyland, 2019), this article investigates the characteristics of the types of digital academic discourse practices, guided by the first research question:

RQ1: What kinds of digital academic discourse practices do researchers create?

As the new media environment continues to increase the volume of potential messages, the competition for attention will intensify, and narratives with persuasive power may be recruited for science communication more frequently, but crossing the border between science and public communication discourse may cause ethical or other considerations for researchers (Dahlstrom, 2014). It may also be challenging for academics to 'unlearn' the rhetorical conventions of formal academic discourse and familiarize themselves with the discourses of public communication (Baram-Tsabari & Lewenstein, 2013). Conscious regulation of automated linguistic strategies is difficult as they are learned tacitly, for example in the process of becoming an expert in an academic field (Kellermann, 1992).

Identification of the types of digital academic discourse practices allows us to look at what kinds of considerations they enact, with the help of second research question:

RQ2: What kind of strategic awareness and considerations do researchers have regarding their processes of creating digital academic discourse practices?

3. Method

3.1. Research Design

This article presents an analysis of semi-structured face-to-face interviews with the BCDC Energy Research project's researchers, during their ongoing process in creating digital academic discourse practices.

Underpinned by the critical realist aim of tentatively disclosing the world's configurations underlying the phenomena under inquiry—and acknowledging that human knowledge is partly a social construction—qualitative research techniques are employed in an organizational context and in accordance with the specific objectives of the study (Sousa, 2010). As the research questions are focused on researchers' views, an interview method was deemed appropriate to elicit interviewees' accounts of their perceptions, understandings and interpretations (Mason, 2004). For rich descriptive and explanatory accounts, the dialogs were ethnographic interviews in the sense that they followed an ongoing relationships and contacts in the field. The interviewer (Kaisu Koivumäki) was involved in the wider project, extending the possibilities for rapport between the parties (Mason, 2004).

In a qualitative approach, the research aims for sensitivity over objectivity, recognizing that professional knowledge may blind or enable researchers to see connections within the data (Corbin & Strauss, 2015). Reflexivity also denotes efforts to expose the social context in which knowledge is created (Sousa, 2010). Therefore, to raise confidence in this study's interpretations, the declaration of Kaisu Koivumäki's involvement with the group is acknowledged. The interpretations may be affected by bias, and therefore the reflexive approach was employed throughout the study. The interviews were conducted at the end of the interviewer's involvement with the group, and her role was made clear and explicitly discussed at the beginning of each interview.

The interview guide was shaped by the literature review, and served as a thought-provoking, inspirational tool for the interviews. A sequence of questions was planned in advance, still allowing flexibility to follow up on particular areas (Mason, 2004). The interviewees were asked to select, read, and analyze their own or another researcher's BCDC Energy Research project-related blog posts and tweets. The interview guide included questions such as, "What does the text do?," "Assess how effective and appropriate the metaphors and style of the text are for representing science," and "Why?"

3.2. Recruitment

This study was one of the project interaction research team's works that the project members were informed

of during the founding phases of the overall project. Invitations to interviews for this study were emailed and the participants gave their consent for the interview data to be used for research purposes according to the ethical principles of research in the humanities and social and behavioral sciences and the Finnish Personal Data Act.

All the interviewed researchers (n = 17) had participated in the project's communication activities by blogging or tweeting, and the majority did so without previous experience. Their fields included the sciences (n = 3), social sciences and humanities (n = 3), economics (n = 5), and information technology (n = 6). Their academic status ranged from PhD students to professors, comprising five nationalities. The interviews lasted on average for nearly two hours (54–132 minutes) and were held at their place of work or in workplace coffee rooms, during June–August 2017.

3.3. Analysis

All the interviews were conducted and audio-recorded by one author, then transcribed verbatim by an assistant. Working systematically with the data set was managed with the qualitative data analysis software NVivo. Thematic analysis was used to identify and analyze patterns of meaning, and how broader social contexts impinged on those meanings (Braun & Clarke, 2006). Although existing conceptualizations were used to organize the data in the first phases of generating codes, insights into the data drew analytical attention inductively and generated clusters of codes, which assisted in constructing major themes and sub-themes when rereading and reviewing the themes at the second level of thematic analysis. The article employs latent levels of thematic analysis to examine the underlying ideas to interpret, organize, and make interconnections between themes, with conclusions drawn from across the whole analysis (Braun & Clarke, 2006), involving cyclic iterations between the empirical data, coding process, and existing theory. The interview quotes were selected to deepen the understanding of the interviewees' views.

To systematically scrutinize how the digital academic discourse practices emerged, Kjellberg's (2014) genre theoretical approach was applied in the analytical framework. The framework includes aspects that can be used to describe and organize the sub-themes' characteristics based on form, content, and purpose. The form describes how the communicative purpose is structured visually and verbally, with the content describing the addressed topics. The purpose is used to describe the shared, recurring communicative aim and underlying wider social agency. The process is described as the researchers' perceptions of enacting digital academic discourse practices. However, it is acknowledged that the different indicators cannot be analyzed in isolation from each other, which is obvious in some parts of the analysis.

4. Results and Discussion

The analysis of the interview data allowed us to identify sub-themes and four key themes which were labelled 'informing,' 'anchoring,' 'luring,' and 'maneuvering.' Achieving visibility and the ways this was linked to academic ethos encompassed the identified themes.

4.1. Informing

4.1.1. Forms and Contents

The aspects of the informing-theme were most frequently and clearly mentioned in the interview quotes, and unsurprisingly clarity (Baram-Tsabari & Lewenstein, 2013) was emphasized. Ambiguous and figurative language as well as rhetorical questions were rejected. Lexical density and expressing the correct meaning to be easily grasped were valued, with the idea that the data makes the tweets interesting—not the captivating means. For example, many felt that the process or data must be included in the picture, only a personal portrait violates the seriousness of the content (Figure 1):

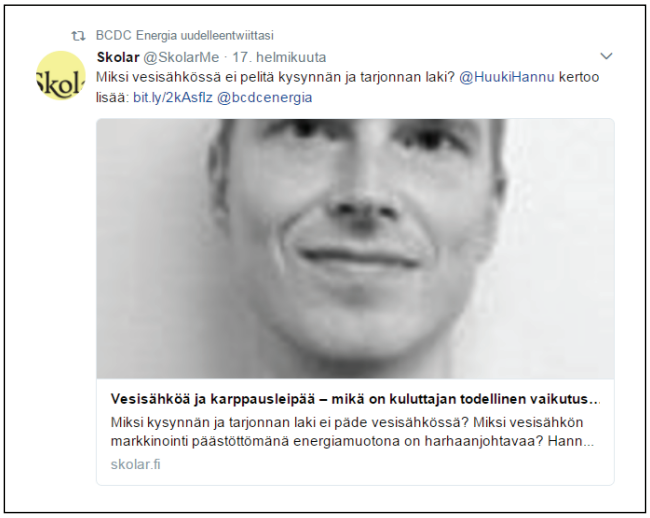
> I do not think this image belongs to science communication, it is more like personal branding or…a dating site.…Something else [other than a face], like a presentation, should have a bigger role. (Researcher 25, economics)

Occasional tweets and images from the researchers' desk highlighting scientific work were favored. However, researchers had concerns about becoming inarticulate by mostly highlighting the research aims or process, as they are not yet scientific results. Many felt that hashtags were meaningless, even visual rubbish disturbing the clarity of the tweets.

The findings support the notion of academia being resistant to mediatization (Rödder & Schäfer, 2010) on the micro-level of digital discourse practices. The informing-theme resembles scientific communication characterized by precision, epistemic modality and informativeness (Molek-Kozakowska, 2017) that may be construed in unintentional ways, such as coldness or irrelevance (Dudo & Besley, 2016).

4.1.2. Purposes

The value of informing was fundamental, and many researchers described good tweeting as being about or directly based on latest scientific developments, reflecting the traditional deficit objectives of science communication (Metcalfe, 2019). However, although building trust was not explicitly discussed, it was manifested when some researchers justified their approach with a sense of keeping things real, to awaken and remind people about the state of things and what actually is possible according to known science, and to challenge common sense or



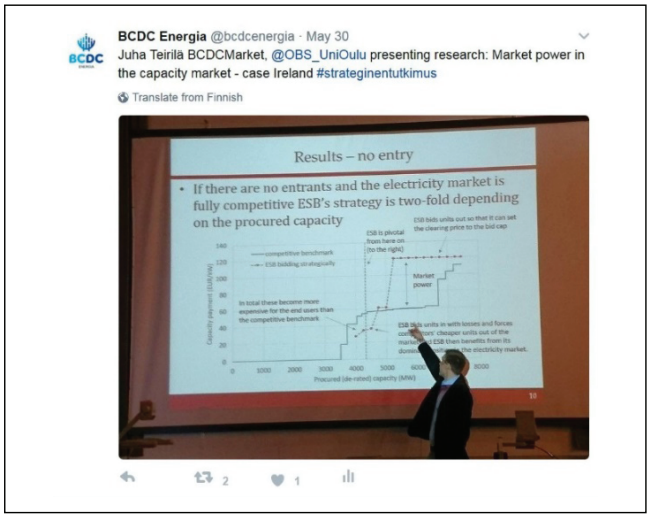


Figure 1. Examples of portraits in tweets. Source: BCDC Energy (2017a, 2017b).

general standpoints that are not well justified with facts. Such purposes may be interpreted as the intentions of reinforcing trust in epistemologies where facts still matter (Lewandowsky et al., 2017).

4.1.3. Researchers' Perception of the Process

Many researchers perceived their process of creating blogs and tweets as rather unintentional and implicit. They consciously analyzed their texts and writing process in retrospect, realizing a lack of such awareness during the writing, illustrating the differences in consciously acquired communicative strategies from those that are automated and made tacitly (Kellermann, 1992). For example, some researchers had not realized that they were using analogies or roles in relation to the public:

> Perhaps unconsciously I chose the public expert or even a teacher role that aims in a way at bringing the knowledge, to enlighten the reader….I cannot say whether I am using the text to represent science, and its role, and it is exactly these things that make me wonder why I should write these [blogs]. (Researcher 14, sciences)

In some unfortunate cases, their posts appeared in retrospect as too 'sciency,' which may only interest scholars. Many interviewees assumed that researchers, projects and blogs are automatically perceived to represent science even without explicit clues. When prompted, many researchers realized the disconnection and the lost representational power (Couldry, 2012):

> I think I should write something there, but it is something that just was left undone….Well, I should say that I am a research professor at [a research center]. (Researcher 1, sciences)
>
> Interviewer: And why?
>
> So that the followers, other people would know who I am….Surely it [researcher's profile] would be more professional and convincing. (Researcher 1, sciences)

4.2. Anchoring

4.2.1. Forms and Contents

The anchoring-theme collected quotes that, instead of informing, describe effectiveness in terms of generating visibility and convey an increasing reliance on perceived social media logics (van Dijck & Poell, 2013) such as 'popularity,' operationalized for example as image-building (Olsson & Eriksson, 2016).

Clear, 'sciency' text without any figurative expressions was perceived as ineffective and dull by some researchers. With a sense that the social relevance of science is not self-evident (Szymanski, 2016), the researchers regarded appealing familiarities, metaphors and images as suitable for creating a sense of 'dialogicity' (Kuteeva & Mauranen, 2018) by connecting the abstract world of science to concepts from the everyday world (Peters, 2014), such as weather forecasts, red traffic lights and the popular myth-busting TV format (Figure 2):

> Myth-busting as a headline has this very positive spin from the TV series of course….This tool of myth-busting can go when you have these certain conceptions of how things are that need to be updated. (Researcher 35, information technology)

However, in the same breath the researchers noted that appealing should not translate into entertaining, but into a pleasant perception of the topic and the author's skills. Analogies and a humorous tone in headlines have their place, but the writer must be very fair to avoid misleading impressions. The subsequent text must be substantial.

Many of the researchers thought that good pictures can attract attention to anything, including science.

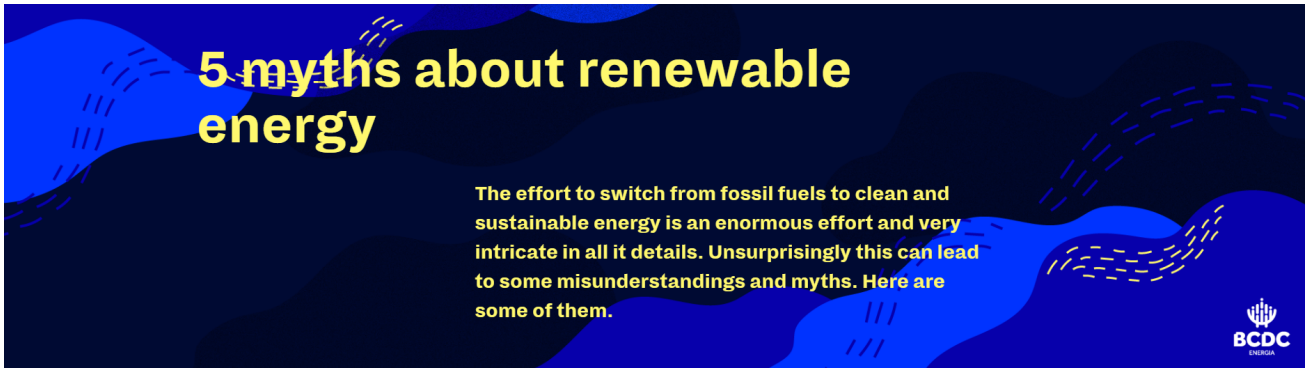


Figure 2. Anchoring with popular concepts. Source: Skolar.fi. (2017).

However, their meaning must be self-contained or provide a link to further information, otherwise they may frustrate. Interestingly, the researchers described the use of amateurish graphics to emphasize authenticity, even if the content is somewhat staged.

4.2.2. Purposes

Although most researchers emphasized anchoring their communication on scientific processes or results, for many it was also acceptable to merely emphasize the importance of science. For example, a blog about a researcher's summer house's solar panels without strictly scientific substances was discussed and justified by many with the effect the text had in terms of humanizing science.

Many interviewees saw the purpose of science to act as a relevant, useful peer or offer free consultancy. It was regarded as useful to bring research from scientists' drawers to the people, and also for the researchers to find their own role in social discussions in a deliberative fashion:

> This peer aspect integrates the public with the research community, and as I was, so everyone is able to handle these [home automation applications] even if one is not exactly an expert in them. It also implies that one's actions may have an impact on the bigger picture. (Researcher 25, economics)

Highlighting the usefulness of applied scientific knowledge is likely to derive from this study's context: the project's funding is granted partly based on societal aims. This view also resembles the understanding of scientific expertise beyond abstraction as advice on practical problems to clients or decision-makers responsible for the solutions (Peters, 2014).

4.2.3. Researchers' Perception of the Process

The unintentional and implicit sub-theme extends to the anchoring-theme, as a number of researchers had difficulties clearly differentiating the goals and intentions of the online contents of others and also their own: whether they were to represent science, inform or softly advocate. This reflects the fusion of facts and various intentions, and the potential of scholars becoming 'just another entertainer,' as prompted in Scheu and Olesk's (2018) interviews. Blurring intentions also may imply that sense-making as a form of identity building (Davies & Horst, 2016) is driven to revision when faced with the digital environment.

4.3. Luring

4.3.1. Forms and Contents

The theme was labelled luring because it collected quotes where the researchers acknowledge that simply laying out scientific facts in long, detailed blogs or churning out tweets may not be regarded as interesting, and some enigma is needed. New ways must be found and interest must be teased with captivating means while progressively adapting to digital media practices. Linguistic features such as rhetorical questions (Figure 3) were regarded as useful for creating an ambience of proximity and dialog, in line with Zou and Hyland's (2019) findings:

> If I read a question like this, it would be a very good way to get my brain into actually clicking the article. Because of course it would be a question…where the answer would be interesting to me. (Researcher 35, information technology)

> Interviewer: It is an old marketing tactic, raising questions.

