*“Falsehood flies, and truth comes limping after it ...”
Jonathan Swift*

Science Disinformation: On the Problem of Fake News

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Abstract—This article is devoted to an important socio-cultural phenomenon that undermines public confidence in science, that is, fake science news. The term *fake news* is analyzed and data on the dissemination of fake news on social networks is provided. Information sources for science news and fake science news are identified. Special attention is paid to the dissemination of fake science news during the COVID-19 pandemic.

Keywords: science information, fake news, fake science news, post-truth, disinformation, misinformation, social media, COVID-19 pandemic, infodemic

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INTRODUCTION

According to the Oxford English Dictionary, the 2016 word of the year was *post-truth*. According to the definition of British linguists, this concept means circumstances in which objective facts have less influence on the formation of public opinion than emotions or personal beliefs [1]. This phenomenon arose due to the influence of the media: by manipulating society, they create a different reality. One of the main reasons for the post-truth era is the abundance of *fake news* that the audience is unable to recognize.

The growing influence of fake news is fueled by a loss of trust in the authorities, as well as in the media and the journalistic profession in general. Fake news fills the vacuum for people or communities offering instant solutions to various problems. In their discourse, knowledge, science, facts, evidence, and rationality are swept aside as the sophistry of the elite. With the development of Internet technologies, anyone can become an author of fake news and begin to spread it instantly; any attempt to refute these false facts is useless. Emotions take over rationalism, i.e., people believe what they want to believe. All this fully applies to science news.

Development of the Internet provides an excellent opportunity to promote scientific knowledge, as well as to educate and disseminate research results. If it is credible, science news can be an influential vehicle for drawing public attention to important issues of our

time; otherwise, such news undermines the credibility of scientific information and science in general.

The scientific news problem has been aggravated by the COVID-19 pandemic and the information wave that followed. Disinformation about the new disease spread faster than the pandemic, resulting in the emergence of the phenomenon of infodemic, i.e., an overabundance of both reliable and inaccurate information, which makes it difficult for people to identify reliable sources. Infodemic has exacerbated the problem of fake science news, since almost any message about COVID-19 relates to science, in particular, to medicine and biology.

FALSE NEWS, DISINFORMATION, AND MISINFORMATION

The term *fake news* became widely known during the American presidential elections and the 2016 Brexit referendum. According to *The Guardian*, Collins Dictionary called *fake news* the word of 2017, citing, as one reason, a 365% increase in its use [2]. Due to the great attention from academic and political circles, the meaning of this term remains controversial and its use in everyday language is extremely heterogeneous.

Despite the fact that, due to the modern media environment, the mass use of the term *fake news* began relatively recently, this phenomenon has been known since ancient times. J.M. Burkhardt divides the history of fake news into four eras: pre-printing press era,

post-printing press era, mass media era and internet era [3]. In the first era, control over information gave some people power over others and contributed to the creation of most hierarchical cultures. Those who controlled knowledge, information, and the means of its dissemination became leaders of privileged groups. As an example, according to the data of Burkhardt, in the 6th century A.D. Procopius of Caesarea used the dissemination of false information to discredit the Emperor Justinian. The invention of the printing press and the simultaneous spread of literacy made the wider dissemination of information possible. Here, the author notes that J. Swift, in his essay, *The Art of Political Lies*, published in 1710, complained of political fake news. He wrote about the harm that a lie can do, whether attributed to a specific author or an anonymous author. The American writer E.A. Poe wrote a fake newspaper article in 1844 claiming that an aeronaut had crossed the Atlantic in a hot air balloon in just 3 days. Lack of attention to detail and the scientific credibility of the facts made many people believe him until journalists refuted the fake. The article was withdrawn 4 days after publication. Poe is credited with at least six stories that turned out to be fake news.

In the era of mass media, after the invention of radio and television, fake news gained a new speed of distribution. As an example, in 1938, radio broadcasting of the American book *War of the Worlds* by H.G. Wells occurred. A realistic radio broadcast with the inclusion of supposedly real news made people believe the story of the Martian invasion, which caused panic among people who had not read this book [4].

The age of the Internet has accelerated the spread and availability of fake news by many times. As an example, Burkhardt cites the “Pizzagate” conspiracy and the Pope’s supposed support of D. Trump for the post of President of the United States [3].

