**Science and the Politics of Misinformation**

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The transformation of the communication environment has been a defining feature of the 21st century. The emergence of media choice at the end of the 20th century (e.g., cable news, the Internet), and later social media, means we now live in a “fragmented and polarized media environment” (Iyengar and Massey 2019). This brings a host of positive consequences, such as easier access to information and worldwide connectivity, but also introduces new challenges, such as echo chambers where people evade information contrary to their standing beliefs (Sunstein 2001). Perhaps the most troubling consequence is the increased likelihood of misinformation and fake news: there are no longer trusted gatekeepers who curate information for accuracy, so anyone can claim to be an expert while disseminating falsehoods.

Misinformation has become a global problem that affects all aspects of life and garners much attention in the political sphere. This is in part due to the 2016 U.S. election, when the Russian government created fake social media avatars with names like “Blacktivist” and “army\_of\_jesus” to stoke partisan outrage, duping millions of Americans into sharing memes about the turpitude of opposing partisans (e.g., Grinberg et al. 2019). Misinformation about science, however, poses a distinct challenge. Science exists to provide systematic knowledge to improve decision-making (Dietz 2013), but the changed media environment has undermined the privileged cultural authority of science by allowing anyone to claim to be “scientific”.

There is an urgency to understand and address science misinformation, illuminated most recently by the COVID-19 pandemic. As we write this chapter, the social-scientific community is mobilizing to advise political actors about the behavioral challenges posed by COVID-19 (Van Bavel et al. 2020). This includes the major challenge of communicating science to the public. Internationally and within the United States, government leaders differ dramatically in their embrace or disdain of scientific expertise. Early evidence indicates that false information, rumors, and conspiracy theories proliferate through the public. At minimum, this misinformation strains experts’ abilities to communicate to the public and coordinate policy; at worst, it leads individuals to make decisions that are downright dangerous.

In this chapter, we summarize research on scientific misinformation and the challenges it poses to the implementation of government policy. Science is certainly valuable for individual decision-making in personal health and other domains. The challenge here is that science in the public sphere often becomes politicized (Oreskes and Conway 2010), with public attitudes and public policies diverging from scientific consensus on topics such as climate change, genetically modified organisms (GMOs), or vaccines (Flynn et al. 2017; Scheufele and Krause 2019). In what follows, we define the problem of science misinformation and misperceptions, discuss its causes, and review potential antidotes.

**Contradicting the Best Available Evidence: Definitions and Nomenclature**

One challenge in studying misinformation concerns the proliferation of terms throughout the literature. We thus hope to offer some conceptual clarity. First, we distinguish between communications and beliefs. *Misinformation* refers to a communication that is “false, misleading, or [based on] unsubstantiated information” (Nyhan and Reifler 2010: 304). This comes in various guises: rumors, defined as misinformation that “acquire their power through widespread social transmission” (Berinsky 2017: 242-243), fake news, defined as misinformation that “mimics news media content in form but not in organizational process or intent” (Lazer et al. 2018: 1094), and conspiracy theories attributing events to “the machinations of powerful people, who attempt to conceal their role” (Sunstein and Vermeule 2009: 205). *Misperceptions*, in contrast, are attitudes – they are “cases in which people's beliefs about factual matters are not supported by clear evidence and expert opinion – a definition that includes both false and unsubstantiated beliefs about the world” (Nyhan and Reifler 2010: 305).

What, then, does it mean to be “false” or “not supported by clear evidence”? This is particularly tricky when it comes to science: the evidentiary standard is ambiguous because the scientific method never allows one to prove a hypothesis is correct. We build on Nyhan and Reifler (2010) and Flynn et al. (2017), who differentiate between information or perceptions that are (1) “demonstrably false” – that is, contradictory to objective empirical evidence – and (2) “unsubstantiated” – that is, unsupported by evidence and expert opinion. This distinction may have normative implications, as Levy (2020) investigates whether demonstrably false and unsubstantiated misperceptions differ in their prevalence and the extent to which they can be corrected. But when it comes to science, the unsubstantiated standard seems most appropriate given the impossibility of definitive conclusions. Thus, we define scientific misinformation as a claim made in political communications that is unsupported or contradicted by the scientific community’s best available information (Druckman 2015).