> Mmhm, sure. But…I think this is very appropriate because I think this is, this curiosity about answers is what drives people to do science. (Researcher 35, information technology)

Many researchers stated that unexpectedness and references to subcultures combined with scientific content effectively spark interest, justify, and intensify the attractive effect of humor, for example, that usefully builds

Figure 3. Luring with raising questions. Source: BCDC Energy (2017c).

positive images and humanizes science. Researchers were also aware of the risks of humor (Mendel & Riesch, 2018):

> I am for the facts, but somehow the public must be tempted to read. If this [headline] were something like 'learn about hydropower,' would anyone bother? (Researcher 3, economics)

> In the past we were maybe, science was seen as very serious et cetera, but with Twitter, or other social media environments, science also seems to be more, let's say, human….You also put the scientist in the position of an ordinary person, so it also makes science more reachable, accessible to people or scientists, because you are using humor that everybody else uses, so you are removing the serious, let's say, rigid identity of science or scientists. (Researcher 26, information technology)

Strategic discourse practices were also apparent, as researchers preferred amateurish pictures and graphics to stand out and emphasize authenticity rather than thematic stock images.

4.3.2. Purposes

Striving to improve the image of science by making rather confident promises of future outcomes was identified as boosting. In some cases, the researchers intertwined the relevance of a research topic with recommendations of related applications, such as home solar power systems. This sort of promotion resembles understandings of hype as both: potentially eroding trust in science but also as a performative device constructing technological futures (Davies & Horst, 2016):

> Here the role of an expert and a decipher is visible in a grand fashion…saying that although this is a more complex problem, we will seize it and solve it…,a self-confident role boosting the research project. (Researcher 11, economics)

Furthermore, the conscious use of buzzwords (Bensaude Vincent, 2014), animation, and familiarities, even without strictly scientific news, were approved as means to attract interest. The justifications seemed to refer to the new media as representing a battle for attention, requiring adjustments of the conventional academic forms to more playful online discourses (Mendel & Riesch, 2018). Many researchers explained that the environment forced stylistic decisions, such as brief wording that casts an advert-style in tweets:

> There was one of those GIF-animations, and actually we were not saying anything there. Nothing about anything whatsoever, but there is something visual and familiar for a person following the weather, thus perhaps awakening interest in energy-research topics. (Researcher 16, sciences)

4.3.3. Researchers' Perception of the Process

The needed means sub-theme was connected to the luring-theme, as researchers often considered luring-style practices in order to be heard at all on digital media. From the limited empirical material, especially from the interviewees within information technology, this seems to prepare the ground for an unprejudiced attitude toward digital practices, reflecting Aristotle's (1997) and Puro's (2006) notion of neutrality in communication techniques, which can be utilized for any intention. Such a perception of the process also mirrors the practical balancing between complexities of ethical standards prevalent in academic communication practices (Priest, Goodwin, & Dahlstrom, 2018). The researchers discussed metaphors and analogies beyond their communicative usefulness as fundamental means of learning and creating scientific concepts, and therefore considered them not to be in opposition to scientific methods:

> It helps people to understand and put it in a certain place in the working model that they have of how things are. And so, yes, I think these all are and should be parts of scientific communication in a blog

post and even in a scientific article, and also, because they are very effective ways of communicating issues. (Researcher 35, information technology)

4.4. Maneuvering

4.4.1. Forms and Contents

The maneuvering-theme introduces the researchers' contradictory hesitations, implying limitations to the new forms of representing science that may mislead the attention away from the meaning, whilst the researchers were simultaneously aware of the effectiveness of mimicking popular formats to attract attention, such as using clickbait or a cat video (Figure 4):

> This cat video is a pretty good example of not crossing into bad taste, since it relates to this internet world. Most people surely understand the analogy, it works. (Researcher 16, sciences)

> It may wear out the credibility if topics are always introduced terrifyingly, at some point it's too much, and the viewer will not bother to follow anymore, because the contents are meaningless worst-case scenarios. (Researcher 16, sciences)

> Is awakening emotional reactions the only effective way? A counter-reaction is probable and makes the message spread, but does it get the message through? (Researcher 16, sciences)

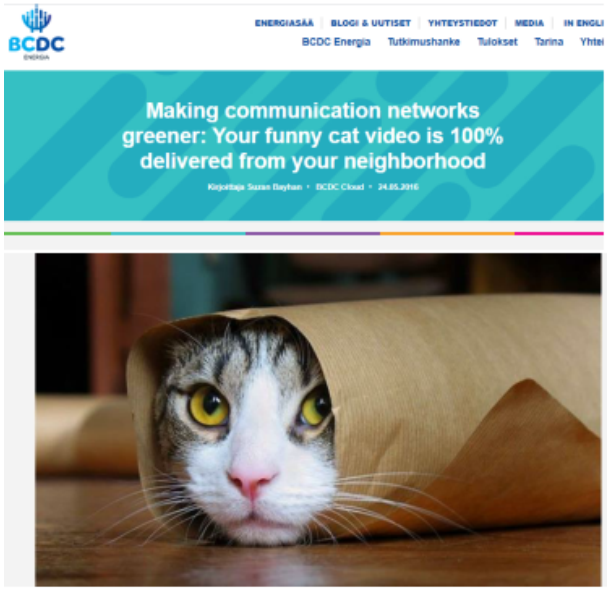


Figure 4. Maneuvering with a cat video. Source: BCDC Energy (2016).

A number of interviewees accepted the use of rhetoric and visual techniques that have traditionally been perceived as distant to scientific communication discourse: silly images or intriguing headlines of dysfunctional home electronics. However, more extreme means seemed to cross the line, such as worst-case scenario metaphors, superlatives, catchy phrases, and overwhelming visions. They were seen as forceless hyping *ad nauseam*, reducing the weight and usefulness of science. Interestingly, the reservations in the researchers' perceptions of hybrid genre mash-ups (Lievrouw, 2011) addressed the lost rhetorical power to draw attention using inflated emotive and speculative modes of stylistic cueing (Molek-Kozakowska, 2017) more explicitly than ethical aspects concerning exceeding the boundaries of the scientific discourse, as suggested by Dahlstrom (2014).

4.4.2. Purposes

Although there is less explicit recognition of marketing amongst science communication scholars (Metcalfe, 2019; Trench, 2008), many researchers interviewed in this study sharply detected and rejected promotional cues, such as wordings, exclamation marks, and visual commercial cues, because they may affect the reading of an expert blog, cast reservations on the reliability of conducted research, or violate the expectations of academic communication style (Yuan, Ma, & Besley, 2019). However, in some cases the researchers accepted the communicative act of marketing, even indicating confidence. For example, marketing a research newsletter was considered necessary and justified because it is free of charge. Marketing and societal goals were intertwined in a similar vein to Chubb and Watermeyer's (2017) results on the marketization of research impact:

> These are morally more acceptable kinds of clickbait, because they are not ads and we are not a commercial actor. We do not make money with them. We aim to gain more publicity and thereby more impact, and with more impact, more money [funding]….Our aim is to get the public interested in the project's results, and we assume that the conducted work is relevant to more than the small scientific community. So I do not consider it bad to use catchy headlines. (Researcher 6, information technology)

> This [wording in a tweet] annoys me a bit: 'the market actor's drive,' oh my! [laughing]….This is such commercial project language….It differs to what I expect to see in academic communication. (Researcher 30, social sciences and humanities)

The researchers were subtly willing to direct the publics' behavior toward generally accepted environmental action. However, statements from individual researchers were not favored, reflecting the expectations of objectivity, but on the project's behalf, statements were expected to guide the interpretation of information and act as a voice of authority (McKaughan & Elliott, 2018).

Adjusting to the surroundings was expressed by some as allying with other players on Twitter, following

Szymanski's (2016) suggestion of engendering relevance by closing the gap between scientific research and professional audiences, and addressing other professional fields' predispositions (Nguyen & Vu, 2019; Walter et al., 2019). In strategic fashion, retweeting and commenting on a commercial company's tweets were seen to lessen the gap between reality and science to display academic research as realistic and relevant:

> It [science] is criticized by companies, who say that scientists always talk about this dreamy world where it is not implemented, it is not reality at all, but, for example, some tweet like this [connecting academic research with Google] shows that what you are working on is realistic and it is really implementable or that it is really doable or it will really change the real world. (Researcher 26, information technology)

Such reassessments of the purposes and role of science and expertise may imply that it is possible to widen the normative rhetorical space of science communicators (Bucchi, 2013).

4.4.3. Researchers' Perception of the Process

A strategic approach was apparent in the data, accompanied with the researchers' careful assessments of their writing process, and cautious use of new media features that need consideration and rehearsal in order to fit in with the digital academic discourse. There was minor evidence in the data of a tendency to lightly frame the facts, which was justified as it sharpened the point with a scientifically accurate message that also resonates with the audience, as suggested by Luong et al. (2019):

> I do not see a bad moral problem there….This is a fully confirmable fact. In that sense, even if it is a little dressed up so that only the best part is displayed and the best case is mentioned in the heading, it is not distorting the truth. It is presented in a certain tone that serves the project's goals. (Researcher 6, information technology)

Some researchers considered using the ethos of science as a communicative advantage. Its effectiveness relies on a neutral expert role and style in contrast to the energy industry actors' tone of voice, for example. This reflects the idea of the researchers themselves serving as symbolic focal points for the sense-making of science (Davies & Horst, 2016), talking science into being (Autzen & Weitkamp, 2019), and contributing to the contextual dynamics of public trust (Irwin & Horst, 2016):

> Energy production might be a sensitive topic, and it is good to keep a matter-of-fact-style when representing science, not least because of the many lobbyists. A neutral narration is good to refer to when the buzz surges elsewhere. (Researcher 16, sciences)

Table 1 provides an overview of the charted types of digital academic discourse practices. The dimensions of the relationships between the digital academic discourse practices and strategic awareness are illustrated in Figure 5.

5. Conclusions

This qualitative interview study sought to broaden the understanding of how researchers shape their discourse practices in the digital communication environment. In the results, it appears that this shaping ranges from traditional to progressively adjusted practices, and is triggered amongst and in comparison with other players in the digital public sphere. Hybrid genre trials with traditional scientific and new style fusions helped these researchers to distinguish the contours of digital academic discourse practices, while the digital academic genres in turn facilitated the adoption of varying styles (Bucchi, 2013), social purposes (Luzón, 2017), relevance (Szymanski, 2016), and broadened perspectives on expertise (McKaughan & Ellliott, 2018; Peters, 2014). Striving for visibility contributed as a driver of the creative recombinations of the academic discourse with the perceived digital discourse, also conveying a goal of positioning science as a dialogical actor in the digital sphere. The researchers' representations of science co-create academic identities (Davies & Horst, 2016) through the digital academic discourse practices found in these results. Thus, this study contributes to the understanding of influences of the digital communication environment on the nuances of public trust in science from the viewpoint of researchers as actors, who are capable of creating representations of science that contribute to the reception of scientific knowledge.

The unconscious nature of automated linguistic strategies (Kellermann, 1992) are apparent in these results, in that sometimes researchers had difficulties in discerning for example which roles and intentions were conveyed in blogs and tweets. On a generic level, this conveys potentially problematic representations of science, and reinforces Bucchi's (2013) suggestion of the willingness to problematize one's own definition of science communication and the underlying rationale as one of the keys to avoiding increased public distrust.

While the current study has an applied focus, it has theoretical implications as the strategic awareness and capability to utilize the features of modern media for a variety of purposes (Scheu & Olesk, 2018) were apparent in these results. This supports recent suggestions to further conceptualize mediatization (Koh et al., 2016) also as a strategic resource beyond adaptation (Eskjær, 2018). Future research would be beneficial on the potentially positive effects of digital mediatization triggering a reassessment of academic discourse practices—in addition to the prevalent critical perspectives on mediatization. The complex digital environment and new variations in science communication allow and call for

Table 1. Characteristics of digital academic discourse practices.

Informing	Anchoring	Luring	Maneuvering
		Forms and contents	
Clarity Rhetorical questions/ambiguous language rejected	Clarity not enough, appeal needed Captivating techniques anchored in scientific substance	Scientific facts may not interest: they need enigma Teasing buzzwords, visuals and questions attract curious minds	Assessing the duality and limitations of the new media styles in representing science: catchy techniques' effectiveness and the nature of the attention gained
Emphasizing the researcher's role, 'from the desk'	Connecting: Weather forecast Myth busting Traffic lights Summer house	Humanizing science with humor and subcultures	Approving carnivalesque features: funny and surprising headlines, clickbait, cat videos, portraits
The hashtags are disturbing and unclear	Tweets require attractive or authentic pictures Composing images	Tactical amateurish pictures vs. stock images	Rejecting horror scenarios, superlatives, overwhelming visions, promotional language, person branding
		Purposes	
Updating the public with the newest developments Opening the research process, but preferring the results for trust building	Being a useful peer Free consulting Connecting abstract research to practical life	Boosting: Positive promises of the project's outcomes and related topics Captivating means approved to stand out in the new media	Marketing of science-related contents: Justified by the accessibility and independency of science Making statements: Not for individual researchers but for a research project; Advocating remotely; Adjusting to environment: Allying with companies.
		Perceptions of the process	
Unintentional and implicit Analysis in retrospect Assuming to be automatically identified as scholars		Needed means: To at all be heard For knowledge creation	Cautious use Ethos of science as a communicative advantage

a consciously strategic mindset in science communication instead of merely educating (Dudo & Besley, 2016) or transferring information beyond deficit-participatory modes, opening the floor for alternative trajectories and future research on science communication, including issues of digital culture and identity (Davies & Horst, 2016; Mendel & Riesch, 2018), as well as organizational influence (Koivumäki & Wilkinson, 2020).

This study was exploratory in nature, focusing on researchers in one research project in one country. Hence, our findings offer only a snapshot of scholars' perspectives on the evolving digital practices. They cannot pre-

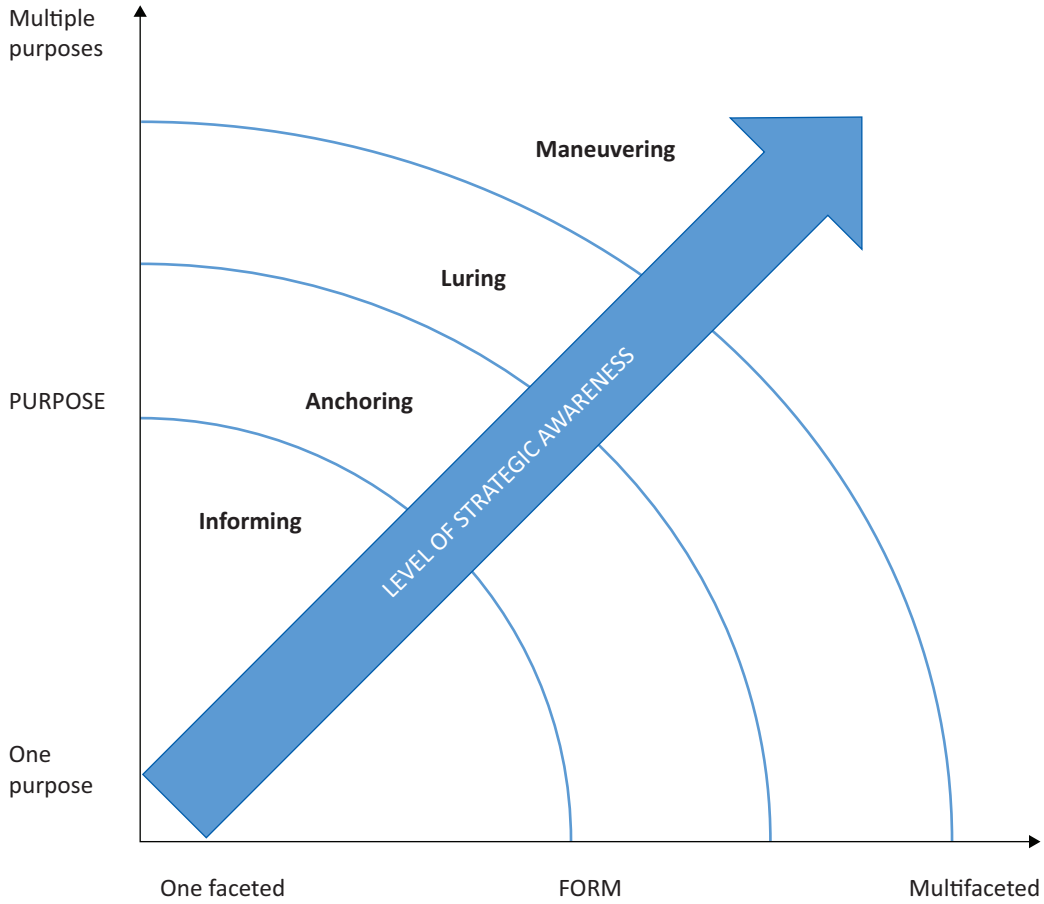


Figure 5. The relationship between digital academic discourse practices and strategic awareness.

dict their prevalence in a wider group of scientists that further research will have to investigate. Primarily, this article presents indicators that could be used to detect and discuss academic practices and can provide building blocks for future frameworks.

