

ALLEA Discussion Paper #5

# Fact or Fake? Tackling Science Disinformation

May 2021



## About this Series

The ALLEA Discussion Paper series is an initiative to provide up to date and informed perspectives from the academic world on some of the most pressing issues facing societies across Europe and beyond. The objective is to contribute to and connect debates in the fields of science, society, and policy. It serves as a transnational forum of the academies of sciences and humanities for outstanding scholars to present and discuss their work within ALLEA. Issues may draw on workshop reports, statements, and position papers by ALLEA working groups or other ALLEA initiatives. The series provides an intellectual space to reflect on complex questions and potential solutions and seeks to inform policy decisions as well as the public debate.

## About this Paper

ALLEA has a keen interest in the interrelationship of trust, science, and society, especially where it concerns or includes science communication. To understand and respond more effectively to the underlying causes of science disinformation, ALLEA and its Member Academies, with the support of Fondazione Compagnia di San Paolo, initiated the project 'Fact or Fake? Tackling Science Disinformation', the findings of which are presented in this paper by an interdisciplinary scientific committee (listed at the end).



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# Executive Summary

The information landscape has undergone dramatic changes with the expansion of the internet and digital social media platforms. Information can be spread more rapidly and can reach more people than ever before. While this offers excellent possibilities to teach and educate and to disseminate information about research results and scientific evidence, it also comes with a downside: False information can be propagated with equal ease and speed.

This discussion paper describes and discusses the problems and the consequences of science disinformation in three areas of concern, namely climate change, vaccines and pandemics, and what we can do to increase awareness and minimize harm caused by the spread of disinformation. It does so by highlighting the societal value of the scientific method, research integrity, open science communication and the resulting trust in science. The underlying question is how to protect the pillars of science from the severe consequences of disinformation while maintaining openness and democratic principles.

This paper presents the central characteristics of science disinformation, its roots, its spread, and potential solutions. The mere existence of disinformation is hard to prevent in open societies with strong protection of individual rights and freedom of expression. The paper identifies underlying cognitive, social and economic mechanisms that amplify the spread of disinformation and evaluates potential solutions.

Extensive research over the past several years has identified cognitive features of the human mind, as well as fast and efficient transmission channels, that contribute to the prevalence of science disinformation in our societies. Potential solutions cover a range of psychological, technical and political measures including inoculation, debunking, recommender systems, fact-checking, raising awareness, media literacy, and innovations in science communication and public engagement. Together, they contribute to tackling problems such as knowledge resistance, pseudoscience, undermining of trust, confirmation bias, filter bubbles, echo chambers, and other problems related to science disinformation.

## **How can we protect the pillars of science from the severe consequences of disinformation while maintaining openness and democratic principles?**

After discussing concrete challenges for implementation in the three areas of concern - climate change, vaccines, and pandemics - the paper offers recommendations on how to encourage those with a factual knowledge base, i.e. scientists, to respond to misinformation, how to encourage science communicators and journalists to carefully check facts and sources, and finally how to raise awareness among policymakers about the importance of checking claims and the senders' underlying motives and intentions.

In a nutshell, the scientific committee and ALLEA call for

- » initiatives to raise science literacy and digital media literacy,
- » more dialogue in science communication practices,
- » a stronger focus on communicating how science works,
- » serious engagement with the public when exercising or communicating research,
- » valuing the virtue of intellectual humility when communicating scientific evidence,
- » the maintenance of good research practices and high ethical standards to ensure integrity and trustworthiness,
- » accountable, honest, transparent, tailored and effective science advice mechanisms.

The paper concludes with the suggestion to create a European Centre/Network for Science Communication which could develop central guidelines and recommendations in a European Code of Conduct for Science Communication, as well as coordinate initiatives to raise science and media literacy, and ultimately tackle science disinformation.

## Key Recommendations

- » Initiatives to raise science literacy and digital media literacy
- » More dialogue in science communication practices
- » A stronger focus on communicating how science works
- » Serious engagement with the public when exercising or communicating research
- » Valuing the virtue of intellectual humility when communicating scientific evidence
- » The maintenance of good research practices and high ethical standards to ensure integrity and trustworthiness
- » Accountable, honest, transparent, tailored and effective science advice mechanisms

# Introduction

## Science Mis- and Disinformation

False information is as old as humankind. Any knowledge void can be filled with beliefs or assumptions that are incorrect. Here we will focus on information that is known to be false, but that is deliberately planted and disseminated nevertheless. Further distribution of this false information can, again, happen either with or without awareness of the lack of evidential support for the claims it contains. Any information that is incorrect is generally described as misinformation. Disinformation is a subcategory of misinformation: information that is incorrect and that has been produced deliberately, i.e. with the intention to deceive.<sup>1</sup> The focus of this discussion paper is on disinformation, although it can be difficult to establish intent and hence distinguish between mis- and disinformation in practice.

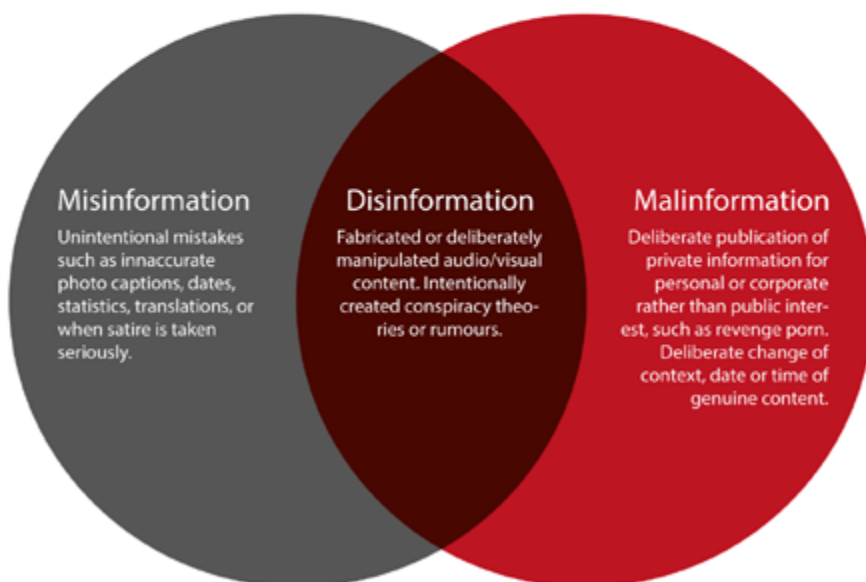
'Science disinformation' can be understood as factually incorrect information regarding claims that concern scientific matters and that is fabricated or deliberately manipulated with the intention to deceive. It also includes claims that deliberately look and sound scientific although they are not. This can include the deliberate spread of science misinformation; incorrect information regarding scientific matters that has been produced by mistake but without the intention to cause harm, caused for instance by scientific misconduct, lack of research integrity, or poor communication of scientific results.

Much of the progress and welfare of human societies has been made possible by remarkable efforts in the systematic collection of information about our world carried out by human cultures across the globe. When observations and experiments are carried out

## TYPES OF INFORMATION DISORDER

FALSENESS

INTENT TO HARM



Credit: Claire Wardle & Hossein Derakshan, 2017.

<sup>1</sup> Cf. Wardle, C. et al (2018). Information Disorder: The Essential Glossary. Harvard Kennedy School. Online Source: [https://firstdraftnews.org/wp-content/uploads/2018/07/infoDisorder\\_glossary.pdf](https://firstdraftnews.org/wp-content/uploads/2018/07/infoDisorder_glossary.pdf) (accessed 07/04/2021)

systematically and interpreted using well-established rules of evidence, they can be described as using scientific methods, and hence as 'scientific'.<sup>2</sup> The progress made through scientific methods has been so spectacular that products and approaches without a scientific basis are often marketed using scientific terms or jargon. Scientific research has become an envied and prestigious endeavour, and its language frequently plagiarized.

The overall success of the scientific method also means that when someone wants to make claims that go against established scientific knowledge and are not grounded in the scientific method, they must seek to undermine the trustworthiness of the scientific method or scientists per se. Thus,

paradoxically, scientific language is often adopted at the same time as scientific activities themselves are being questioned. An extreme and particularly harmful form of anti-scientific activity appears in the form of conspiracy theories with notable examples in the three areas chosen for analysis in this discussion paper: climate change, vaccines, and pandemics.<sup>3</sup>

Science disinformation is one of the major challenges of our times, with consequences for society at large and for (trust in) science.<sup>4, 5</sup> This paper sheds light on the characteristics and mechanisms of science disinformation and discusses what scientists, science communicators and policymakers can do about it.