Why should we care if people are misinformed about science? First, it undermines the scientific community’s ability to provide systematic knowledge to “help nonscientists make better decisions” (Lupia 2013: 14048). Further, it can be worse for an individual to be misinformed and hold inaccurate beliefs than to be uninformed and hold no factual beliefs on some topic. When individuals form subjective attitudes from misperceptions, their decisions do not occur randomly but become systematically and deleteriously skewed (Kuklinski et al. 2000: 792-793). On the collective level, “misinformation may form the basis for political and societal decisions that run counter to a society’s best interest” (Lewandowsky et al. 2012: 107).

**Science Misinformation as a Public Problem**

The exact prevalence of misinformation and misperceptions is not entirely clear. What is clear, we think, is that some degree of public concern is warranted. But it is still important to keep in mind certain findings that may temper our alarm about misinformation in general. For example, political misinformation in the 2016 U.S. election “only reached a small proportion of the public who have the most conservative online information diets [Guess et al., 2020] and who are heavy Internet users (Nelson and Taneja, [2018](about:blank)), while those who are exposed to misinformation do not always believe what they read (Allcott and Gentzkow, [2017](about:blank))” (Li 2020: 126).

Yet, given the extent to which science is interwoven into governmental decision-making (Dietz 2013), there may be unique reasons to be concerned when it comes to misperceptions about science. Many of the most prominent misperceptions concern science topics. In a meta-analysis on health-related information, particularly vaccines and infectious diseases, Wang et al. (2019: 8) conclude, “there is broad consensus that misinformation is highly prevalent on social media and tends to be more popular than accurate information.” In addition, large proportions of the public hold misperceptions about climate change, the safety of GMOs, or a link between vaccines and autism (Flynn et al. 2017). Using 2019 ANES data, Jerit et al. (2020) show that the percent of respondents holding these misperceptions are 25.4%, 46.6%, and 15.5%, respectively. Sixty percent of respondents held at least one misperception, and individuals holding misinformed beliefs were confident in their answers.

A further reason for concern is that people do not invariably update their beliefs when offered information intended to correct or fix misperceptions. For example, in a meta-analysis of 32 experimental studies, Walter and Tukachinsky (2020) find that corrections do not eliminate the effects of misinformation, even though they tend to move attitudes in the intended direction on average. This broad conclusion appears transferable to science misperceptions specifically. Scholars have tested whether individuals, when exposed to corrective information, update their misperceptions concerning vaccines (Nyhan and Reifler 2015; van Stekelenburg et al. 2020), GMOs (Bode and Vraga 2015), climate change (Vraga et al. 2019), food safety (van Stekelenburg et al. 2020), or the size of the federal science budget (Goldfarb and Kriner 2017). The evidence confirms that corrections have a mixed record. As we discuss later, many scholars have sought to better understand the conditions by which corrections lead individuals to update their attitudes.

**Why Do Individuals Hold Misperceptions about Science?**

A myriad of individual-level and group-level factors have been theorized to influence the prevalence of misperceptions about science. The former concerns psychological processes following exposure to misinformation, and the latter concerns systemic factors that affect exposure in the first place.

***Individual Ability and Motivation to Evaluate Science***

The likelihood that individuals develop misperceptions about science depends on their *ability* and *motivation* to critically evaluate science information, and then recognize and reject misinformation. Regarding ability, individuals’ limited epistemic knowledge about science constrains their capacity to assess science information. For example, findings from a recent national survey show that 77% of respondents could not explain the idea behind a scientific study and 36% had trouble understanding probability, signaling major obstacles to conceptual understanding of the scientific process (Scheufele and Krause 2019).

