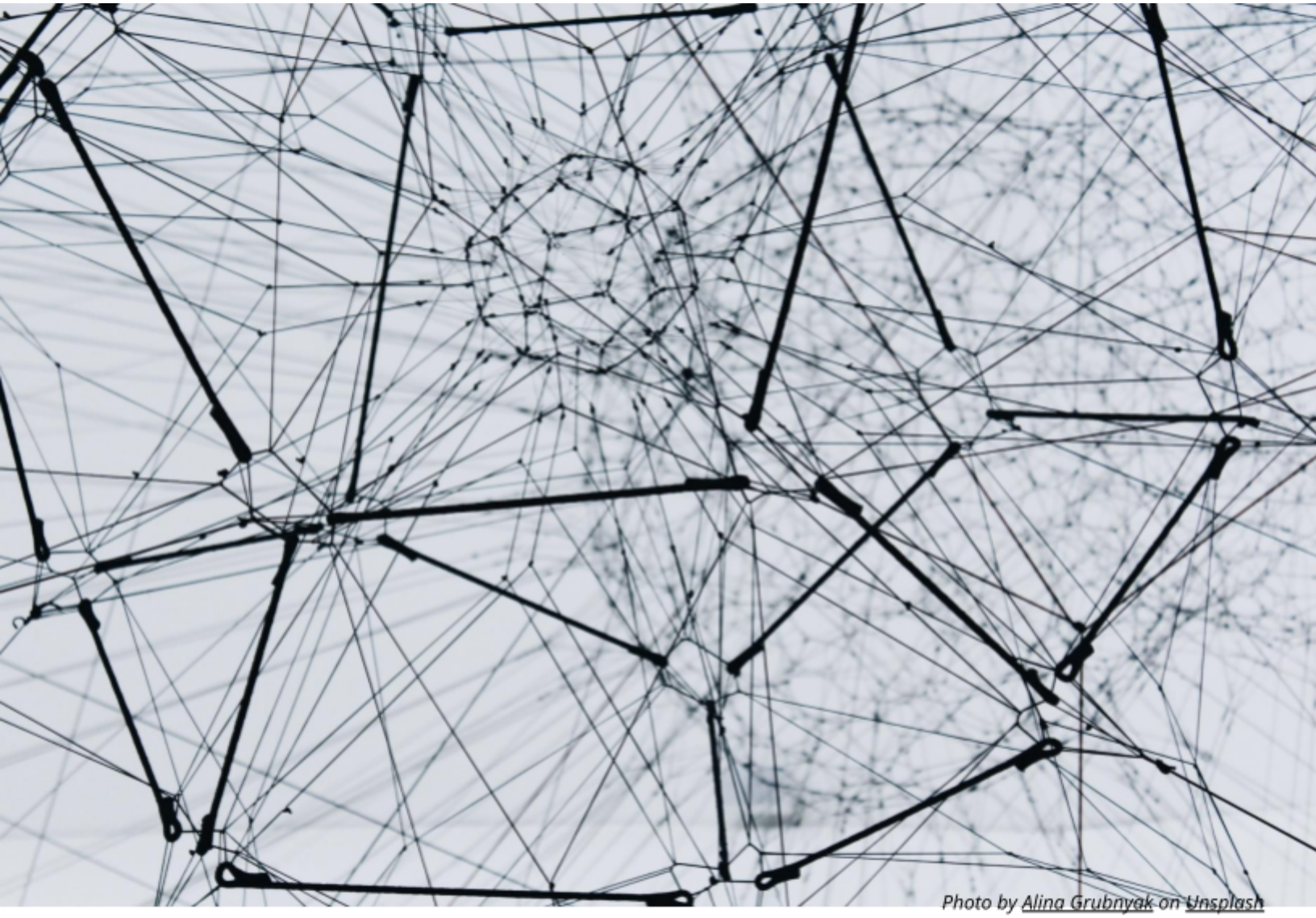

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TRESCA

Trustworthy, Reliable and Engaging Scientific Communication Approaches

D1.1 Meta-analysis map: relevant factors shaping public attitudes of science communication

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EXECUTIVE SUMMARY

This report offers an overview of academic studies which have focused on instances of effective science communications and on psychological mechanisms that facilitate, or hamper, one's ability to understand scientific findings. The aim of this literature review is to create a theoretical understanding of how citizens interpret and frame scientific communication efforts. This review serves as a basis to identify research questions to be explored during the data collection phases undertaken in WP2 and WP3. This mapping exercise will also help the TRESCA team identify factors that may influence citizen perceptions of science communication, and to shed light on how these factors are interrelated during the empirical analyses.

The review includes three main sections. It begins with a brief overview of the history of science, and of how the way we conceive science, especially social sciences, has changed from the early days of positivism to a shared view of science as a co-produced social practice. From this standpoint, the following introductory section presents the specific role of science communication and RRI in transferring scientific findings from the practice of science to everyday life in a constant cross-fertilization exercise, which is not immune to crisis and power dynamics that affect the credibility of scientists and the trust people have in them. In the second part, the review moves then to presenting what we know about effective science communication. To better pursue this goal, themes are organised around four main categories: (1) audience's characteristics; (2) communicator's characteristics; (3) features of the message; and (4) type of media environment and communication channel adopted. The third section of the review focuses on the serious problem of misinformation, both in general and in science in particular. It sheds light on the role that conspiracy theories play in upholding false beliefs. Findings are summarised in the conclusions. Further information on findings of specific science communication studies are reported in the appendix.

INTRODUCTION

Before having an in-depth discussion about psychological mechanisms and factors influencing people's understanding of science communication, this introductory section offers some reflections on the specificity of science as social and knowledge-creation practice. It also invites us to reflect on science communication as a practice that helps establish and communicate the trustworthiness of scientists. The importance of reflecting on the trustworthiness of scientists, especially their competence, integrity and benevolence, becomes more evident at the end of the report. In the final section, in fact, the discussion on the relationship between misinformation and conspiracy theories foregrounds the need to understand how to foster people's trust in scientists and build trusted communications between them, and so avoid the trap of partisanship, confirmation bias, and the risk of believing misinformation about science because of affective polarisation.

1.1 What 'Science' stands for in SciCom

What do we mean by 'science' when we talk of science communication (SciCom)? How shall we define science? Is science what scientists do? Is science what is published in scientific outlets? Is engineering a type of science? Is SSH science? How can we distinguish science from other types of expert knowledge? Is STEM science? Shall humanities be included within science communication? Or are social sciences and humanities fundamentally different because of the methods they apply? Why has the National Academies of Sciences, Engineering, and Medicine a "Division of Behavioral and Social Sciences and Education" with a "Committee on the Science of Science Communication" that writes a report titled "Communicating Science Effectively: A Research Agenda"?[1] Has any Social Science and Humanities Research Council of any country written a similar report?

One way to answer these questions is to start by elaborating a working definition of science. Science, as we know it, is a social practice aiming at the progressive, cumulative generation of knowledge. Indeed, it is not the only one which seeks to produce knowledge, as there are other social practices that do produce knowledge, but which we do not classify as science. Furthermore, the knowledge produced by what we call science may be very different, depending on the branches of science that have produced it. So, back to our question, what can be said to be science communication and what cannot?

If we think of science as a social practice, we may agree that scientific activities (as well as scientific methods and results) are shaped by cultural factors and political institutions, by existing written and unwritten norms and regulations, funding opportunities, calls and resources, dominant social values and priorities, power and gender

[1] National Academies of Sciences, Engineering, and Medicine. 2017. *Communicating science effectively: A research agenda*. National Academies Press.

dynamics and geopolitical factors. Yet, this does not mean that the knowledge generated by scientific institutions and methods is similar to the knowledge generated by other social practices, it rather means that science is subjected to the same forces and influences that shape other social practices, such as, for instance, healthcare, employment or education.

So, we have come to the preliminary definition of what happens to science compared to other social practices: it is, allegedly, different from other social but it is subjected to the same social, political, cultural and economic forces. In other reports (see D1.2 and D1.5), the TRESCA team will address the consequences of the pressure of these forces, and how science exerts an influence back onto these forces and institutions, in a process known in STS as co-production[2]. According to Sheila Jasanoff, science and social order are co-produced; and these co-production processes have implications for science communication. For the moment, we rather need to go back to the fundamental question we posed at the very beginning of this section: what makes science different from other social practices of knowledge generation?

Clearly, we are not the first scholars to ask this question. It lays at the heart of the very emergence of science as a knowledge generation process, back in the 17th century. Human civilization has been producing knowledge (and technology) for thousands of years before the term science was even coined. And yet, we speak of science only from the 17th century onwards, when we commonly consider that a scientific revolution took place. What made science different from the contemporary forms of knowledge generation, such as, for instance, alchemy? The end of the 16th century and the beginning of the 17th century witnessed a blooming process of scientific societies, groups, or colleges, whose common characteristics was a general tendency to share ideas, hypotheses, experiments etc. Some of these societies were actually secret, to the point that we still doubt they ever existed at all, such as the Brotherhood of the Rosycross; others were semi-secret, like the Invisible College, others were quite well known among scholars of the time, like the Universal College founded by Comenius. Other societies, like the British Royal Society, still exist today. Some of the early societies, mostly secret and mostly associated with what is generally known as alchemical knowledge, adopted an impenetrable system of recruitment, and were deeply inspired by a protestant view of *Nature* and of the *Revealed Knowledge of the Bible*. To these early scientists, if the *Book of God* and the *Book of Nature* were written by the same *Divine Entity*, there could not be any divergence between the two. Hence, the idea of deepening the knowledge of the Book of Nature to increase and improve our knowledge of God: experimenting with natural processes, organisms and forces was a key element of this new, essentially religious, spirit.

However, the secretiveness of the early alchemical brotherhoods and societies did not encourage the diffusion (and testing) of these experiments and, thus, of this new form of knowledge. These societies were more interested in training new affiliates than in the

[2] Jasanoff, S. (Ed.). (2004). *States of knowledge: the co-production of science and the social order*. Routledge.

generation of new, verifiable, knowledge, and had a quite marked political (often escathological) program. Things began to change with Francis Bacon. The latter, who had been trained in this quite peculiar epistemic and religious environment, was among the first to suggest the need to publish the actual experiments, their methodology and their outcomes so that other scientists, or natural philosophers as they were then called, could replicate the experiments and verify the results. Bacon was no more secular or "modern" than his contemporary authors, and was moved by deeply religious beliefs, but disagreed with the secretiveness of the "scientific" societies of his time. He believed that a wide diffusion of experiments and results would serve the progress of natural philosophy much better than secretiveness: the book of nature would be better studied by sharing knowledge than by preserving it under constrained access. In turn, he believed, our knowledge of God would also improve rapidly. The scientific societies that followed Bacon, such as for instance the Universal College of Comenius, still had a marked religious character and conceived "science" as part of a *utopian political program*[3], which sought to create the Eden on earth through the advances of science, medicine and technology. This religious and political character was, in many ways, responsible for the religious warfare in Europe at the time, and underpinned a more well known battle between Catholicism and Protestantism across the continent. In the aftermath of the Thirty Years war, when the Royal Society was founded, the religious aspects of science and scientific practices were put to a side, for the sake of coexistence and collaboration, and so were the political aspirations. Yet, the key elements of science, the experimental nature and the importance to share data, methods and results, began to consolidate as the main characteristics of science compared to other social practices of knowledge generation.

From this brief historical overture, we have identified some elements that have been considered distinctive of science during its history: the experimental method and the validation of results by other scientists (peers) who replicate experiments, methods and observe similarities or differences in the results. These elements are fundamental pillars of scientific practices still nowadays. In contrast, the "secularization" of science led to a separation between the more speculative, spiritual and religious elements of the scientific practice and science itself. Soon, science was no longer about knowing the *Book of God* or bringing the *Paradise on Earth*; it was rather about mastering *Nature* for improving life conditions of human civilizations. As part of this process of change, a rapid assimilation of the word 'science' with the experimental branches of science (physics, chemistry, biology) happened. Theology or philosophy, which were an integral part of natural philosophy in the 17th century, were no longer part of science in the 18th century. It was not until the 19th century that scholars like Comte applied the scientific methods to social phenomena. During the period that is known as Positivism, social science was (re)born. Comte, and the Positivists in general, however, shared a political and religious view of science, and believed it was possible to elaborate a universal religious *credo* based on science, which was also

[3] Pavone, Vincenzo. *From the Labyrinth of the World to the Paradise of the Heart*. Lexington Books, 30 May 2008, 276 pages.

meant to be the basis of a political revolution, with concerning authoritarian elements. Nonetheless, their fundamental intuition of extending the use of the experimental method of natural science to social phenomena had a profound impact on disciplines such as economics, sociology, political science, or anthropology.

Under positivism, the scientists assumed a distance between the observer and the phenomena observed. This distance allowed the observer to believe in her capacity to observe and study the phenomenon, collecting and analysing data and delivering universally valid results, especially when these findings were replicated by other scientists in other settings. However, as the twentieth century moved to its second half, such distance was deeply questioned not only in relation to social science, where the observer is clearly part of the observed reality, but also in relation to natural science, where the objects of study can only really exist (at least insofar science is concerned) within the mind of the observer. This means that a given reality, say a planet, regardless of its pure and inaccessible existence, can only be studied (and therefore known) from a specific vantage point (the mind of the observer), which is shaped and influenced by a variety of social, economic, and cultural factors, and changes over time.

From this then unconventional point of view, it was increasingly clear that science was, indeed, a distinctive social practice, with its own shared methods and epistemic credo, conducted by specialised actors who had received a specific training, subjected to shared norms of knowledge validation and with a rather unique place in the societal fabric. Nonetheless, a social practice it was, and therefore it was, in many ways, (socially) constructed. That is to say, it was not the final result of a targeted process of evolution leading to a stable, universal and supracultural practice, but a contextualised, contingent and ever changing practice, which evolved along with the societal dynamics which surrounded and took part in it.