## Research Integrity and Trust in Science

To guarantee scientific progress, established standards for research integrity are in place that help to ensure the trustworthiness of science and scientists. Cases of plagiarism, insufficient or insufficiently communicated responses from academia and the limited possibilities (even legally) to adequately solve these cases show clearly that assuring research integrity and other critical mechanisms of good scientific conduct, as well as their public communication, are essential for establishing and maintaining the high societal trust that is placed in science and scientists. Research integrity, the trustworthiness of science and the question of whether science is losing trust are core priorities for ALLEA. See, for instance:

- » Research Project: [PERITIA - Policy, Expertise and Trust \(2020-2023\)](#)
- » ALLEA Discussion Paper #1: [Loss of Trust? Loss of Trustworthiness? Truth and Expertise Today \(2018\)](#)
- » ALLEA Discussion Paper #2: [Trust Within Science - Dynamics and Norms of Knowledge Production \(2019\)](#)
- » ALLEA Discussion Paper #3: [Trust in Science and Changing Landscapes of Communication \(2019\)](#)
- » Conference Report: [Democracy in a Digital Society - Trust, Evidence and Public Discourse \(2019\)](#)
- » Conference Report: [Science in Times of Challenged Trust and Expertise \(2018\)](#)
- » [The European Code of Conduct for Research Integrity \(2017\)](#)

<sup>2</sup> We use the words 'science' and 'scientist' to cover academic research in general, regardless of discipline, and thus explicitly include the humanities and social sciences. 'Science' is used here in the wider sense of the German term *Wissenschaft*.

<sup>3</sup> For a comprehensive guide on conspiracy theories see Lewandowsky, S., & Cook, J. (2020). *The Conspiracy Theory Handbook*. Online Source: <http://sks.to/conspiracy> (accessed 14/04/2021)

<sup>4</sup> Research integrity and other 'internal' factors within the scientific community play an important role for trust in science and expertise and have been discussed elsewhere (see box).

<sup>5</sup> For examples of continuously high and even growing levels of trust in science and scientists see, for instance, *Wissenschaft im Dialog* (2020). *Science Barometer 2020*. Online Source: <https://www.wissenschaft-im-dialog.de/en/our-projects/science-barometer/science-barometer-2020/> (accessed 06/04/2021)

# What is the Problem with Science Disinformation?

While science disinformation and misinformation is common in many different areas, we have chosen to focus on three that strike us as particularly important: climate change, vaccine safety and pandemics.

**Climate change** in the form of global warming resulting from human activities was first predicted more than a century ago. Continuous monitoring of various physical and chemical parameters shows that the process of warming has accelerated during recent decades. Signs of global warming include melting glaciers, thawing permafrost, and rising sea levels. These changes are caused by growing concentrations of greenhouse gases in the atmosphere. Findings in many areas of research are almost unanimously interpreted to mean that the large number of humans and their activities have prominent roles in these developments.<sup>6</sup>

Major concerns are now if the increase in carbon dioxide levels and temperatures mean that efforts to break the rising curves will come too late. Models predict rising sea levels and flooding of large coastal areas, thereby reducing areas for human settlements and food production. This is predicted to displace hundreds of millions of people, resulting in an increased population density and raising the potential for violent conflicts. Together, these processes will extinguish habitats for many species of organisms and exacerbate the ongoing mass extinction.

Despite overwhelming scientific evidence, politically motivated refusal to accept anthropogenic global warming (increasing temperatures due to human influence) has been intense and has used both 'cherry-picking' and conspiracy theories in order to counter widely accepted scientific evidence. This resistance has received strong financial support from business interests, further amplified by certain sections of the media. If the facts of climate change

**Politically motivated refusal to accept climate change has received strong financial support from business interests, further amplified by certain sectors of the media.**

and its causes are countered with false claims about cause-and-consequence relationships, this will delay actions to reduce global warming, potentially with disastrous consequences.

**Vaccines** are considered one of the most important inventions ever for the benefit of humankind. The World Health Organization has estimated that vaccines save 2-3 millions of lives every year, especially children, and prevent unimaginable suffering.<sup>7</sup> High immunity at the population level arising from vaccinations leads to reduced transmission of an infectious disease and may even eliminate it completely. Those who have been vaccinated will serve as a protective barrier by not transmitting the disease to those who have not been vaccinated (so called 'herd immunity').

Nevertheless, opposition towards vaccination has existed since vaccination programmes were introduced. The reasons for this resistance have varied over time and have at times been based on valid doubts as to the vaccine's efficacy. However, some vaccines have been used for decades and all vaccines are consistently monitored to ensure a high ratio of benefits over risks. In addition, high standards for the approval of new vaccines have been implemented worldwide. Nevertheless, public resistance to vaccines prevails in some pockets of our societies, sometimes keeping vaccination uptake below the threshold required for herd immunity.

6 See, for instance, IPCC (2014). Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Online Source: [https://www.ipcc.ch/site/assets/uploads/2018/02/WGIIAR5-PartA\\_FINAL.pdf](https://www.ipcc.ch/site/assets/uploads/2018/02/WGIIAR5-PartA_FINAL.pdf) (accessed 06/04/2021)

7 Cf. WHO (2019). Immunization. Online Source: <https://www.who.int/news-room/facts-in-pictures/detail/immunization> (accessed 14/04/2021)



False information, exaggerated/unjustified claims about side effects, or conspiracy theories regarding underlying objectives for global vaccination programmes may ultimately lead to an insufficient rate of vaccination and therefore inadequate levels of immunity at the population level. Vaccine hesitancy can not only lead to unnecessary disease outbursts, but also puts those at risk who have not yet been vaccinated, especially infants, and those who cannot be vaccinated, such as individuals with immune deficiencies. Misinformation that increases vaccine hesitancy may cause more people to suffer from an epidemic, more people to show severe symptoms, and more people to die.

**Pandemics** have repeatedly struck humankind. It has never been a matter if further pandemics will come, but when. When a new infectious virus is transmitted from animals to humans, careful research is required to find ways to treat the disease and limit the spread of the virus. At the time of writing, the Covid-19 pandemic has been ravaging for more than 15 months and is still escalating with the discovery of novel virus mutations. The initial lack of knowledge about how to treat patients or prevent the virus from spreading was immediately exploited by frivolous

marketing campaigns run by proponents of various pseudoscientific treatments, but with a total lack of evidence from clinical studies and devoid of any plausible biological mechanisms of action.

The origin and spread of the pandemic have been the subject of much speculation, some of which has involved fanciful conspiracy theories such as linking the pandemic to 5G mobile phone technology or suggesting the virus was man made and introduced into the population on purpose. In addition, there have been numerous cases of fraudulent marketing of health care products, ranging from face masks to ventilators. Even political leaders in several countries have promoted regimens that completely lacked clinical or biological evidence. Those who complied may have caused themselves unnecessary harm and/or felt unduly safe and have displayed more risky behaviour, either by exposing themselves to individuals infected with the virus or by ignoring their own symptoms and thereby exposing others. This 'infodemic' coined by the WHO may have contributed to the spreading of the pandemic and may have increased the number of patients with severe symptoms requiring intensive care, as well as the number of deaths.





# Characteristics and Mechanisms of Science Disinformation

## Roots of Disinformation

Generating disinformation can be incited by different motivations in different actors and in numerous combinations. The most apparent motivations are financial profit and ideological conviction. Both can at times deviate from norms of rationality and moral standards when individuals ignore or are unable to recognise harmful consequences for others. In other instances, the aim of disinformation is to deliberately cause confusion, instability, or mistrust for political purposes.

## Knowledge Resistance & Confirmation Bias

We humans are generally prone to absorbing information that supports our established personal beliefs and opinions based on previous information or emotional appeal, an effect known as 'biased assimilation'<sup>8</sup> that often leads to 'motivated reasoning'<sup>9</sup> and may even result in self-deception. This often leads to counterarguing or finding reasons to disparage sources of evidence. It can be both value-based and identity-protective. Opinions can also rely on misplaced trust, i.e., trust in authorities

**Instead of finding ways to prevent disinformation from being generated in the first place, efforts will have to focus on limiting the spread of disinformation and minimising the damage it may cause.**

Deliberate construction of false information is very difficult to prevent. When lies are generated wilfully, the responsible individuals have already committed themselves to fraud. Likewise, it may also be hard to convince those who knowingly disseminate existing misinformation to change their behaviour. In open societies with strong protective individual rights and freedom of expression, it is difficult to stop disinformation at its roots, except by appealing to humanitarian values and hoping that those who produce and spread disinformation will consider with empathy the consequences for other people and then stop themselves and change their behaviour.