Individuals also bring motivations to their consumption of science information that affects the likelihood of forming misperceptions, regardless of their abilities. Theories of motivated reasoning posit that people access and evaluate information in ways that fulfill certain goals and motivations (Kunda 1990). Individuals can be driven by accuracy motivation – in which case they are motivated to arrive at accurate conclusions – or they can be driven by directional motivations – in which case they are motivated to arrive at a particular, desired conclusion. For many policy decisions, scientific consensus serves as the most accurate, “factually competent” information available (Dietz 2013). However, individuals with directional motivations may pursue reasoning strategies that lead them to reject such consensus and develop misperceptions.

A common directional goal is one’s motivation to defend a prior-standing belief: individuals exposed to scientific information may resist updating their attitudes when the information does not cohere with standing beliefs. For example, Ma et al. (2019) study the effect of a consensus message concerning human-induced climate change. The results showed a backlash in which people who entered the study skeptical of climate change were unpersuaded by the message and updated their beliefs in the opposite direction. Druckman and Bolsen (2011) similarly show that, once people form opinions about emerging technologies like carbon-nanotubes and GMOs, they cling to those opinions even in the face of contradictory scientific information. Thus, people may maintain science misperceptions due to a motivation to protect their beliefs.

One’s defense of group-based identities constitutes another source of directional motivation. Many people want to maintain the beliefs held by their valued groups, regardless of scientific accuracy, to protect against costly social ostracization. For example, partisans in the U.S. often form beliefs on climate change, fracking, and other scientific issues to align with fellow partisans, regardless of the science (Kahan 2015). Identity-protective motivation does not guarantee misperceptions, but it is likely that individuals will develop misperceptions because their goal is group alignment instead of accuracy. One exception, though, may be if the relevant group is scientists themselves. van der Linden et al. (2018) argue that some individuals see scientists’ beliefs as a relevant group norm, which drives them to align their beliefs with the scientific consensus.

Core values can also underlie a directional motivation. In such cases, individuals may only accept science information if it fits their value system. Lewandowsky et al. (2013) find that conservatives and individuals who value free markets reject climate change when the science implies heavier government regulation. In another study, conservatives deny climate science when it is framed in terms of “fairness,” but accept it when it is discussed in terms of the more cherished value of “sanctity” (Wolsko et al. 2016).

It is worth noting that individuals with accuracy motivation can still develop misperceptions about science. For instance, people who rely on scientific and social consensus as heuristics to help them achieve accuracy may be wrong about the consensus. Scheufele and Krause (2019) cite survey data indicating that a majority of respondents erroneously believe there is no scientific consensus regarding the health effects of GMOs, or the proposition that the universe was created in the Big Bang. About one-third erroneously believe there is no scientific consensus on climate change and evolution. People also misestimate social consensus among their peers and the general public, particularly on environmental issues (Schuldt et al. 2019) and human-caused climate change (Mildenberger and Tingley 2019).

Furthermore, accuracy-motivated individuals may still exhibit directional bias regarding the information sources they judge to be accurate: individuals may evaluate scientists as trustworthy sources of information more frequently when science’s message is compatible with their standing beliefs (Kahan et al. 2011). As a result, partisan perceptions of source credibility can lead to polarized views on matters of science, despite accuracy motivation (Druckman and McGrath 2019).

***Systemic Factors that Encourage Misinformation and Misperceptions***

While individual-level factors influence susceptibility to misperceptions given exposure to misinformation, systemic factors determine the overall permeation of misinformation into the informational environment in the first place. One important factor is politicization. The politicization of science occurs when actors exploit uncertainty in the scientific process to cast doubt on findings (Bolsen and Druckman 2015). Unfortunately, the inherent uncertainty of science can be difficult to communicate to the public. Even when certain conclusions constitute a scientific consensus, they are vulnerable to politicization (Druckman 2017), and misinformation is more likely to spread as various science issues become politicized.