The imperative implications of this standing point led Latour[4], Law[5] and Callon[6], just to mention a few very important scholars, to broaden the anthropological gaze beyond the indigenous societies and cultures across the developing world to the very heart of the scientific practices: laboratories, universities, technological and innovation companies. What these authors, along with several others scholars, found was that the scientific activity in the labs was subjected to the very same dynamics and forces influencing other common social practices, and science could, and indeed should, become an object of scholarly enquiry *per se*. In fact, they also noticed that, as a social practice, not only science was subjected to the same dynamics you would find elsewhere, it was also characterised by an horizontal network of interactions and relations where human actors and non-human actors (devices, tools, norms, data, methods, machines and animals) jointly contributed to

[4] Latour, Bruno. Science in action: How to follow scientists and engineers through society. Harvard university press, 1987.
[5] John, Law. "Actor network theory and material semiotics." *Social theory* (2009): 141.
[6] Callon, Michel. "Performativity, misfires and politics." *Journal of Cultural Economy* 3, no. 2 (2010): 163-169.

the operational functioning of the practice. It was impossible, as they say, to separate human and non-human actors, relegating the burden and responsibility of action solely to human actors. Rather, actions, and indeed the practice as a whole, were always the outcome of a constant interaction between all these actants (human and non-human), which could not be studied or understood separately.

From the vantage point of what is widely known as *Actor Network Theory* (ANT), thus, science not only is subjected to the forces influencing other social practices, it also functions and operates as other social practices. Other authors within the field of *Science and Technology Studies* (STS) have criticised ANT for its narrow focus. While it is true that science does operate like other social practices, and in a way not so different from what ANT scholars suggest, the 'horizontal' characterization offered by ANT is misleading. Science is subjected to the same power relations and economic dynamics shaping other social practices, and this implies that it contributes to the reinforcement (or to the critique) of a dominant social order, which is reflected in scientific advancements. Technologies, and the science contributing to their development, are not neutral: they reflect, at all times, the values, priorities, interests and norms of the social order in which they were conceived. Science and social order, again, are co-produced. In this co-production process, the social forces that shape science, and are shaped back by science, may not directly affect the scientific method and its outcomes, but they do influence science priorities (through funding and promotions), as well as scientific approaches and research questions. Issues that will be further explored in D1.5.

Let us consider the following example. During historical periods when dominant discourses were oriented towards collectivity and the idea of the common good, disciplines like epidemiology flourished. In contrast, in periods when the social order was more inclined to give priority to individuals and their rational benefits, disciplines like genetics experienced an impressive advance. While epidemiology and genetics are both scientific disciplines, which equally endorse the scientific method and produce validated and falsifiable outcomes, their different trajectory in space and time is not a casual occurrence. In fact, they shape the world differently because they contribute differently to the social order, encouraging a different take on diseases, for instance, and treatments. For instance, epidemiology may encourage an approach to cancer that emphasises the importance of environmental, social and economic factors on the likelihood of developing cancer. These considerations may lead to the implementation of public health measures tackling these same factors. On the other hand, genetics may rather encourage a more individualised approach to cancer treatment, by emphasising genetic predispositions to develop cancer and personalised treatments to increase the efficacy of existing drugs. From the epidemiology vantage point, we would rather be encouraged to act upon the external factors that are known to induce cancer, whilst from the genetics point of view, we are more inclined to support measures and treatments that operate on individual factors that contribute to the development of cancer.

If science is not only subject to the same forces and factors influencing other social practices, but also operates according to the same dynamics and mechanisms, what makes science distinctive then? The very fact that science is (socially) constructed should not lead us to think that its outcomes and results have no epistemological validity. None of the contributions from ANT and STS have ever challenged the validity of scientific knowledge, they have mainly shown how such validity is generated, consolidated and maintained.

Saying that science is (socially) constructed does not lead to deny the value of science as a form of knowledge; this perspective was also not conceived to discredit scientists and their work. Karl Popper[7] never held that non-scientific activities were meaningless or even intellectually disreputable. In the words of Bruno Latour[8] conspiracy theories are an absurd deformation of critical arguments. For critical STS scholars "the question was never to get away from facts but closer to them, not fighting empiricism but, on the contrary, renewing empiricism". Latour writes:

> *I myself have spent some time in the past trying to show 'the lack of scientific certainty' inherent in the construction of facts. I too made it a 'primary issue.' But I did not exactly aim at fooling the public by obscuring the certainty of a closed argument—or did I? After all, I have been accused of just that sin. Still, I'd like to believe that, on the contrary, I intended to emancipate the public from prematurely naturalized objectified facts. Was I foolishly mistaken? [...] Why does it burn my tongue to say that global warming is a fact whether you like it or not? Why can't I simply say that the argument is closed for good?*

The admissibility of scientific evidence, and its inclusion into the collective body of knowledge, is an important peer-review process by which scientists fence out 'junk science' by continuously revising their theories based on findings that have not been refused yet. What makes science special is that scientific knowledge is produced according to standardised methods, reviewed and validated by expert peers, replicated several times and communicated widely across the globe. This set of norms make scientific knowledge a robust and reliable, yet not perfect, way of generating knowledge. In proposing quantitative theories and claiming to measure the attributes involved, psychologists are logically committed to perform two research tasks[9]: the scientific one of showing that the relevant attribute is quantitative; and the instrumental one of constructing procedures for numerically estimating magnitudes. Rigor and consistency from theory to empirical testing are fundamental elements of science. A science that can rely on a large variety of methods (qualitative or quantitative empirical research methods, deductive agent-based simulations, or the analysis of unstructured information in 'big data' environments). These days, Open Science, which is a form of transparent and accessible knowledge that is shared and

[7] A. O'Hear, Popper, in *The Oxford Companion to Philosophy* 702, Ted Honderich ed. 1995.
[8] Latour, Bruno. "Why has critique run out of steam? From matters of fact to matters of concern." *Critical inquiry* 30, no. 2 (2004): 225-248.
[9] Michell, Joel. "Quantitative science and the definition of measurement in psychology." *British journal of Psychology* 88, no. 3 (1997): 355-383.

developed through collaborative networks, is further increasing transparency of scientific production and engagement of different stakeholders.

1.1 Science communication and RRI

According to Burns, O'Connor, and Stocklmayer (2003)[10], science communication (SciCom) can be defined as the use of appropriate skills, media, activities, and dialogue to produce one or more of the following personal responses to science: Awareness, Enjoyment, Interest, Opinion-forming, and Understanding (AEIOU). According to the network of *National Contact Points for Science with and for Society* (SiS.net)[11] in Horizon 2020, science communication can bridge the gap between science and society by the use of appropriate media and activities meant to improve individuals' awareness, interest, and understanding of science. Science communication can either be led by professional scientists and addressed to non-expert audiences (*science outreach*) or it can be a form of expert-to-expert communication between scientists from similar or different scientific backgrounds (*science inreach or scholarly communication*).

In the view of Medvecky and Leach (2019: 37-38)[12]

> *Science communication is a communicative practice that is socially engaged, embedded, personal, interested. It is part journalism, part PR. And it is also part science, or at least, science communication is attached to some of the ethos of science, from its association to accuracy and its aspiration for universalism and disinterestedness.*

Besides science inreach or scholarly communication, science communication is often something in between public relations (PR) and journalism. Both PR and journalism are part of science communication, and science communication includes and invites all forms of communication. However, PR is often seen as inherently self-serving and a cousin of marketing, despite the fact that two central principles of PR are a commitment to factual accuracy and a commitment to loyalty. In fact, the Public Relations Society of America (PRSA) has as a principle the "highest standards of accuracy and truth in advancing the interests of those we represent and in communicating with the public". We may say that SciCom comes closer to PR when scientific institutions communicate science directly to the public or in response to inquiries made by governments and corporations. SciCom is more a form of journalism when journalists or scientific communicators mediate the relationship between scientists and the public and make the effort of translating scientific findings in plain language while also adopting engaging and attractive communication formats. Depending on who is speaking, whether it is a journalist or a scientist, and on which

[10] Burns, Terry W., D. John O'Connor, and Susan M. Stocklmayer. "Science communication: a contemporary definition." *Public understanding of science* 12, no. 2 (2003): 183-202.
[11] SIS.net "Science Communication: Policy Brief".
[12] Medvecky, F., & Leach, J. (2019). An Ethics Of Science Communication: Palgrave Pivot.

method that person is using to communicate (a newspaper article, a podcast or a TV show), members of the audience will be more or less persuaded to transform the information received into valuable knowledge.

In order to improve the quality and quantity of effective and valuable SciCom, we need to focus on four basic elements influencing public perception of scientific communications. These elements refer to the audience's and communicators' characteristics as well as to features of the message and of the media environment. In the rest of this report we focus on research conducted across a variety of disciplines on exactly these four basic elements. The objective of the analysis presented in the following pages is to create a theoretical understanding of how people consume and interpret SciCom so as to help journalists help scientists help people fight scientific misinformation.

Science itself is a communal activity and scientific results should be seen as 'common goods' to be communicated freely. What knowledge is worth communicating? In science communication we need to distinguish between knowledge, knowing, information and informing. Roughly, data are bits of raw facts, information is data organised so as to increase its usefulness, and knowledge is the subjective experience (of an individual or a collective) of evaluating and incorporating new information and experiences into a meaningful mental frame. Once the data are aggregated and presented in a more useful form, say a table or chart, it becomes information. And it becomes knowledge for an individual once that individual has taken that information in and incorporated it as part of their mental structure. It becomes knowledge for a collective, such as an organisation or a state, once that collective has incorporated the information in its knowledge structure. What is of concern for science communication is the extent to which the pursuit of knowing should be encouraged, given a set of information. Valuable information is the one that is relevant to the individual's life.

Indeed, if information is relevant, that provides a good reason to go to the effort of knowing it. This is one of the reasons why TRESCA focuses on communicating social science and humanities (SSH) research relevant to people's everyday life. TRESCA is meant to help people distinguish trustworthy sources and contents from untrustworthy ones, and to support journalists and policy makers in learning how to better draw upon the communication of scientific research.

Factors influencing public perceptions of SciCom

One of the fundamental questions of TRESCA is what kind of science communication (SciCom) methods are more effective overall, and which specific approaches we should adopt to fight and revert the effects of misinformation. While it is relatively easy to communicate scientific facts to an uninformed audience, it is remarkably difficult to eradicate inaccurate beliefs once they are formed. In this literature review we focus on (a) factors that increase the effectiveness of science communication, and (b) studies that

explore ways to counteract misinformation by either leveraging psychological mechanisms or developing technical tools.

According to the National Academies of Sciences, Engineering, and Medicine (2007)[13], four main types of factors affect public perceptions of science communications. As reported in Table 1, these factors include: (1) audience's characteristics; (2) communicator's characteristics; (3) features of the message; and (4) type of media environment and communication channel adopted. These four categories influence public support for the content presented in science communication. In the rest of this report, we use these four categories to present what we currently know based on previous studies. As the objective of TRESCA is to improve the effectiveness of accurate science communication, we will pay special attention to the issue of misinformation, its antecedents and countermeasures.

Table 1: Factors affecting how the public perceives science communication

Factors affecting how the public perceives science communication
1) Audience's characteristics a) psychological biases b) audience's goals and needs, knowledge and skills, and values and previously held beliefs, familiarity with the topic c) individual characteristics, like personality, education, cognitive abilities
2) Communicator's characteristics a) diversity of science communicators i) scientific community (individual scientists, universities, and scientific associations) ii) journalists iii) government agencies iv) advocacy organizations v) think tanks vi) corporations, nonprofit research organizations, health professionals b) goal of the message/ communicator? e.g., to inform, to influence or to engage c) lack of formal training in science communication d) lack of trust in science communicators
3) Features of the message a) controversial content

[13] National Academies of Sciences, Engineering, and Medicine. 2017. *Communicating science effectively: A research agenda*. National Academies Press.

b) scientific evidence is insufficient, ambiguous, or uncertain

4) **Type of communication channel adopted and media environment**

a) many sources of varying quality

b) overabundance of information

c) misinformation and false news

d) one-way versus two-way communication (dialogue/public engagement)

2.1 Audience characteristics

Depending on individual characteristics, such as personality traits or political orientation, audiences perceive science communication differently. In addition, audiences are not always neutral and detached at the time of judging scientific information; psychological biases and emotions may impact the way people select, accept and retain information and form their opinions of science.

2.1.1 Personality traits

The Five Factor Model of personality represents the various diverse systems of personality description in a common framework; it includes Neuroticism (or Emotional Stability), Extraversion, Openness, Agreeableness, and Conscientiousness. The Big 5 is merely one, albeit very popular, model representing personality[14]. The Self-defeating personality style (SDPS) or the Dark Tetrad (Machiavellianism, psychopathy, narcissism, and everyday sadism) are other alternative models. The HEXACO[15] is a six-factor model of personality, which shows through cross-cultural studies the consistent emergence of a sixth personality factor called Honesty-Humility, which taps into individual differences in fairness and modesty. Dimensions measured on different scales tend to be related: for instance, psychopathy and agreeableness share larger negative correlations across studies.

Personality traits can influence the way people judge information and they play a role [16] in people's willingness to share misinformation on social media. Misinformation which is perceived to be accurate is more likely to be shared. People who are more open to new experiences are also more likely to share it, while neurotic people are less likely to share as they tend to control more which information they share. However, neurotic people are less

[14] Feher, Anita, and Philip A. Vernon. "Looking beyond the Big Five: A selective review of alternatives to the Big Five model of personality." Personality and Individual Differences (2020): 110002.
[15] Ashton, Michael C., and Kibeom Lee. "Empirical, theoretical, and practical advantages of the HEXACO model of personality structure." *Personality and social psychology review* 11, no. 2 (2007): 150-166.
[16] Ecker, Ullrich KH, and Li Chang Ang. "Political attitudes and the processing of misinformation corrections." *Political Psychology* 40, no. 2 (2019): 241-260.

resilient than open people. A 2018 study[17] finds a strong negative relationship between ego-resiliency[18] and Neuroticism, and strong positive relationship with Openness and Agreeableness.