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that turn out to be unreliable sources of information, which may be unpleasant to admit.

We filter out information that contradicts personal views with such ease that we hardly notice it. Once information that we judge to be likable or convincing has been established in our minds, it becomes difficult to replace it with diverging information, even if this new information is more accurate. Hence, we are by nature prone to confirmation bias. Resistance to new knowledge may prevail because of the cognitive dissonance that may arise when novel facts contradict previous notions.<sup>10</sup> However, bias is not the only mechanism; it has also been proposed that a lack of reasoning or lack of thinking in an analytic way, described as 'lazy thinking', leads to susceptibility to disinformation.<sup>11</sup>

By explaining and informing people that it is normal to automatically reject new facts that contradict

<sup>8</sup> Biased assimilation: Tendency to interpret information in a way that supports a desired conclusion. Cf. Greitemeyer, T. et al (2009). Biased assimilation: the role of source position. *Eur. J. Soc. Psychol.*, 39, 22–39.

<sup>9</sup> Motivated reasoning: Constructing seemingly reasonable justifications to arrive at conclusions that you want to arrive at. Cf. Kunda, Z. (1990). The case for motivated reasoning. *Psychological Bulletin*, 108(3), 480–498.

<sup>10</sup> Cf. Wikforss, Å. (2019). Critical thinking in the post-truth era. In: Kendeou, P. et al. *Misinformation and Fake News in Education*, 279–304.

<sup>11</sup> Cf. Pennycook, G., & Rand, D. G. (2019). Lazy, not biased: Susceptibility to partisan fake news is better explained by lack of reasoning than by motivated reasoning. *Cognition*, 188, 39–50.

a habitual notion, whether based on previous information or on emotional appeal, it may be possible to increase their willingness to consider new information. Awareness can be raised by explaining confirmation bias, thereby reducing knowledge resistance, and the spread of disinformation.

**Knowledge gaps are challenging to most people, which is why we tend to fill missing links in our chains of knowledge with invented explanations rather than the acceptance that our knowledge is temporarily incomplete.**

### **Sense-Making Stories**

Many misconceptions resulting from misinformation have become established as common beliefs because they have a certain appeal. They are stories that appear to make sense. Knowledge gaps are challenging to most people, which is why we tend to fill missing links in our chains of knowledge with invented explanations rather than the acceptance that our knowledge is temporarily incomplete.<sup>12</sup> Stories without knowledge gaps are easier to remember because they offer continuous chains of explanations. Made-up stories can usually be recognized because they are typically vague about the sources of information, for instance so-called 'urban myths'. Furthermore, personal anecdotal episodes or testimonies may have a strong emotional appeal. However, anecdotes cannot be compared with the explanatory power of large scientific investigations when it comes to determining whether a correlation between observations also has a causal relationship.

If an incorrect description is to be replaced by a correct explanation, the new information should completely replace the misconception in a way that makes sense, i.e. no knowledge gaps should remain and it should address the emotional appeal and sense-making of the (mis-)information it is trying to replace.

12 See Duffy, B. (2018). *The perils of perception: Why we're wrong about nearly everything*. Atlantic Books.

13 Cf. Kruger J. & Dunning D. (1999). Unskilled and unaware of it: how difficulties in recognizing one's own incompetence lead to inflated self-assessments. *J Pers Soc Psychol*, 77, 1121–34.

14 Cf. Motta et al. (2018) Knowing less but presuming more: Dunning-Kruger effects and the endorsement of anti-vaccine policy attitudes. *Social Science & Medicine*, 211, 274–281.

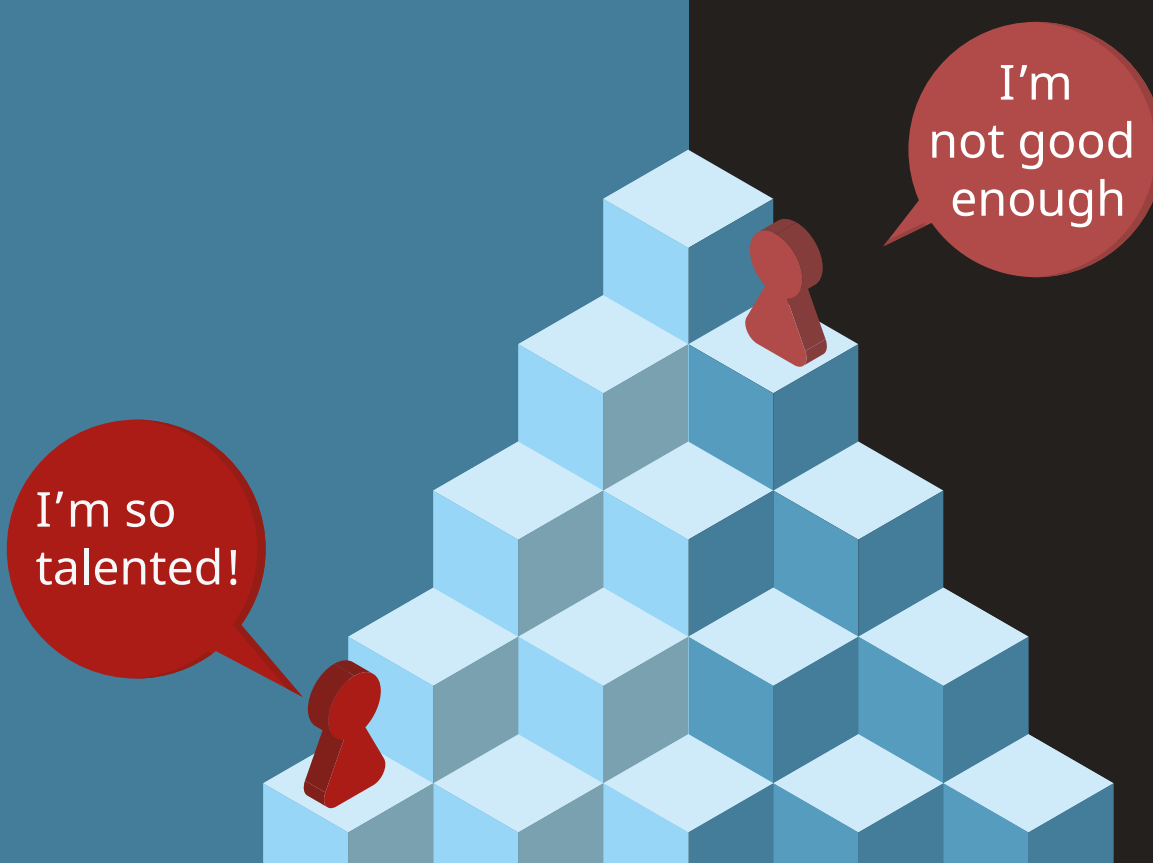
### **The Dunning-Kruger Effect**

It appears that the tendency to think highly of ourselves is so common for many people that it can be considered part of human nature. Scientific investigations have examined how well our opinion of ourselves relates to our actual performance. Many of those studies show that even the individuals with the lowest actual performance scores tend to think that they performed better than average. A study published in 1999 found that those who had the lowest test scores overestimated their performance the most, succinctly summarized in the article's title: "Unskilled and unaware of it".<sup>13</sup> This has since been known as the 'Dunning-Kruger effect' and has been observed in individuals who are against vaccination because of fear that it would cause autism. Those who knew the least even thought they knew more than doctors about autism.<sup>14</sup>

The impact of the Dunning-Kruger effect on the spread of misinformation may be reduced by increased awareness of the level of personal knowledge. The aforementioned study by Kruger and Dunning shows that fact checking provides people with insights into their personal level of knowledge and can lead to a reassessment of the degree of comprehension in relation to the complexity of the matter. It also provides opportunities to upgrade and increase personal knowledge. The major challenge here is to be able to judge what is a reliable source of information. This can be done by comparing different sources of information and checking if these sources may have specific underlying motivations, for example if they are run by certain interest groups, have commercial interests or ideological agendas.

### **Psychological Awareness**

Many of the mechanisms that enable the spread of misinformation are closely associated with human psychology. The way the human mind works seems to favour acceptance and further dissemination of many kinds of false information. Furthermore, humans tend to be eager to share information with others quickly.



## Studies show that even the individuals with the lowest actual performance scores tend to think that they performed better than average.

These features of human behaviour are well known to many who plant and disseminate disinformation. One countermeasure is therefore to inform potential recipients of misinformation about these human inclinations and how they are being exploited by disinformers. By raising awareness of human vulnerability, we can strive to handle these fallacies of the human mind more efficiently and thereby protect ourselves and others from misinformation.