Another, closely related, factor is partisan polarization. Growing evidence suggests that enflamed partisan tensions in a more polarized political environment abets the spread of misinformation. In a study of 2,300 American Twitter users, Osmundsen et al. (2020) find that individuals with out-party animus are more likely to share fake news, particularly when they are Republicans. This suggests that polarization is partly fueling the proliferation of misinformation on the Internet. In addition, as political elites polarize on high-profile science issues like climate change, rank-and-file partisans have clearer cues about the “correct” party position. In such cases, partisans attend more to party endorsements than to substantive information when forming opinions (Druckman et al. 2013). Therefore, a polarized information environment implies both greater exposure to partisan misinformation and higher individual propensities to use party cues, increasing the likelihood that individuals form misperceptions.

Third, the evolved information environment may now be more amenable to spreading misinformation, through the rise of bots and trolls on social media platforms, the use of algorithms designed to garner clicks that reward outlandish stories, and the influence of dark money (Lazer et al. 2018; Iyengar and Massey 2019). Researchers hypothesize that structural aspects of technology and digital media facilitate the increased spread of misinformation, as a larger interpersonal network size, greater deindividuation, and ability to share or post immediately provides fewer constraints and inhibitions on online behavior (Brady et al. n.d.). Gossiping and the sharing of outrageous content, which would be costly behaviors in physical settings, are less costly online and may even yield rewards in the form of positive social feedback (Crockett 2017).

Given such social feedback incentives, misperceptions can be especially contagious if shared in a morally charged environment. Brady et al. (n.d.)’s MAD model of moral contagion shows how the growing strength of partisan group identity in the American electorate might enhance individual-level motivations. As a result, individuals are likely to share morally charged political messages that attack outgroup members and elevate ingroup members. The informational value of shared content is secondary to the social status and positive social feedback sharers receive from likeminded partisans in their social network. Thus, content that sparks moral outrage along partisan lines may quickly spread to a large number of viewers, regardless of its accuracy.

While the last quarter-century of media and social transformations have had many positive benefits, there have also been negative consequences that can increase the likelihood of scientific misperceptions. Politicized science, polarized parties, social media practices, and the interaction of these forces can lead to the spread of misinformation and the formation of misperceptions.

**Misperception Antidotes**

Next, we turn to antidotes – that is, strategies to combat the formation of scientific misperceptions. Many of these focus on communication strategies aimed at addressing the individual-level psychological drivers of misperceptions. These include inoculation messages, corrections, shifting motivations, and framing. Finally, we also discuss possible interventions to respond to systemic sources of misperceptions.

***Inoculation Messages***

One promising avenue to address misperceptions involves inoculations that warn people that they will be exposed to misinformation (Cook, Lewandowsky, and Ecker 2017; van der Linden et al. 2017). Inoculation theory (or “prebunking”) posits that this kind of warning – provided through a “weakened dose” of inaccurate information followed directly by a refutation – can result in resistance to misinformation. The inoculation works to establish an accurate standing belief in the recipient, which they will later “defend” when they encounter misleading information. For example, Bolsen and Druckman (2015) test inoculation techniques in survey experiments asking respondents about two novel energy technologies. The authors show that warnings are effective in the face of politicized communications. Scientific consensus messages about the benefits of each technology moved opinion for respondents who received a warning prior to receiving a contrary, politicized message. By contrast, respondents who only received a politicized message ignored the scientific consensus. Similarly, van der Linden et al. (2017) warned respondents they would be exposed to belief-threatening information (“some politically motivated groups use misleading tactics to try to convince the public that there is a lot of disagreement among scientists”) and then provided a preemptive refutation (“there is virtually no disagreement among experts that humans are causing climate change”). As in the above experiment, this technique restored the impact of scientific-consensus messages, despite politicization.

Cook, Lewandowsky, and Ecker (2017) explore inoculation messages highlighting the *argumentation tactics* employed in the politicization of climate science. Such tactics include the presentation of a “false balance” of evidence and the use of “fake experts” to manufacture doubt. In one study, they report that an inoculation message was effective at neutralizing the impact of a false balance of evidence. However, in a second study, the findings were more mixed: an inoculation message only reduced the effect of politicization among respondents who valued free markets.