2.1.2 Ideology and political views

Ideology and political views also influence the way people interpret science. Partisan bias in factual beliefs has been documented among individuals of either side of the political spectrum (see Iyengar and Massey 2019).[19] Especially in the face of polarization, individuals were found to increasingly align their attitudes and beliefs with partisan ideology rather than scientific facts. This has been described as motivated reasoning, which is a process by which individuals reach judgements based on emotionally-biased reasoning in order to reduce cognitive dissonance. Accordingly, beliefs are driven not by careful consideration of facts and evidence, but by the desire to affirm one's partisan identity.

For science communicators, the challenge is to penetrate through these cognitive biases that are motivated by partisan loyalty, especially when scientific evidence opposes partisan ideology. For instance, there are visible differences between how Democrats/liberals and Republicans/conservatives interpret fact-checking information (Walter 2019)[20]. A study[21] conducted in 25 countries shows that approval of hierarchy and inequality in society indexed by Social Dominance Orientation (SDO) extends to support for human dominance over the natural world. The negative SDO–environmentalism relation is stronger in societies with marked societal inequality, lack of societal development, and environmental standards.

SDO appears to deal specifically with group inequalities and a belief that some groups are inherently superior to other groups. Those at the top of the social hierarchy tend to score higher on SDO than do members of other groups, which may reflect their desire to

[17] Oshio, Atsushi, Kanako Taku, Mari Hirano, and Gul Saeed. "Resilience and Big Five personality traits: A meta-analysis." *Personality and Individual Differences* 127 (2018): 54-60.

[18] Ego-resiliency refers to the individual's adaptive reserve, a dynamic ability to temporarily change the reactions and perceptions to meet the situational demands of life. Individuals at the higher end of ego-resiliency are capable of shifting their behaviors with a versatile set of cognitive and social procedures in the search for adaptation and are generally resourceful in adapting to novel situations. Conversely, those at the lower end tend to be brittle and exhibit little adaptive flexibility when encountering novel or stressful situations.

[19] Iyengar, Shanto, and Douglas S. Massey. "Scientific communication in a post-truth society." *Proceedings of the National Academy of Sciences* 116, no. 16 (2019): 7656-7661.

[20] Walter, Nathan, Jonathan Cohen, R. Lance Holbert, and Yasmin Morag. 2019. 'Fact-Checking: A Meta-Analysis of What Works and for Whom', Political Communication: 1-26.

[21] Milfont, Taciano L., Paul G. Bain, Yoshihisa Kashima, Victor Corral-Verdugo, Carlota Pasquali, Lars-Olof Johansson, Yanjun Guan et al. "On the relation between social dominance orientation and environmentalism: A 25-nation study." *Social Psychological and Personality Science* 9, no. 7 (2018): 802-814.

maintain their dominant position[22]. SDO correlates with Right-Wing Authoritarianism (RWA), [23] which is closely related to conservative ideology. Research evidence indicates that individuals scoring high on RWA tend to favour traditional values, are submissive to those in authority, and act aggressively toward outgroups.

An analysis[24] of the relationship between the Big Five personality traits, RWA and SDO sheds light on the psychological profile of people scoring high on these indexes. Despite being separate constructs, both RWA and SDO are negatively associated with the personality trait Openness. RWA is positively aligned with Conscientiousness and SDO with low Agreeableness. RWAs and SDOs are opposed to novel experiences; in particular, they tend not to endorse artistic and intellectual pursuits.

The connection between personality and science communication consumption is not immediate, but mediated by other factors. As the studies mentioned above demonstrate, personality has an effect on worldviews such as RWA or SDO, which in turn, may correlate with the predisposition to believe conspiracy theories and be vulnerable to misinformation.

2.1.3 Predisposition and confirmation bias

People differ in their attitudes and predisposition toward new information. People have a general tendency to seek out, favorably evaluate, and preferentially remember information that is congruent with one's attitudes and beliefs, while being distrustful of evidence that runs counter to one's attitudes and beliefs. Decision-making is more likely to be flawed when individuals only select and retain information that are compatible with their worldview, but which are inconsistent with (most) empirical evidence and (most) expert interpretations. Information acquisition is important in risk informed-decision making. Information seeking is a significant factor in health decision-making and in the adoption of both recommended and avoidance behaviors[25].

The observation that individuals prefer consonant cognitions, developed as part of the theory of cognitive dissonance (Festinger 1957)[26], lead to the theoretical foundation of selective exposure. Selective exposure refers to the act of choosing to read or view

[22] For example, American whites score higher on SDO than do African-Americans, while men usually score higher on SDO than do women.
[23] Rattazzi, Anna Maria Manganelli, Andrea Bobbio, and Luigina Canova. "A short version of the Right-Wing Authoritarianism (RWA) Scale." *Personality and Individual Differences* 43, no. 5 (2007): 1223-1234.
[24] Heaven, Patrick CL, and Sandra Bucci. "Right-wing authoritarianism, social dominance orientation and personality: An analysis using the IPIP measure." *European Journal of Personality* 15, no. 1 (2001): 49-56.
[25] Lee, M., Ju, Y., & You, M. (2019). The Effects of Social Determinants on Public Health Emergency Preparedness Mediated by Health Communication: The 2015 MERS Outbreak in South Korea. Health communication, 1-11.
[26] Festinger, Leon. *A theory of cognitive dissonance*. Vol. 2. Stanford university press, 1957.

belief-consistent information over belief-inconsistent information (when given the choice). This selectivity may be more likely to occur among strong partisans[27]. For instance, in a study on nanotechnology perceptions, Yeo and coauthors (2015)[28] found that when individuals are exposed to information that lacks clear ideological cues, they are significantly more likely to avoid news that come from sources inconsistent with their attitudes and predispositions. A person's ideology, or worldview[29], may influence how information is sought out and evaluated, and if the information runs counter to prior beliefs, it is likely to be ignored.

Research on motivated reasoning adds to this line of inquiry showing that people process new information in a way that protects their preexisting values and beliefs, producing a biased assimilation of information. This is due to a predisposition to privilege certain information or because of confirmation bias. Lorenzoni and Hulme (2009)[30] found that prior beliefs about climate change determined people's evaluations of information regarding anthropogenic global warming. Information on the scientific consensus on climate change reduced acceptance of climate change in strong supporters of the free market (Cook & Lewandowsky, 2016)[31]. Hart and Nisbet (2011)[32] observed that information regarding the health effects of climate change led Democrats to increase their support for mitigation policies, while ironically reducing support in Republicans.

Van Prooijen (2017)[33] empirically illustrates that the ability to detect nuances and subtle differences across judgment domains, called cognitive complexity, along with people's feelings of control of their social environment are independent processes through which higher levels of education predicts decreased likelihood of believing in conspiracy

[27] Scholars are concerned about whether political polarization is caused by partisan media use. We know that individuals tend to filter information according to their ideological preferences, but the contexts under which selective exposure occurs are relatively unknown (Yeo at. All 2015).
[28] Yeo, Sara K, Michael A Xenos, Dominique Brossard, and Dietram A Scheufele. 2015. "Selecting our own science: How communication contexts and individual traits shape information seeking." The ANNALS of the American Academy of Political and Social Science 658 (1):172-191.
[29] Worldview backfire effect has been demonstrated when correcting misinformation surrounding contentious issues such as climate change (Hart & Nisbet, 2012), or vaccine safety (Nyhan & Reifler, 2015). Worldview biases are particularly difficult to overcome, as even neutral coverage of an issue can lead to polarization (Jerit & Barabas, 2012).
[30] Lorenzoni, I. & Hulme, M. (2009). Believing is seeing: Laypeople's views of future socio-economic and climate change in England and in Italy. Public Understanding of Science, 18, 383-400. doi:10.1177/0963662508089540
[31] Cook, J., & Lewandowsky, S. (2016). Rational irrationality: Modeling climate change belief polarization using Bayesian Networks. Topics in Cognitive Science, 8, 160-179. doi:10.1111/tops.12186
[32] Hart, P. S., & Nisbet, E. C. (2011). Boomerang effects in science communication: How motivated reasoning and identity cues amplify opinion polarization about climate mitigation policies. Communication Research, 39, 701-723. doi:10.1177/0093650211416646
[33] Jan-Willem van Prooijen. "Why Education Predicts Decreased Belief in Conspiracy Theories." *Applied Cognitive Psychology* 31, no. 1 (2017): 50-8.

theories. Swami and colleagues (2014)[34] find that analytic thinking could help limit impacts and prevalence of conspiracy theories. Other studies demonstrate that high education levels predict a decreased likelihood of people believing in conspiracy theories (Douglas et al. 2016; Van Prooijen, Krouwel, and Pollet 2015)[35] and being less educated predicts beliefs in conspiracy theories (Oliver, and Wood 2014).[36]

2.1.4 Polarisation

Attitudinal polarisation concerns partisans taking opposite positions on an issue. It tends to occur more often amongst politically knowledgeable and sophisticated people (Herne et al., 2019)[37]. The problem with polarisation is that it may lead different segments of society to show conflicting and incompatible views and decisions. People can arrive to endorse opposite conclusions even about the health threat of the COVID-19 pandemic. At the same time, events such as pandemics can increase social cohesion and solidarity by emphasising common faith.[38] When individuals face the same risks and circumstances and need to react collectively, they can develop a common identity or shared aspects of their identities can become more salient. When superordinate identities, such as national identities, become salient, partisan out-group animus may also decline, producing a depolarizing effect.

Garret and coauthors (2019)[39] suggest that affective polarisation (i.e., hostility and distrust among supporters of different political parties) plays a critical role in endorsing misperceptions that are consistent with a person's political worldview. Partisan media exposure promotes positive feelings toward members of the political ingroup and negative feelings toward the outgroup.

[34] Viren Swami, Martin Voracek, Stefan Stieger, Ulrich Tran, and Adrian Furnham. "Analytic Thinking Reduces Belief in Conspiracy Theories." *Cognition* 133, no. 3 (2014): 572–85.
[35] Karen Douglas, Robbie Sutton, Mitchell Callan, Rael Dawtry, and Annelie Harvey. (2016). "Someone is Pulling the Strings: Hypersensitive Agency Detection and Belief in Conspiracy Theories." *Thinking and Reasoning* 22, no. 1 (2016): 57–77; Jan-Willem van Prooijen, Andre Krouwel, and Thomas Pollet. "Political Extremism Predicts Belief in Conspiracy Theories." *Social Psychological and Personality Science* 6, no. 5 (2015): 570–8.
[36] Eric Oliver, and Thomas Wood. "Conspiracy Theories and the Paranoid Style(s) of Mass Opinion." *American Journal of Political Science* 58, no. 4 (2014): 952-66.
[37] Herne, K., Christensen, S.H., & Grönlund, K. (2019) The influence of political knowledge on opinion polarization in citizen deliberation. Political Research Exchange, 1, 1-23.
[38] Cortland, Clarissa I., Maureen A. Craig, Jenessa R. Shapiro, Jennifer A. Richeson, Rebecca Neel, and Noah J. Goldstein. "Solidarity through shared disadvantage: Highlighting shared experiences of discrimination improves relations between stigmatized groups." *Journal of Personality and Social Psychology* 113, no. 4 (2017): 547.
[39] R Kelly Garrett, Jacob A Long, Min Seon Jeong, "From Partisan Media to Misperception: Affective Polarization as Mediator", *Journal of Communication*, Volume 69, Issue 5, October 2019, pp. 490–512.

2.1.5 Emotions

Emotions felt in response to a risky situation influence judgments. The type of emotion (e.g., positive vs negative) pushes the decision-maker to focus on congruent information, which is then used to guide judgment. Emotions also act as a powerful motivator of behaviors. Science communicators need to take emotional responses into consideration and balance exposure to negative and positive information. Previous studies demonstrate that experience influences information processes, judgments, and decisions in the area of cancer screening and treatment decision-making (Peters, Lipkus, & Diefenbach 2006).[40] Weeks (2015)[41] found that emotions can affect susceptibility to attitude-congruent political misinformation, but that corrections affected belief updating independent of partisanship. Lewandowsky and coauthors (2012)[42] consider that further research is needed to shed light on the role played by emotions, individual differences (e.g. race or culture), and social networks in misinformation contagion and persistence.

2.2 Communicator characteristics

People are more keen on seeking information from other people, or experts, they know and trust. In this section we explore the role trust and trustworthiness play in shaping the relationship between scientists, or science communicators, and the public.

2.2.1 Social and institutional trust

The level of trust the audience has in the person or entity communicating science influences public opinions toward the topic and their reactions. Scientific journalists and communicators play a key brokerage role in the chain of trust, as they have to accurately and in a timely manner pass on new scientific findings to citizens. The relationship between social trust and institutional trust is relevant in this respect as general trust in institutions is associated with trust in science and scientists.