### Media Literacy

A viable first step would thus be to make common human predispositions to being seduced by certain types of information or communication strategies known to the public and especially to young people. The psychology of information processing and behaviour should be taught in schools and discussed in public. Special attention both in education and public discussion should also be paid to the media and recurring structural patterns of misinformation. Increased awareness may strengthen abilities to resist the temptation to embrace unfounded claims and thereby serve as consumer protection.

Critical thinking skills help people evaluate premises and tackle intellectual blind spots caused by often unreliable, intuitive methods. To fight the spread of disinformation and limit its impact, we need to know how to test the validity of information, identify, assess and reconstruct arguments, and distinguish between causal and probabilistic drawing of conclusions ('inference').<sup>15</sup> Teaching such skills is essential to combat science disinformation, especially at times of changing communication patterns and growing polarisation.

New tasks for education in order to prevent the spread of disinformation must therefore also consider education about new (digital) media. One reason behind the spread of misinformation is the lack of experience with digital media and their underlying mechanisms and dynamics. Education programmes should focus more on (digital) media literacy.

Efforts to raise the general public's awareness and competence regarding media and information already exist. In 2013, UNESCO initiated a global alliance encompassing more than 500 organizations called the Global Alliance for Partnerships on Media and

15 Cf. Lyons, J., & Ward, B. (2017). *The New Critical Thinking: An Empirically Informed Introduction*. Routledge.

## Debunking Steps

1. Describe the facts.
2. Warn that there is a myth.
3. Explain in what way the myth is incorrect.
4. Repeat the facts to consolidate this information.



Information Literacy (GAPMIL). The alliance aims to enable people to "access, find, evaluate, [and] use the information they need in ethical and effective ways; understand the role and functions of media and other information providers such as libraries, museums and archives, including those on the Internet [...]; understand the conditions under which media and information providers can fulfil their functions; [and] critically evaluate information and media content".<sup>16</sup>

### Inoculation

To limit the harm caused by disinformation, it has been shown that it is "better to prevent than to cure".<sup>17</sup> This strategy aims to provide protection against falsehoods by informing people beforehand about misinformation tactics and presenting its contents in weakened form. This approach has been given a term borrowed from immunology: 'inoculation'. It is also known as 'pre-bunking'. Pre-exposure is intended to trigger a cognitive process that generates counter-arguments to disinformation like a form of "cognitive antibodies".<sup>18</sup> The method has been shown to work in different contexts. As it makes it possible to recognise

disinformation, it has the potential to limit its spread in social media and elsewhere.<sup>19</sup>

### Debunking

Another major strategy is to respond to misinformation by explaining why it is incorrect, and to provide correct information after this misinformation has been exposed and explained. If it is a case of deliberate disinformation, it is also relevant to uncover the tactics and potential intentions of its sender. For debunking to have the intended effect, it is important to carry it out in a pedagogical way so that the correct information is not confused with the misinformation it is intended to debunk. It is essential both to explain why the misinformation is false and to provide the true information instead (see box). As mentioned above, the fact-based explanation should ideally replace the myth entirely. Naturally, the explanation should be intelligible, i.e., it should avoid unfamiliar terms and can be aided by diagrams as a pedagogical tool. Multiple arguments against the misinformation may weaken it further.<sup>20</sup>

<sup>16</sup> Cf. UNESCO (2021) UNESCO MIL Alliance. Online Source: <https://en.unesco.org/themes/media-and-information-literacy/gapmil> (accessed 07/04/2021)

<sup>17</sup> Cf. Van Der Linden, S. et al (2017). Inoculating against misinformation. *Science*, 358(6367), 1141–1142.

<sup>18</sup> Cf. Van der Linden, S., & Roozenbeek, J. (2020). Psychological inoculation against fake news. In: Greifeneder et al. *The Psychology of Fake News: Accepting, Sharing, and Correcting Misinformation*.

<sup>19</sup> Cf. Lewandowsky, S. et al (2017). Beyond misinformation: Understanding and coping with the 'post-truth' era. *Journal of applied research in memory and cognition*, 6(4), 353–369.

<sup>20</sup> Cf. Lewandowsky, S. et al (2020). *The Debunking Handbook 2020*. Online Source: <https://sks.to/db2020> (accessed 07/04/2021)

## Pseudoscience - Plagiarising the Language of Science

Contributions from science to human health and welfare over the past centuries have been remarkable, including medicine, food production, technology, education, and communication (although the benefits of science are still unevenly distributed within societies and across the globe, and the achievements of science have often been abused or misused). The extraordinary human progress thanks to science also means that products and ideas can be marketed more efficiently by using the terminology of science, even in the absence of a scientific base for their claims. Such false pretensions are usually denoted as 'pseudoscience'. However, it is not always easy to see through pseudoscientific claims. Studies have shown that several psychological factors may explain the temptation to be persuaded by pseudoscientific jargon, including unfamiliarity with the meaning of terms and a lower degree of analytic thinking.<sup>21</sup>

Science literacy and understanding the meaning of terms are again key to judging the plausibility of claims that may be false or exaggerated (see box). For instance, some early claims about efficient treatments of Covid-19 were not only too quick to be able to be tested on Covid-19 patients, but also cited old studies that had been performed long before the Covid-19 virus appeared. Those studies sometimes concerned completely different types of viruses and therefore could not be trusted.

The quality of sources can be difficult to judge, but in general an article in a scientific journal is likely to have undergone some degree of peer review, making it more trustworthy than many other sources. However, this is complicated by the fact that the quality of scientific journals can vary considerably and some journals publish studies without peer review by qualified experts.

## Undermining Trust in Science and Scientists

Scientists are generally held in high esteem in many societies due to their extraordinary contributions to human health and welfare, and are also involved in addressing current societal challenges.<sup>22</sup> At the same time, as the progress of science is envied and its terminology appropriated, trust in science is paradoxically under attack.

Purported disagreement among scientists has been used to sow doubt about scientific evidence by spreading disinformation about the degree of disagreement, for instance regarding evolution versus creationism, or regarding the health problems caused by smoking. A few scientists have been paid by special interest groups such as commercial companies or ideological organizations to interpret and exaggerate scientific findings to their patron's advantage or to criticize scientific investigations that do not fall within their own areas of expertise.<sup>23</sup> It is essential for efforts to respond to and debunk science disinformation that such anti-scientific behaviour - even if it comes from

## How to check an unfamiliar topic

1. Check whether references to sources are provided.
2. Check if those sources are reasonably recent (if products are marketed with references to old sources, this may indicate that the results have not been verified, have not held up to scrutiny, or have not been worth pursuing).
3. Check if the sources are credible scientific journals.

21 Cf. Pennycook G. et al (2015). On the reception and detection of pseudo-profound bullshit. *Judgment and Decision Making*, 10, 549–563.

22 Cf. Smith, M. & Ballard, J. (2021) Scientists and doctors are the most respected professions worldwide. Online Source: <https://today.yougov.com/topics/economy/articles-reports/2021/02/08/international-profession-perception-poll-data> (accessed 07/04/2021)

23 Cf. Oreskes, N. & Conway, E. (2010) Defeating the merchants of doubt. *Nature* 465, 686–687.



sources that might appear credible at first glance - is exposed, so that trust in science and scientists can be maintained at a high level.

Science's great achievements build upon its ability to self-correct. This may occasionally be an irritatingly slow process, and can be delayed further by personal and commercial interests. There is usually a sufficient number of scientists who are eager to challenge prevailing views and question common claims. This constant challenge ensures the progress of science. Moreover, science is a collective enterprise, encompassing an ever growing number of collaborators who not only contribute to new discoveries and ideas, but also are a safeguard and corrective measure against error and fraud. These features of science - its continuous questioning and pursuit of new knowledge and its reliance on other scientists to confirm or refute their findings - make accusations against scientists as members of a united powerful secretive conspiracy highly implausible.

## Speed of Communication in a Digital World

In our societies today, information transfer takes place to an increasing extent via digital social media, especially among younger generations. Digital media offer excellent opportunities to disseminate information about science, including popular science. Thanks to the internet, reliable and intelligible information is more readily available than ever before from a variety of sources, including open access scientific journals and numerous popular-science websites and lectures (provided they are not censored by governments). However, digital media are a mixed blessing, as they make it just as easy to propagate false information.

The speed of communication in social media means that little time and effort is spent on checking the quality of information and the trustworthiness of its sources. Although it would require just a few extra clicks, it takes time to read, contemplate and evaluate the plausibility and reliability of the claims, and a

certain level of media literacy. This means that, for instance, conspiracy theories can quickly reach a larger number of people than ever before.<sup>24</sup>

Time is also a precious commodity for communication professionals, e.g. for journalists and science communicators. Nevertheless, it is essential for them to take the time needed to check claims and sources. For communicators, transmission of misinformation can have serious consequences for reputation and trust.