Acknowledgments

This study has been funded by the Strategic Research Council at the Academy of Finland, project no. 292854 and the Finnish Cultural Foundation. We are grateful to Dr. Emma Weitkamp for her useful comments on this article.

Conflict of Interests

The authors declare no conflict of interests.

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Commentaries:

Rapid Responses to the Covid-19 Infodemic

COGITATIO

Media and Communication (ISSN: 2183–2439)
2020, Volume 8, Issue 2, Pages 440–443
DOI: 10.17645/mac.v8i2.3223

Commentary

Africa and the Covid-19 Information Framing Crisis

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Submitted: 1 May 2020 | Accepted: 18 May 2020 | Published: 26 June 2020

Abstract
Africa faces a double Covid-19 crisis. At once it is a crisis of the pandemic, at another an information framing crisis. This article argues that public health messaging about the pandemic is complicated by a competing mix of framings by a number of actors including the state, the Church, civil society and the public, all fighting for legitimacy. The article explores some of these divergences in the interpretation of the disease and how they have given rise to multiple narratives about the pandemic, particularly online. It concludes that while different perspectives and or interpretations of a crisis is not necessarily wrong, where these detract from the crisis itself and become a contestation of individual and or sector interests, they birth a new crisis. This is the new crisis facing the continent in relation to the pandemic.

Keywords
Africa; Coronavirus; Covid-19; crisis; health journalism; misinformation; news framing

Issue
This commentary is part of the issue "Health and Science Controversies in the Digital World: News, Mis/Disinformation and Public Engagement" edited by An Nguyen (Bournemouth University, UK) and Daniel Catalan (University Carlos III of Madrid, Spain).

1. Introduction

Much of Africa is in the grip of a double Covid-19 crisis. It is a crisis of the pandemic as well as an information framing crisis. Public health messaging is complicated by a mix of competing framings of the pandemic by a number of actors including the state, the Church, civil society, the public and many others. The narrative around the Covid-19 pandemic in Africa is therefore a decidedly complex one. It is a multi-faceted narrative largely informed by the tensions between these competing sites of 'knowledges' in the continent all seemingly fighting for legitimacy.

2. Politics and the Framing of the Pandemic

The Covid-19 pandemic has been foremost a political story. It has exposed a number of weak healthcare systems in several countries in the continent, just as it has underscored the advantages of having well-developed community health care structures in others such as South Africa. The investment in health care infrastructure remains critically low across the continent but ironically against the background of a worryingly heavy disease burden (Mostert et al., 2015). This has made many African countries particularly susceptible to the Coronavirus. But where poor health systems have been exposed, the default response from governments has been denial, secrecy, even official misinformation, primarily because of its political implications. This has in turn encouraged the manufacturing of alternative narratives of the Covid-19 crisis, particularly online.

In recent years online media spaces have assumed significant communicative, cultural and political agency in Africa (Ogola, 2019). Platform media such as Facebook, Twitter and messaging apps such as WhatsApp have become critical political spaces for the creation, contestation and dissemination of public information. They are sites used as much by none-state actors as they are by the state. In a country such as Kenya, for example, where the state plays the role of regulator and active actor in these online spaces, the government is using official

Twitter handles and hashtags to communicate state policy on the pandemic, post updates on infection rates, deaths and to rally the country around its public health messaging. The hashtag #komeshacorona (Kiswahili for 'Stop Corona'), for example, has been created for purposes of public information but more crucially, for information management regarding the pandemic.

It is this latter aspect that is furiously contested. Online platforms have in recent years provided civil society and the general public important tools and spaces to contest such management and to call governments to account. It is notable therefore that in response to such official government hashtags regarding the pandemic, Kenyans on Twitter (commonly referred to as KOT) have created their alternative hashtags to anchor their criticism of government responses to the crisis. Using the hashtag #covid_19ke KOT have demanded a much better response to the pandemic, pointing out state malpractices and criticising interventions such as the lockdowns, which have been notably militarised as curfews.

Overall, public health messaging by governments in many parts of the continent have been undermined by public distrust following years of official misinformation practices. Public reaction to government information thus tends to be one of apprehension and ambivalence as many people are aware that these governments have often been interested foremost in the (political) control of the message than the message itself.

3. Misinformation and Disinformation Practices

When the state cannot be trusted on important national issues such as an international health pandemic, misinformation and disinformation practices proliferate. Pandemics create fear, anxiety and confusion and therefore fuel a determination to seek information and clarity. According to a recent Reuters Institute for the Study of Journalism report, disinformation and misinformation take multiple forms—from reconfigurations of information to complete fabrication of stories (Brennen, Simon, Howard, & Nielsen, 2020). These abound in relation to Covid-19. A number of misinformation and disinformation actors have appropriated well known communication traditions in the continent such as the use of rumours, which are generally considered to be subversive to offer alternative framings of the pandemic on platforms such as Twitter, WhatsApp and Facebook. It is important to reiterate that in Africa, rumour has historically been considered a site of truth (Ellis, 2002). It was and remains a means through which state narratives are routinely subverted and dismembered, where alternative scripts are written and where silent stories are made legible. In fact, even the state is known to generate its own rumours.

Rumour finds particular relevance and utility in an environment in which there is not only widespread distrust of the state as a source of credible information but also where much of the mainstream media similarly suffer a trust deficit, a point I return to later in this commentary. Alternative framings of the pandemic have therefore proliferated in the form of rumours mainly in closed networks such as WhatsApp and on platforms such as Facebook. These are the two most commonly used online platforms in the continent. Importantly, these are generally networks of shared socialities and therefore users are particularly vulnerable to mis/disinformation because they receive such information from people they know. Questions have, for example, been raised about government data on the number of Covid-19 infection and mortality rates in Kenya, Tanzania, Uganda, Ethiopia, Nigeria and several other African countries. People have therefore come up with alternative data and are circulating these within their networks.

In Tanzania, which is one of a handful of countries that have only grudgingly acknowledged the severity of the pandemic, the government's desire to control public information relating to the pandemic has fuelled an infodemic of misinformation and disinformation online. The Magufuli government holds a tight rein on the mainstream media and journalists who have questioned state policy relating to the pandemic have been threatened and or arrested.

In the absence of credible official information and seeming state intransigence, rumours attempting to show the severity of the pandemic have been widely circulated on social media. Among these have been videos of alleged bodies of the victims of Covid-19 dumped on the streets and many others buried in the night. One such video, circulated mainly in WhatsApp groups and Facebook, turned out to be a 2014 footage of dead bodies of refugees washed ashore on the Libyan coast. The refugees had tragically died trying to cross the Mediterranean Sea in their attempt to get to Europe.

These stories and videos while subverting the state's narrative about the crisis, simultaneously create a climate of fear and a powerful sense of helplessness making individuals even more susceptible to disinformation practices. Such fear feed already existing attitudes relating to pandemics thereby stigmatising victims. They recreate the horror of pandemics that have previously afflicted the continent such as Ebola and HIV. The containment of these diseases was undermined by the resultant social stigma described by Davtyan, Brown, and Folayan (2014, p. 2) as "stressors with incapacitating consequences." Those with symptoms avoided seeking medical help thus either dying or continuing to spread infections. In Kenya, the government has been forced to appeal to the public to welcome back into the community those who have recovered from Covid-19. A suicide has been reported of a survivor of the disease in the country. Meanwhile, circulating videos of burials conducted in the night, reportedly of those who have succumbed to the disease by state officials, is feeding the stigma as it also solidifies the criticism and distrust of the state.

Misinformation is also being attributed to religious leaders, many with considerable followers online. Several religious leaders have elected to give a spiri-

tual interpretation of the pandemic. Across the continent there are religious leaders appealing to adherents to pray for their salvation from the disease and at the same time to emphasise their 'exceptionalism.' From leaders such as the Nigerian Islamic scholar Abubakr Imam Aliagan—who has claimed that Muslims are immune from Covid-19—to Protestant Ethiopian Prophet Israel Dansa—who told his followers that he "saw the virus completely burned into ashes" with the power of his prayer—the pandemic has been framed as a battle between faith and science (Lichtenstein, Ajayi, & Egbunike, 2020). Most of these religious leaders have YouTube channels where they post their sermons and messages relating to the pandemic.

4. Health Journalism and Making Sense of the Pandemic

Contributing to this public susceptibility to dis/misinformation practices is the failure of mainstream media to effectively play its normative roles. Mainstream media in the continent finds itself in a difficult space. Structurally, it operates in an environment in which its independence is fundamentally compromised primarily by its reliance on the state as its single largest advertiser (Ogola, 2019). There is only so far it can go in destabilising its affective relationship with the state. But it also suffers from considerable institutional deficiencies. For example, with few exceptions, in regard to the coverage of Covid-19, it has become standard practice for media organisations across the continent to simply reproduce government press statements about the pandemic. This has been problematic not only because of the relative vagueness and unreliability of much of the information, but also because the lack of broader contextual details make such information discursively distant to local audiences. One of the key problems arising from the coverage of this pandemic in Africa has been the reproduction of internationalised stock phrases, many contextually unhelpful. There is very little involvement of African scientists interpreting the pandemic in a relatable local vocabulary, rooted in local everyday practices and experiences. In the absence of these local translations, concepts such as 'flattening the curve,' 'social distancing,' 'case fatality rate,' 'R0' and others are reproduced with barely any relatable references or context provided.

As local audiences are looking for stories that are relevant to their everyday experiences, social media is providing many such stories, some true but a good number fabricated. These range from conspiracy theories relating to the alleged immunity of Africans to Covid-19 and the role of 5G technology in the spread of the pandemic to stories about easily available traditional medicines that have been used to cure the disease.

The paucity of relatable stories about the pandemic in mainstream media is partly a result of the lack of investment in health journalism by media organisations in the continent. Resource limitations have forced most media organisations to focus on stories and areas that maximise audience and advertising revenues. In most cases the focus is usually on entertainment (in the case of broadcast media) and politics (in the case of newspapers). Health journalism and, more broadly, science journalism do not therefore command editorial urgency as they are seen to attract little or no advertising. Indeed most health pull-outs in many newspapers across the continent are funded by the state, non-governmental organisations or philanthropic foundations with an interest in public health, such as the Melinda Gates Foundation. Health journalists also tend to be general beat or political reporters, often without the necessary expertise to critically engage with health stories. Complex health stories thus tend to be narrated primarily as political stories. It is no coincidence therefore that mainstream media coverage of the Covid-19 pandemic has focused mainly on the political impact of the crisis than on the understanding of the pandemic as a health crisis in need of scientific interventions too.

This political domination of the coverage of the pandemic has also revealed a worrying lack of public engagement by local African scientists in a number of countries. It is arguable that they should have been at the forefront of providing distinctly local and relatable interpretations of the pandemic.

The multiple framings of the Covid-19 pandemic brings into sharp relief the state of health communication in Africa. While having different perspectives and/or interpretations of a crisis is not necessarily wrong, perhaps even inevitable, where such framings detract from the crisis itself and become a contestation of individual and/or sector interests, they birth a new crisis. This is the double crisis Africa must now resolve.

Acknowledgments

I would like to express my appreciation to An Nguyen for his invitation to contribute to this issue at a time when the subject is of such considerable relevance and importance.

Conflict of Interests

The author declares no conflict of interests.

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COGITATIO

Media and Communication (ISSN: 2183–2439)
2020, Volume 8, Issue 2, Pages 444–447
DOI: 10.17645/mac.v8i2.3227

Commentary

Covid-19 Misinformation and the Social (Media) Amplification of Risk: A Vietnamese Perspective

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Submitted: 3 May 2020 | Accepted: 5 May 2020 | Published: 26 June 2020

Abstract
The amplification of Coronavirus risk on social media sees Vietnam falling volatile to a chaotic sphere of mis/disinformation and incivility, which instigates a movement to counter its effects on public anxiety and fear. Benign or malign, these civil forces generate a huge public pressure to keep the one-party system on toes, forcing it to be unusually transparent in responding to public concerns.

Keywords
Covid-19 infodemic; disinformation; misinformation; online incivility; risk amplification; Vietnamese social media

Issue
This commentary is part of the issue "Health and Science Controversies in the Digital World: News, Mis/Disinformation and Public Engagement" edited by An Nguyen (Bournemouth University, UK) and Daniel Catalan (University Carlos III of Madrid, Spain).

1. Introduction

Friday, the 6th of March, 2020 was a critical turning point in Vietnam's battle against coronavirus. A midnight press conference was called after a residence street in the centre of Hanoi was locked down. A few days before that, a young resident in this area returned from London, failing to declare to airport quarantine officers that she had been terribly unwell. She had now tested positive and become Vietnam's 17th Covid-19 patient. It was a brutal blow: The country had done its best to contain the virus from Day 1 and had seen no new case for 24 days. Flashing back to January, when coronavirus started to wreak havoc in Wuhan, Vietnam's top leadership, disregarding all assurances from the Chinese government, its traditional political frenemy, was quick to take heavy-handed measures—including closing its 900-mile land border with China, ordering schools not to reopen after the Lunar New Year, and deploying its extensive surveillance system to track and trace primary, secondary and tertiary contacts of patients. By mid-February, things seemed to have eased off, with the number of cases staying unchanged from the 12th onwards. Until now.

The midnight press conference led many Vietnamese into a white night of hysteria and then days of panics. With that came an extreme level of incivility on social media. In the hours following the news, Patient 17 became a target of brutal online attacks, especially on Facebook, with a staggering amount of hate speech against her. Unsubstantiated information about her whereabouts in Europe before returning to Vietnam was, intentionally or unintentionally, spread on Facebook, as were intimate images and details about her seemingly prodigal lifestyle and decadent personality. A Facebook page named Patient 17 was created for people to post information about the "rich kid" and voice anger towards her. Some labelled her a national traitor and called for her to be criminally prosecuted for being dishonest about her health at the airport, which for them was the root of this

new saga. A few even wanted to kill her. Some of the domestic media and expatriates' news sites were quick to join the crowd, creating a chaotic world where human dignity—in this case, that of a hospitalized patient battling for life—was relentlessly stampeded in temper.

Incivility is nothing unfamiliar on Vietnamese social media. A week before the above incident, Microsoft (2020) published a Digital Civility Index report, ranking Vietnam at the 21th out of 25 surveyed countries, mainly because of the pervasive risks that its digital media pose to professional reputation, personal safety, and health and wellbeing. Among the oft-mentioned problems are unwanted contacts, sex-related offences, hate speech, and the spread of fake news, hoaxes, and scams. Disrupting Vietnamese life in that context, Covid-19 seems poised to cause incidents such as the above. This commentary will examine this social media phenomenon through the theoretical lens of social amplification of risk.

2. A Vicious Circle

The central assumption of social amplification theory is that events pertaining to hazards 'interact with psychological, social, institutional, and cultural aspects in ways that can heighten or attenuate public perceptions of risk and shape risk behaviors' (Renn, 1991, p. 287). Social amplification happens in two stages: The risk is first amplified during the transfer of information, triggering social responses that in turn, further amplify the risk (Renn, Burns, Kasperson, Kasperson, & Slovic, 1992). As hazardous events, especially those with a close proximity to a community (Costa-Font, 2020), interact with individual psyches and socio-cultural factors—such as the intensity of public reactions on social networks—they create ample room for miscommunication about related risks (Busby & Onggo, 2013). Given the unforeseeable and uncontrollable aspects surrounding hazardous events, even minor hiccups in the process of relaying legitimate, fact-based information can trigger a strong public response and/or result in detrimental impacts on society and the economy.