Social trust is the trust we overall have in strangers. Trust can be defined here as the actor's belief that, at worst, others will not knowingly or willingly do harm, and at best, that they will act in one's interests. Institutional trust is the trust we have in institutions such as the government, political parties, scientific bodies, corporations, the media, civil society

[40] Peters, E., Lipkus, I., & Diefenbach, M. A. (2006). "The functions of affect in health communications and in the construction of health preferences". Journal of Communication, 56, S140-S162.
[41] Weeks, B. E. (2015), "Emotions, partisanship, and misperceptions: How anger and anxiety moderate the effect of partisan bias on susceptibility to political misinformation", *Journal of Communication*, 65, 699-719. doi:10.1111/jcom.12164
[42] Lewandowsky, Stephan, Ullrich KH Ecker, Colleen M Seifert, Norbert Schwarz, and John Cook. 2012. "Misinformation and its correction: Continued influence and successful debiasing." *Psychological Science in the Public Interest* 13 (3):106-131.

organisations, and so on. Amongst these categories, political trust, namely the trust we have in political institutions (e.g. confidence in parliament), has been widely investigated. For instance, survey research that asks questions about both social trust and political trust finds a weak or non-existent relationship between them (Newton et al., 2018)[43]. Nonetheless, social and political theorists argue that social and political trust are important in societies because they are essential for a civilized social life and for a democratic and stable political life. Of special importance is the relationship between disinformation and political stability and the fact that political trust reflects people's evaluative orientation toward the polity and is thus vital to regime stability. According to Levi and Stoker (2000)[44], the search has been successful – whether citizens judge a government to be trustworthy influences whether they become politically active, how they vote, whether they favor policy or institutional reforms, whether they comply with the political authorities, and whether they trust one another. Social theorists such as de Tocqueville or Putnam argued that social trust helps sustain civil society and community relations.

Social trust correlates positively, if weakly and sporadically, with high income, high education, and high social status, and is more likely to be found in men and the middle-aged, and in those who say they are happy, satisfied with their jobs, and proud of their nation (Levi and Stoker 2000)[45]. Political trust is rather more strongly associated with a set of political variables measuring interest in politics, pride in the national political system, a belief in open government, and a low priority given to social order. According to Brehm and Rahm (1997)[46], those with more positive beliefs about others are more inclined to have confidence in the president, Congress, and the courts than those with more distrustful views of others. There is also a tight reciprocal relationship between civic engagement and interpersonal trust, and that this relationship has consequences for confidence in institutions. There is the potential for a "virtuous" circle: an increase in the level of civic participation leads to an increase in positive beliefs about others, leading to greater participation, and so on. The reverse can also happen leading to generalised mistrust and to a vicious cycle in civic participation.

There is great variability in the average level of social and political trust declared by people in different EU countries (see figure 1 below). In general, northern countries tend to display higher levels of social trust than southern countries. The chart below shows the average level of social trust in Europe between 2002 and 2018 measured by the biannual European Values Survey. Dark blue indicates high levels of trust, while light blue indicates low levels of trust. Within countries, social trust tends to be a pretty stable indicator as

[43] Newton, K., Sotolle, D., & Zmerli, S. (2018) Social and Political Trust. In Uslaner E. (Ed.), *The Oxford Handbook of Social and Political Trust*. Oxford University Press.
[44] Levi M and Stoker L (2000) Political trust and trustworthiness. *Annual Review of Political Science* 3: 475–507.
[45] Newton, Kenneth. "Trust, social capital, civil society, and democracy." *International Political Science Review* 22, no. 2 (2001): 201-214.
[46] Brehm, John, and Wendy Rahn. "Individual-level evidence for the causes and consequences of social capital." American journal of political science (1997): 999-1023.

there is little variability over the years in how people reply on average to the question of how much they trust others.

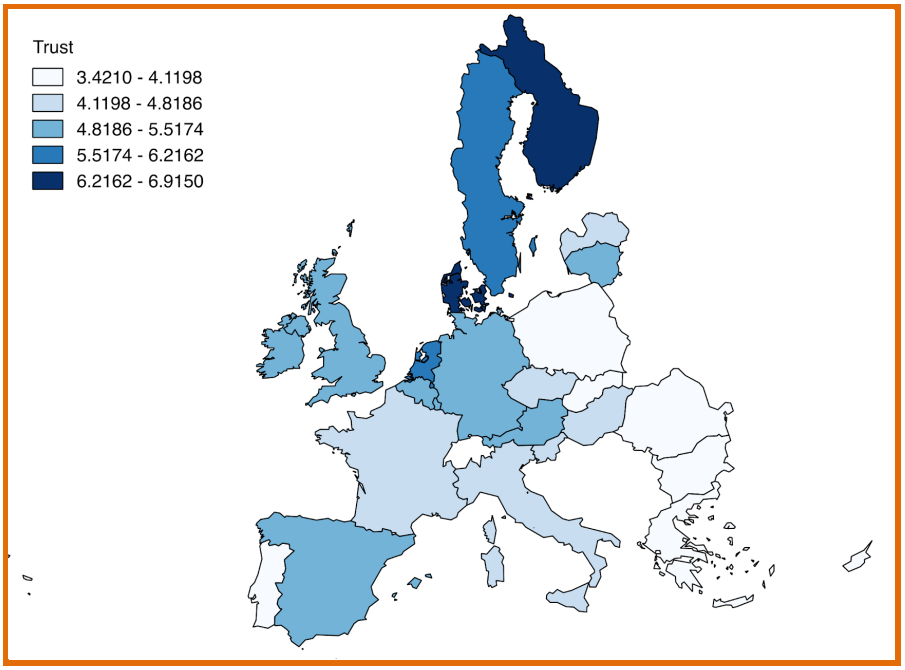

Fig. 1 Social trust across the EU: percentage of people stating that they trust "completely" or "somewhat" the government.

2.2.2 Trust in scientists

Trust in every-day life, the trust we place in friends, family, co-workers, or strangers, is a three-part relationship: A trusts B to do C. Trust in scientists is also a three-part relationship, but it would be more accurate to define it in the following form: A (a member of the public) trusts B (the scientists) about C (a specific piece of scientific knowledge communicated by B). In this scheme, "about C" refers to A's belief that C is both true (or provisionally true, as all scientific knowledge is) and beneficial to the public. A trust relationship involves two specific parties: a trusting party, —that is, the individual rendering trust judgments (trustor)—and a party to be trusted (trustee).

The bases of the first, everyday form of trust, are nicely captured in Hardin's (2002: 4)[47] notion of trust as a form of encapsulated self-interest: "I trust you because I think it is in your interest to attend to my interest in the relevant matter". According to Hardin, there are three mechanisms by which the trustee can encapsulate the trustor's interest: they are in an ongoing relationship that is valuable for the trustee; the trustee loves or is a friend of the truster, and the trustee has a good reputation and upholding it provides him with

[47] Hardin, Russell. 2002. *Trust and Trustworthiness*. New York: Russell Sage.

incentives to behave in a trustworthy way. Of the three, the second one is related to emotions, as trust behaviour could be motivated by strong positive affect for the trustee, in the sense advocated by Lewis and Weigert (1985)[48] and McAllister (1995)[49].

The most important basis for trust as encapsulated self-interest is, however, the first one (Cook, Hardin and Levi 2005: 31-32; Hardin 2006: 22-23)[50]. As far as the trustee values the on-going relationship with the trustor, it is in their interest to pay attention to the trustor's interest, to encapsulate that interest in their own. The third of the mechanisms is also to a certain extent related to the existence of ongoing relations; in this case, if you have built a reputation as someone trustworthy by reciprocating cooperation in ongoing relationships, then it is in your interest to uphold that reputation because otherwise, you will lose the advantages associated with being able to cooperate with others, even those with whom you are not engaged in enduring relationships, but who know of your reputation as a trustworthy person. Under indirect reciprocity[51], Alice's trusting act toward Bob inspires Brad to engage in a trusting act toward Alice, which in turn motivates Amy to behave similarly toward Brad. Here a trusting act between individuals (from Alice to Bob) leads to trust between groups of individuals (organisations A and B).

Trust in scientists does not typically share the foundations of interpersonal, every-day trust. The scientist certainly has an incentive to keep a reputation of competence, but it is not clear whether this reputation is directed towards the general public or their peers. Wynne (2005)[52] argues that public divergences from the views of scientific experts are based on ontological differences as much as differences regarding propositional knowledge claims.

Public trust in science can be seen as the public's acceptance of dependency on expert views in the absence of knowledge about their reliability, in order to support personal and social identities, social meanings, social relationships, and social reality. Unlike emotional experiences such as love and hate, which have the *alter* as their object, or pride and shame, which have the ego as their object, trust has the future as its object (Engdahl and Lidskog 2014)[53]. The basis of trust in scientists has probably more to do with the presence of exogenous mechanisms that guarantee the reliability of scientist's

[48] Lewis, J. David and Andrew Weigert. 2015. "Trust as Social Reality". Social Forces 63 (4): 967-985.

[49] McAllister, Daniel J. 1995. "Affect- and Cognition-Based Trust as Foundations for Interpersonal Cooperation in Organizations". *Academy of Management Journal* 38 (1): 24-59.

[50] Cook, Karen S., Russell Hardin and Margaret Levi. 2005. Cooperation without Trust? New York: Russell Sage Foundation.

[51] Bart S. Vanneste (2016) From interpersonal to interorganisational trust: The role of indirect reciprocity, Journal of Trust Research, 6:1, 7-36, DOI: 10.1080/21515581.2015.1108849

[52] Wynne B (2005) Risk as globalizing "democratic" discourse? Framing subjects and citizens. In: Leach M, Scoones I and Wynne B (eds) Science and Citizens: Globalization and the Challenge of Engagement. London: ZED Books, pp. 66–82.

[53] Engdahl, Emma and Rolf Lidskog. 2014. "Risk, communication and trust: Towards an emotional understanding of trust". *Public Understanding of Science* 23 (6): 703-717.

outcome. In current science, these mechanisms include publication in peer-review journals, recognition of the scientist's research by other leading scientists, lack of previous misconduct, such as plagiarism, and so on (Irzik and Kurtulmus 2019)[54]. These mechanisms could guarantee, in principle, that the research communicated by the scientist complies with criteria of reliability and competence. This would however cover only part of the abovementioned definition of trust in scientists: the presence of these mechanisms can make people believe that B (the scientist) is competent, but not necessarily that her scientific knowledge serves the interests of the public. In the terms of Barber (1987)[55], trust in scientists includes a belief in the scientist's competence and a belief in her fulfilment of a fiduciary obligation, a moral obligation to put the interest of society first, of devoting her research to the well-being of society.

Given the complexity and specialization of modern science, this second component of trust in science seems more difficult to achieve than the first one, and it is perhaps what underlies current public distrust towards experts. Some of the reasons put forward to explain distrust in science are in one way or another related to its fiduciary component, as the perception that science is too closely involved with private companies and nation-states in detriment of the common good (Beck 1992[56]; Jasanoff 2005[57]). In brief, trust in science is the belief that the scientific knowledge communicated by scientists is both true and beneficial to the public. The first component of trust in scientists is related to competence and somewhat guaranteed by the exogenous incentives that the scientific community impose to the scientists. The second component has to do with a moral obligation of social responsibility by the scientist. This is probably harder to communicate to the trustor, that is to the public. According to Mandana[58], what differentiates trust from reliance and is that trust can be subject to betrayal. If your alarm clock fails to ring in the morning, it simply fails you; if a person you consider a friend shares your secrets with others, they have betrayed your trust. Trustworthiness is stronger than reliance, as it encompasses responsibility and guarantee, which only people (or organisations) can offer.

Our trust in science is based on our hope and expectation that science will make our lives healthier, longer, more interesting and therefore more pleasant. Trust in science is an important parameter for assessing the impact of science. According to Rathenau Instituut's 'Public trust in science' 2018 survey[59], 78% think that scientists work carefully, are experts in their field, and can be trusted and 66% believe that they are objective and independent in

[54] Irzik, Gürol and Faik Kurtulmus. 2019. "What is Epistemic Public Trust in Science?" *British Journal of the Philosophy of Science* 70: 1145-1166.

[55] Barber, Bernard. 1987. "Trust in Science". Minerva 25 (1/2): 123-134.

[56] Beck, U. 1992. Risk Society: Towards a New Modernity. London: Sage.

[57] Jasanoff, S. 2005. Designs of Nature: Science and Democracy in Europe and the United States. Princeton, N. J.: Princeton University Press.

[58] Mandana "Designing Trust Part 1: Understanding Trust", Medium, Mar 22, 2019.

[59] Public trust surveys (Scientific Council for Government Policy and Rathenau Institute), 2015 and 2018 (Rathenau Institute).

their work. However, 23% of respondents also think that scientists modify their research to get the answers they want, whilst 10%-15% think that scientists make a lot of mistakes, have less expertise than most people think, and cannot be trusted because they often disagree with each other (van den Broek-Honingh, & de Jonge 2018)[60]. This group of people is characterised by low levels of institutional trust overall. As shown in the chart below, public confidence in the scientific community as a whole remains stable over time. Dutch respondents were asked to indicate on a scale of 1 (absolutely no trust) to 10 (complete trust) how much trust they have in a number of institutions and science had an average score of 7.07 between 2012 and 2018.

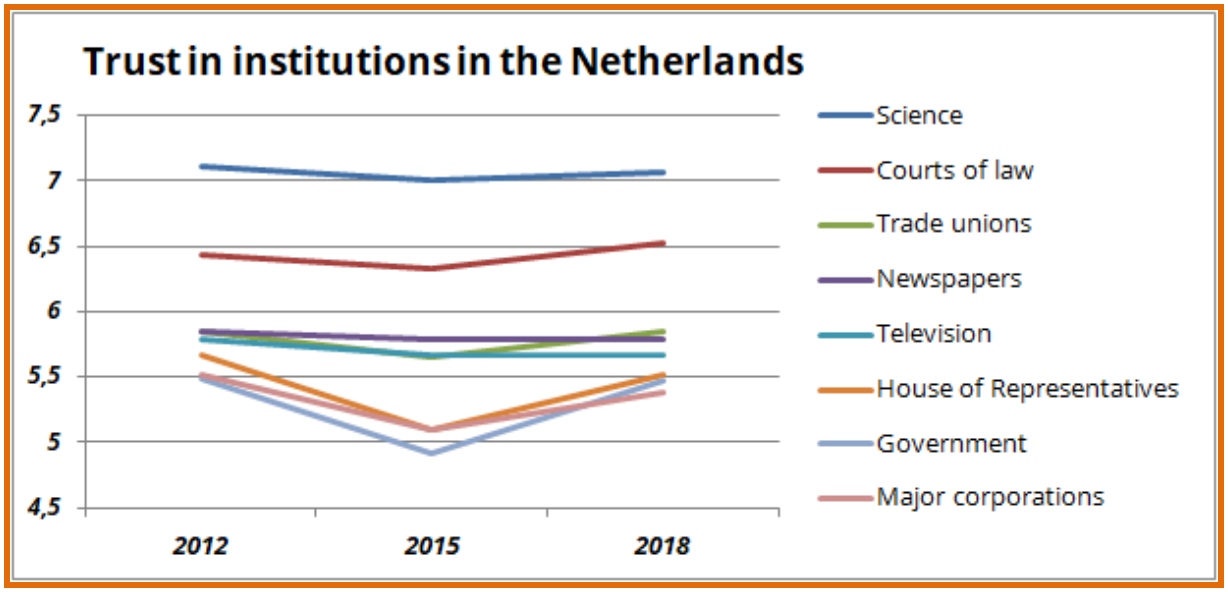

Fig. 2 Authors' elaboration of Rathenau Instituut's indicators of trust in institutions in 2012, 2015, and 2018.