Due to its relative novelty and the large amount of attention from academic and political circles, the meaning of the term *fake news* remains controversial, and its use in everyday language is highly heterogeneous. According to C.A. Watson, this term was first introduced in appeal by M. Webster at the end of the 19th century [5]. S.N. Ilchenko defines *fake news* as a “journalistic message published in the media containing unreliable and unverified information that does not correspond to real facts and empirical reality” [6]. According to A.P. Sukhodolov and A.M. Bychkova, “fake news” is a message that is stylistically created as real news, but is false in whole or in part” [7]. J. Zhang, B. Dong, and P.S. Yu present them as disinformation or a hoax, spread both through traditional print media and through social networks [8]. J.P. Baptista and A. Gradim provide a broader definition of this term: a type of online disinformation with a wholly or partly false content, intentionally created with the aim of deceiving and manipulating a certain

audience using a format that imitates news or credible reporting, with an opportunistic structure (headline, image, or content), which may or may not be related to real events. Fake news is created to grab the attention of readers, convince them to believe a lie, receive more clicks and reposts, and therefore, have a higher ad revenue and ideological benefit [9]. D.M.J. Lazer understands it as fabricated information that imitates the information content of the media in form, but not in organizational process or intentions. In his opinion, fake news sources lack editorial norms and processes to ensure the accuracy and reliability of information [10].

The term *fake news* is closely related to two concepts that characterize violations in the information field: disinformation and misinformation. Disinformation is understood as the process of manipulating information (misleading someone by providing incomplete information, distorting the context, and distorting part of the information) [11], while misinformation is dissemination of false, erroneous information, but without the author realizing that this information does not correspond to reality [12]. Examples include publications with unverified facts and inaccurate translations of articles from foreign languages. The main feature of misinformation is that mistakes were not deliberately made by the author.

Thus, fake news can be produced both by traditional print media and various Internet resources and have the properties of disinformation and misinformation, i.e., such publications may be malicious or simply erroneous.

FALSE NEWS ON SOCIAL MEDIA

According to the company Hootsuite (an annual survey of 11 189 marketers, interviews with industry experts and exhaustive research), almost 60% of the world’s population is digital. In 2020, the average user spent almost 7 h a day on the Internet, which is 9% more than in the previous year. This means that a person spends about the same amount of time using the Internet as sleeping, and spends approximately 40% of their waking hours using devices connected to the Internet (Fig. 1). In Russia in 2020, there were 124 million Internet users (85% of the total population of the Russian Federation), the annual growth of users was +5.1% (+6 million people), and the average time spent on the Internet was 7 h 52 min [13].

Most often, people go to the Internet and use social networks (95.8%), instant messengers (95.5%), and search services (83.4%) to make purchases (58.2%), to determine their location and use maps (56.2%), e-mail (50.6%), listen to music (46.4%), watch news (41.8%) and weather (40.6%), and for entertainment (40%) [14], i.e., using social media to keep abreast of news and current events is a common reason for logging in around the world [15].

Fig. 1. An overview of the global use of the Internet (compiled from [13]).

Fig. 2. The use of social networks and messengers (compiled from [13]).

By the beginning of 2021, almost half a billion new users had registered on social networks. On average, over 1.3 million new accounts were created every day during 2020, which is approximately 15.5 new users per second. An ordinary user of social networks now spends 2 h and 25 min every day on these platforms [13] (Fig. 2).

The most popular social networks in the world are Facebook, Youtube, and Instagram (Fig. 3); in Russia they are YouTube, VK, and Instagram (Fig. 4).

The German company Statista, in its report dated June 16, 2021, notes that fake news is a complex and widespread problem in the news industry, which has grown into a serious global problem. Statista highlights the leading role of social networks in spreading fake news: the study showed that more than 50% of Internet users in 24 countries use social networks to read news information, although they have been considered the least reliable source of news since 2016 [16]. At the same time, social media is being used for validation of online news [17]. While this is not the most effective way to validate a news article, many users look at how many other people have shared or liked the news on social media to assess the reliability of content.

Younger social media users are at greater risk of being exposed to fake news than older generations, because they use social media more often. This problem has worsened by the coronavirus pandemic. A survey conducted in spring 2020 showed that in Great

Britain 60% of young people aged 16–24 used social media to get information about the coronavirus and 59% found fake news on this topic [18]. In France, almost 30% of the people between the ages of 15 and 18 used social media as their primary source of information about the coronavirus. A separate global survey found that while most of the generation Z news consumers and millennials ignored fake COVID-19 news, some preferred to share such content [19].