This social phenomenon manifests in the informational chaos that coronavirus creates in Vietnam's social media. Like other outbreaks, it is associated with a great deal of uncertainty. Ironically, as science and other authorities know the least about the novel virus, the public thirst for answers is at the highest point. For Vietnamese, this was asymmetry at the extreme. The risk is perceived to be at the doorstep since Vietnam has strong physical, economic, and political connections with China, a country that the Vietnamese public—often at odds with its leadership's ambivalent relationship with its Chinese communist counterpart—holds a strong sentiment against. This, aided by a general lack of trust in government transparency and confusing responses by public authorities in the early stage of the outbreak, led people to have nowhere to satisfy their need to know but their own interpersonal networks. Simply put, when rushing for answers without receiving any from authoritative sources such as scientists, health professionals, and government bodies, people turn to any source they trust in daily life, even though those sources are in no better position to know more about the disease.

Such amplification is seen in any disease outbreak, but things would have been a little more manageable in the past. During the H1N1 pandemic (2009–2010), for instance, gossips about the outbreak were restricted to smaller settings, such as a beer/coffee catch-up, a phone chat, a community meeting, a family reunion, or at best, the less interactive and less personal online spaces like blogs, forums or the then nascent Facebook. 2020 was, however, different: Vietnam now had 68 million Internet users, with 65 million being active on social media (Hootsuite & We Are Social, 2019). Amidst the vast uncertainty, Facebook quickly became a main place for Vietnamese to seek, share, and discuss news and information about Covid-19 as a way to deal with their growing uneasiness and impatience. By allowing users to get news and information from not only friends but "friends of friends" or even "friends of friends of friends," social media create a fertile land for pandemic rumours, fake news, hoaxes and so on—especially those appealing directly to negative emotions such as anxiety and fear—to grow at an exponential rate.

Overall, as we have reviewed elsewhere (Nguyen, 2020), the Covid-19 infodemic on Vietnamese social media features three major types of mis/disinformation. The first is false information and conspiracy theories about the origin of the virus—such as that Coronavirus is a biological weapon being leaked from a lab in Wuhan, that Coronavirus is an attempt to make money by the big pharma, that coronavirus is an effort by the rich and powerful to reduce global population growth. Most of this was translated from foreign sources by either social media users or some gullible mainstream news outlets.

The second surrounds the development of the pandemic. This can take the form of deliberate make-believe posts—such as a translated video of a fake Wuhan health worker claiming in January that hundreds of thousands were infected with the virus, not thousands as the Chinese government said. Sometimes, it might be just rudimentary posts declaring something without any supporting evidence—e.g., someone has died of the virus somewhere. Such crude mis/disinformation could find its way through the net simply because it is the daily obsession of a worried public.

The third is around prevention and treatment measures: While scientists are yet to understand the virus and its working mechanisms, a plenitude of "health advice" has been posted online to teach people how to kill it or even to treat Covid-19. The most shuddering is advice for people to drink their own urine or bleach to prevent, even treat, Covid-19. Less severe are the numerous posts claiming people can stay away from Coronavirus by sunbathing, drinking hot water, avoiding ice creams, using

hair driers, wearing a face mask soaked with saline solution, or eating garlic, pepper, ginger, kimchi and so on.

To be sure, some mis/disinformation has stealthy intent behind it. There are, for example, the invisible hands of hackers and state apparatuses who spread false and malicious content about the Covid-19 to exploit public fear for personal, commercial or political gains. In most cases, however, it is likely that the information chaos is down to a combination of negative emotions and low media literacy: People, out of fear/anxiety and the lack of news evaluation skills, unwittingly like and share wrong or untruthful information in their genuine but hasty belief that it is true. In February, soon after a woman died at a hospital in Ho Chi Minh City, her death declaration, personal identity, and close-up photos were immediately circulated on Facebook and other social platforms. The "news" was that she died of Coronavirus. The death note, however, specifies clearly that her death was caused by 'myocarditis, multiple organ dysfunction' (quoted in Nguyen, 2020). It was the few extra caution words after that—'flu not excluded'—that sparked the rumour. It was easily taken as truth by many people who, in their sincere intention to alert others, did not pause to question the information or read the death note.

In short, from the perspective of social amplification theory, Covid-19 on Vietnamese social networks could be a classic example of risk being amplified in a vicious circle of intensified and attenuated signals about itself. The more information people seek on social media, the more confusion many—if not most—seem to have. As confusion goes that direction, it reaches a point when information quality becomes secondary to bias confirmation. As social messaging around Coronavirus is amplified to deaf ears, it contributes considerably to the formation and consolidation of anxiety and fear. Its effects can be seen in a range of irrational behaviours in real life: stockpiling food, queuing from 4 am to buy facemasks, abusing rumoured Covid-19 cures (e.g., chloroquine), discriminating people from areas with Covid-19 cases (e.g., Vinh Phuc province), and so on.

3. The Bright Side

Not everything is bleak, however. The chaos has seen many troubled users trying to do their bit, either as individuals or as group members, to mitigate its dreadful impacts. A voluntary Facebook page called News Check (*Kiểm Tin*) has been proactive in exposing fake Covid-19 news. By the end of April, less than five months since its birth, the page had about 24,000 followers, having published more than 260 posts that fact-check, cross-verify and debunk fabricated stories or false claims on both mainstream and social media. On YouTube, there is a boom of clips warning people of the emerging infodemic. Many KOLs (Key Opinion Leaders) support the fight by voicing their views about false claims, helping bring the "infodemic" concept into Vietnamese households. Some doctors, epidemiologists and journalists have become essential Facebook places for confused members of the public to check for authoritative news and advice.

In the absence of systematic research, however, it is impossible to know the extent to which such efforts have changed the hearts and minds of a panicked public. Like other bad news, misleading or untruthful content around Covid-19 sweeps through the network with a much faster speed and wider reach than any correction. Further, those with the good intention to fix things are still a minority compared with the millions of emotionally driven Facebook users. While social media companies have been proactive in cleaning their space, their efforts seem to focus on clear fabrications, with insufficient attention to the subtle, probably more popular type of factually correct but substantially untrue content (e.g., correct facts that are "massaged" or misinterpreted during sharing or commenting).

The amplification of Covid-19 risk through mis/disinformation on social media, however, does seem to have an unexpected positive effect: It creates immense pressures on the one-party regime, forcing it to go out of its usual secrecy to address public concerns. After an initial period of disconcerted responses, Vietnamese authorities realised the urgent need to unite words and actions, sparing no effort to control the flow of information in parallel with its extensive track-and-trace system. There have been controversial moves—such as a new decree that has since February led about 800 people to be heavily fined (at amounts equivalent to three to six months of basic salaries) for spreading mis/disinformation about Covid-19 (Reed, 2020). But, under intensive public scrutiny, there has been an unexpected level of transparency and creativity. Every new Covid-19 case, with details about their movements and contacts, is immediately published on governmental websites, mainstream media, and social media. Different forms of media, such as outdoor posters, television trailers, and even dancing performances, are used to keep people abreast of developments as well as to understand the virus, its transmission and its prevention measures. In February, Coronavirus Song (*Ghen Cô Vy*)—a Ministry of Health's edutainment clip to mobilise people to fight the virus—went viral on YouTube (with 4.4 million views as of April 30), made news on global news channels and websites and has since been translated and mutated in other countries.

As we write, Vietnam has started to return to normal life, being internationally acclaimed for its resolute, low-cost response to Covid-19. If this sustains as a success throughout the rest of the pandemic, future historians will have one sure thing to say: the strangely joined force of the good, the bad and the ugly on Vietnam's social media was part of that success.

Conflict of Interests

The authors declare no conflict of interests.

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COGITATIO

Media and Communication (ISSN: 2183–2439)
2020, Volume 8, Issue 2, Pages 448–451
DOI: 10.17645/mac.v8i2.3229

Commentary

"Cultural Exceptionalism" in the Global Exchange of (Mis)Information around Japan's Responses to Covid-19

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Submitted: 7 May 2020 | Accepted: 11 May 2020 | Published: 26 June 2020

Abstract
Despite reporting early cases, Japan's infection rates of Covid-19 have remained low. This commentary considers how a discourse of cultural exceptionalism dispersed across the networked global public sphere as an explanation for Japan's low case count. It also discusses the consequences for wider public understanding of evidence-based public-health interventions to reduce the transmission of the coronavirus.

Keywords
Covid-19; culture; Japan; social media

Issue
This commentary is part of the issue "Health and Science Controversies in the Digital World: News, Mis/Disinformation and Public Engagement" edited by An Nguyen (Bournemouth University, UK) and Daniel Catalan (University Carlos III of Madrid, Spain).

While there has been an uptick in Covid-19 cases in Japan in recent weeks, prompting prime minister Shinzo Abe to declare a nationwide state of emergency on April 16, infection rates have remained low. Many acknowledge that without widespread testing it is difficult to ascertain the extent of Covid-19 in Japan, which at 1.41 tests performed per 1,000 people is lower than many other advanced market economies (Japan Ministry of Health, Labour and Welfare, 2020). Understandably, as the pandemic intensified across Europe then the United States in March, questions were raised about what Japan may be doing differently that has helped to slow spread of the virus. Early interventions included the launch of a public health campaign, in line with recommendations by the World Health Organisation (WHO), emphasising the importance of basic hygiene and advising people to avoid the 3Cs of closed spaces, crowded spaces, and close contact, a focus on the identification and containment of infection clusters, and the closure of schools. Some suggested, however, that Japanese culture may in fact explain its low case count. These include claims that people in Japan may be more willing to follow recommendations, the importance of cleanliness and hygiene, the widespread use and acceptance of facemasks, and greetings that avoid physical contact.

Presently, beyond what is known about the spread of other respiratory viruses, there is limited scientific evidence for cultural factors—those that underpin the adoption of preventative behaviours—in reducing the spread of Covid-19. Instead, this emphasis on cultural factors indicates a recycling of a common discourse on Japan, one that accentuates the homogeneity of cultural values and practices and its distinctiveness from other cultures. This discourse has a long history shaping how the West view Japan but one that is also repurposed by elites in Japan to underline Japan's distinction from other countries (Iwabuchi, 1994). This commentary considers why this discourse emerged, both within and outside of Japan, and how these cultural explanations dispersed across the networked global public sphere during the Covid-19 pandemic. It also reflects on the role of critical voices, in particular those on Twitter, that have warned that reductionist cultural explanations may detract from the criticisms of the Japanese government's response to the epidemic. The consequences for wider public understanding of evidence-based public-health interventions

to reduce the transmission of the coronavirus will be also discussed.

Cultural factors are well established as significant determinants of health, influencing, amongst others, perceptions of diseases and their management, approaches to health promotion, and compliance with recommended treatment options (Pasick, D'onofrio, & Otero-Sabogal, 1996). Health promotion strategies, consequently, often emphasise cultural sensitivity and the importance of tailoring messages to recognise these differences (Kreuter, Lukwago, Bucholtz, Clark, & Sanders-Thompson, 2003). It is important to recognise, however, that there are different conceptions, ideologies, and discourses of a culture, which would suggest caution toward the static, essentialist views of culture that may support and influence such interventions (Grillo, 2003). Culture, alternatively, is theorised as dynamic, socially constructed, and in constant flux. Some argue therefore that is necessary for health communication to shift from notions of cultural sensitivity toward a cultural context approach, where culture-based assumptions are interrogated and culture is seen as a "contextually embedded, complex web of meanings," which can inform the development of effective health communication programmes (Dutta, 2007).

While it is plausible that culture may intersect with public health interventions to reduce the spread of the virus, simply focusing on values or behavioural traits, at this stage, promotes assertions rather than evidence-based explanations. Despite that, early in the course of the pandemic social media were awash with posts claiming that culture may explain Japan's low infection numbers, including tweets that described people's attention to hygiene and hand-washing (Rinley, 2020), stressed the importance of "mask culture," or championed the cleanliness of the environment and people's homes in Japan (sctm27, 2020; also see Klopp, 2020). Prominent users also shared data about Japan's low case numbers in comparison to its near neighbours in the region or simply asked what may make Japan an outlier. A YouTube livestream hosted by popular musician, Yoshiki (2020), which was widely praised for informing the public about that virus, explored its impacts and directly addressed misinformation that was circulating about the virus. Such posts and content online generated substantial debate about what made Japan different and the part played by culture and associated behaviours, a discussion that could be found in comments made in both Japanese and English. These debates were replicated in mainstream media, both within Japan (see Klopp, 2020) and internationally, as a stream of articles and comments across different media contexts explored Japan's apparent outlier status as the pandemic progressed and other countries introduced more stringent measures to reduce the spread of the virus (see Patrick, 2020).

It is not possible to determine the agenda-setting function of these posts and debates that emerged in Japan but the timing of and wider dispersal of these ideas are indicative of the nature of the contemporary networked media environment and the multidirectional flows of information that may give rise to shared explanations, ideas, and perspectives within different contexts (Heinrich, 2011).

It is important to note that while social media offered a platform to circulate cultural explanations, it also provided an important space for debate and criticism of the Japanese government's strategy and response to the epidemic. Most significant were those that centred on the capacity and strict criteria for testing for Covid-19 (Adelstein, 2020). In recent years, social media, and specifically Facebook and Twitter, have become more significant in Japan as spaces for critical discourse and connective action. Facebook use grew much slower in Japan than in US and Europe, largely due to the popularity of the local social media platform Mixi. Alongside Twitter and other networks, Facebook played a significant role in movements established to address ongoing concerns about nuclear power in Japan after Fukushima, the rise of the Students Emergency Action for Liberal Democracy against proposed security legislation that impinged on Japan's pacifist constitution, and anti-Olympic activism (Tagsold, 2019). Therefore, at a time when Japan's media have been facing greater political pressure, as the Abe-led government has attempted to influence coverage and reduce criticism, social media served as a valuable space for those that may otherwise be excluded from debates to be able to offer comment on the Japanese government's response to the epidemic.

Platforms such as Twitter also provided a space for experts to speak directly to the public. In response to a Twitter thread posted by a journalist writing for the Japan Times, for example, the infection control expert, Kentaro Iwata, downplayed assertions that cultural practices may be contributing to slow the spread of Covid-19, describing it as "valid but unproven theory" and cautioning against overreliance on these behaviours alone to reduce transmission (Ripley, 2020). This aligns with the existing research that shows how social media may serve as a corrective to false information about health issues, whether this is through platform-generated algorithms, social comments, or expert correction (Bode & Vraga, 2018).

Others underline the difficulties that the Japanese public face in accessing high-quality health information and its consequences for health literacy. The shortage of international data and information published in Japanese, the absence of a central public health agency to provide "public guidance on how to respond to health threats," and the lack of clinicians in leadership roles that are able to communicate risks effectively to the public, as Nakayama (2020) suggests, work together to encourage people to seek information from other sources. Often this will mean turning to misleading or inaccurate information that may be found online. The absence of evidence-based information and international comparisons in Japanese may have contributed to the prolifer-

ation online and across social media of speculative information that placed undue emphasis on the role of culture and associated behaviours in minimising the spread of Covid-19.

The WHO has declared that the pandemic also sees an accompanying 'infodemic' and emphasised the importance of evidence-based information. While cultural factors facilitate and might have intersected with the adoption of Covid-19 prevention behaviours recommended by the WHO, there is currently insufficient evidence to support the weight afforded to such claims, and the extent to which they have dispersed across the networked global public sphere. It is a familiar discourse but one that contributes to the noise circulating around this public health emergency. Later, evidence may emerge to confirm that the progression of the virus in Japan was slowed due to the adoption of preventative behaviours. Equally the opposite may be found, with evidence emerging that other behaviours attributed to culture may have contributed to its transmission. Nevertheless, we should remain cautious about confining such behaviours to particular national characteristics due to the problematic essentialist notion of culture upon which these assumptions are made. For broader public understanding of Covid-19, asserting the influence of culture may serve to obfuscate failures in governance and the response to this global health crisis, especially when barriers to the public accessing high-quality health-related information are at work. It may also contribute to perceptions that some preventative behaviours and interventions that have confirmed positive outcomes are culturally limited and, as a consequence, impact on people's willingness to engage and follow such recommendations.

Conflict of Interests

The author declares no conflict of interests.