Roozenbeek and van der Linden (2019a, 2019b) investigate whether prompting respondents to actively engage with inoculation messages confers resistance to misinformation. In an initial study, participants were provided facts about an increase in the number of police-related incidents involving Dutch asylum seekers (Roozenbeek and van der Linden 2019a). Small groups of respondents were randomly assigned to produce a fake news article on the topic by role-playing one of four different types of “characters”, including: (1) the denier; (2) the alarmist; (3) the clickbait monger; and, (4) the conspiracy theorist. The results showed that participation in the game increased resistance to political misinformation in a fake news article. In a large follow-up study, participation in the game increased people’s ability to detect misinformation and resist it, irrespective of individual-level factors such as political ideology.

Taken together, the results from these studies suggest that pre-emptively refuting science politicization may be an effective strategy when politicization can be anticipated. While this is not always possible, the theory and evidence on inoculations do provide one potential route to reducing misperceptions.

***Corrections***

A large literature explores the extent to which corrections lead individuals to discard factual misperceptions. As mentioned above, corrections do not entirely eliminate the effects of misinformation, but evidence suggests that they can be effective under particular conditions. Many findings in this regard follow from psychological concepts such as mental models or fluency. Individuals incorporate misinformation into larger “mental models of unfolding events” (Lewandowsky et al. 2012: 114), and may “prefer an incorrect model over an incomplete model” (114). Following, corrections tend to be more effective if they are detailed and provide an explanation of why a misperception is incorrect, and less effective if individuals preemptively generate reasons supporting the misinformation (Chan et al. 2017). Additionally, individuals may perceive information to be more accurate when they can recall it more easily – the information is characterized by high fluency (Berinsky 2017). As a result, corrections are less effective when misinformation is repeated more often (Walter and Tukachinsky 2020), and many scholars agree that a correction should not repeat the misinformation itself (Cook and Lewandowsky 2011).

While this research has generated insights concerning the conditions for successful corrections, overcoming directional motivations continues to be a fundamental challenge. One can expect corrections to be less effective the more they threaten an individual’s worldview or pre-existing attitudes. For instance, Bode and Vraga (2015) find that corrections are more effective for misperceptions concerning GMOs, compared with vaccines. The authors attribute the difference in part to prior-attitude strength. In Bolsen and Druckman (2015), directional motivations account for the findings that corrections were far less effective than inoculations. As discussed previously, directional motivations also interact with individuals’ evaluations of information sources. Studies of misinformation corrections are consistent with evidence suggesting that individuals value source trustworthiness more than source knowledge, and that directional motivations influence perceived trustworthiness (Jerit and Zhao 2020). This may be troubling in the context of science misperceptions, as it suggests that scientific expertise is insufficient for bolstering the effect of corrections. Given the overarching challenge posed by directional motivation in the case of corrections, we now discuss strategies that seek to address individuals’ directional motivations and worldviews more directly.

***Shifting Motivations***

One such strategy is to prompt accuracy motivation. As mentioned, such motivation does not ensure accurate beliefs, but it can help. Bolsen and Druckman (2015) find that a correction only worked when respondents were primed to pursue an accuracy motivation. Similarly, Pennycook et al. (2019) find that a prompt to think about “the concept of accuracy” reduces respondents’ propensity to share false and misleading news attacking their political opponents.

There are a variety of approaches to stimulating accuracy motivation. One approach involves attenuating the effects of directional motivation by satisfying the underlying goal (see Dunning 2015), which reduces directional rejection of accurate information. For example, Bolsen and Druckman (2018b) show that affirming participants’ worldview – even if it involves conspiratorial tendencies –increases their inclination to accept accurate scientific information. Alternatively, encouraging deliberations about science can induce accuracy (Dietz 2013). Finally, highlighting the salience or personal relevance of an issue can temper directional motivations and lead to accuracy, since holding inaccurate beliefs may have direct personal consequences. Indeed, this is one possible reason that residents of areas most affected by climate change often accept climate science (Scannell and Gifford 2013). The same has been found with regard to COVID-19 – in areas with more cases, people were less likely to form opinions about policies based on their partisan leanings (Druckman et al. 2020).