Trust in scientists is influenced by evidence of scientists' trustworthiness, namely of their competence, integrity and benevolence. People recognise the competence and ability of scientists in specific fields such as medicine. According to results of the Wellcome Global Monitor 2018, 73% of people interviewed by Gallup in 140 countries say they would trust a doctor or a nurse more than several other possible sources of health advice, including family, friends, religious leaders or famous people. This figure ranges from a low of 65% in East Asia and the Middle East, to a high of nearly 90% in Northern Europe, Southern Europe, Northern America and Australia and New Zealand. People who have studied science at school are more likely to trust scientists; people living in more economically unequal societies tend to have lower trust in scientists.

[60] Nelleke van den Broek-Honingh and Jos de Jonge, "Trust in science in the Netherlands : survey monitor 2018", Rathenau Institute, 2018-10-12.

Scientists' integrity and benevolence also play a role in shaping public views of their trustworthiness. According to the results of a 2019 Pew Research Center survey[61], only 20% of American respondents said that scientists across disciplines are upfront about their potential conflicts of interest with industry all or most of the time. Perceptions change between ethic groups in the US. 42% of white people, 59% of black respondents, and 60% of those describing themselves as Hispanic, viewed misconduct among medical research scientists as a moderately big or very big problem. More Democrats (43%) than Republicans (27%) have "a great deal" of confidence in scientists – a difference of 16 percentage points.

According to the results[62] of a 2018 parliamentary inquiry[63], one in four UK universities does not comply with research integrity guidelines released six years before the assessment. One move to incorporate social and ethical values in research that has garnered substantial traction in Europe is *Responsible Research and Innovation* (RRI). RRI has taken a central role in research governance, though it is largely focused on innovation, and more specifically, technological innovations. At its core, RRI is premised on the view that, if the research being carried out will lead to new goods and services coming into the public space, then this better be done responsibly. Responsibility in RRI is about ensuring that societal and ethical norms, views, and values are included throughout the research and innovation process. If the current research or innovative trajectory is misaligned with social views and societal ethical expectations, then the trajectory should not just be followed without a satisfactory response to the social concerns. There are now well-established ethical guidelines for research involving humans, especially medical research. The guiding principles of research involving humans and bioethics more generally are usually presented as the following: respect for persons, also referred to as autonomy; beneficence and non-maleficence; and justice.

Ethical considerations are nowadays also broadly discussed within marketing and communication scholarship and by professional associations. For instance, the International Communication Association (ICA)'s Code of Ethics is largely about ethical scholarship (e.g. Scholarly and scientific integrity; Plagiarism; Fair use of copyrighted material). The Credo for Ethical Communication from the United States' National Communication Association (NCA) is about ethical communication beyond the scholarly realm (e.g. truthfulness, accuracy, honesty; understanding and respect for other communicators; promoting 'access to communication resources and opportunities as

[61] Cary Funk, Meg Hefferon, Brian Kennedy and Courtney Johnson, "Trust and Mistrust in Americans' Views of Scientific Experts", August 2, 2019. The survey of 4,464 adults was conducted in January 2019 using Pew Research Center's American Trends Panel, a nationally representative panel of randomly selected U.S. adults.

[62] Dalmeet Singh Chawla "UK universities fall short on reporting misconduct investigations", Nature, 11 JULY 2018, doi: 10.1038/d41586-018-05697-7

[63] House of Commons Science and Technology Committee, "Research integrity Sixth Report of Session 2017–19", House of Commons, 26 June 2018.

necessary to fulfil human potential and contribute to the well-being of individuals, families, communities, and society').

2.3 Features of the message

The way in which information is presented influences people's perceptions and willingness to believe the content of the message.

2.3.1 Credibility of the message

In the digital environment, people cannot rely on traditional indicators like facial expressions or tone of voice, new mechanisms and rituals are needed to facilitate trust digitally. According to the Content-Source Integration Model (Stadtler & Bromme, 2014)[64], when people try to answer the question "Is this statement/claim true?", they make 'first-hand evaluations'; namely they can compare whether a claim is compatible with their own prior knowledge on a topic and assess its logical coherence.

The appearance of the message can influence its credibility, as well as additional information about sources or the connection with a person's previous beliefs. Science communications requires a simplification in order to be effective, but not an oversimplification that could lead to misunderstanding. Repeated exposure to a statement is known to increase its acceptance as true. Fact boxes—simple tabular messages—led to more comprehension (d = 0.39) and slightly more knowledge recall after six weeks (d = 0.12) compared to the same information in text (Brick, McDowell & Freeman 2019)[65]. These patterns of results were consistent between the two medical topics and across all levels of objective numeracy and education. Fact boxes were rated as more engaging than text, and there were no differences between formats in treatment decisions, feeling informed or trust.

Information perceived as of good quality (useful, accurate, important, current, from authoritative sources, and consistent with the user's beliefs), and entertaining (fun, interesting, new and eye-catching, and a good topic for conversation) is more likely to be shared. A study[66] conducted in Singapore in 2015 on young adults (18–29 years old) shows that social media users are more likely to share on social media misinformation, which is perceived as accurate, mostly for entertainment purposes. As misinformation usually

[64] Stadtler, M., & Bromme, R. (2014). The content–source integration model: A taxonomic description of how readers comprehend conflicting scientific information. In D. N. Rapp, & J. L. G. Braasch (Eds.), Processing inaccurate information: Theoretical and applied perspectives from cognitive science and the educational sciences, (pp. 379–402). Cambridge: The MIT Press.
[65] Brick, C., McDowell, M., & Freeman, A. (2019). Risk communication in tables vs. text: a Registered Report randomised trial on 'fact boxes'. PsyArXiv. doi:10.17605/OSF.IO/N3R5G
[66] Chen, X., 2016. The influences of personality and motivation on the sharing of misinformation on social media. *IConference 2016 Proceedings*.

appears fun and novel, it may help people socialise and increase their social status. Besides information accuracy and personality traits, information sharing is motivated by a demand for entertainment[67], improving one's social status and as an opportunity to socialise.

Features of the message, such as its credibility, can also influence and be influenced by perceptions about the communicator. A trustworthy communicator is more likely to make statements to be perceived as credible or authoritative. In 2015, during the Middle East respiratory syndrome (MERS) outbreak in South Korea, which caused 138 infections and 38 deaths, a content analysis[68] of leaders' messages quoted in news coverage of the MERS health crisis revealed the leaders' tendency to emphasize their control of the crisis situation. The most salient frame function identified was displaying that leaders were in control of the emergency, followed by offering guidance and explaining what happened; however, instilling hope and showing empathy was hardly visible.

Finally, it is important to acknowledge the role of visual aids (graphs, charts, infographics, etc.) in science communications. Images have become an important tool with which to communicate science. According to Rodríguez Estrada and Davis (2015)[69], science communicators can become more effective visual communicators if they learn from the discipline of design and overcome current limitations in the way images are commonly treated in SciCom. Current limitations refer to the fact that visual material is typically treated as an add-on instead of being an integrated part of the whole message, and that there is limited effort to tailor visual elements to address the needs of specific target audiences. Studies[70], which attempt to quantify the effects of comics on the communication of science, find that the effects of comics and text are equivalent in terms of knowledge acquisition, though comics are consistently more effective at improving students' engagement and motivation.

2.4 Type of communication channel adopted

Traditionally science communication has travelled through specialised press and newspapers. These days, social media and digital platforms play a key role in the

[67] Ecker, Ullrich KH, and Li Chang Ang. "Political attitudes and the processing of misinformation corrections." *Political Psychology* 40, no. 2 (2019): 241-260.
[68] You, M., & Ju, Y. (2019). Salience of public leaders'"meaning making" in news coverage of a health crisis. Journal of Contingencies and Crisis Management, 27(4), 400-405.
[69] Rodríguez Estrada, Fabiola Cristina, and Lloyd Spencer Davis. "Improving visual communication of science through the incorporation of graphic design theories and practices into science communication." *Science Communication* 37, no. 1 (2015): 140-148.
[70] Farinella, Matteo. "The potential of comics in science communication." *Journal of science communication* 17, no. 01 (2018): Y01-01.

dissemination of scientific findings. In this section we focus explicitly on social media rather than on newspapers, which have been the focus of other inquiries[71].

2.4.1 The social media environment

How does science communication 'fit' with the high-speed communication environment? On the one hand, blogs, Twitter and Instagram provide platforms for science. On the other hand, more is not necessarily better and the glut of scientific communication of varying quality can actually stymie effective communication. Huber and coauthors (2019)[72] find a positive relationship between social media news use and trust in science in an analysis of survey data collected in 20 countries.

The coronavirus pandemic has demonstrated that social media went beyond merely being a conduit/channel of communication to being a source for community mobilization and also social bonding. However, in addition to being a force unifier, social media was also a hotbed for misinformation, hoaxes, falsehoods, and rumors that enhanced and exploited public vulnerabilities at a critical time. It also demonstrates a need to develop better pathways for listening to assess the effectiveness of communication, but almost more importantly, to be aware of different communication needs and values among the public/audience. Because of the intensification of disinformation campaigns and the proliferation of misinformation, trust in experts and scientists can decrease. Social media and instant messaging applications have been exploited the past few years to disseminate fake news and political propaganda. As a result, science communicators increasingly demand tools, such as fact-checking platforms, to verify scientific information and give visibility to the science produced by trustworthy scientists. Psychological factors and features of the digital media environment can interact in such a way as to reinforce the persistence of inaccurate or misleading information about science. These false or inaccurate beliefs about science can be especially dangerous during a crisis such as the 2020 COVID-19 pandemic. Widespread beliefs tend to be the most repeated, become more familiar and thus be perceived as more credible. Psychological effects (memory bias; selective exposure) may be triggered or reinforced by filter bubbles or informational cascade effects.

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[71] See for example Ashwell, Douglas James. "The challenges of science journalism: The perspectives of scientists, science communication advisors and journalists from New Zealand." *Public understanding of science* 25, no. 3 (2016): 379-393. Schäfer, Mike S. "How changing media structures are affecting science news coverage." *The Oxford handbook of the science of science communication* (2017): 51-57. Dearing, James W. "Newspaper coverage of maverick science: Creating controversy through balancing." *Public Understanding of Science* (2016). King, Nia, Katherine E. Bishop-Williams, Sabrina Beauchamp, James D. Ford, Lea Berrang-Ford, Ashlee Cunsolo, Sherilee L. Harper, and IHACC Research Team. "How do Canadian media report climate change impacts on health? A newspaper review." *Climatic Change* 152, no. 3-4 (2019): 581-596.

[72] Huber, Brigitte, Matthew Barnidge, Homero Gil de Zuniga, and James Liu. "Fostering public trust in science: The role of social media." Public Understanding of Science 28, no. 7 (2019): 759-777.

Misinformation often continues to influence people's memory and inferential reasoning after it has been retracted; this is known as the *continued influence effect* (CIE).[73] Repeating a rumor can backfire in the attempt to correct misinformation because of memory effects. CIE may at least partially be an effect of motivated reasoning because CIE is particularly pronounced if corrected misinformation is congruent with a person's worldview. The retraction of worldview-congruent misinformation can even backfire and ironically strengthen the very misconception they are meant to correct, a phenomenon coined the *worldview backfire effect* (Lewandowsky et al. 2012).[74] In the field of science communication, corrections of vaccine-related misperceptions ironically reduced the willingness to vaccinate in vaccine-skeptical parents even when those corrections reduced misperceptions (Nyhan, Reifler, Richey, and Freed 2014).[75]

Knowledge of publics' social media use in a crisis can provide valuable practical insights to help organizations understand what works (or not) and to tailor their communication in future crisis scenarios. An online survey experiment[76] conducted during the COVID-19 outbreak in mid-February 2020 in Hong Kong shows that an endorsement from a non-official source can enhance the credibility of a government press release more than an official source can. Allowing information flow from non-official sources and medical experts can be a practical measure for governments to address the problem of a credibility deficit in a period of epidemic outbreak. According to Gozzi and coauthors (2020)[77], during the COVID-19 pandemic, collective attention was mainly driven by media coverage rather than epidemic progression. Collective attention was also rapidly saturated, and decreased despite media coverage and COVID-19 incidence remaining high.