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COGITATIO

Media and Communication (ISSN: 2183–2439)
2020, Volume 8, Issue 2, Pages 452–457
DOI: 10.17645/mac.v8i2.3187

Commentary

How China's State Actors Create a "Us vs US" World during Covid-19 Pandemic on Social Media

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Submitted: 25 April 2020 | Accepted: 18 May 2020 | Published: 26 June 2020

Abstract
Health and science controversies surrounding Covid-19 pandemic have been politicized by state actors to manipulate international relations and politics. China is no exception. Using a package of communication tactics, the Chinese government has been engaging in an English-language information campaign to create an "Us vs US" world during the pandemic on social media. While the world is scrutinizing the accuracy of and the intention behind the information disseminated by China's state actors, this commentary urges scholars to also focus on the influence of such information on global audiences, as well as on global power dynamics.

Keywords
China; Coronavirus; Covid-19; ideological square; information campaign; mis/disinformation; national responsibility; soft power; "us" vs "them"

Issue
This commentary is part of the issue "Health and Science Controversies in the Digital World: News, Mis/Disinformation and Public Engagement," edited by An Nguyen (Bournemouth University, UK) and Daniel Catalan (University Carlos III of Madrid, Spain).

1. Introduction

The world is struggling to uncover the harm caused by Covid-19 to human health and to propose scientific solutions to the virus itself and to the collateral damages of the pandemic. The uncertainties embedded in the crisis grant state actors spaces to restructure global power dynamics. One way to fracture and reshape the global power landscape is to initiate an information campaign on social media. This commentary focuses specifically on such information practices performed by the Chinese government. Political and public sectors in other countries are keen to check the accuracy of and the intention behind the information disseminated by China's state actors. As they investigate the nature of the information, scholars studying the intersections of international communication as public diplomacy to gain soft power should not neglect global audiences who have been and will continue to be exposed to the information circulated on social media. Therefore, this commentary urges scholars to focus on the impact of China's governmental pandemic communication tactics on global audiences, as well as on global power dynamics.

2. With Crisis Comes Opportunity

The uncertainties of the pandemic crisis and the convenience of social media offer the Chinese government an opportunity to tell its own story of the pandemic. China has long been embracing the notion of soft power (Nye, 2011), aiming to have its political and socio-cultural values and behaviors acknowledged by other global community members. Driven by this mindset, the government has been leveraging English-language social media platforms such as Twitter and Facebook, although they are blocked in mainland China, to strategically brand itself to the outside world. Chinese missions, consulates, and diplomats have been coordinating with Chinese

state media, such as Xinhua News Agency, China Central Television, and *China Daily*, to disseminate strategically constructed messages on these platforms (Huang & Wang, 2019). These information measures aim to secure the discursive power (*huayuquan* in Chinese) of China in the world, which is one of the most important goals of China's soft power augmentation. These measures are obviously manifested during the pandemic. One of the main themes of the Chinese story of the pandemic is "Us vs US": "Us" refers to China and/or its allies who are opposed to "US" (United States). Although there are diverse debates about the health and science elements surrounding the pandemic, the mainstream response in the global range is to proactively deal with the pandemic from a humanitarian perspective. China's state actors attempt to use the spirits of solidarity and proactive actions to contrast with the politicization of the pandemic and the inadequate action in the US. China sees in this crisis an opportunity to challenge the US as the dominant global superpower through an information campaign.

3. Constructing "Us vs US" with Perplexing Communication Tactics

An information campaign usually involves a myriad of accurate and mis/disinformation (Jack, 2017). Misinformation refers to inaccurate information without an intention to mislead and disinformation is maliciously constructed information (Jack, 2017). A package of perplexing information tactics has been adopted by China's state actors in discursively constructing the "Us vs US" division during the pandemic. They tend to emphasize information that is positive about "Us" and negative about "US" and suppress information that is positive about "US" and negative about "Us," which forms an ideological square (van Dijk, 1998). The central topic of the "Us" and "US" disparity is the notion of national responsibility, which has connotations of (1) having a duty to deal with problems and (2) to be blamed for wrongdoings (Erskine, 2003; Loke, 2016). In mediated politics, the first connotation can be further differentiated by clarifying whether the duty is self-claimed, which positively depicts the one who shoulders the duty, or requested by others, which suppresses the positive meaning of the message (X. Zhao, 2019).

China's state actors have been constantly emphasizing China's proactive measures in taking on the duties to tackle this public health crisis. A pro-China tone, which has long been used in China's outward focused propaganda (Edney, 2012), is manifested through examples such as Pakistan's endorsement of China's measures (Figure 1). Examples like this positively frame China's responses to the pandemic. Moreover, it indicates that the two countries align themselves with each other, forming a sense of solidarity.

China's state actors not only used information with no factual inaccuracies but also blended in information which are difficult to define its nature (see Figure 2 for an example). The *Financial Times* (Johnson & Yang, 2020) documented attempts to clarify the accuracy of this tweet but reached no conclusion. Messages of this kind sowed confusion about the facts of China's massive medical aids to Italy and Italy's real responses to China's support.

Figure 1. Screenshot of @XHNews' tweet (captured on 10 April 2020, same with the following screenshots). Source: China Xinhua News (2020).

Figure 2. Screenshot of @SpokespersonCHN's tweet. Source: Hua (2020).

The construction of a positive "Us" is also based on rejecting the US's condemnation of China's faults. Interestingly, an example (Figure 3) showed that China's state actors teamed up with Hillary Clinton, the former US Secretary, to refute President Donald Trump's blaming of China as the origin of the virus. Opinions of this kind further perplexed readers about who they should believe in this public health crisis.

Figure 3. Screenshot of @Echinanews' tweet. Source: China News (2020).

In constructing a negative "US," China's state actors have also been applying a myriad of information strategies. Firstly, their social media accounts highlighted what is negative about the US, especially the US's irresponsible actions to tackle the pandemic. For example, Figure 4 shows that CGTN America indicated the hinderance caused by the US's trade restrictions on China's efforts in providing assistance overseas. What makes this tweet interesting is that CGTN America mixed US's irresponsibility during the pandemic with the prolonged trade war between China and the US, which cemented the accusation of the US in dealing with major global issues.

Figure 4. Screenshot of @cgtnamerica's Facebook post. Source: CGTN America (2020).

Moreover, the tit-for-tat narrative was further ignited when China's Foreign Ministry Spokesperson Zhao Lijian urged people to read a poorly verified article which claims that Covid-19 originated in the US (Figure 5). While scientists are still on the way to figure out the origin of the virus, this tweet by one of China's most important state actors further muddled the water of the health and science controversies emerged from this pandemic.

Figure 5. Screenshot of @zlj517's tweet. Source: L. Zhao (2020).

Secondly, China's state actors requested the US to behave responsibly and benevolently (Figure 6). A combination of factual information in the original tweet by Jack Ma Foundation and the opinion by Chinese Embassy in South Africa solidified the image of an inactive "US."

Figure 6. Screenshot of @ChineseEmbSA's tweet. Source: Chinese Embassy in South Africa (2020).

Overall, using a package of information tactics and with the aid of English-language social media platforms, China's state actors have been fracturing international relations and politics and trying to reshape it from a "Us vs US" perspective through a confusing range of both factual and dubious information. Social media audiences' reactions to these information urge scholars to zoom in on new research agendas.

4. Symptoms of the "Infodemic": New Research Agendas

While the world is investigating the nature of the information disseminated by China's state actors on English-language social media during the pandemic (e.g., Insikt Group, 2020), scholars in media and communication studies should also focus on the audience reception of the information. Answering this question is crucial to understanding in a timely manner the implications of China's pandemic information campaign on global publics' perceptions of international relations and politics, and on the transformation of global power dynamics.

From a short-term perspective, scholars may want to start with the rich social media data composed of comments, retweets, likes, and creative content such as memes and emojis. Factors including China's state-backed internet commenters, state employees, and computational propaganda make this research agenda far more complicated than merely identifying the sentiment or themes of social media users' reactions such as the positive comments on Sino–Italian solidarity (Figure 7), anti-US sentiment (Figure 8), and the China–US tit-for-tat arguments (Figure 9). Studies indicate the quick development of China's computational propaganda alone. Not long ago, Bolsover and Howard (2019) found no evidence of pro-Chinese-state automation in Twitter posts. However, during the pandemic, an analysis shows the massive involvement of bots in tweets with pro-Chinese-state hashtags (Alkemy Lab, 2020). Scholars face the challenge of disentangling the distraction caused by the

Figure 7. Screenshot of @chinadaily's Facebook post (left) and some of the responses (right). Source: China Daily (2020).

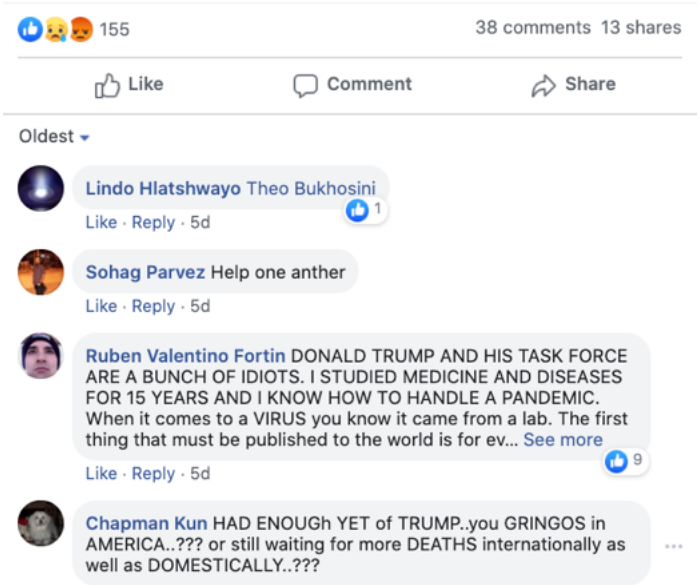

Figure 8. Screenshot of some of the responses to the post in Figure 4. Source: CGTN America (2020).

Figure 9. Screenshots of some of the responses to the posts in Figures 2 (left) and 5 (right). Sources: Hua (2020) and L. Zhao (2020).

mixed responses to social media users. Audiences' attention may be deflected from the real health and science problems in the pandemic, for which China shoulders global responsibilities, and the transforming international politics, on which China is exerting influence. Advanced computational approaches to social media interactions, as well as global public opinion polls, are helpful for clarifying global publics' perceptions of China and international relations and politics.

The implications of this ongoing information loop featured in true/dubious posts and manufactured responses should also be examined from a long-term perspective. China has been endeavoring to transform the US-dominated global power landscape along with its rising economy. Therefore, the fractured and confusing map of information caused by China's information campaign seems to be a result of a hard version of Nye's (2011) idea of soft power initiatives which value gaining foreign publics' trust in the practicing country. It is more important than ever to examine whether the communication tactics applied by China's state actors during the pandemic contribute to a transformation of the 'international alignment and balance of power' (Gerrits, 2018, p. 21) in the long run.

Acknowledgments

Thank you to the academic editor Dr. An Nguyen for the valuable comments and continuous support.

Conflict of Interests

The author declares no conflict of interests.

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COGITATIO

Media and Communication (ISSN: 2183–2439)
2020, Volume 8, Issue 2, Pages 458–461
DOI: 10.17645/mac.v8i2.3219

Commentary

Spreading (Dis)Trust: Covid-19 Misinformation and Government Intervention in Italy

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Submitted: 30 April 2020 | Accepted: 25 May 2020 | Published: 26 June 2020

Abstract
The commentary focuses on the spread of Covid-19 misinformation in Italy, highlighting the dynamics that have impacted on its pandemic communication. Italy has recently been affected by a progressive erosion of trust in public institutions and a general state of information crisis regarding matters of health and science. In this context, the politicization of health issues and a growing use of social media to confront the Coronavirus "infodemic" have led the Italian Ministry of Health to play a strategic role in using its official Facebook page to mitigate the spread of misinformation and to offer updates to online publics. Despite this prompt intervention, which increased the visibility and reliability of public health communication, coordinated efforts involving different institutions, media and digital platform companies still seem necessary to reduce the impact of misinformation, as using a multichannel strategy helps avoid increasing social and technological disparities at a time of crisis.

Keywords
Coronavirus; Covid-19; emergency; health communication; Italy; misinformation; public communication; social media

Issue
This commentary is part of the issue "Health and Science Controversies in the Digital World: News, Mis/Disinformation and Public Engagement" edited by An Nguyen (Bournemouth University, UK) and Daniel Catalan (University Carlos III of Madrid, Spain).

1. Introduction

Originating in December 2019 in Wuhan, Covid-19 rapidly spread across China due to the interconnected systems of globalized modernity (Sastry & Dutta, 2012), where everybody is a plane ride away from chains of lethal transmission (Ungar, 2001). As Italy became the first Western country to be affected by Covid-19, it immediately was involved in an "infodemic" characterized by a mix of facts, fears, rumors and speculations.

The lack of information about the virus and its consequences for people's safety, the uncertainty as to how it might be transmitted, and the dissemination of various types of misinformation about Covid-19 worked together to increase this stream of infodemic. The chaotic flow of communication compounds an information crisis that has dogged Italy over the last decade, with anti-science movements having gained visibility in the digital realm, being often covered by the mass media and heavily politicized by populist parties (Lovari, Martino, & Righetti, 2020).

When, on 20 February, a 38-year-old Italian man was placed in intensive care in Codogno (North of Italy) and tested positive for the virus, the country was immediately up against an emergency from a health and communication point of view. The following weeks saw a rollercoaster of polarized interventions and sentiments, accelerated by constant public disputes between scientists and politicians, spectacularized by mainstream media, and fueled by partisan interests. This anxiogenic situation escorted the country until 9 March when the Prime Minister, Giuseppe Conte, declared a lockdown in order to stop the spread of the virus. A few days later, the Word Health Organization (WHO) characterized Covid-19 as a pandemic, the first caused by a Coronavirus and the first entrenched on social media.

In this framework, the commentary focuses on the main characteristics of the Italian infodemic, with specific attention to misinformation about Covid-19 on social media, and highlights how the Italian Ministry of Health (IMH) has faced this online.

2. The Italian Context

In recent years, Italy has increasingly dealt with anti-science movements that have questioned the value of experts and scientists and that represent one of the main effects of a postmodern conception of health (Kata, 2012). This process is related to socio-cultural transformations which have led to a growing public engagement with scientific questions and increasing intersections between expert knowledge and citizens' responses, which foster a demand for non-expert participation in health intervention processes and a less passive attitude towards the professionals' authority. In this respect, the relationship between science and lay publics has profoundly changed, impacting on the credibility of public health institutions. The development of digital technologies and the pervasiveness of personal media have enhanced this process, challenging the role of governments and institutions. This demands the adoption of new communication models not only to relate with media, but also to converse with different publics who are now enabled to make their voices heard by medical experts and health institutions on social media (Lovari, 2017).

In this context, Italy suffers from a general lack of trust in public institutions. Italy was one of the six countries to register an extreme decline in trust, with an overall decrease of 21 points in one year, and with government and media being the least trusted institutions (Edelman, 2018). This lack of trust is also marked in relation to science and scientists. Italians were found to be more skeptical than other European citizens about the beneficial impact of technoscience (Eurobarometer, 2010). Moreover, Italians have much less confidence in the impact of technological and scientific innovations on their health (51%), in comparison with the other countries (76.5% on average). Lower rates are also reported for trust in scientists (56.9%), especially when scientific studies deal with controversial research funded by private companies (54%; Eurobarometer, 2014).

This skepticism was clearly manifested in the controversy which has raged in Italy over the issue of vaccinations, fueled by the activism of the anti-vax movements on social media (Tipaldo, 2019), a debate which reveals starkly polarized user opinions, often accompanied by echo-chamber effects (Schmidt, Zollo, Scala, Betsch, & Quattrociocchi, 2018). This process was accelerated by the politicization of the topic, which meshed with the spread of populist anti-elitism movements and the diffusion of conspiracy theories (Mancosu, Vassallo, & Vezzoni, 2017), helping to erode the lay-public's confidence in scientific and health facts. In facing this challenge, the Italian Ministry of Health and public health authorities decided to use social media to make their voices heard online and counteract the misinformation, but with mixed results and a lack of coordination at central and regional level (Lovari, 2017).

This information crisis was the fertile humus for the Covid-19 infodemic that struck Italy in February 2020. Uncertainty, distrust and fears were further accentuated by the role played by several Italian physicians who publicly started talking about the virus on their social media profiles or were interviewed by mainstream media in news and talk shows. Discordant medical voices were embedded and spectacularized by media logics, becoming spreadable content on digital platforms, often politicized or associated with fake news and conspiracy theories, thus increasing distrust among connected publics.