According to the working group of the Public Chamber of the Russian Federation on countering the dissemination of inaccurate information, public control, and network security, the level of fake news increased by 50% in Russia in the first half of 2021. According to the group, fake news is recorded in 10 categories; the first of these is elections. As well, fake news was recorded on the topic of vaccination against COVID-19 (10000 cases of fake news) and coronavirus (8000). In addition, distorted information on the Internet concerns the following topics: forest fires, mining of secondary schools (approximately 2500 messages), illegal protest actions (less than 2000), political fakes, war fakes (publications about military operations near Russian borders) and financial fakes (more than 2000 messages) [20].

A poll conducted by the Public Opinion Foundation in February 2021 showed that 56% of Russians read news on the Internet. Most often, users search for news through aggregators (39%), followed by social

Fig. 3. The world's most popular social networks and messengers (million people) [13].

Fig. 4. The most used social networks and messengers in the Russian Federation (million people) [13].

networks (19%). To the question: “On what forums, blogs, social networking sites, in which messengers do you usually find news, information messages?” 13% answered VK, 10% said Instagram, and 8% each gave Whatsapp, Viber, and Telegram; 5% of Russians learn news from Odnoklassniki, 4% from Facebook, and 2% from Twitter [21].

Thus, social networks have become a powerful tool through which the minds of citizens are manipulated; these networks have significant propaganda potential and can also distort reality on a global scale.

FAKE SCIENCE NEWS

In our time, science is more relevant than ever for society, given such important problems of our time as climate change, the energy supply, and the global spread of viral infections. Science news is a key resource for helping the public understand new scientific knowledge and the latest technological advances. The media, including social media, mediate relationships between people and technological development and help them to understand the new world by playing

Fig. 5. Science news sources.

the role of a science conduit. According to the reach of the audience, the main channels for the receipt of science news can be divided into sources for professionals (scientists) and sources for society as a whole (Fig. 5). Accordingly, professional sources of information (mostly scientific articles) are the main channels for obtaining information for popular scientific publications and news agencies. It is difficult to judge the quality of scientific articles, but an article in a scientific journal is most likely to be peer reviewed, which makes it a more reliable source of news. However, this is compounded by the fact that the quality of scientific journals can vary significantly and some journals publish research without peer review.

Ideally, scientific information should have the following properties: objectivity, reliability, completeness, accuracy, relevance, and usefulness (value). However, in practice, *Nature* estimated that about one-third of all researchers are involved in plagiarism and data falsification. Of the 7000 scientists surveyed by the journal, 33% admitted to violating scientific ethics [22]. The driving forces of fake science are embedded in the existing scientific publishing system, which was designed to disseminate reliable knowledge, in which a combination of scientific advances and financial rewards for scientists and publishers stimulates the creation and promotion of fake results. False scientific data lead to fake science news.

Science (especially the social sciences) has become highly politicized. A striking example of this is the not

entirely ethical experiment conducted in 2018 by three American scientists. For an entire year, they deliberately wrote completely meaningless and frankly absurd scientific articles dedicated to various manifestations of the fight against social injustice: studies of feminism, the culture of masculinity, issues of racial identification and sexual orientation, positive body image, etc., to prove that ideology in this area has long won out over common sense. In total, 20 papers were written, of which 7 received reviews from leading scientists and were accepted for publication in journals specializing in cultural studies and identity studies. One of the most absurd works even received a special award. After the outbreak of the scandal, the authors of these works wrote an open letter to the scientific community with an appeal to begin a thorough review of these areas of study (gender studies, critical race theory, postcolonial theory, and other areas of the humanities and social sciences, especially sociology and anthropology) in order to separate science-intensive disciplines and scientists from those who create constructivist sophistry [23].

Science journalism is in poor condition, according to the American Council on Science and Health, one of the compilers of the 2017 ranking of US news sources for science news, and they emphasize that science journalism is not only subject to the biases inherent in conventional journalism, but also especially vulnerable to outrageous sensations [24].

The news aggregator RealClearScience, which also worked on this ranking, notes that much of the science reporting is a morass of ideologically motivated junk science, bloated research, or technically jargon that almost no one can understand [25].

The most popular science fake news over the years has been vaccine manufacturer conspiracy theories and denial of man-made climate destruction. Vaccines are considered one of the most important inventions ever made for the benefit of humanity. The World Health Organization estimates that vaccines save 2–3 million lives every year. However, a fabricated scientific article that claimed that the measles, mumps, and rubella vaccine causes autism [26] led to widespread dissemination of this misinformation, especially through social media. This, in turn, led not only to record levels of measles incidence in Europe in 2018, but also expanded the range of so-called anti-vaxxers [27].

The denial of anthropogenic climate change, which is dismissed as fake science without any evidence, has led to universal acceptance of the international agreement on climate change being lost, and its impact on global warming is likely to be disastrous around the world [28].