## Biased Information and Filter Bubbles

Social media companies have constructed algorithms that constantly feed consumers with information similar to what they have shown interest in the past. This can lead to the consolidation and amplification of already established ideas and opinions, even if they are incorrect.<sup>25</sup> Similarly, the internet offers excellent opportunities for people with similar interests to congregate and interact. Sometimes such interest groups meet in closed fora where content moderators decide which information is allowed. People who ask critical questions are blocked and discharged. When repeated exposure to similar types of information is combined with filter bubbles in closed groups, confirmation bias may intensify and result in knowledge resistance. Thus digital media and its algorithms may feed a spiral of echo-chambers, filter bubbles and confirmation bias, thereby facilitating yet further transmission of misinformation. Social media platforms may have subordinated expertise to a logic of likability, leaving institutional experts trailing behind.<sup>26</sup>

There is still much ongoing debate in the research literature about how accurate the described mechanisms actually are. What is clear, however, is that the algorithms are not under public scrutiny or control, and that the platforms can change the world over night by changing their algorithms. That is undeniable and should be sufficient cause for concern.

<sup>24</sup> For the question of how the changing media landscape affects communication patterns and trust in science see All European Academies (2019). Trust in Science and Changing Landscapes of Communication. ALLEA Discussion Papers, 3. Berlin.

<sup>25</sup> Cf. Lewandowsky, S. et al (2020). Technology and Democracy: Understanding the influence of online technologies on political behaviour and decision-making. Publications Office of the European Union, Luxembourg.

<sup>26</sup> See O'Callaghan et al (2015). Down the (white) rabbit hole: The extreme right and online recommender systems. Social Science Computer Review, 33(4), 459-478. See also Marchal, N. & Au, H. (2020). Coronavirus EXPLAINED: YouTube, COVID-19, and the Socio-Technical Mediation of Expertise. Social Media + Society, 6(3).



## Socio-Technological Aspects

Commercial or other sponsorship to make information freely available for target groups is widespread; it is actually more the rule than the exception. Thus – to put it bluntly – the notion of objective or factual information in digital media is generally not to be expected. As a consequence, the end user must exercise considerable acuity to obtain the information that is most useful or pertinent to their needs. Even when the information presented is accurate, the choice of information that is presented to the end user may depend on the commercial interests and its potential for generating a revenue. Thus, for instance, the response to a search that an end user performs on a commercial website will receive the response that maximises the website’s income. This is automatically carried out with sophisticated and finely attuned algorithms.

The website provider must in turn expend considerable funds to invest in up-to-date computer and telecommunications equipment that offers end users a fast and technologically reliable response, in up-to-date software and software maintenance, in competent technical and business personnel to manage its operations, in massive usage of costly electricity, and in visually and psychologically

appealing user interfaces, information and advertising to make the web site attractive. Thus the end user and the public at large must be aware and vigilant to the fact that what is being sold is whatever generates the highest profit, rather than what is likely to meet the user’s needs.

This problem that has been created by information technology, especially by search engines and the world wide web, does not have a simple solution. However, there are constructive ways forward. End users can ‘consult’ general purpose or specialised Software Recommender Systems.<sup>27</sup> An end user may feed a recommender system with its actual needs and requirements. The recommender system may also learn from the end user’s reactions to the advice offered by various web search engines, as well as from the recommendations of other similar systems. The user can then use the recommender system – or several specialised systems that deal with different subjects – to make the best choices from suggestions that the web services provide. Of course, the user’s recommender system should not be funded by the same sources as the websites; it should presumably be paid for by the end users’ subscriptions.

There are notable initiatives by companies for voluntary commitment and self-regulation, especially

27 Cf. Serrano, W. & Gelenbe, E. (2018), The Random Neural Network in a neurocomputing application for Web search. *Neurocomputing*, 280, 123–134.

**Policymakers can regulate content directly, provide someone with the authority for regulating content, redesign the structures (platforms) in which content is generated and distributed, or support the creation of instruments that can raise citizen awareness and enable them to identify and prevent the dangers of misinformation.**

the EU Code of Practice on Disinformation.<sup>28</sup> They can be a valuable instrument for ensuring greater transparency of platforms' policies against disinformation, but have significant shortcomings mainly due to the Code's self-regulatory nature.<sup>29</sup>

### **Translating into Legislation**

Policymakers have at least four ways to prevent the spread of misinformation: They can regulate content directly, provide someone with the authority for regulating content, redesign the structures (platforms) in which content is generated and distributed, or support the creation of instruments that can raise citizen awareness and enable them to identify and prevent the dangers of misinformation.<sup>30</sup>

One way forward is to ask public regulators of news media to intensify their regulation of social media platforms and websites. Web services are often sources of news and information while also financed by advertising agencies. This leads to an obvious conflict of interest that needs to be examined and constantly regulated.

However, search engines and social media platforms should not be viewed as a threat to our democracy per se. We should act in an enlightened manner to nurture and guide the rich value of diverse commercial sources of digital information, as we do with newspapers and television channels. We

need to regulate them in a manner that allows us to access the accurate information and exploit emerging information technologies, e.g. automated fact-checking and recommender systems.

It is extremely difficult to regulate content directly without raising legitimate concerns about censorship. It is very hard to clearly distinguish disinformation from, for example, irony or satire, in a standardized way, as such designations would depend on both the intention of the actor and the context of the given information.

A viable alternative could be to mandate content to be regulated. Media outlets and platforms could be mandated to ensure that their content is constantly checked by independent and constantly audited researchers and fact-checkers. They could apply flexible approaches that do not need to be regulated in much detail. Some major platforms have already installed internal fact-checkers for this purpose. Governments could also require platforms more realistically to limit misinformation to a certain level instead of eliminating it entirely. Some countries have already introduced legislation in this regard, such as the German Network Enforcement Act.

Using knowledge about cognition for redesigning social media platforms and their algorithms ('technocognition') could be another way to prevent the spread of misinformation. An example is simply reducing the numbers of times that certain content can be shared with others, slowing the distribution of information down and forcing people to consult the source or even validate the information.

Last but not least, governments have the option of strengthening incentives for empowering recipients of information to identify and cope with mis- and disinformation, either themselves or with the help of machine learning systems. (Digital) media literacy is crucial here for evaluating the content and context of information and ultimately detecting its accuracy. Several endogenous cues (content) and

28 See, for instance, EU Code of Practice on Disinformation. Online Source: [https://ec.europa.eu/newsroom/dae/document.cfm?doc\\_id=54454](https://ec.europa.eu/newsroom/dae/document.cfm?doc_id=54454) (accessed 06/04/2021)

29 See the EC's Assessment of the EU Code of Practice on Disinformation. Online Source: [https://ec.europa.eu/newsroom/dae/document.cfm?doc\\_id=69212](https://ec.europa.eu/newsroom/dae/document.cfm?doc_id=69212) (accessed 06/04/2021)

30 See Lewandowsky, S. et al (2020). Technology and Democracy..., 87ff for a detailed account of the challenges for regulation and potential solutions mentioned here.





exogenous cues (context) can help test the validity of information.<sup>31</sup> However, such cues to disinformation and their uptake for regulation remain largely underexplored.

## Science Communication and Public Engagement

Trust in science, the recognition of trustworthy scientific information and its distinction from misinformation is always mediated. The communication practices of researchers and journalists thus play a central role in tackling science disinformation. Like any part of the media landscape, science communication is also heavily affected by the transformation into a globalised, technologically mediated and commoditised environment. This transformation provides opportunities to reach new audiences with new methods, but also paves the way for the problematic mechanisms described above and puts even more financial and time pressure on science communicators.

In addition to such external factors, there is an apparent lack of exchange between science communicators and scientists. There is clearly a need for more dialogue in

science communication practices. A stronger focus on communicating how science works, i.e. standards and methods, will raise science literacy as well as media literacy.

Communication with the public must be open and inclusive. Open conversations on an equal footing between scientists and nonscientists, with room for uncertainties, assumptions, values and social questions, could lead to greater mutual understanding and trust. For instance, the model of citizen assemblies on science based policy is designed to bring science closer to the people and engage the public, e.g. on climate science.<sup>32</sup> The virtues of openness and intellectual humility allow for a plurality of voices and apply to experts even more than to the end users of information.<sup>33</sup> However, openness and humility should not lead to an attitude of 'anything goes' which neglects certain aforementioned (scientific) standards and methods.