3. Misinformation Meets Covid-19

The uncertainty surrounding the etiology and the consequences of the virus gave rise to a cacophony of voices, in which institutional communication was often misaligned with media coverage and with an indistinguishable mix of misinformation, unverified rumors and intentionally manipulated disinformation (Larson, 2020). The quantity of information about Coronavirus rapidly increased online. According to social media monitoring by the Vaccine Confidence Project, 3.08 million messages about Covid-19 were disseminated daily between January and mid-March 2020 (Larson, 2020). Different types of misinformation accounted for a sizeable portion of the content. These rumors and hoaxes spread rapidly on the social web, disturbing the authenticity balance of the communication ecosystems. This factor quickly pushed governments to commit to curbing the spread of misinformation to avoid the risk of behaviors that are potentially harmful to the population. For instance, a study analyzing misinformation rated false by independent fact-checkers reported that false content was mostly spread on social media (88%), assuming various textual and visual reconfigurations. Moreover, the most recurrent claim concerned policies or interventions taken by public authorities to tackle the spread of Covid-19, alleging that health organizations and governments had not fully succeeded in offering reliable information in response to demands from the public (Brennen, Simon, Howard, & Nielsen, 2020).

Italy was totally involved in this infodemic. For instance, a report highlighted that the term "Coronavirus" accounted for 575,000 searches by Italian users out of a monthly total of 950,000 (Sciuto & Paoletti, 2020). In a study by Edelman (2020), Italy was the country with the highest percentage of people accessing news and information about the virus on a daily basis (58%), overtaking countries like Korea, Japan and US. AGCOM (2020) found that, as a proportion of disinformation published online, Coronavirus contents rose from 5% in early January to 46% in late March. On social media, in particular, Coronavirus posts increased to 36% of all messages produced by disinformation sources. Part of this

disinformation seemed to be linked to conspiracy theories and false reports and claims from actors close to Russia and China, aiming to undermine alliances within the European Union when Italy was facing the first phase of the emergency (EEAS, 2020). Despite the commitment of digital companies to stop the spread of misinformation, and notwithstanding the strategic partnerships forged between the WHO and the health ministries of several countries, fake news remained difficult to contain. One study described how misinformation was not uniformly removed by Facebook (Avaaz, 2020): 68% of Italian-language misinformation was not labeled to alert users to Covid-19 fake news. Moreover, 21% of the Italian misinformation posts fell into the category of "harmful content" that Facebook has committed to remove, but these posts were still present in early April.

4. The Role of The Italian Ministry of Health

It was in this problematical situation that the Italian Ministry of Health assumed a central role by starting to produce messages about the virus in an attempt both to respond to growing demands from citizens and to stem the tide of inaccurate information. Specific attention was devoted to the ministerial website with a Covid-19 section, both in Italian and English, with a thematic page to counter misinformation, named "Attenti alle bufale" (Beware of hoaxes), which disproves more than 50 Coronavirus hoaxes circulating on social media.

A key effort was addressed to the Italian Ministry of Health Facebook page. With the emergency, the number of likers rose from 61,196 on 30 January to 409,145 on April 3, showing the need felt by users to find a reliable institutional source about the virus, but also the strategic function played by this page in mitigating the infodemic. In those two months, the page published 301 posts, 94% of which were about Covid-19, turning into a thematic page to face the emergency. The engagement rate reached an average of 2,652 likes, 1,983 sharing, and 378 comments per post. As regards the contents, the Italian Ministry of Health created campaigns about Coronavirus (21.9%), involving famous people and digital influencers, and using specific hashtags (e.g., #iorestoacasa). Messages countering fake news occupied 7.1% of the institutional flow. These posts were enriched with emoticons, infographics and social cards, frequently integrating the words *falso* (false) or "fake news" in visuals, and linking to the Covid-19 section in the ministerial website. Several posts (12.4%) explained the measures adopted by the Italian government in order to ensure appropriate behaviors during the lockdown. Furthermore, the contents did not feature a marked incidence of politicians (8.9%), thus reducing the risk of a politicization of the virus, one of the main concerns of the population (Edelman, 2020). One negative aspect was the shortage of replies to users' comments on the page (less than 5%), leaving people's queries largely unanswered and thus possibly undermining trust in this institution.

5. Conclusions

In this first social media pandemic, the Italian Ministry of Health has adopted specific digital communication strategies to face the Covid-19 emergency, devoting intense efforts to keeping the citizen constantly informed and to reducing misinformation, using data and visuals to make the messages easily understood. In February, the Italian Ministry of Health signed partnerships with Facebook and other digital companies to convey users' searches on the ministerial channels. In April, the Italian government launched a specific task force to promote collaboration with fact-checkers and to encourage citizens' activism in signaling misinformation.

From the point of view of public health communication, all these actions proved useful in facing the acute phase of the infodemic, raising the visibility of official sources and aiming to restore credibility by reconnecting with citizens. In this period of fear and uncertainty, a transparent, strategic and proactive use of social media by public health organizations seems to be fundamental to increasing trust and reducing the impact of false narratives. In states of emergency, institutions should also depoliticize health topics on social media channels to reduce further polarization and to limit the rise of new conflicts, both already fostered by the nature of social media and their algorithms. Furthermore, to flatten the curve of misinformation it seems necessary to make constant and coordinated efforts involving authorities, mass media and digital companies. For instance, the media could give a greater voice to journalists specialized in health and science topics in order to contextualize data and statistics about the virus and to decrease the spectacularization of these themes merely to gain audience or clicks. Digital companies should continue to collaborate with governments to stop the spread of Covid-19 misinformation, elevating authoritative content and paying strategic attention to cultural and linguistic factors that could enhance the dissemination of fake news. Furthermore, misinformation should be counteracted through an extensive investment in media education and digital literacy to develop a critical awareness of the use of media and digital technologies. In this respect, media education should involve society as a whole in order to increase the skills and competences necessary to interact effectively while negotiating the pitfalls of misinformation. Lastly, it is important that public health institutions should continue to inform citizens with offline tools and traditional media, using a multichannel strategy, so as not to exclude parts of the population or to increase technological and social disparities.

Acknowledgments

A special thank to the editors of this thematic issue for their attention and interest in my research.

Conflict of Interests

The author declares no conflict of interests.

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COGITATIO

Media and Communication (ISSN: 2183–2439)
2020, Volume 8, Issue 2, Pages 462–466
DOI: 10.17645/mac.v8i2.3217

Commentary

Coronavirus in Spain: Fear of 'Official' Fake News Boosts WhatsApp and Alternative Sources

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Submitted: 30 April 2020 | Accepted: 14 May 2020 | Published: 26 June 2020

Abstract
The communication of the Coronavirus crisis in Spain has two unexpected components: the rise of the information on social networks, especially WhatsApp, and the consolidation of TV programs on mystery and esotericism. Both have emerged to "tell the truth" in opposition to official sources and public media. For a country with a long history of treating science and the media as properties of the state, this very radical development has surprised communication scholars.

Keywords
Coronavirus; Covid-19; fake news; journalism; social media; Spain; WhatsApp; YouTube

Issue
This commentary is part of the issue "Health and Science Controversies in the Digital World: News, Mis/Disinformation and Public Engagement" edited by An Nguyen (Bournemouth University, UK) and Daniel Catalan (University Carlos III of Madrid, Spain).

1. Background

Spain is a Western European country, but with some differences from others when it comes to scientific culture and scientific information in the media. In 17th and 18th centuries, the country suffered an oppressive inquisition which, after Galileo's trial, considered science a threat to religion and the State (Elías, 2019; Jacob, 1988). Furthermore, during the last century (1936–1975), the country suffered a dictatorship that considered science not as knowledge, but as a method of persuasion at the service of the state and religion. This perspective is still prevalent now amidst the Coronavirus crisis.

2. Government Control of Coronavirus Communication

In Spain, the heads of scientific organizations such as the Spanish National Research Council (CSIC) are chosen by the government. The royal academies of science and medicine are financed by the Government (Rubio, 2019); therefore, contrary to developments in Germany, the US and the UK, they fear a confrontation with power. The same applies to the state-run news agencies—e.g., the EFE Agency—and state-owned radio and television. In a way, they work just like the Chinese news agency Xinhua, i.e., they are propaganda by nature (Ingram, 2019; Twitter, 2019). This subsidized ecosystem of science and the media facilitates an environment in which an important part of public opinion does not believe in official sources—the government, government scientists, public media or royal academies—because they are not free to disagree with the official line. If there is no criticism, the impression is that information is either manipulated or controlled by the State.

One important aspect of government efforts to tame public opinion around Coronavirus is its misuse of language, namely the presentation of a negative reality through positive metaphors. For example, the lockdown is called "hibernation" of the economy. The centres to host thousands of asymptomatic patients were called "Noah's arks." The most successful of all is that the number of deceased and infected has become the "curve."

The most repeated aim by the government and its scientists is not to reduce deaths or infections, but "to flatten the curve." Even anti-government journalists have fallen into the dialectical trap of these metaphors.

Another very controversial metaphor has been the "committee of wise experts," scientists hand-picked by the government. It does not call them "scientists" but "wise experts"; that is to say, "unquestionable." The newspaper *El Mundo* (second in national circulation) ran a headline on its front cover on April 12: 'The eight "wise experts" of the president against Coronavirus: Three of them were deniers at the beginning of the pandemic' (Rego & Iglesias, 2020). The article, widely shared and discussed on social media, showed the ties of these experts with political parties, which might indicate hidden influences. Such dynamics are in fact used as a common government manoeuvre to control health information in the media (Catalan-Matamoros, 2011) and have been followed in other previous scientifically-based Spanish catastrophes such as the toxic spill of Doñana Natural Park in 1998, and the Prestige oil tanker accident in 2002. Here the government uses scientists with alignment to the dominant political ideology, who are used to cloak political slogans with science. The rest of government scientists do not have permission to speak with journalists under the threat of revealing state secrets, a very serious crime in Spain (Elías, 2007). The strategy is always the same: (1) electing a government scientist as a spokesperson who will then be rewarded with a promotion; (2) inundating journalists with tons of confusing data so that they do not have time to look for independent sources and check it; (3) threatening independent scientists (with indirect threats if they speak to the media); and, finally, (4) twisting language.

The Covid-19 crisis has also seen a novel element: the frequent and long press conferences given by the President, Pedro Sánchez (PSOE, centre-left wing party). But journalists could not attend these conferences to ask questions, prompting the Spanish Journalists' Association to complain. The government, in an attempt to give an image of transparency, invited journalists to a WhatsApp group to submit questions. The problem arose when the selection of these questions was made by the State Secretary for Communication, a position appointed by the President, and many journalists never saw their questions being asked at press conferences. Some media outlets and opposition politicians suggested that the government emulates the strategy of communist leaders, such as the Cuban Fidel Castro or Venezuelans Hugo Chávez and Nicolás Maduro with his *Aló Presidente* (Hello President). The alleged links with Venezuela of leaders of the Podemos political party, who acted as advisers to Chávez and Maduro, have inflamed social media, which criticise Podemos for adopting the Chávez communication strategy. But the President, Pedro Sánchez, a member of the PSOE, still needs Podemos to govern in coalition. This debate on whether Pedro Sánchez is emulating communist leaders has diverted the attention from the pandemic information given by the President. Many journalists refer to "yesterday's press conference" not as such but as "yesterday's *Aló Presidente*," undermining the President's image (Rodríguez, 2020).

Even the left-wing media such as *Público* have criticized the government for using the bandwagon effect (herd effect), whereby people assimilate the beliefs of the majority even when they are not convinced. In one article, Sánchez is criticised for copying the strategy of former US President Harry Truman: 'If you cannot convince them, confuse them' (Calderón, 2020). The journalist who wrote this comment, César Calderón, was immediately fired by *Público* (Carvajal, 2020), who admitted that it was pressured by the government, demonstrating how it exerts enormous power not only on state-run but also on private media. All this explains why that a large segment of the Spanish population prefers alternative sources—namely social media platforms and, quite curiously, "alternative television" shows that usually rely on mystery—for news during the Coronavirus crisis.

3. Alternative Media Spaces for Independent Science

In Spain there are two well-defined types of scientists. Those working at universities are quite independent and are allowed to publish their articles an in their blogs with full freedom. Indeed, some of them are being very closely followed during this Coronavirus crisis, such as members of the Spanish Mathematics Committee (Comité Español de Matemáticas, 2020). These scientists working at universities must pass a rigid and demanding national accreditation system to secure tenure and be promoted (ANECA, according to the Spanish acronym). On the other hand are scientists working in public research organizations such as the CSIC or the Carlos III National Health Institute. These do not have to pass any national accreditation or have to teach, although they are required to achieve the same research levels as university scientists. This privilege comes at a high price: They are not allowed to publish/speak without the approval of managers who are appointed by the government in office. If politicians tell the public to follow a specific expert advice which then turns out to be problematic, the blame is placed on scientists who cannot protest because this would be considered a serious disciplinary offense to reveal national secrets, even if they are scientific data. In Spain, it would be impossible for a government scientist to discredit the government, as, for example, Dr. Fauci is doing with US President Donald Trump (Mars, 2020). It is happening now when the left is in government, and it has happened before when the right was in office. Spain can thus be regarded as what the Portuguese sociologist Boaventura de Sousa Santos describes as 'politically democratic, but socially fascist societies' (Revista IHU, 2016).

This has led to quite a significant situation in the Coronavirus crisis: Pubic trust is placed in the information that comes through social media, especially

WhatsApp, as well as through "alternative" television programs that usually cover mystery and esoterism. The first WhatsApp messages on the Coronavirus, which contradicted the official messages claiming that this pandemic was not dangerous, were videos and audios from clinicians denouncing the real situation they were facing in their own hospitals and asking for more protective equipment. Some of them were subjected to disciplinary action by their professional associations (La Voz, 2020; Vizoso, 2020), which restricted their freedom of expression against politicians and the authorities. Despite these threats, "alternative" TV programs, of an esoteric and mysterious nature (e.g., Fourth Millennium), invited these clinicians to speak (Molina, 2020). In this Coronavirus crisis, the digital media platform that has benefited most has been WhatsApp, which takes a leading role in positioning Spain as the country with the highest growth: 76% compared to 50% in other countries (EuropaPress, 2020). In April 2020, the company limited a number of groups to share messages, which was criticized by the media because only the messages against the government were restricted. WhatsApp quickly clarified that the orientation of the messages was not filtered, and that it was just a method to stop massive sharing of fake news. However, there was a general feeling that most of the forwarded messages were against the government.

Another winner seems to be YouTube. The Spanish state-run media are bound to the State, similarly to Chinese public media. In February, a report from Italy by the popular correspondent in the Spanish public television, Lorenzo Milá, went viral (TRESB, 2020): 'Covid-19 is a new type of flu; it is true, we have no viral memory, nor do we currently have a vaccine, but it is just a type of flu,' he declared. This report was shared widely on social networks and was retweeted by, among others, Pablo Echenique, the CSIC scientist and national deputy of Podemos (a political party governing in coalition together with the PSOE). The counterpoint in these previews about the pandemic was, curiously, given by a TV program on mystery and esotericism, *Cuarto Milenio* (Fourth Millennium), which attracted the highest audience ratings of all programs broadcast by the private channel Cuatro (Ecoteuve, 2020). While the public media tried to soften the pandemic, this program interviewed a Spaniard living in China who predicted, together with some guest experts, what would happen later (Reinoso, 2020). This would have been shocking for Spanish state-run television, and it led social networks to contrast the two approaches, which has surely impacted on public opinion. This development would have been impossible before the digital era. Following the pandemic restrictions, channel Cuatro put Fourth Millennium on pause, as well as others, but curiously, it coincided with the government support of 15 million euros for private media as these were considered a public service during the pandemic. Criticisms were raised in social media: Was this support aiming to influence a favourable view for the government? As this controversial TV program was put on pause, the presenter opened a YouTube channel which within a few days reached more than 500,000 subscribers (Jiménez, 2020). His interviews and his live shows surpassed a million views in only a few days and are highly forwarded on social media, strongly impacting public opinion.