One of the most widely replicated fakes is the so-called flat Earth theory. Tens of thousands of videos, social media accounts, podcasts, and websites are devoted to this absurd theory [29, 30]. Today, when space probes are exploring the planets of the solar system, such “scientific” information can only cause confusion.

The COVID-19 pandemic has exacerbated the problem of fake science news, both for the scientific world and for the entire society. Misinformation about the new disease spread faster than the pandemic, as a result of which the WHO declared it an infodemic, which means an overabundance of reliable and inaccurate information, which makes it difficult for people to identify reliable sources, i.e., the information itself began to spread virally.

Infodemic touched not only science news disseminated through social networks, but also scientific articles. According to the journal *Nature*, in 2020, approximately 100000 scientific articles were published in the world on the subject of COVID-19, of which 30000 were preprints (i.e., articles without going through the peer review procedure) [31]. According to the portal Retraction Watch, to date, approximately 200 articles have been withdrawn from scientific journals [32]. These are relatively small numbers, but until these articles were withdrawn and were available on the websites of journals in electronic form, the data from them could obtain into news feeds, and the articles themselves could become sources of fake science news.

A study by the London School of Economics suggests that the COVID-19 crisis could have a negative impact on the perception of scientists by ordinary peo-

ple, especially those without education [33]. Using past pandemics as a guide, they concluded that the COVID-19 crisis would diminish the credibility of individual scientists, impair perceptions of their honesty, and weaken the belief that their work is beneficial to society.

It is especially dangerous when pseudoscientific information comes from real scientists or doctors. In particular, Doctor of Biological Sciences Irina Ermakova in an interview posted on *Youtube*, stated that the cause of the COVID-19 disease is a certain mysterious bacterium *Cynthia* [34]. If a person with knowledge in biology can suspect pseudoscientific news, then a common man in the street may well believe a biologist with a scientific degree. As well, the Deputy Chief Physician of Australia, Professor P. Kelly pointed out that there is no need to wear protective masks; this negates the abundant scientific evidence of the benefits of masks in reducing infection with COVID-19 [35].

In general, the coronavirus pandemic has spawned a host of conspiracy theories and fake science news, which can be roughly divided into the following categories:¹

- the origin of the SARS-CoV-2 virus (bat soup, a laboratory leak, creation of the virus by Bill Gates or the US Government);
- racial theory (for example, only Asians are infected with the virus);
- the spread of coronavirus (5G networks);
- treatment and prevention of coronavirus (alcohol consumption; rinsing with chlorine dioxide; bleach injections; swimming in a pool with chlorinated water; eating garlic, ginger, sesame oil, bananas; using cocaine; washing hands and rubbing surfaces with baby urine; warming up the nose with a hairdryer; taking baths with granite);
- politics (governments hiding the real deaths from coronavirus and falsifying vaccinations; the increase in the incidence in Europe is caused by illegal migrants);
- epidemiology and statistics (overestimated/underestimated statistics on morbidity and mortality);
- vaccines and vaccinations (death after vaccination; mass vaccination for the sake of obtaining superprofits by corporations; the contents of heavy metals in the vaccine).

Most readers probably found this news funny, but there are examples where such messages caused serious harm to health and even led to death. As an example, by the end of March 2020, over 2100 Iranians had been poisoned by oral methanol. Iran, as an Islamic country, has strict restrictions on alcohol consumption, but in this case patients said that, according to information on social networks, SARS-CoV-2 infection can be prevented with alcohol. As a result, almost

¹ Data collected by the author on social networks.

900 patients poisoned with illegal alcohol were admitted to the intensive care unit and 296 of them died [36].

The colossal role in the dissemination of pseudo-scientific information of the so-called influencers (influential persons) with tens and even hundreds of millions of subscribers on social networks should be noted. As an example, the famous American popularizer of science Bill Nye has 3 million subscribers on the social network Instagram, while the footballer Ronaldo has 365 million. If a hypothetical football player publishes pseudo-scientific information, this can seriously affect the views of many people from around the world.

This is confirmed by a recent study by the Center for Countering Digital Hate where it was revealed that just 12 people are responsible for many of the misleading claims and outright lies about COVID-19 vaccines that are circulating in Facebook, Instagram, and Twitter, i.e., The Dozen Disinformers, reaching an audience of 59 million people, produce 65% of the pseudoscientific anti-vaccination information on social media [37]. After the publication of this report, the management of Facebook stated that the accounts of these 12 people have been blocked, and 22 accounts were restricted, for example, they are prohibited from recommending anything to other users, the reach of their messages has been reduced, and they are prohibited from promoting themselves through paid advertising [38]. In particular, one Facebook account blocked the anti-vaccination activist Robert F. Kennedy, Jr., one of the Dozen Disinformers. Before the pandemic, he actively promoted the idea of linking vaccines to autism. During the pandemic, he shared unsubstantiated conspiracy theories linking 5G cellular networks with coronavirus and without evidence stated that the death of the baseball player Hank Aaron was part of a wave of suspicious vaccine-related deaths.