[73] Ecker, Ullrich KH, and Li Chang Ang. "Political attitudes and the processing of misinformation corrections." Political Psychology 40, no. 2 (2019): 241-260.
[74] Lewandowsky, Stephan, Ullrich KH Ecker, Colleen M. Seifert, Norbert Schwarz, and John Cook. "Misinformation and its correction: Continued influence and successful debiasing." *Psychological science in the public interest* 13, no. 3 (2012): 106-131.
[75] Nyhan, Brendan, Jason Reifler, Sean Richey, and Gary L. Freed. "Effective messages in vaccine promotion: a randomized trial." *Pediatrics* 133, no. 4 (2014): e835-e842.
[76] Sheen, G. C.-H., Tung, H. H., & Wu, W.-C. (2020). Citizen Journalism and Credibility of Authoritarian Government in Risk Communication Regarding the 2020 COVID-19 Outbreak: A Survey Experiment. Division of Social Science Working Paper Series. New York University Abu Dhabi.
[77] Nicolo Gozzi, Michele Tizzani, Michele Starnini, Fabio Ciulla, Daniela Paolotti, Andre Panisson, and Nicola Perra, "Collective response to the media coverage of COVID-19 Pandemic on Reddit and Wikipedia", June 12 2020.

MISINFORMATION AND CONSPIRACY BELIEFS

3.1 Mis/disinformation: a terminological clarification

People can know nothing about a specific topic, or hold an inaccurate understanding of it or even present a view of the issue which has been intentionally misled by somebody. These three states, which can be called 'uninformed', 'mis-informed' and 'dis-informed', lie at the bottom of a graph plotting information accuracy over information understanding, as displayed in the chart below. The arrows within the graph show that the transition between these categories is fluid, and that people who are uninformed about a topic can be informed, and depending on the context, the accuracy of the information can vary. Instances of misinformation or disinformation can also coexist with accurate information in the mind of people.

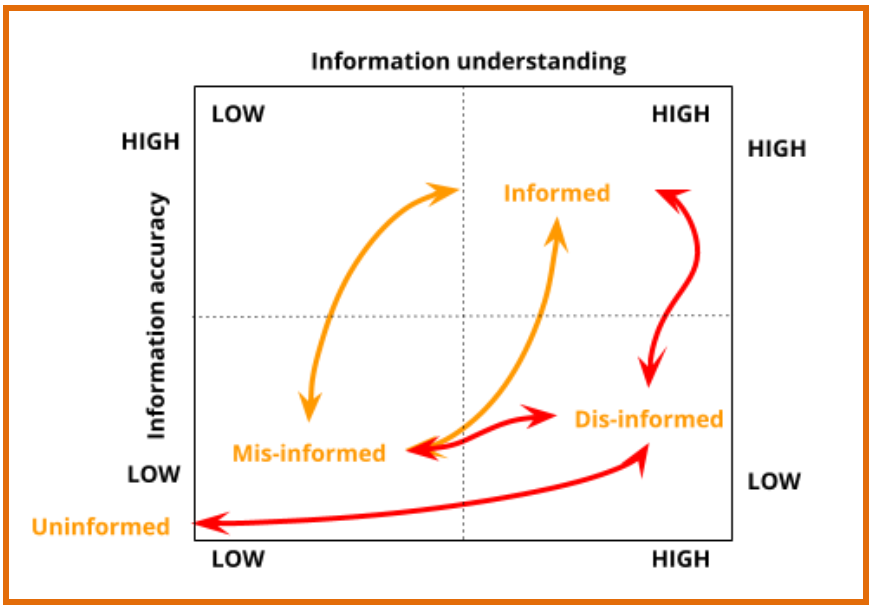

Fig. 3 Relationship between information accuracy and understanding

While in the case of misinformation, information is incorrect possibly by accident; in the case of disinformation the information provided is intentionally false, potentially fabricated and meant to intentionally deceive the audience as part of some sort of information operation or propaganda campaign. While misinformation only refers to the presence of inaccurate information, to have disinformation we need an agent (an attacker or malicious entity) using inaccurate information to intentionally deceive the audience. Overall it is more accurate to refer to misinformation and treat disinformation as a subcategory of it for those instances in which the presence of a malicious communicator was established.

Misinformation originates from rumors, works of fiction, but also vested interests; the media can also inadvertently oversimplify or overdramatize scientific results.

In the past, mistrust in science used to be considered the result of poor science communication. In the digital age, misinformation interacts with disinformation, which has grown to become a much bigger problem. Better science communication approaches can partly, but not fully, address the problem of mistrust in science. This is because the problem is no longer only that scientific information is misunderstood, but it is also that misleading and biased scientific information are widespread and systematically used for malicious purposes. As such, it is important to understand not only how to better communicate science, but also how to counteract the perversion of scientific information.

In the current digital media environment proactive forms of science communication are necessary in order to respond to the effects of disinformation campaigns and of the presence of inaccurate or mistaken information about science. Exploring the intentions of the communicator can offer insights into the effect that the communication will have on social and institutional trust. The distinction between mistrust and distrust signals the presence of a third-party (an external attacker) intentionally biasing the trust perceptions of the trustor. As presented in previous sections, in the science communication domain, the trustor is the member of the public, while the trustee is the scientist. In a disinformation campaign about science, an external attacker can manipulate scientific findings or create a fake scientist to disseminate false information creating false perceptions and potentially dangerous behaviours. The discussion around mis/disinformation is summarised in the table below.

Tab. 2 Relationship between communicators' intentions and level of public trust

Communicator's intentions	Message accuracy	Effect on the audience	Trust level
Proactive science communication	Accurate information	Public Understanding of Science	Trust
No intentional influence	Inaccurate information	Misinformation	Mistrust
Malicious attacker	Fabricated information (mix of false and true info)	Disinformation	Distrust

During the 2020 Covid-19 pandemic, there have been numerous examples of disinformation campaigns meant to raise social conflicts or create disruptions or political destabilisation. A famous example is the burning of 5G masts in the UK produced by conspiracy theories about the relationship between 5G technology and SARS-Cov-2

contagion. In the middle of a health crisis as the COVID-19, people may become confused and be frightened by targeted disinformation campaigns.

The Web's false information ecosystem includes different types of false information and malicious actors (Zannettou et al. 2018).[78] Current research on disinformation focuses on (a) the detection and containment of false information on the Web; (b) the propagation of false information; and (c) public perceptions and reactions to disinformation and their implications for democracy and politics. The majority of studies around disinformation tend to study political propaganda. For instance, Zannettou and coauthors (2018) focus on political false information, because they seem to propagate faster and further when compared to other types of false information.

Fact-checkers play a critical role as gatekeepers of 'trusted' information. But fact-checking teams get easily overloaded by the huge and quick explosion of fake news in social media. To counterback its effects, debunking services must be able to cope with huge amounts of disinformation in a short time. However, a meta-analysis (Walter et al. 2019)[79] assessing the effectiveness of fact-checking[80] in correcting political misinformation, found that the ability to correct political misinformation with fact-checking is substantially attenuated by participants' preexisting beliefs, ideology, and knowledge.

Tab. 3 Example of fact-checking platforms and tools currently available to debunk mis/disinformation

Name	Region/Country
Google Fact Check	International
WhatsApp Monitor	International
Maldito Bulo	Spain
Newtral - Zona de verificación	Spain
Salud sin bulos	Spain
Verification plugin by InVID and WeVerify (H2020 projects)	Europe

[78] Zannettou, Savvas, Michael Sirivianos, Jeremy Blackburn, and Nicolas Kourtellis. "The web of false information: Rumors, fake news, hoaxes, clickbait, and various other shenanigans." *Journal of Data and Information Quality (JDIQ)* 11, no. 3 (2019): 1-37.
[79] Walter, Nathan, Jonathan Cohen, R. Lance Holbert, and Yasmin Morag. 2019. 'Fact-Checking: A Meta-Analysis of What Works and for Whom', Political Communication: 1-26.
[80] "Fact checking is the practice of systematically publishing assessments of the validity of claims made by public officials and institutions with an explicit attempt to identify whether a claim is factual" (Walter et al. 2019: p. 2).

FactCheck.org by Annenberg School	USA
Snopes.com	USA

3.2 Conspiracy theories

An important and ever-present conduit of misinformation is conspiracy theories. Conspiracy beliefs constitute a predisposed way of presenting social and political relations as dominated by clandestine groups via plots. Indeed, most of the working definitions of conspiracy theory aptly emphasise power and secrecy. Conspiracy theories feature explanations of 'events in terms of the significant causal agency of a relatively small group of persons--the conspirators--acting in secret' (Keeley 1999, 116)[81] or accounts that cite 'as a main causal factor a small group of powerful persons, the conspirators, acting in secret for their own benefit against the common good' (Uscinski, and Parent 2014, 32).[82] Building on the insight of these definitions, this section discusses the relationship between conspiracy theories and scientific knowledge.

Scholars adopt two fundamental frameworks in trying to understand conspiratorial rhetoric; these approaches can be called 'classical' and 'cultural' (Nefes 2012, 2013)[83]. As hinted in Hofstadter's (1964)[84] 'paranoid style' description, the former sees conspiracy theories as irrational accounts that fail to understand the nature of events and as a social or political pathology of marginal groups (e.g. Goertzel 1994; Pipes 1997; Robins, and Post 1997).[85] For example, Byford (2011)[86] warns that conspiracy theories should be avoided, because they lead to 'a dead-end', away from genuine solutions to social and political problems by the virtue of being incorrect explanations. In contrast, the cultural perspective views conspiracy theories as people's rational attempts to understand social reality and as alternative explanations (e.g. Birchall 2006; Bratich 2008; Brotherton 2015; Gray 2010).[87]

[81] Brian Keeley. "Of Conspiracy Theories." *The Journal of Philosophy* 96, no. 3 (1999): 109-126.
[82] Joseph Uscinski and Joseph Parent, *American Conspiracy Theories* (New York: Oxford University Press, 2014).
[83] Turkay Salim Nefes. "Political Parties' Perceptions and Uses of Anti-Semitic Conspiracy Theories in Turkey." *The Sociological Review* 61, no. 2 (2013): 247-64; Turkay Salim Nefes. 'The history of the social constructions of Dönmes (converts)', *Journal of Historical Sociology* 25, no. 3 (2012): 413-39.
[84] Richard Hofstadter, *The Paranoid Style in American Politics, and Other Essays* (Cambridge: Harvard University Press, 1964).
[85] Ted Goertzel. "Belief in Conspiracy Theories." *Political Psychology* 15, no. 4 (1994): 733–44; Daniel Pipes, *Conspiracy: How the Paranoid Style Flourishes and Where it Comes from* (New York: Free Press, 1997); Robert Robins and Jerrold Post, *Political Paranoia: The Psychopolitics of Hatred* (New Haven, CT: Yale University Press, 1997).
[86] Jovan Byford, *Conspiracy Theories: A Critical Introduction* (Basingstoke: Palgrave MacMillan, 2011).
[87] Clare Birchall, *Knowledge Goes Pop: From Conspiracy Theory to Gossip* (Oxford: Berg, 2006); Rob Brotherton, *Suspicious Minds: Why We Believe Conspiracy Theories* (London: Bloomsbury, 2015); Matthew Gray, *Conspiracy Theories in the Arab World* (London: Routledge, 2010).

Knight (2000) describes conspiratorial accounts as a do-it-yourself sociology.[88] In short, the scholarship vacillates between tolerating conspiracy theories as natural consequences of human will to learn, and warning about their likely harmful impact.

With regards to the causes of conspiracy theories, the academic literature underlines social, political and psychological factors, all factors previously analysed. Some studies present conspiracy theories as a response to people's need to make sense of social phenomena (Cubitt 1993; Van Prooijen, and Van Dijk 2014).[89] Political context and interests also seem to play a role (Davis 1969; Goldberg 2001; Miller, Saunders, and Farhart 2016; Nefes 2014, 2015, 2017; Rohr 2003; Uscinski, Klofstadt, and Atkinson 2016; Yablokov 2015).[90] Olmsted (2009)[91] attributes the prevalence of conspiracy theories in the United States to people's mistrust to the State. Other scholars highlight psychological predictors of conspiratorial thinking, such as delusional ideation (Dagnall et al 2015)[92], boredom proneness (Brotherton, and Eser 2015)[93], and stress (Swami et al 2016)[94].

With regards to the effects of conspiracy theories, academic studies foreground negative effects such as depoliticisation (Butler, Koopman, and Zimbardo 1995; Fenster

[88] Peter Knight, *Conspiracy Culture: From the Kennedy Assassination to the X-Files* (London: Routledge, 2000).
[89] Geoffrey Cubitt, *Jesuit Myth: Conspiracy Theory and Politics in Nineteenth-Century France* (London: Clarendon Press, 1993); Jan-Willem van Prooijen, and Eric van Dijk. "When Consequence Size Predicts Belief in Conspiracy Theories: The Moderating Role of Perspective Taking." *Journal of Experimental Social Psychology* 55, (2014): 63–73.
[90] David Brion Davis, *The Slave Power Conspiracy and the Paranoid Style* (Baton Rouge, LA: Louisiana State University Press, 1969); Robert Goldberg, *Enemies Within: The Culture of Conspiracy in Modern America* (New Haven and London: Yale University Press, 2001); Joanne Miller, Kyle Saunders, and Christina Farhart. "Conspiracy Endorsement as Motivated Reasoning: The Moderating Roles of Political Knowledge." *American Journal of Political Science* 60, no. 4 (2016): 824–44; Turkay Salim Nefes. "The Impacts of the Turkish Government's Conspiratorial Framing about the Gezi Park Protests." *Social Movement Studies* 16, no. 5 (2017): 610-22; Turkay Salim Nefes. 'Scrutinizing impacts of conspiracy theories on readers' political views: a rational choice perspective on anti-Semitic rhetoric in Turkey', *British Journal of Sociology* 66, no. 3 (2015): 557-75; Turkay Salim Nefes. "Rationale of Conspiracy Theorizing: Who Shot the President Chen Shui-bian?" *Rationality and Society* 26, no. 3 (2014): 373-94; Isabelle Rohr. "The Use of Antisemitism in the Spanish Civil War." *Patterns of Prejudice* 37, no. 2 (2003): 195-211; Joseph Uscinski, Casey Klofstad, and Matthew Atkinson. "What Drives Conspiratorial Beliefs? The Role of Informational Cues and Predispositions." *Political Research Quarterly* 69, no.1 (2016): 57-71; Ilya Yablokov. "Conspiracy Theories as a Russian Public Diplomacy Tool: The Case of Russia Today (RT)." *Politics* 35, no. 3-4 (2015): 301-15.
[91] Kathryn Olmsted, *Real Enemies: Conspiracy Theories and American Democracy, World War I to 9/11* (New York: Oxford University Press, 2009).
[92] Neil Dagnall, Kenneth Drinkwater, Andrew Parker, Andrew Denovan, and Megan Parton. "Conspiracy Theory and Cognitive Style: A Worldview." *Frontiers in Psychology* 6, (February 2015): 1-9.
[93] Rob Brotherton and Silan Eser. "Bored to Fears: Boredom Proneness, Paranoia, and Conspiracy Theories." *Personality and Individual Differences* 80, no. (July 2015): 1–5.
[94] Viren Swami, Adrian Furnham, Nina Smyth, Laura Weis, Alixe Lay, Angela Clow. "Putting the Stress on Conspiracy Theories: Examining Associations between Psychological Stress, Anxiety, and Belief in Conspiracy Theories." *Personality and Individual Differences* 99, (September 2016): 72–76.