As Spanish public opinion continues not to trust official sources, WhatsApp messages and YouTube channels criticizing the government have become so relevant and prevalent that the government has considered using the Prosecutor's Office to censor this alternative discourse in the social media. And, as Donald Trump does, the Spanish government's strategy to handle critical views is to call them fake news (Elías, 2018). Whether such strategy succeeds is a matter for much more research.

Acknowledgments

This work was supported by the Jean Monnet Chair "EU, Disinformation & Fake News" (Erasmus+ Programme of the EU) and the Ministry of Science, Innovation and Universities of the Government of Spain under grant with reference RTI2018–097709-B-I00.

Conflict of Interests

The authors declare no conflict of interests.

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COGITATIO

Media and Communication (ISSN: 2183–2439)
2020, Volume 8, Issue 2, Pages 467–470
DOI: 10.17645/mac.v8i2.3242

Commentary

German Media and Coronavirus: Exceptional Communication—Or Just a Catalyst for Existing Tendencies?

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Submitted: 11 May 2020 | Accepted: 12 May 2020 | Published: 26 June 2020

Abstract
The Covid-19 pandemic has immediate effects on science journalism and science communication in general, which in a few cases are atypical and likely to disappear again after the crisis. However, from a German perspective, there is some evidence that the crisis—and its accompanying 'infodemic'—has, above all, accelerated and made more visible existing developments and deficits as well as an increased need for funding of science journalism.

Keywords
coronavirus; fake news; journalism funding; science communication; science journalism

Issue
This commentary is part of the issue "Health and Science Controversies in the Digital World: News, Mis/Disinformation and Public Engagement" edited by An Nguyen (Bournemouth University, UK) and Daniel Catalan (University Carlos III of Madrid, Spain).

1. Introduction

"Which virologist do you trust the most?" The fact that scientists can be chosen in a 'Germany's-next-top-model' manner by a tabloid such as BILD in April 2020 is just one of many curiosities in coronavirus communication. Another is that a public relations (PR) agency has scripted to some extent the field research of one of these virologists (#heinsbergprotokoll) at the hotspot in the community of Heinsberg, nicknamed "Germany's Wuhan" (Connolly, 2020). More serious but still remarkable is when the radio podcast of another virologist is not only nominated for the *Grimme Online Award*, for which journalistic quality plays a major role, but also for the *Communicator Award* of the German Science Foundation. The difference between science journalism and the self-communication of science seems to become increasingly blurred in times of coronavirus. Less curious than paradoxical, finally, is that, at a time when the demand for information in the classic journalistic media is higher than it has been for long, many of these very media are on the verge of ruin, with losses of 80% on advertising. If one wants to interpret such events and developments, one must carefully distinguish between what is due to the current exceptional situation and what is symptomatic of general trends in science communication and the mass media.

2. The Interaction between Science and Journalism

It has been more than six years since an intensified discussion about the quality of science communication began in Germany (e.g., acatech – National Academy of Science and Engineering, German National Academy of Sciences Leopoldina, & Union of the German Academies of Sciences and Humanities, 2017). Since then, there have been repeated calls to strengthen science journalism and to sharpen the distinction between genuine science communication and mere science PR. In recent years, however, there has also been growing pressure on scientists to regard communication with the general public as an additional compulsory task. The demands of the German Federal Ministry of Research are particularly far-reaching (and often criticised) in this respect.

The coronavirus crisis highlights the dilemma that could arise if science journalists' expertise is lost while scientists are overloaded with communication tasks. This problem becomes even more acute in a small field of research as very few experts have specialised in coronaviruses. In the pandemic, these experts are to press ahead with research at full speed on the one hand, but on the other hand they are expected to be available for the media. Science journalists also complain that health authorities and research institutions increasingly tend to channel information through their press offices so strictly that reasonable investigation becomes hardly possible. For example, questions for press conferences have to be sent in days in advance so that journalists have even joked that the way German health authorities carry out press work in those days is almost reminiscent of totalitarian states.

Another well-known phenomenon could be observed particularly vividly in coronavirus time: a convergence of science journalism and self-communication of science (Russ-Mohl, 2012). In this particular case, the publicly funded *Norddeutscher Rundfunk* produced an almost daily podcast with Christian Drosten, recently featured in *Science*, and probably the leading coronavirus expert in Germany. Thus, a broad public of a prominent radio station received first-hand, not press-office filtered information from a competent scientist. In this respect, considering the exceptional situation, the mentioned double nomination for a *Grimme Online Award* and the *Communicator Award* (as a 'special one-time prize') may be justified. However, from the overarching perspective of journalism research, the format may be regarded as another symptom of the described convergence between science journalism and science's self-communication. From a pessimistic point of view, it could even mark the beginning of a relapse into long gone times of 'embedded' science journalism, in which science journalists, instead of persistently inquiring watchdogs, are once again degraded to well-behaved cheerleaders (Rensberger, 2009).

Furthermore, the enormous reach of the podcast should not blur the fact that the format of an expert almost monologuing for 30 to 45 minutes, often without critical questioning of the present journalist, would hardly be suitable for popular science journalism beyond the crisis. It is true that the explanations provided are often helpful for educated listeners, but without the extremely high intrinsic pre-interest in view of the pandemic probably far fewer people would follow. However, even if you do not understand everything these days, listening to a potential rescuer from the threatening virus should make many users feel good. Such an emerging personality cult reminds a little bit of Stephen Hawking's book, *A Brief History of Time*. Gail Vines (1997) once explained its success as follows: "Some say a science book can become a 'talisman'—a reassuring thing to have on the shelf at home, even if you can't understand it." In this respect, both the success of a quite sophisticated format and the emergence of a scientist personality cult are remarkable, but they are rare phenomena that may not be easily transferred to the times after Covid-19.

3. The Role of Classical, Social, and Fake Media

The second major area on which Covid-19 puts a special emphasis is the distribution of roles between classical and social but also on fake media. In an international comparison, the trust in Germany's established media before the crisis can be considered quite high. Intensive debates about 'fake news' and hate comments had led to a loss of trust in social media a few years ago, as longitudinal research by the Mainz Media Trust Study (Mainzer Langzeitstudie Medienvertrauen, 2020) indicates. It will be interesting to see how coronavirus will have affected trust in journalism in the future. In any case, the use of traditional media during the crisis has increased dramatically. Many, even young users, seem to be returning to public television (AGF Videoforschung, 2020). Initial surveys indicate that TV is used much more frequently to provide information about Covid-19 than, for example, social media channels (COSMO, 2020). Similarly, many newspapers and magazines report an all-time high of hits on their online pages and a strong rise in the number of digital subscriptions. Again, it remains to be seen whether this trend will continue when the crisis has passed by (or already when people are no longer encouraged to stay at home).

Another question is the quality of reporting on Covid-19. While national daily and weekly newspapers, science editors and especially the journalistic Science Media Center Germany predominantly receive a positive evaluation, communication scholars have criticised television coverage as a "special form of court reporting" (Jarren, 2020). Too often the same experts would have been asked, mainly a handful of virologists, while other disciplines such as social and political scientists, psychologists, or ethicists would have been underrepresented. Other points of criticism concern well-known deficits of journalism: the handling of numbers and statistics (here, for example, of affected people) or the concentration on individual cases (e.g., Meier & Wyss, 2020; for a summary of the criticism see Russ-Mohl, 2020).

The observation that, initially, the side effects of measures against the pandemic were not sufficiently addressed by asking also enough (non-virologist) experts is correct, but this has changed in the course of reporting. As far as the variety of virologists who have their say is concerned, it must be noted that corona viruses are not a common field of research. The choice of experts is therefore limited and as all media wanted to talk them, it automatically led to a shortage of experts. However, the criticism that there had been too much 'announcement journalism' may also be justified.

The criticism by academics is in turn criticized by journalists as too sweeping and without considering the extreme working conditions for journalists these days.

Another problem with the communication scientists' criticisms of the classical media is that they receive much applause from the wrong side, having been misused in many fake news articles as 'proof' of conspiracy theories against the 'mainstream' media.

It is not yet possible to say what impacts fake news in the 'alternative' media has on public opinion about the pandemic. In a preliminary study, researchers from Muenster and Munich (Boberg, Quandt, Schatto-Eckrodt, & Frischlich, 2020) established a computational content analysis of a corona-related sample consisting of 2,446 alternative, 18,051 mainstream, and 282 fact-checking posts. One of the results was:

> Alternative news media stay true to message patterns and ideological foundations identified in prior research. While they do not spread obvious lies, they are predominantly sharing overly critical, even anti-systemic messages, opposing the view of the mainstream news media and the political establishment. (Boberg et al., 2020, p. 1)

Furthermore, the "majority of posts mirrored traditional mainstream media reports in terms of their topical structure and the actors involved" (Boberg et al., 2020, p. 17). The authors conclude that the observed information mix (or "pandemic populism"; Boberg et al., 2020, p. 17) with a recontextualization into an anti-systemic metanarrative is much more likely to contribute to the feared 'infodemic' than simple lies. For media users, such a mix is much more difficult to unmask than just highly non-credible disinformation bits. More recently, there is also some evidence that conspiracy theories have received much more attention since late April/early May.

Such results speak in favour of the need of the investigation skills of professional journalism to navigate media users through the observed mix of truths, half-truths, and lies. However, this highlights a paradoxical situation: On the one hand, as also the media data underline, the demand for reliable information from serious news media is growing in the corona crisis, but on the other, these established, often privately financed media are now suffering severe economic losses (Meier & Wyss, 2020). As already mentioned, publishers are reporting advertising declines of 80%, and many have announced short-time working. The same virus that has once again increased the demand for their product could also herald their final end.

4. Conclusion: Five Theses

1. The corona crisis underlines the necessity of a reform of science communication of research institutions. Instead of primarily promoting the reputation of their own institution, the press and PR work must be strongly committed to the information about science—which would also create capacities to support extremely busy scientists with honest communication even in times of crisis. This may require new forms of organisation for PR work in these institutions. Furthermore, in the communication of complex topics, different scientific disciplines must be considered simultaneously.

2. The success of individual formats in the corona crisis bears the temptation for television and radio to build up a new cult of stars around individual researchers—and to offer them a stage that is hardly ever accompanied by journalism. However, more TV professors as solo entertainers and cheap content producers are not a solution for keeping the public informed. Competently selected scholars from a wide range of disciplines are important discussion partners in journalistic media. But they need informed and critically inquiring journalists as counterparts. This especially applies to government scientists, who must not be accompanied by mere announcement journalism.

3. Future media criticism should be more solution-oriented. In Germany, the fierce and only partially justified media criticism by academics was apparently understood by some journalists as know-it-all behaviour of securely paid professors towards a profession under extreme conditions and, financially, sometimes with its back to the wall. One way forward for academics could be to provide the editors with assistance in such cases (e.g., direct help in dealing with statistics) rather than simply analysing the deficits. In analogy to 'constructive journalism' a more 'constructive media criticism' should emerge to clearly support the role of journalism in a democracy, not to be misused as a key witness for alternative fake media.

4. The corona crisis has once again demonstrated how urgent it is for the general population to receive more training in media and source competence in schools and further education. The susceptibility of many people to targeted misinformation can be as risky as susceptibility to an aggressive virus. However, the kind of 'misinformation mix' observed has shown that many sources can often only be unmasked by professionals.

5. The corona crisis has shown the need for professional journalistic sources just as clearly as it has affected many of these sources in its business models. Reliable journalism, however, is as relevant as science or the health system. A support for journalism in the future is inevitable, and tax money can flow into it if the independency of the reporting is ensured. To this end, the money could be allocated directly to authors on the basis of peer review by journalists, following the model of research funding. Such grant procedures have already been established in the midst of the crisis: In April, the German Association of Science Journalists, for example, launched a donation-financed funding initiative which, following a peer review process, promotes investigations around the pandemic. Such initiatives should be continued and expanded.

In summary, the Covid-19 pandemic has immediate effects on the media and communication system, which in a few cases are atypical and likely to disappear again

after the crisis. However, there is some evidence that the crisis has, above all, accelerated and made more visible developments and deficits that existed before. A seven-year-old quotation from Martin Bauer (2013) illustrates that not everything observed above is new: "When independent science journalism is most needed, its economic basis is eroding." In the era of corona and its aftermath, this statement is truer than ever.

Conflict of Interests

The author declares no conflict of interests. However, he is member of the jury of the *Communicator Award* of the German Science Foundation as well as of the German Association of Science Journalists, both mentioned in the commentary.

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COGITATIO

Media and Communication (ISSN: 2183–2439)
2020, Volume 8, Issue 2, Pages 471–474
DOI: 10.17645/mac.v8i2.3224

Commentary

Science Journalism and Pandemic Uncertainty

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Submitted: 1 May 2020 | Accepted: 5 May 2020 | Published: 26 June 2020

Abstract
Novel risks generate copious amounts of uncertainty, which in turn can confuse and mislead publics. This commentary explores those issues through the lens of information seeking and processing, with a focus on social media and the potential effectiveness of science journalism.

Keywords
Covid-19; information processing; information seeking; science journalism; social media

Issue
This commentary is part of the issue "Health and Science Controversies in the Digital World: News, Mis/Disinformation and Public Engagement" edited by An Nguyen (Bournemouth University, UK) and Daniel Catalan (University Carlos III of Madrid, Spain).

As I write this commentary, Covid-19 continues its relentless march across nations, neighborhoods and families. While stringent control measures are beginning to weaken the coronavirus's foothold in some parts of the world, scientists continue to scramble to understand this novel threat and to develop ways to intervene.

What fertile ground for perceptions of uncertainty! Both communication scholars (see, for example, Krause, Freiling, Beets, & Brossard, 2020) and savvy science journalists such as *The Atlantic*'s Ed Yong (2020) are turning their attention to uncertainty as both a facilitator of and a roadblock to functional use of Covid-19 information. Front and center in these explorations is social media, where information, misinformation and disinformation all flourish. In this brief commentary, I will reflect on the ways in which social media are affecting uncertainty perceptions about the pandemic, as well as on ways in which journalists can contribute to a more accurate reckoning in this crisis.

First, a quick look at uncertainty itself. I like to think of uncertainty as an awareness of what we do not know. Where that uncertainty resides and how it is articulated varies, according to Kahneman and Tversky (1982), who divide uncertainty into two domains: external and internal. External uncertainty captures the limitations of evidence in the external world, articulated in journal articles, in TED talks by experts, in conversations with our doctors. Internal uncertainty, on the other hand, is reflected in our personal judgments about the risks around us. Those perceptions may be influenced by an understanding of what we do not know (uncertainty), as well as, inadvertently, by phenomena of which we are not aware (ignorance).

Kampourakis and McCain advance this understanding of uncertainty by themselves employing two dimensions. In their recent book, *Uncertainty: How It Makes Science Advance* (Kampourakis & McCain, 2019), they distinguish between epistemic and psychological certainty. Epistemic certainty requires the presence of evidence that is "so strong that it makes it *impossible* that you could be wrong" (Kampourakis & McCain, 2019, p. 7, italics in original), while psychological certainty reflects "how strongly we believe something" (Kampourakis & McCain, 2019, p. 6). Since science can never muster enough evidence to enable epistemic certainty, they argue, we must live with personal, psychological uncertainty and better understand the factors that influence it. Kahneman and Tversky, I believe, would agree.

Those factors include the extent to which a person is willing to seek out and then process information ef-

fortfully, as systematic processing has long been associated with more accurate risk perceptions. Alas, we humans have never been good at this. We typically engage in rather superficial information seeking and processing, relying on small dollops of information from a modest cadre of sources (sometimes even one source will do!) for even the most important decisions. And when it comes to judgments of the credibility of evidence about a risk, that means we are far more likely to judge the credibility of information *channels* rather than engaging in the more effortful process of evaluating information *sources*. Assuming that stories in *The Guardian* or on *Fox News* are trustworthy saves individuals the time needed to evaluate the credibility of each of the many sources that they encounter in the stories offered by those channels.

German psychologist Gerd Gigerenzer maintains that relying on such "rules of thumb" to make rapid decisions can be quite functional, as that reliance is often based on years of experience with the world around us (see, for example, Gigerenzer, 2015). I get that. But how can we extract reliable information when we encounter a novel threat *and* when our information environment is awash in contradictory information? That, in a nutshell, is the situation we face with the Covid-19 pandemic.