All of the above, on the one hand, emphasizes the problem of controlling scientific publications, and on the other, the problem of controlling the media and social networks. Over the past year, there have been some changes in social media policy, in particular, the Facebook and Twitter social media companies removed millions of fake news stories related to COVID-19. Both companies are taking steps to attract reliable information about the disease and vaccinations. Twitter deleted more than 22400 tweets and challenged 11.7 million accounts worldwide that contain problematic content. Facebook removed 2 million pieces of content from Facebook and Instagram [39, 40].

However, fake news spreads faster than social media workers react to it. As an example, in the first quarter of 2021, the most viewed material on the social network Facebook was the *Chicago Tribune* article titled "A 'healthy' doctor died two weeks after getting a COVID-19 vaccine; CDC is investigating why" [41]. The message was soon blocked, but more than 54 million people read and disseminated it.

In Russia in 2019 and 2021 amendments to the Law On Information, Information Technologies, and Information Protection² were accepted and changes to the Code of Administrative Offenses³ were aimed at countering fake news. According to this law, by early 2021 Roskomnadzor deleted or blocked 3516 Internet pages with fake information about the coronavirus [42]. From April 1, 2021, Russia introduced criminal liability for the dissemination of knowingly false information about the coronavirus, which led to grave consequences. Such measures are carried out by the governments of many countries of the world. This gives hope that the infodemic can be taken under control and, possibly, lives can be saved.

CONCLUSIONS

With the development of science and technology, there has been a clear increase in interest in science and scientific research. On the one hand, society is aware of the dependence of progress on the development of scientific research; on the other hand, it perceives science as something that carries potential threats. The digital revolution contributed to the replacement of vertical models of dialogue between science and society with horizontal models [43]. An important subject of the dialogue between society and science is the diversity of scientific knowledge in the information environment. The transition of scientific knowledge into knowledge for all is ensured by the popularization of science, which gives knowledge a form accessible to the general public.

Fake science news is a socio-cultural phenomenon of imitation of reliable scientific knowledge. Fake news creators use complex terms to promote ideas that are not recognized by the scientific community, which can seriously affect the worldview of society. In the information environment, reliable and fake science news compete with each other and the user's real choice is far from always obvious. The user chooses not between science and pseudoscience, but between understandable science and complex science. In addition, resistance to new knowledge may prevail due to the cognitive dissonance that occurs when new facts contradict their own ideas.

The massive dissemination of fake science news can be seen as a crisis of the political system and science journalism and as a new propaganda tool, where fake scientific information is deliberately disseminated on social networks in a viral manner with the aim of quickly impacting the audience. There are many motives for creating fake science news, the most obvious being financial gain and ideological beliefs.

² Federal Law On Information, Information Technologies, and Information Protection. <http://pravo.gov.ru/proxy/ips/?docbody&nd=102108264>.

³ Code of the Russian Federation on Administrative Offenses. <http://pravo.gov.ru/proxy/ips/?docbody&nd=102074277>.

Preventing the deliberate creation of false information is very difficult, and, in democratic societies that operate on the principles of free speech and freedom of expression, it is even more difficult. Thus, instead of looking for ways to prevent the creation of misinformation, the primary focus should be on limiting the spread of fake news and minimizing the damage it can cause.

On the one hand, it is up to the scientific community to stand up against the spread of false information and fake science and to resolutely oppose the public figures who promote it. Scientists should contribute to research that promotes the understanding of false information, to education that develops knowledge and skills in the assessment of information, and to the scientific literacy of society. Even the publication of a “popular,” understandable to the general public, press release about one’s scientific work on the website of a scientific organization or university can contribute to the reliability of news information, i.e., the best way to combat fake science news is to fill the modern media environment with engaging and reliable information. On the other hand, the scientific community must promote ethics and integrity in research, the development of policies and practices to reduce the publication of false data and results and the use of predatory journals without adequate peer review [44, 45].

Reporting suspicious content, using only reputable news sources, and verifying information can help to create a safer news environment.

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CONFLICT OF INTEREST

The author declares that she has no conflicts of interest.

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