31 Cf. Lorenz-Spreen, P. et al (2020) How behavioural sciences can promote truth and autonomy and democratic discourse online. *Nature Human Behaviour*, 4, 1102–1109.

32 See Suiter, J. et al (2016). When do deliberative citizens change their opinions? Evidence from the Irish Citizens' Assembly. *International Political Science Review*, 37(2), 198–212.

33 See Alfano, M. et al (eds.). *The Routledge Handbook of Philosophy of Humility*. Routledge.

# Challenges for Implementation

## Climate Change

The opposition to scientific evidence on climate change, more specifically anthropogenic global warming (AGW), has an interesting history with academic, political, and financial roots. Opposition has continuously been voiced by economic interests in fossil-based fuels and other industries causing large emissions of carbon dioxide. Studies show that attitudes towards climate science are highly polarised and divided along political lines.<sup>34</sup> Among political leaders, for instance, denial of AGW is more common among right-wing representatives, especially those who support free markets. Interestingly, warning signals from climate scientists in the 1990s were initially also questioned by some academic scholars from Science and Technology Studies<sup>35</sup> who were sceptical towards knowledge claims of natural scientists based on mathematical models.<sup>36</sup>

The heated debate around climate change shows us how philosophical and theoretical debates in and across academic disciplines can (temporarily) lead to contradicting claims, demonstrating the complex and non-linear scientific progress, as well as how challenging it is to find, understand and communicate scientific evidence. Nowadays, the overwhelming majority of leading scientists in this field stand united in their conclusions as described in the reports of the Intergovernmental Panel on Climate Change (IPCC). Experts on the IPCC panels have been criticised for exaggerating the prognosis of global warming, but also for underestimating the temperature change. IPCC has admitted to some errors and some speculation, but by and large their assessments have been reasonably correct and their predictions sometimes too modest. The most recent IPCC report released in

## The heated debate around climate change shows us how challenging it is to find, understand and communicate scientific evidence.

2018 concluded that "human influence on climate has been the dominant cause of observed warming since the mid-20th century".<sup>37</sup>

Urgent action on a global scale is necessary to mitigate these processes. However, many political leaders and large proportions of populations still deny the factual observations, the observed or inferred causes, and the predicted consequences. This causes necessary decisions to be insufficient both in extent and time. Thus scientists and science communicators are facing an immense challenge to explain the chains of causal events, the ongoing global warming and the predicted future consequences.

## Vaccine Hesitancy

The overall evidence for the usefulness of vaccines is overwhelming. The risk-benefit ratio leans overwhelmingly towards the continued development of vaccines against infectious diseases and other health problems. A large part of the world population is eagerly awaiting opportunities to be vaccinated against the SARS-CoV-2 virus that causes Covid-19. Overall support for Covid-19 vaccines seems to remain high in many countries despite the misinformation surrounding it.<sup>38</sup> Scientists in pharmaceutical companies and academia have developed a number of vaccines in an impressively short period of time. Expectations are high.

34 Cf. Lewandowsky, S. et al (2015), Seepage. Climate change Denial and its Effect on the Scientific Community. *Global Environmental Change*, 33, 1–13.

35 STS, Science and Technology Studies, are the study of how society, politics, and culture affect scientific research and technological innovation, and how these, in turn, affect society, politics and culture.

36 Cf. Hansson, S. O. (2020). Social constructionism and climate science denial. *European Journal for Philosophy of Science*, 10(3), 1–27.

37 Cf. United Nations (2014). Human cause of global warming is near certainty, UN reports. Online Source: <https://news.un.org/en/story/2014/01/460872> (accessed 07/04/2021)

38 See, for instance, Johns Hopkins University (2021). KAP COVID. Vaccine Acceptance Around the World. Online Source: <https://public.tableau.com/views/JHUCOVID-19KAPVaccineAcceptance/VaccineAcceptanceStory> (accessed 14/04/2021)



**It is difficult to use rational arguments to reach ardent opponents to vaccines. Evidence-based information should therefore be adapted for those who hesitate so that they can have access to factually correct information.**

There have been some causes for concern regarding vaccines in the past, which have probably contributed to vaccine hesitancy. Some previous vaccines provided low protection due to poor quality or incorrect handling. In some countries, there is mistrust in authorities due to corruption and in pharmaceutical companies due to scandals (unrelated to vaccines). Some individuals fear injections or unintended effects of vaccine stabilisers. In general, there is limited knowledge among citizens about how vaccines work and an exaggerated fear of side effects. Vaccine hesitancy has been ranked by the WHO as one of the ten most important threats to human health.<sup>39</sup>

Recent research has shown that those who know the least about vaccines and are misinformed about their side effects are the most likely to think that they know more than medical professionals.<sup>40</sup> This is in line with the Dunning-Kruger effect described above. In addition, vaccine opponents display trust in fake experts, including one who was found guilty of fraud and lost his licence to practice medicine. Other anti-vaccine activists have been found to endorse bizarre racist conspiracy theories.<sup>41</sup>

Studies show that it is difficult to use rational arguments to reach ardent opponents to vaccines. Evidence-based information should therefore be

adapted for those who hesitate and are uncertain so that they can have access to factually correct information and make an informed decision.<sup>42</sup>

## **The Covid-19 Pandemic**

Covid-19 is a devastating pandemic for human health and societies. Its highly variable symptoms, ranging from unnoticeable to death, have triggered intense interest in disease mechanisms and efforts to minimize its spread. Immediately after the pandemic started, many cures were marketed, often derived from traditional medicine although there had been no experience whatsoever in treating Covid-19 as it was caused by a new virus. Conspiracy theories emerged regarding both the origin and spread of the virus.<sup>43</sup> The flood of misinformation forced many agencies and academics to compile evidence-based information to debunk the false information and warn against relying on claims that are not based on scientific studies.<sup>44</sup>

Scientists have made tremendous progress at an impressive rate. The short time taken to develop Covid-19 vaccines has surpassed even the most optimistic expectations. Importantly, Covid-19 has offered excellent opportunities to explain how science works and has informed the general public that science at the research front is uncertain and conclusions can be premature. This has been clearly illustrated in relation to the predominant mode of virus transmission (aerosol, drops or contact), the efficacy of face masks (and which types), which pharmacological treatments can reduce symptoms and shorten recovery time, and whether the most severe symptoms are caused by the virus itself or the immune response it evokes.

39 Cf. World Health Organization (2019). Ten threats to global health in 2019. Online Source: <https://www.who.int/vietnam/news/feature-stories/detail/ten-threats-to-global-health-in-2019> (accessed 07/04/2021)

40 Cf. Callaghan, T. et al (2021). Correlates and disparities of intention to vaccinate against COVID-19. *Social science & medicine*, 272, 1136–42.

41 Cf. Hornsey M. J. et al (2018). The Psychological Roots of Anti-Vaccination Attitudes: A 24-Nation Investigation. *Health Psychology* 37, 307–315.

42 See Lewandowsky, S. et al (2021). The COVID-19 Vaccine Communication Handbook. A practical guide for improving vaccine communication and fighting misinformation. Online Source: <https://sks.to/c19vax> (accessed 14/04/2021). See also Goldenberg, M. J. (2021). *Vaccine Hesitancy: Public Trust, Expertise, and the War on Science*. University of Pittsburgh Press.

43 See Leibovits T. et al (2021). COVID-19 conspiracy beliefs: Relations with anxiety, quality of life, and schemas. *Personality and Individual Differences*, 175.

44 See WHO (2021). Coronavirus disease (COVID-19) advice for the public: Mythbusters. Online Source: <https://www.who.int/emergencies/diseases/novel-coronavirus-2019/advice-for-public/myth-busters>. (accessed 07/04/2021). See also Lewis, T. (2020). Eight Persistent COVID-19 Myths and Why People Believe Them. *Scientific American*. Online Source: <https://www.scientificamerican.com/article/eight-persistent-covid-19-myths-and-why-people-believe-them> (accessed 07/04/2021)

**Conspiracy theories emerged regarding both the origin and spread of the virus. The flood of misinformation forced many agencies and academies to compile evidence-based information to debunk the false information and warn against relying on claims that are not based on scientific studies.**

The avalanche of scientific studies of Covid-19 inevitably means that a few reports may have drawn conclusions from findings that will turn out to be random and thus not possible to replicate. Others may have exaggerated conclusions or may be based on poorly designed studies. The scientific process will eventually weed out the studies that cannot be replicated or do not hold up to scrutiny.

The continued scientific progress is expected to increase our understanding of this evasive virus and will hopefully facilitate development of many different types of vaccines as well as pharmacological treatments that can be used to reduce infection, alleviate symptoms and reduce the time required for recovery. In the meantime, scientists and communicators must keep on disseminating evidence-based information so that Covid-19 precautions and restrictions are respected.