***Framing***

Another approach to combating misperceptions is framing, where messages strategically highlight considerations that may be persuasive for a target audience (Druckman and Lupia 2017). As mentioned above, a values-based directional motivation often leads to misperceptions when scientific findings are at odds with strongly held values; reframing seems especially effective for correcting such misperceptions. For example, Campbell and Kay (2014) demonstrated that reframing the need for climate action in free-market-friendly terms allowed proponents of laissez-faire economics to express greater belief in human-induced climate change. Other studies report similar success using moral value frames that appeal to conservatives, such as in-group loyalty, purity, and respect for authority (Feinberg and Willer 2013; Wolsko et al. 2016).

***Institutional and Techno-cognitive Strategies***

In addition to social-psychological approaches, scholars are examining the degree to which institutional and “techno-cognitive” strategies can combat the systemic changes in the information environment, discussed above, that exacerbate the spread of scientific misperceptions (Lazer et al. 2018). To address the institutional and financial roots of misinformation spread, a coordinated multidisciplinary effort is necessary to identify groups that finance, produce, and disseminate misinformation and politicization as a way to confuse the public and protect the policy status quo. Farrell et al. (2019) suggest several interconnected strategies to combat the spread of misinformation that entail: (1) academics working more closely with journalists and educators to disseminate inoculations or warnings when possible; (2) the use of lawsuits to defend climate scientists against personal attacks and to identify the most prominent misinformation creators and distributors; and (3) enacting legislation that requires greater financial transparency to eliminate hidden private contributions that shield both individuals and companies who produce fake news.

Another strategy involves using “technocognition [to] design better information architectures” to suit the “post-truth era” (Lewandowsky, Ecker and Cook 2017: 362). This approach advocates using technological adaptations to prevent the spread of misinformation, as well as cognitive approaches that might better educate and inform the public. For instance, social media outlets such as Facebook and Twitter can: (1) provide feedback to users that allows them to better identify fake news; (2) provide credible sources for different groups that will confirm when a particular story is false; (3) develop and employ algorithms that detect bots and eliminate their ability to spread misinformation; and, (4) identify the primary producers of fake news and eliminate their access to social media platforms. Of course, given the contemporary social and informational landscape, technological solutions must be accompanied by serious discussion of political and ethical complications.

**Conclusion**

Governments and foundations make massive investments in science with the intention of benefitting both individuals and societies. Yet, misperceptions among the public can undermine the potential positive impact of science. Concern about scientific misperceptions has increased in the last quarter century due to societal and technological changes, but our understanding of what underlies these misperceptions and possible ways to address them has also advanced. Furthermore, the COVID-19 pandemic is showcasing how quickly misperceptions form and spread, while also showing that social scientists – who quickly offered practical advice – can contribute to limiting that spread.

Perhaps the most substantial hurdle going forward is for researchers to identify interventions that can scale to large populations. This means not only overcoming technological challenges, but also finding ways – such as the aforementioned fake news game – to engage individuals. Another obstacle is to determine how research findings concerning inoculation should be incorporated into the communication environment. While inoculations appear to be more effective than corrections, little research has elaborated concrete strategies for targeting inoculation campaigns. This represents a considerable challenge, as it is difficult to forecast when misinformation will be widely disseminated. Finally, solutions must consider the interaction of individual psychology, institutional settings, and communication infrastructures. For example, some individuals hold intuitionist worldviews where they interpret events based on their feelings rather than empirical evidence (Oliver and Wood 2018: 48). Reaching and communicating with intuitive thinkers requires approaches that are quite distinct from those that would succeed with more “rationalist” thinkers. These challenges remind us of the work that still needs to be done to translate research findings into actionable steps for reducing misperceptions and their impact.

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