Uncertainty in the face of health threats scares people, and novel threats such as Covid-19 maximize the perception of uncertainty in several ways. For one thing, as of this writing we truly know little about this virus, whose official name, conferred only in February 2020, is "severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2)'' (Joseph, 2020). The illness itself is called Covid-19, which stands for "coronavirus disease 2019"; I will use that latter term henceforth. Scientists are continually unearthing information about this coronavirus, but external/epistemic uncertainty remains extremely high. Ed Yong, in his April 29 article, notes that much about the pandemic remains "maddeningly unclear" (Yong, 2020). Even systematic information seekers and processors, as rare as they are, are hard-pressed to learn enough about the virus and its impact to feel even modestly efficacious.

Another uncertainty generator is the wide variance in policy responses to the spread of Covid-19 both across countries and within them. While one country remains virtually locked down, another restricts only the elderly and infirm. While one city extends orders to stay home, another opens restaurants and hair salons. Country leaders uniformly express caution, but their messaging reveals wildly varying levels of coping with the pandemic.

Finally, the internet and social media have played a major role in exacerbating uncertainty perceptions. Many individuals worldwide now use social media as their primary—perhaps their only—news channel, although surveys in the US indicate that Americans regard social media as less trustworthy deliverers of news than more traditional channels. A recent survey of US adults about their pandemic perceptions found high levels of distrust of social media channels; for example, nearly 50% of respondents said that they distrust Facebook as a source of Covid-19 information (Ballew et al., 2020). The most trusted sources of information emerging from that survey, not surprisingly, were personal physicians and infectious disease experts.

Reliance on less trustworthy channels, such as stories posted on one's Facebook feed, seems to make no sense. But scholars who study channel use have found that, given two factors influencing channel choices—the likelihood of finding relevant information and the 'cost' of accessing a channel—the latter often trumps the former. For example, although we prefer to interact with medical professionals when we need health information, we rarely do so. Instead, we 'make do' with mediated channels and the internet because the cost—both in terms of time and money—is much less.

However, reliance on less trustworthy channels opens the door to misinformation (information that is inadvertently inaccurate) and disinformation (information that is deliberately inaccurate) about the pandemic. In mid-April, UN Secretary-General António Guterres warned of a "global misinfo-demic" around the world prompted by "falsehoods" on the airwaves and "wild conspiracy theories" on the internet (United Nations, 2020). We know that false messages are shared more frequently online than are accurate ones, thanks to their high levels of emotional content and vividness (Vosoughi, Roy, & Aral, 2018). And we also know that the presence of conflicting messages in one's social feed makes it more difficult for an individual to distinguish the credible from the non-credible (Karduni et al., 2018). That means this avalanche of inconsistent, sometimes misleading information can dramatically increase perceptions of uncertainty.

We are desperate to reduce uncertainty in times like this in order to select a path through an imminent risk, and communication theories suggest a number of uncertainty reduction drivers that influence our seeking and use of information. For example, Kim Witte's Extended Parallel Process Model (Witte, 1994) predicts that fear combined with a sense of helplessness can lead a person to try to bury a problem by ignoring it. In such situations, individuals may avoid information altogether and engage in 'business as usual.'

Another driver is our tendency to perceive ourselves as more immune to a risk than are others. Multiple studies over the years have found that we tend to downplay our likelihood of harm from risks of all kinds. When asked, we report that 'others' are far more likely to be harmed than are we. Dubbed 'optimism bias' (Weinstein, 1989), this sense of personal invulnerability can lead a person to readily ingest even conflicting information about a risk but then to set aside the information because it is 'not about me.' A recent survey supporting this "me/them" differential pattern found that, while 62% of Americans thought the coronavirus will do a "great deal" of harm to people in the country, only 25% felt that the virus would harm them personally (Ballew et al., 2020).

A third important driver is to limit one's exposure to conflicting information by employing that channel heuristic, defaulting to the information channels we deem credible. That means that individuals, although they may access a similar *volume* of messages about the pandemic, are not encountering the *same* messages. Beliefs about what is true begin to vary in dysfunctional ways at an aggregate level, leading to a challenging situation: Individuals may report relatively high levels of Covid-19 knowledge but may, in fact, 'know' wildly dissimilar things.

Intensifying this channel heuristic is the early politicization of the Covid-19 pandemic itself. Nisbet and colleagues have tracked this process in other science issues and found that information about a science issue is usually driven largely by the scientific community in initial stages but then is gradually dominated by political sources (Nisbet & Fahy, 2015). Over time—think climate change, evolution, vaccines and autism—the issue becomes firmly embedded in ideological discourse, encouraging use of information channels that help support those ideological viewpoints. While issue politicization in science is, unfortunately, not unusual, the speed with which the coronavirus pandemic became politicized has been breathtaking. Political figures and ideological groups began building partisan narratives about the risk immediately, competing directly with science narratives that sought to focus on evidence.

So how can journalists negotiate these volatile waters in ways that deliver information that can help readers maintain an accurate sense of pandemic uncertainty? For one thing, science journalists continue to privilege scientific sources and, although trust in all occupations has declined in the US over the decades, scientists and physicians remain high in the credibility line-up. Most of us are more likely to believe what scientists tell us about a scientific issue than what we glean from other types of sources.

For another thing, a large contingent of news consumers continues to rely on mediated channels for information, where journalists gather and evaluate information before packaging it for public consumption. This gives specialized journalists an opportunity to maintain some control over the Covid-19 narratives. The quality of science journalism stories generally has increased over the years, and efforts to cope with declining revenue and competition from social media has sparked an increase in analytical stories, which concentrate on context and promoting understanding. The piece by journalist Ed Yong (2020) is an excellent example of that trend. Nisbet and Fahy (2015) devote an entire article to a discussion of "knowledge-based" journalism as a "fix" for the volatile information world journalism now inhabits.

Finally, a dramatic increase in fact-checking among media organizations around the world gives audiences the opportunity to access almost immediate comparisons between claims and evidence for or against those assertions. Krause et al. (2020) warn that issues of trust can attenuate the power of fact-checking, but journalists' willingness to analyze the validity of truth claims is a welcome step.

Conflict of Interests

The author declares no conflict of interests.

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COGITATIO

Media and Communication (ISSN: 2183–2439)
2020, Volume 8, Issue 2, Pages 475–479
DOI: 10.17645/mac.v8i2.3200

Commentary

Empowering Users to Respond to Misinformation about Covid-19

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Submitted: 28 April 2020 | Accepted: 8 May 2020 | Published: 26 June 2020

Abstract
The World Health Organization has declared that misinformation shared on social media about Covid-19 is an "infodemic" that must be fought alongside the pandemic itself. We reflect on how news literacy and science literacy can provide a foundation to combat misinformation about Covid-19 by giving social media users the tools to identify, consume, and share high-quality information. These skills can be put into practice to combat the infodemic by amplifying quality information and actively correcting misinformation seen on social media. We conclude by considering the extent to which what we know about these literacies and related behaviors can be extended to less-researched areas like the Global South.

Keywords
Coronavirus; correction; Covid-19; misinformation; news literacy; social media

Issue
This commentary is part of the issue "Health and Science Controversies in the Digital World: News, Mis/Disinformation and Public Engagement" edited by An Nguyen (Bournemouth University, UK) and Daniel Catalan (University Carlos III of Madrid, Spain).

1. Introduction

Social media are often blamed for spreading misinformation. During the Covid-19 pandemic, the World Health Organization (WHO) raised concerns about an "infodemic" (WHO, 2020), as social media amplify and exacerbate the spread of misinformation and uncertainty that has long surrounded emerging health issues (Dalrymple, Young, & Tully, 2016; Zarocostas, 2020).

Misinformation on social media is a problem that must be taken seriously in the case of Covid-19. Misinformation circulates surrounding the origins of the virus, how it spreads, and how to cure it (Brennen, Simon, Howard, & Nielsen, 2020), which could deter effective preventative behaviors. For example, misinformation about chloroquine as a "cure" for Covid-19 has resulted in negative health outcomes including death (Lovelace, 2020).

At the same time, the Covid-19 pandemic represents a novel context in which to consider how to mitigate misinformation. The voracious public appetite for news (Jurkowitz & Mitchell, 2020b; Koeze & Popper, 2020) creates an opportunity to leverage this interest into long-lasting, effective information consumption habits that could serve as a grounding for online behaviors.

Building news literacy and science literacy provide a foundation to improve information consumption processes by giving social media users the tools to identify, consume, and share high-quality information regarding Covid-19. With these tools, users can expand the reach of expert organizations and correct misinformation on the virus as it spreads.

2. Bolstering News and Science Literacy

Growing concerns about misinformation have sparked a reemergence of interest in how news literacy might help audiences make informed information decisions (Mantas, 2020). News literacy is defined as 'knowledge of the personal and social processes by which news is produced, distributed, and consumed, and skills that allow users some control over these processes' (Vraga, Tully, Maksl, Craft, & Ashley, in press), and must be developed in combination with a sense of efficacy, social norms about the value of news literacy, and positive attitudes towards the application of news literacy.

Applying news literacy provides one solution to help people manage social media environments, where good and bad information comingle (Vosoughi, Roy, & Aral, 2018). Social media information surrounding Covid-19 exemplifies this: One study found that 48% of Americans said they have seen at least some made-up news about Covid-19, and this percentage was highest among those who say social media was the most common way they get news (Jurkowitz & Mitchell, 2020a; Schaeffer, 2020).

Previous research has suggested that familiarity with news routines and experience with news literacy helps audiences identify misinformation (Amazeen & Bucy, 2019; Kahne & Bowyer, 2017) and reduce their acceptance of conspiracy theories (Craft, Ashley, & Maksl, 2017). Likewise, news literacy and valuing news literacy are associated with more skepticism of information on social media (Vraga & Tully, 2019). Therefore, a background in news literacy may also help people identify misinformation regarding Covid-19.

Given the emergent nature of the crisis, however, we must consider what can be done to boost news literacy and its application to information about Covid-19 *right now*. Even those high in news literacy may not *apply* their knowledge and skills to the difficult task of differentiating high-quality from low-quality information (Tully, Vraga, & Smithson, 2018; Vraga et al., in press). Therefore, interventions that translate news literacy into behaviors that shape information consumption surrounding Covid-19 should be prioritized.

This translation is not necessarily easy. Our recent research shows that a tweet offering tips for identifying misinformation (such as double-checking the source, being aware of your reaction, and watching for red flags) led people to rate a false news story about the flu vaccine as less credible (Tully, Vraga, & Bode, 2020). Notably, however, that message did *not* make people more receptive to expert correction on the topic, which is often connected to reduced misperceptions (Vraga, Bode, & Tully, 2020). Other news literacy messages that reminded people about biases in news and personal interpretations were ineffective for recognition of misinformation and reception of expert correction (Tully et al., 2020; Vraga et al., 2020).

This research provides concrete suggestions for news literacy efforts on social media. First, news literacy messaging should offer concrete recommendations regarding misinformation and its characteristics, rather than general messages about information processing. Second, invoking injunctive and descriptive norms about what people *should be* or *are already* doing in terms of critical information processing may help people see sharing high-quality information as both normal and important (Cialdini et al., 2006; Vraga et al., in press). Third, frequent posting of news literacy messages may be necessary to have an impact, as our previous research found that news literacy messages often went unnoticed (Tully et al., 2020). In addition, repeated messages can build on each other and address distinct strategies and behaviors.

As one example, the News Literacy Project's (2020) "sanitize before you share" posts, which offer four concrete steps to stop the spread of misinformation on Covid-19, meet many of these criteria. Likewise, National Public Radio released a cartoon sharing tips for identifying and responding to misinformation that may prove not only informative but engaging (Jin & Parks, 2020). These types of messages should be shared frequently and widely to boost their impact, and may be improved by invoking normative beliefs about the value of news literacy.

Messages that focus on scientific or health literacy could further the utility of news literacy efforts. Public knowledge regarding the scientific process is generally low, which can be problematic in the context of a rapidly evolving pandemic like Covid-19. For example, a 2019 Pew research study (Kennedy & Hefferon, 2019) found that 76% of Americans can define an incubation period, 67% understand that science is an iterative process, and 60% are aware of the importance of a control group in determining drug effectiveness. This knowledge is directly relevant to Covid-19, as efforts to mitigate the spread of the disease are tied to the relatively long incubation period, and promising new drugs require clinical trials with control groups. Helping the public understand the scientific process may facilitate acceptance of evolving recommendations like the use of face masks to prevent the spread of Covid-19, without undermining trust in scientists and health professionals.

3. Empowering Users

With a stronger foundation in understanding news, science, and health domains, users may not just be more critical consumers of information on Covid-19, but emboldened to improve the information environment for everyone. One study of UK news sharers found that many more people had shared content they later found out was misinformation on social media (that is, had shared it thinking it was true) than those who knowingly shared misinformation (Chadwick, Vaccari, & O'Loughlin, 2018). If much of the misinformation circulating on social media is shared unwittingly, news and scientific literacy that helps people distinguish between good and bad informa-

tion on Covid-19 could reduce the amount of misinformation shared.

Another way that news and scientific literacy may be acted upon is through more active curation of social media feeds that contain high-quality information to be shared. The American public broadly approves of the job of public health officials during the Covid-19 outbreak (Funk, 2020) and holds favorable views of the Centers for Disease Control and Prevention (CDC) and the Department of Health and Human Services (Pew, 2020). If news literacy behaviors involve not just consuming but sharing accurate news, these positive views of experts may translate into people sharing expert content about Covid-19 on their own feeds, broadening the reach of this content.

News literacy advocates may also encourage users to correct Covid-19 misinformation they see on social media as an extension of their news literacy knowledge and skills. The "sanitize before you share" post from the News Literacy Project could expand that sanitizing behavior to include correcting others; the NPR cartoon already offers that suggestion. Experimental studies demonstrate that user corrections of health misinformation about a range of controversial and emerging health issues reduce misperceptions among the community seeing that interaction (Bode & Vraga, 2018; Vraga & Bode, 2017). Now is an ideal time to encourage and facilitate this user correction.

4. A Global Response

Just as the pandemic is a global problem that requires a global response, so, too, should efforts to bolster science and news literacy and to reduce misinformation around Covid-19 be global. However, current research is not evenly distributed. An April 2020 compilation of public opinion polls reflects the discrepancy in data about public understanding of the virus—accounting for 147 polls, 29 were conducted in the United States, 23 in the UK, and 12 in China, with far fewer in the rest of the world (Gilani Research Foundation, 2020). Although not an exhaustive list, this account provides a snapshot of the limited data about Covid-19 from the Global South and even from many parts of Europe.

Similarly, we have limited research on news literacy outside of the Global North. One notable study found that news literacy varies widely across countries and that literacy matters for how people use social media for news and information (Newman, Fletcher, Kalogeropoulos, Levy, & Nielsen, 2018). Designing interventions and messages that address the core tenets of news literacy and are also adaptable to distinct contexts is a challenge that researchers and practitioners must address as a means of equipping audiences with the knowledge and skills they need to engage with Covid-19 information (Vraga et al., in press). For example, in many countries, WhatsApp is a popular source of information and connection, making it fertile ground for the spread of misinformation (Resende et al., 2019). Developing news literacy interventions for WhatsApp and similar apps represents both a challenge and opportunity as both misinformation and correction are likely to be more trusted when originating from close ties (Margolin, Hannak, & Weber, 2018).

More work is needed to understand how well research on science and news literacy translates across contexts. For example, trust in government, health officials and media systems vary widely by country, which affects how information is received and acted upon by citizens (AFP, 2020; Bratton & Gyimah-Boadi, 2016). Asking people to promote messages about Covid-19 from public health organizations may not be merited or useful in all contexts. Likewise, norms around social media uses and expectations about information dissemination on social media platforms likely vary by country, culture, and context (Newman et al., 2018).

5. Conclusion

In many ways, Covid-19 represents a novel pandemic, in terms of its spread and impact on the global economy as well as the media environment in which people learn about the virus and its effects. But we can build from existing research to improve how we respond to misinformation about the virus. Fostering news and science literacy provides a flexible solution that can help people distinguish quality information about Covid-19 and empower more active curation of their social media feeds to protect themselves and others from misinformation. To be effective, we must consider global implementation, starting with an improved understanding of diverse contexts and existing science and news literacy to develop appropriate interventions.

Conflict of Interests

The authors declare no conflict of interests.

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Media and Communication (ISSN: 2183-2439)

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