# What can Scientists do?

As producers and purveyors of information based on scientific evidence, scientists are in a unique position to make this knowledge useful for members of our societies. A considerable proportion of all research is carried out at universities and academic institutions, and many of these are to a large extent funded by tax-payers' money. Hence, it seems reasonable that the general public should have access to useful information resulting from this research. Scientists may thus be considered to have an obligation to engage in outreach activities to share and communicate scientific knowledge. It is essential to avoid elitist attitudes; instead, efforts should be made to present science in a way that is comprehensible to the target group, and to seriously engage with the public when exercising and communicating research.

However, the amount of misinformation in our societies is rather extensive and it may take considerable time to investigate a particular claim to determine its degree of support from research. But if many scientists take responsibility and contribute, it should be possible to limit the impact of misinformation.

To maintain a high level of trust in science and scientists, it is crucial to ensure that good research practice and high ethical standards are maintained, as described in ALLEA's European Code of Conduct for Research Integrity.<sup>45</sup> Suspected researcher misconduct must be investigated. Young scientists and PhD students must be properly educated in these matters. This together with openness about the scientific process can sustain the good reputation of science and scientists. Trust must be deserved and earned.

Scientists also need to interact with science communicators and policymakers. Close contact with communicators helps to ensure that the disseminated information is correct and the conclusions reasonable. Contact with policymakers will alert them to signs of potential misinformation.

**It is essential to avoid elitist attitudes; instead, efforts should be made to present science in a way that is comprehensible to the target group, and to seriously engage with the public when exercising and communicating research.**

The ongoing Covid-19 pandemic has brought scientists to the centre stage to explain what is happening on the research frontier. It may have been somewhat surprising for the general public to experience that scientists may differ in the way they interpret the same observations. The ongoing pandemic provides opportunities to describe in real time how research is done and how results are debated among scientists to reach the most plausible conclusions.

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<sup>45</sup> See All European Academies (2017). The European Code of Conduct for Research Integrity. Online Source: <https://www.allea.org/wp-content/uploads/2017/05/ALLEA-European-Code-of-Conduct-for-Research-Integrity-2017.pdf> (accessed 06/04/2021)

# What can Science Communicators do?

Science communicators such as science journalists have important roles in making scientific research accessible and comprehensible for policymakers and the general public, as well as for scientists in other fields of research. Close contact with researchers is necessary to ensure accurate reporting. Communicators and scientists alike must strive to explain science at a level suitable for the intended audience.

Good science communication also includes refraining from writing exaggerated headlines in news releases, as such hyperbole may strike back and undermine trust. Thus, it is important not to oversell science. Communicators may even have a role in harnessing over-enthusiastic reports by scientists.

In addition to explaining research results, science communicators must carefully trace sources of information. It is especially important that science communicators do not transmit any type of misinformation. It is crucial to check plausibility, reliability and sources and to remain up to date in a fast changing information landscape. It is essential to identify the sender, not only to avoid spreading disinformation, but also to avoid falling into the trap of disseminating pranks. Made-up results as well as fraudulent research may have such an appeal that journalists cannot resist the temptation to write about the alleged findings.

**It is crucial to check plausibility, reliability and sources and to remain up to date in a fast changing information landscape.**

If misinformation or untrustworthy sources are detected, science communicators too can make important contributions to debunking. Often exposures of fraudulent claims and pseudoscience make excellent news stories. It is imperative to describe not only the misinformation, but also replace the fraudulent claims with correct information and strive to consolidate this as described for debunking.

Furthermore, science communicators, like scientists, can help inform the public about the scientific methods and the nature of scientific research such as replicability and self-correction. The scientific meaning of the commonly used terms 'uncertainty', 'significance' and 'evidence' may not (yet) be part of every citizen's vocabulary, but they are very useful concepts that should be widely known. Indeed, one important aspect of scientific research that must be conveyed is that new evidence 'on the frontier of knowledge' necessarily has some degree of uncertainty as the evidence can still be falsified and be subject to change.

**For policymakers it seems especially important to check if the sources of information have specific commercial interests or ideological agendas that may conflict with the best available evidence.**

# What can Policymakers do?

Several science advice mechanisms aim to provide policymakers with the best available scientific evidence on which to base decisions.<sup>46</sup> Not only decisions in politics should be informed by scientific evidence, but also in industry and finance and other parts of our societies. Large organisations may have their own science advice and communication functions that can ensure that accurate information is available and used.

Naturally, policymakers may need to consider a range of considerations, including scientific, economic, cultural and social. But it should nevertheless be emphasized that decisions must be made on the basis of the most reliable information. The negation test proves the applicability of this concept: Who would dare to make decisions based on misinformation?

High-ranking policymakers do not have expert knowledge about all topics relevant to their

responsibilities and they are also very understandably short of time. This is why they must have access to experts that can supply the best evidence-based information available and provide a broad perspective on the matter. This includes pointing out what evidence is still uncertain or incomplete. Expert science advice is especially vital concerning highly complex matters such as climate change and novel challenges like Covid-19.

For policymakers it seems especially important to check if the sources of information have specific commercial interests or ideological agendas that may conflict with the best available evidence. Such special interests are known for all three topics in this discussion paper. For instance, conspiracy theories are nurtured by stakeholders in debates about climate change, vaccines, and Covid-19. All three matters also involve commercial interests.