1999),[95] justification of intergroup hatred (Cohn 2005),[96] decreasing levels of prosocial behaviour (van der Linden 2015),[97] damaging organizations (Van Prooijen, and De Vries 2016),[98] or reducing trust in science and in the government (Bogart, and Thorburn 2015; Einstein, and Glick 2015)[99]. A few studies identify positive consequences of conspiracy theories (e.g. Newheiser, Farias, and Tausch 2011).[100] For example, Roisman (2006)[101] argues that conspiracy theories relieved the Athenians in Ancient Greece from ambiguity by externalizing their enemy.

Conspiracy theories about sciences constitute a crucial topic, because they could have immediate, widespread and detrimental effects on society, whose potential impacts are reported in various studies. Goertzel (2010, 494)[102] states that conspiracy theories could lead to tragic consequences for society by undermining the credibility of sciences, as they "can be used as a rhetorical device to appeal to the emotions of a significant public." He recommends that scientists should avoid discussions with conspiracy theorists and be careful about how to communicate findings about controversial issues. Lobato and coauthors (2014)[103] present evidence of a significant overlap between believing in paranormal, conspiracy theories and pseudoscience claims in their study on the association of epistemically unwarranted beliefs among university students.

Some of the studies on the relationship between conspiracy theories and scientific knowledge focus on climate change (e.g., Douglas, and Sutton 2015; Lewandowsky et al.,

[95] Lisa Butler, Cheryl Koopman, and Philip Zimbardo. "The Psychological Impact of Viewing the Film "JFK": Emotions, Beliefs, and Political Behavioural Intentions." *Political Psychology* 16, no. 2 (1995): 237-57; Mark Fenster, *Conspiracy Theories: Secrecy and Power in American Culture* (Minneapolis, MN: University of Minnesota Press, 1999).

[96] Norman Cohn, *Warrant for Genocide: The Myth of the Jewish World Conspiracy and the Protocols of Elders of Zion* (London: Serif, 2005).

[97] Sander van der Linden S "The Conspiracy-effect: Exposure to Conspiracy Theories (about Global Warming) Decreases Pro-social Behavior and Science Acceptance." *Personality and Individual Differences* 87, (2015): 171–3.

[98] Jan-Willem van Prooijen, and Reinout de Vries. "Organizational Conspiracy Beliefs: Implications for Leadership Styles and Employee Outcomes." *Journal of Business and Psychology* 31, (2016): 479-91.

[99] Laura Bogart and Sheryl Thorburn. "Are HIV/AIDS Conspiracy Beliefs a Barrier to HIV Prevention among African Americans?" *Journal of Acquired Immune Deficiency Syndromes* 38, no. 2 (2005): 213–8; Katherine Einstein KL and David Glick. "Do I think BLS Data are BS? The Consequences of Conspiracy Theories." *Political Behaviour* 37, no. 3 (2015): 679–701.

[100] Anna-Kaisa Newheiser, Miguel Farias, Nicole Tausch. "The Functional Nature of Conspiracy Beliefs: Examining the Underpinnings of Belief in the Da Vinci Code Conspiracy." *Personality and Individual Differences* 51, (2011): 1007–11.

[101] Joseph Roisman, *The Rhetoric of Conspiracy in Ancient Athens* (London: University of Berkeley Press, 2006).

[102] Ted Goertzel. "Conspiracy Theories in Science." *EMBO Reports* 11, no .7 (2010): 493–9.

[103] Emilio Lobato, Jorge Mendoza, Valerie Sims, and Matthew. "Examining the Relationship Between Conspiracy Theories, Paranormal Beliefs, and Pseudoscience Acceptance Among a University Population." *Applied Cognitive Psychology* 28, no. 5 (2014): 617–25.

2015)[104], AIDS (the acquired immune deficiency syndrome) (e.g. Ford et al., 2012; Hogg et al., 2015),[105] and vaccination (e.g. Jolley, and Douglas 2014).[106] They highlight harmful impacts of conspiracy theories. Jolley and Douglas (2014) find that conspiracy theories about climate change lower people's intention to reduce carbon print.[107] Conspiracy beliefs about AIDS seem to constitute a barrier to prevention, as they are associated with increased odds for having unprotected intercourse (Bogart, and Thorburn 2005; Grebe, and Natrass 2011)[108] and non-adhering with medical treatment (Bogart et al., 2010).[109] Moreover, Jolley and Douglas (2014) provide evidence that people show less intention to get vaccinated if they were exposed to material supporting anti-vaccine conspiracy theories.[110] Given the substantial global impact of the current pandemic of the Covid-19 and the emerging conspiracy theories about it (Pinsker 2020),[111] there is growing interest in better understanding this topic. Uscinski and coauthors (2020)[112] report that general conspiratorial thinking, along with the psychological predisposition to reject authoritative information (denialism) and partisan motivations, are the most significant predictors of the conspiracy beliefs about Covid-19. These findings are consistent to those of other studies, which show partisanship and ideological motivations along with conspiracy theories are

[104] Karen Douglas and Robbie Sutton. "Climate Change: Why the Conspiracy Theories are Dangerous." *Bulletin of the Atomic Scientists* 71, no. 2 (2015): 98–106; Stephan Lewandowsky, John Cook, Klaus Oberauer, Scott Brophy, Elisabeth Lloyd, and Michael Marriott. "Recurrent Fury: Conspiratorial Discourse in the Blogosphere Triggered by Research on the Role of Conspiracist Ideation in Climate Denial." *Journal of Social and Political Psychology* 3, no.1 (2015): 142–78.

[105] Chandra Ford, Steven Wallace, Peter Newman, Sung-Jae Lee, William Cunningham. "Belief in AIDS-Related Conspiracy Theories and Mistrust in the Government: Relationship with HIV Testing among at-risk Older Adults." *The Gerontologist* 53, no. 6 (2013): 973–84; Robert Hogg, Bosisiwe Nkala, Janan Dietrich, Alexandra Collins, Kalysha Closson, Zishan Cui, Steve Kanters, Jason Chia, Bernard Barhafuma, Alexis Palmer, Angela Kaida, Glenda Gray and Carrie Miller. "Conspiracy Beliefs and Knowledge about HIV Origins among Adolescents in Soweto. South Africa." *PLOS ONE* 12, no. 2 (2017), e0165087.

[106] Daniel Jolley and Karen Douglas. "The Effects of Anti-vaccine Conspiracy Theories on Vaccination Intentions." *PLoS ONE* 9, no. 2 (2014), e89177.

[107] Daniel Jolley and Karen Douglas. "The Social Consequences of Conspiracism: Exposure to Conspiracy Theories Decreases Intentions to Engage in Politics and to Reduce One's Carbon Footprint." *British Journal of Psychology* 105, no. 1 (2014): 35–56.

[108] Laura Bogart and Sheryl Thorburn. "Are HIV/AIDS Conspiracy Beliefs a Barrier to HIV Prevention among African Americans?" Journal of Acquired Immune Deficiency Syndromes 38, no. 2 (2005): 213–8; Eduard Grebe, and Nicoli Nattrass. "AIDS Conspiracy Beliefs and Unsafe Sex in Cape Town." *AIDS and Behavior* 16, no. (2012): 761–73.

[109] Laura Bogart, Glenn Wagner, Frank Galvan, and Denedria Banks. "Conspiracy Beliefs about HIV are Related to Antiretroviral Treatment Nonadherence among African American Men with HIV." *Journal of Acquired Immune Deficiency Syndromes* 53, no. 5 (2010), 648–55.

[110] Daniel Jolley and Karen Douglas. "The Effects of Anti-vaccine Conspiracy Theories on Vaccination Intentions." *PLoS ONE* 9, no. 2 (2014), e89177.

[111] Joe Pinsker. "If Someone Shares the 'Plandemic' Video, How Should You Respond?" *The Atlantic*, May 9, 2020.

[112] Joseph Uscinski, Adam Enders, Casey Klofstad, Michelle Seelig, John Funchion, Caleb Everett, Stephan Wuchty, Kamal Premaratne, and Manohar Purthi. (2020) "Why Do People Believe COVID-19 Conspiracy Theories?" *The Harvard Kennedy School Misinformation Review* 1, (2020).

statistically significant factors explaining climate science denial (Lewandowsky, Oberauer, and Gignac 2013; Uscinski, and Olivella 2017).[113]

In conclusion, while the academic literature on the interplay between conspiracy theories and scientific knowledge does not deny the importance of scepticism for sciences, they warn about the potentially harmful effects of conspiracy theories. This predominant perspective is closer to the classical approach on conspiracy accounts, which conceptualises them as irrational explanations with negative consequences. It seems to be the most rational approach to view conspiracy theories in relation to sciences. Nevertheless, it should not go without remembering that conspiracy theories do not have to be incorrect at the outset, because it would be too naïve to expect that there are no plots taking place in the field of sciences. For example, most recently, the United States government accused the Chinese government of attempting to hack the research groups working on the Covid-19 (BBC 2020).[114] Clearly there is ground to believe in the harmful potential of conspiracy theories for scientific knowledge and progress.

3.3 Debiasing and corrective information

Theories of public opinion and voting behavior have suggested that feelings and heuristics are more primary to behavior than factual beliefs, thus belief update induced by corrections may happen at the expense of other types of biased reasoning which aims at maintaining individuals' preferred worldviews. This could take the form of preserving or even reinforcing prior attitudes, making biased attributions, or developing hostile perceptions toward the source of the correction.

In order to fight misinformation, it is important to check not only the accuracy of the information, but also the potential the communication has to elicit emotional responses (Swire & Ecker 2018).[115] When providing factual alternatives to the retracted inaccurate information, it is important to minimise unnecessary explicit repetition of misinformation to avoid boosting memory and retrieval effects. Good strategies offer factual alternatives such as alternative causal explanation of the event to fill the gap left by the information retracted. Another good strategy is to foster skepticism and lead people to self-affirming corrections by means of educational tools for refuting misinformation. Warnings at the time of the initial exposure to misinformation is also useful (Lewandowsky, Ecker, Seifert,

[113] Stephan Lewandowsky, Gilles Gignac, and Klaus Oberauer. "The Role of Conspiracist Ideation and Worldviews in Predicting Rejection of Science." *PLoS ONE* 8, no. 10 (2013), e75637; Joseph Uscinski, and Santiago Olivella. (2017). "The Conditional Effect of Conspiracy Thinking on Attitudes toward Climate Change." *Research & Politics* (2017): 1-9. https://doi.org/10.1177/2053168017743105

[114] "Coronavirus: US Accuses China of Hacking Coronavirus Research." *BBC*, May 14, 2020.

[115] Swire, Briony, and UKH Ecker. 2018. 'Misinformation and its correction: Cognitive mechanisms and recommendations for mass communication', Misinformation and mass audiences: 195-211.

Schwarz, & Cook. 2012).[116] Skepticism can reduce misinformation effects, as it leads to more cognitive resources being allocated to the task of weighing up the veracity of both the misinformation and the correction. The alternative explanation must be plausible, account for the important causal qualities in the initial report, and, ideally, explain why the misinformation was thought to be correct in the first place.

According to previous studies (Swire & Ecke 2018),[117] certain individuals are predisposed to refrain from belief change even in the face of good corrective evidence; in these cases special correction mechanisms need to be designed to debunk misinformation. Li (2020),[118] invites us to explore the relationship between belief and attitude change, as well as conditions where incremental changes in political judgments happen in order to contribute to a more comprehensive theory of corrective information effects.

According to Lewandowsky et al. (2012),[119] ideology and personal worldviews can be major obstacles for debiasing. However, subtyping can sometimes lower these effects. In a traditional *continued influence effect*, Ecker, Lewandowsky, and Apai (2011)[120] presented participants with a fictitious plane crash scenario and attributed the cause to a terrorist bomb. Later on, in one condition the cause was retracted and a faulty fuel tank was stated as the cause of the crash; in another condition there was no retraction. A post-hoc analysis showed that people with higher islamophobia scores referred to terrorism as the cause of the crash more often than participants who scored lower in islamophobia, but this was true both in the retraction and the no-retraction condition, and thus the retraction was equally effective in both groups of participants.