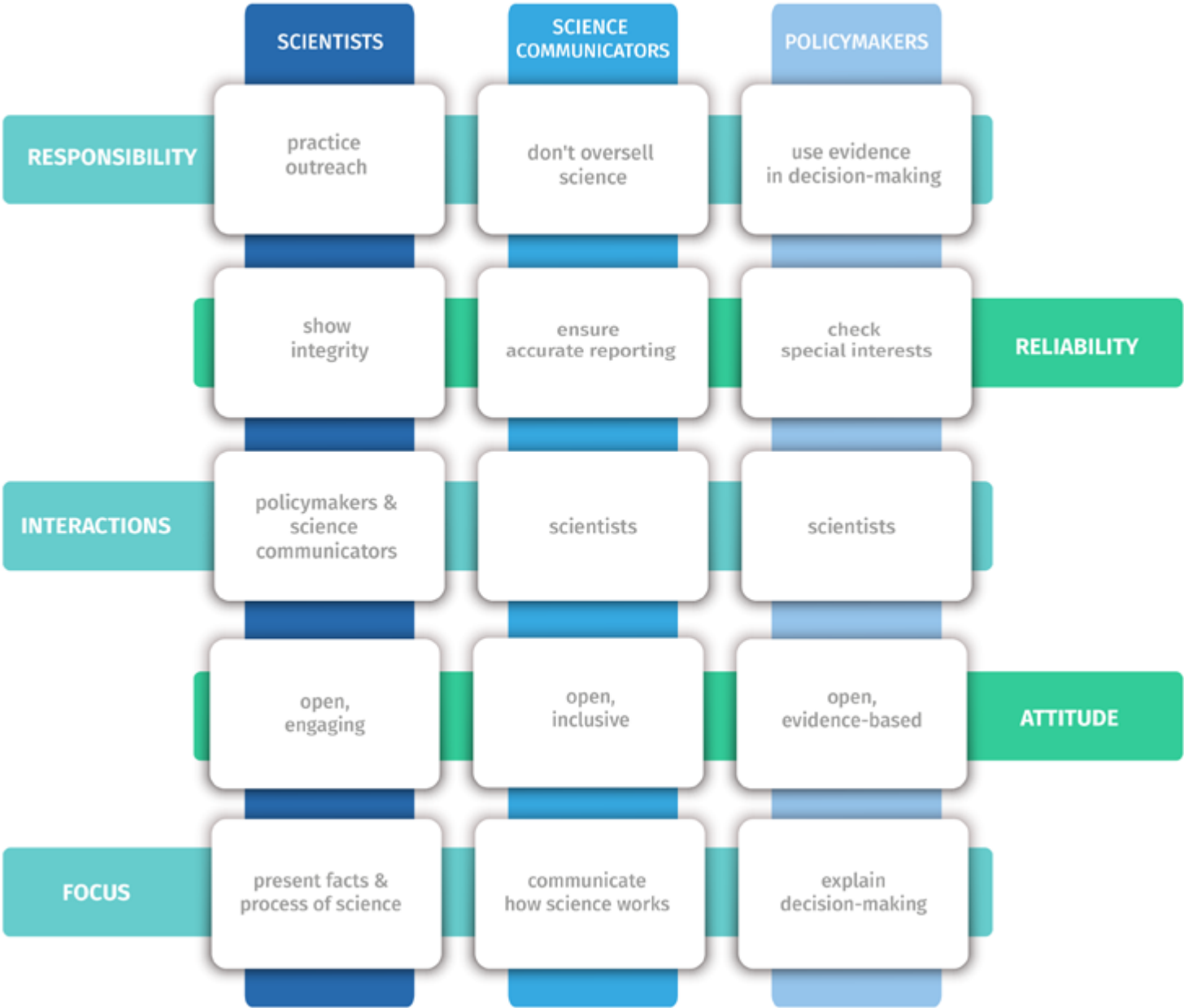
## Relevant European Commission reports

- » Tackling COVID-19 disinformation - Getting the facts right. (2020) [https://ec.europa.eu/info/sites/info/files/communication-tackling-covid-19-disinformation-getting-facts-right\\_en.pdf](https://ec.europa.eu/info/sites/info/files/communication-tackling-covid-19-disinformation-getting-facts-right_en.pdf)
- » Action Plan against Disinformation. (2018) [https://eeas.europa.eu/headquarters/headquarters-homepage/54866/actionplan-against-disinformation\\_en](https://eeas.europa.eu/headquarters/headquarters-homepage/54866/actionplan-against-disinformation_en)
- » Tackling online Disinformation: a European Approach. (2018) <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52018DC0236>
- » Code of Practice on Disinformation. (2018) [https://ec.europa.eu/newsroom/dae/document.cfm?doc\\_id=54454](https://ec.europa.eu/newsroom/dae/document.cfm?doc_id=54454)
- » A multi-dimensional approach to disinformation. Report of the independent High-level Group on fake news and online disinformation. (2018) [http://ec.europa.eu/newsroom/dae/document.cfm?doc\\_id=50271](http://ec.europa.eu/newsroom/dae/document.cfm?doc_id=50271)

<sup>46</sup> See the work of SAPEA and the European Commission's Science Advice Mechanism as a prominent example: <https://www.sapea.info/>. For a concise analysis of science advisory ecosystems and the science-policy interface see Gluckman, P.D. et al (2021). Brokerage at the science-policy interface: from conceptual framework to practical guidance. *Humanit Soc Sci Commun* 8(84).



# How to Tackle Science Disinformation



# Concluding Thoughts

Misinformation is frequently accepted and spread uncritically without checking its origin or possible underlying motivations. Extensive research over the past several years has identified psychological features of the human mind, as well as fast and efficient transmission channels, that contribute to its prevalence in our societies. Such fascinating information about the characteristics of human thinking and new communication media can greatly enhance our understanding of ourselves and other individuals regarding attitudes towards misinformation. This new knowledge brings the humble realization that we can easily be misled. Fortunately, the new research also suggests strategies to protect ourselves from both commercial and ideological manipulation. If insights about these mechanisms could be widely disseminated, the harm caused by misinformation, and especially disinformation, would hopefully be considerably reduced.

As acceptance of misinformation can happen so easily, we should be careful about accusing one another of holding factually incorrect views (unless there are good reasons to express it clearly). Instead, it can be advisable to offer opportunities for those who have been factually misled to consider more well-founded explanations. This can be done by raising awareness of the sources of the misinformation and the mechanisms that may lead to its absorption. A much more constructive discussion is likely to follow upon the phrase "maybe you have been misinformed" rather than the confrontative "you are wrong". After all, what we want to achieve is increased knowledge that agrees with facts as well as to improve protection against future misinformation.

Special responsibility to limit the spread of misinformation rests upon those who have the knowledge and tools to diagnose and counteract it: scientists who can present the facts that contradict the fake; science communicators who can make scientific results easier to understand and who know which information channels and strategies to use to counteract misinformation; and policymakers who need to have a reliable evidence base for their

**Even though there seems to be widespread awareness of the problems and harm caused by disinformation, there is still no coordinated European effort to respond to this with increased and better science communication.**

decisions and therefore must make sure that they are not deceived by false information.

Multiple initiatives are in progress to raise awareness about science disinformation and the attempts to undermine trust in science, especially for European policy, illustrated by a number of documents produced by the European Commission Services (see box on page 21). They provide constructive advice on how to counteract misinformation and disinformation and how to encourage people to consider arguments, plausibility, and sources. These initiatives are valuable sources of information for those who have important roles in society to reduce misinformation, primarily scientists, science communicators, and policymakers.

As evidenced in this paper, there is still a need for a) initiatives to raise science literacy and digital media literacy, b) more dialogue in science communication practices, c) a stronger focus on communicating how science works, d) serious engagement with the public when exercising or communicating research, e) valuing the virtue of humility when communicating scientific evidence, f) the maintenance of good research practices and high ethical standards, g) accountable, honest, transparent, tailored and effective science advice mechanisms.

Even though there seems to be widespread awareness of the problems and harm caused by disinformation, there is still no coordinated European effort to respond to this with increased and better science communication. While mechanisms of science advice

for policy have been introduced on different levels to bridge the gap between scientists and policymakers, no central pan-European mechanism or institution is in place to coordinate existing initiatives and develop coherent guidelines and recommendations on science communication in an inclusive manner.

The solution could be a European centre or network for science communication which, among others, could aim at defining central guidelines and recommendations in a European Code of Conduct for Science Communication, similar to the European Code of Conduct for Research Integrity. This network could also coordinate initiatives to raise science literacy and media literacy by developing curricula, courses, guidelines, etc.

For important matters such as climate change and lethal pandemics, our destiny relies on the successful communication and use of scientific evidence, both as individuals and as societies. Only facts can provide a basis for appropriate decisions. Fakes cannot!

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ALLEA is the European Federation of Academies of Sciences and Humanities, representing more than 50 academies from over 40 EU and non-EU countries. Since its foundation in 1994, ALLEA speaks out on behalf of its members on the European and international stages, promotes science as a global public good, and facilitates scientific collaboration across borders and disciplines.

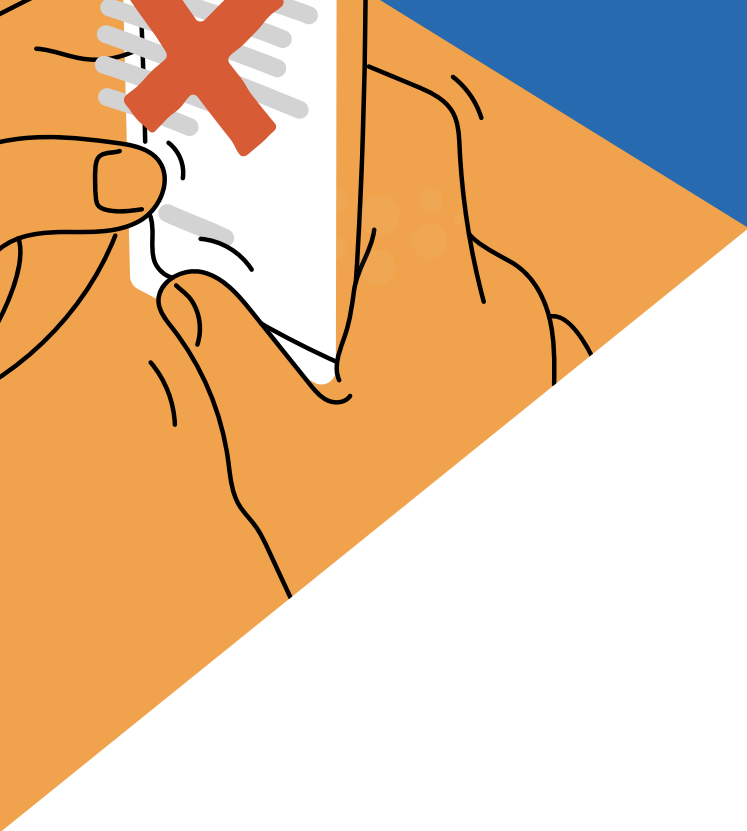
Academies are self-governing bodies of distinguished scientists drawn from all fields of scholarly inquiry. They contain a unique human resource of intellectual excellence, experience and multidisciplinary knowledge dedicated to the advancement of science and scholarship in Europe and the world.

Jointly with its members, ALLEA seeks to improve the conditions for research, to provide the best independent and interdisciplinary science advice available, and to strengthen the role of science in society. In doing so, ALLEA channels the expertise of European academies for the benefit of the research community, decision-makers and the public. Outputs include science-based advice in response to societally relevant topics, as well as activities to encourage scientific cooperation, scientific reasoning and values through public engagement.

ALLEA is constituted as a non-for-profit association and remains fully independent from political, religious, commercial or ideological interests.







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