The stereotype subtyping literature tells us that Subtyping occurs during exemplar classification when people accommodate an exemplar (e.g., an object or individual) that violates their stereotype by viewing it as an exception and placing it in a separate distinct subcategory of their stereotype. For example, a racially-prejudiced person could maintain their belief that black people are often criminals by placing an honest black person in a separate special category. This movement would safeguard a person's racially biased worldview. Changing this racially biased worldview would require a deep attitudinal change. Thus, the ensuing conflict between attitude maintenance and belief updating can

[116] Lewandowsky, Stephan, Ullrich KH Ecker, Colleen M Seifert, Norbert Schwarz, and John Cook. 2012. 'Misinformation and its correction: Continued influence and successful debiasing', Psychological science in the public interest, 13: 106-31.
[117] Swire, Briony, and UKH Ecker. 2018. "Misinformation and its correction: Cognitive mechanisms and recommendations for mass communication." Misinformation and mass audiences:195-211.
[118] Li, Jianing. 2020. 'Toward a Research Agenda on Political Misinformation and Corrective Information', Political Communication, 37: 125-35.
[119] Lewandowsky, Stephan, Ullrich KH Ecker, Colleen M Seifert, Norbert Schwarz, and John Cook. 2012. "Misinformation and its correction: Continued influence and successful debiasing." Psychological science in the public interest 13 (3):106-131.
[120] Ecker, U. K. H., Lewandowsky, S., & Apai, J. (2011). Terrorists brought down the plane!—No, actually it was a technical fault: Processing corrections of emotive information. Quarterly Journal of Experimental Psychology, 64, 283-310. doi:10.1080/17470218.2010.497927

be achieved at least partially through stereotype subtyping (Kunda & Oleson, 1995[121]; Richards & Hewstone, 2001).[122] By contrast, partisan attitudes strongly influenced the effectiveness of a misinformation retraction when the misinformation was of a general nature and thus more directly attitude-relevant. In this case, if the misinformation was attitude-incongruent, the retraction was clearly effective, and if the misinformation was attitude-congruent, the retraction was clearly ineffective.[123]

Misinformation containment policies should emphasise behavioral interventions, like labeling and incentives to dissuade the spread of misinformation, rather than focusing exclusively on curtailing bots because human behavior largely contributes to the differential spread of falsity and truth. Vosoughi, Roy, and Aral's (2018)[124] analysis of all the verified true and false rumors that spread on Twitter confirms that false news spreads more pervasively than the truth online. It also overturns conventional wisdom about how false news spreads. Though one might expect network structure and individual characteristics of spreaders to favor and promote false news, the opposite is true. The greater likelihood of people to retweet falsity more than the truth is what drives the spread of false news, despite network and individual factors that favor the truth.

Social media may also contribute to opinion polarisation by reinforcing pre-established views through recommendation systems that offer contents based on past preferences. Fringe websites (e.g., 4chan) and subreddits have great influence over which memes[125] and news[126] are shared on large social networks such as Twitter. Some scholars also claim that because of the decreasing trust in mainstream media and increasing influence of social networks there is a "radicalization pipeline" on YouTube. A recent study [127] demonstrates that the pipeline effect does exist as it shows that users who consumed Alt-lite or Intellectual Dark Web (I.D.W.) content in a given year, go on to become a

[121] Kunda, Z., & Oleson, K. C. (1995). Maintaining stereotypes in the face of disconfirmation: Constructing grounds for subtyping deviants. Journal of Personality and Social Psychology, 68, 565-579. doi:10.1037/0022-3514.68.4.565

[122] Richards, Z., & Hewstone, M. (2001). Subtyping and subgrouping: Processes for the prevention and promotion of stereotype change. Personality and Social Psychology Review, 5, 52-73. doi:10.1207/s15327957pspr0501_4

[123] Ecker, Ullrich KH, and Li Chang Ang. "Political attitudes and the processing of misinformation corrections." Political Psychology 40, no. 2 (2019): 241-260.

[124] Vosoughi, S., Roy, D., & Aral, S. (2018). The spread of true and false news online. Science, 359(6380), 1146-1151.

[125] Savvas Zannettou, Tristan Caulfield, Jeremy Blackburn, Emiliano De Cristofaro, Michael Sirivianos, Gianluca Stringhini, and Guillermo Suarez-Tangil. 2018. On the Origins of Memes by Means of FringeWeb Communities. In Proceedings of the Internet Measurement Conference 2018. ACM.

[126] Savvas Zannettou, Tristan Caulfield, Emiliano De Cristofaro, Nicolas Kourtelris, Ilias Leontiadis, Michael Sirivianos, Gianluca Stringhini, and Jeremy Blackburn. 2017. The Web Centipede: Understanding How Web Communities Influence Each Other Through the Lens of Mainstream and Alternative News Sources. In Proceedings of the 2017 Internet Measurement Conference. ACM.

[127] Ribeiro, Manoel Horta, Raphael Ottoni, Robert West, Virgílio AF Almeida, and Wagner Meira Jr. 2020. "Auditing radicalization pathways on youtube." Proceedings of the 2020 Conference on Fairness, Accountability, and Transparency.

significant fraction of the Alt-right user base, which was used as a proxy for extreme content, in the following year. Seven categories of tweet behavior were identified: attack left, support right, attack right, support left, attack media, attack civil institutions, and camouflage. While camouflage was the most common type of tweet (52.6%), descriptive analyses showed it was followed by attack left (12%) and support right (7%).

How to systematically identify emerging political falsehood remains a methodological challenge (Bradshaw et al., 2019; Shao, Ciampaglia, Flammini, & Menczer, 2016). However, Scheufele (2013)[128] invites to explore the relationship between people's knowledge and their attitudes and to think creatively about new directions for rebuilding science-society interfaces to facilitate stakeholders' participation in the ongoing debates surrounding emerging technologies.

Conclusion

This report has offered an overview of scientific findings shedding light on factors influencing the way people perceive science communication. Along the report attention has been paid to the effect that audience's and communicators' characteristics, features of the message and of the channels adopted to communicate those messages, have on people's willingness to believe in the content of the communication. Starting from a discussion on the definition of science as a social practice, the following issues have been discussed: predispositions and biases of the audience; the trustworthiness of scientists and the relationship between social and institutional trust; credibility of the message and of the communication channel adopted; antecedents and consequences of conspiracy beliefs and strategies to revert the effect of misinformation.

From this review we have learned that people have a tendency to align their attitudes and beliefs with partisan ideology rather than scientific facts. Because of motivated reasoning and confirmation bias, individuals prefer cognitions consonant with their worldview. The problem is that cognitive biases that are motivated by partisan loyalty can lead to the biased assimilation of information. Especially when scientific evidence opposes partisan ideology, accurate scientific information can be dismissed in favour of inaccurate ones, more consistent with a person's beliefs. Particular worldview expressions, such as Social Dominance Orientation (SDO) and Right-Wing Authoritarianism (RWA), are especially dangerous as they may lead people to believe in false claims. Everybody is vulnerable to selective exposure, namely to the general tendency to seek out, favorably evaluate, and preferentially remember information that is congruent with one's attitudes and beliefs.

[128] Scheufele, D. A. (2013). Communicating science in social settings. Proceedings of the National Academy of Sciences, 110(Supplement 3), 14040-14047.

This consideration implies that a person's ideology, or worldview, may influence how information is sought out and evaluated. This tendency, linked to the fact that emotions felt in response to a risky situation influence judgments, may produce instances of attitudinal polarisation, which concerns partisans taking opposite positions on an issue. When a scientific issue turns into a political controversy, polarisation and worldview effects can influence reasoning and lead people to be more vulnerable to disinformation campaigns. To have disinformation implies the presence of an agent (an attacker or malicious entity) willing to use inaccurate information to intentionally deceive a target audience.

Traditionally mistrust in science and the presence of misinformation (inaccurate information) used to be considered the result of poor science communication. In the digital age, scientific misinformation sometimes interacts with disinformation, becoming a geopolitical problem that goes beyond traditional science communication themes. In the new global communication and scientific arena, the trust people have in each other, in scientists and in other institutions interact with each other. People who do not trust scientists, are highly skeptical of scientific results. Those who question the trustworthiness of scientists say that they have evident conflicts of interest with the industry and they often disagree with each other. The credibility of scientific messages is also influenced by perceptions about the trustworthiness of the communicator.

Sometimes, people's rational attempts to understand complex social or technical realities, can lead them to believe in conspiracy theories. Unfortunately, these theories do not offer genuine solutions to social and political problems and are conduit of misinformation. Mistrust in institutions, delusional ideation and stress are predictors of conspiratorial thinking. There is also a relationship between believing in paranormal, conspiracy theories and pseudoscience claims; these people show less intention to get vaccinated or engage in more environmentally sustainable habits.

In brief, previous studies show that (a) ideology and personal worldviews can be major obstacles for debiasing; (b) misinformation often continues to influence people's memory and inferential reasoning after it has been retracted; (c) the positive effect of fact-checking to debunk misinformation is substantially attenuated by participants' preexisting beliefs, ideology, and knowledge; (d) fact-checking teams get easily overloaded by the huge and quick explosion of fake news (an fake science) in social media. Thus, misinformation containment policies should go beyond correcting political misinformation, emphasise behavioral interventions, and pay attention to the way social media contribute to opinion polarisation by reinforcing pre-established views.

APPENDIX

Table A.1 Results from specific studies

Year	Reference	Result	Method
2020	Sheen, G. C.-H., Tung, H. H., & Wu, W.-C. (2020). Citizen Journalism and Credibility of Authoritarian Government in Risk Communication Regarding the 2020 COVID-19 Outbreak: A Survey Experiment. Division of Social Science Working Paper Series. New York University Abu Dhabi.	An online survey experiment conducted during the COVID-19 outbreak in mid-February 2020 in Hong Kong shows that an endorsement from a non-official source can enhance the credibility of a government press release more than an official source can.	Online survey experiment
2020	Brick, C., McDowell, M., & Freeman, A. (2019). Risk communication in tables vs. text: a Registered Report randomised trial on 'fact boxes'. PsyArXiv.	Fact boxes—simple tabular messages—led to more comprehension (d = 0.39) and slightly more knowledge recall after six weeks (d = 0.12) compared to the same information in text. These patterns of results were consistent between the two medical topics and across all levels of objective numeracy and education. Fact boxes were rated as more engaging than text, and there were no differences between formats in treatment decisions, feeling informed or trust.	Online experiment
2020	Battiston, P., Kashyap, R., & Rotondi, V. (2020, May 11). "Trust in science and experts during the COVID-19 outbreak in Italy"	Trust in science is found to be the most consistent predictor of 274 agreement with measures of social isolation and social distancing net of 276 a range of socio-demographic control variables. The increasing willingness to consult expert sources, as suggested by the Telegram and Twitter data in the period leading up to the Facebook survey, was also reflected in knowledge outcomes.	Online experiment

2019	König, L., & Jucks, R. (2019). When do information seekers trust scientific information? Insights from recipients' evaluations of online video lectures. International Journal of Educational Technology in Higher Education, 16(1), 1. doi:10.1186/s41239-019-0132-7	Lobbyist reporting self-conducted studies lead to significantly lower message credibility in comparison to when the message is reported by scientists.	Online experiment
2019	Ecker, Ullrich KH, and Li Chang Ang. "Political attitudes and the processing of misinformation corrections." Political Psychology 40, no. 2 (2019): 241-260.	Partisan attitudes have an impact on the processing of retractions, in particular (1) if the misinformation relates to a general assertion rather than just a specific singular event, and (2) if the misinformation is congruent with a conservative partisanship.	Experiment
2019	Fernández Pinto, M., & Hicks, D. J. (2019). Legitimizing Values in Regulatory Science. Environmental Health Perspectives, 127(3), 35001-35001.	Public deliberation, adaptive management, and community-based participatory research can be used to improve the legitimacy of scientists as representatives of the general public on issues of environmental knowledge.	Theoretical
2019	Scheufele, D. A., & Krause, N. M. (2019). Science audiences, misinformation, and fake news. Proceedings of the National Academy of Sciences, 116(16), 7662-7669.	The article concludes that more analysis of science communication in new media environments and a (re)focusing on traditionally underserved audiences is necessary.	Theoretical
2019	Mann, Marcus, and Cyrus Schleifer. 2019. "Love the Science, Hate the Scientists: Conservative Identity Protects Belief in Science and Undermines Trust in Scientists." Social Forces 156.	They find that those with stable conservative identities hold more positive attitudes toward scientific research while simultaneously holding more negative attitudes towards the scientific community compared to those who switch to and from conservative political identities	National representative survey

2019	You, M., & Ju, Y. (2019). Interaction of individual framing and political orientation in guiding climate change risk perception. Journal of Risk Research, 22(7), 865-877.	When self-efficacy, trust, and other demographics were controlled for, multiple regression analyses revealed that those focusing on what is happening (diagnostic framing) rather than what-to-do (prognostic framing) had higher risk perception.	National representative surveys
2018	Broniatowski, David A, Amelia M Jamison, SiHua Qi, Lulwah AlKulaib, Tao Chen, Adrian Benton, Sandra C Quinn, and Mark Dredze. 2018. "Weaponized health communication: Twitter bots and Russian trolls amplify the vaccine debate." American journal of public health 108 (10):1378-1384.	Compared with average users, Russian trolls ($\chi2(1) = 102.0$; $P < .001$), sophisticated bots ($\chi2(1) = 28.6$; $P < .001$), and "content polluters" ($\chi2(1) = 7.0$; $P < .001$) tweeted about vaccination at higher rates. Whereas content polluters posted more antivaccine content ($\chi2(1) = 11.18$; $P < .001$), Russian trolls amplified both sides. Unidentifiable accounts were more polarized ($\chi2(1) = 12.1$; $P < .001$) and antivaccine ($\chi2(1) = 35.9$; $P < .001$). Analysis of the Russian troll hashtag showed that its messages were more political and divisive.	Content analysis
2018	Lazer, D. M., Baum, M. A., Benkler, Y., Berinsky, A. J., Greenhill, K. M., Menczer, F., ... & Schudson, M. (2018). The science of fake news. Science, 359(6380), 1094-1096.	People prefer information that confirms their preexisting attitudes (selective exposure),view information consistent with their preexisting beliefs as more persuasive than dissonant information (confirmation bias), and are inclined to accept information that pleases them (desirability bias). People tend o remember information or how they feel about it, while forgetting the context within which they encountered it. They are more likely to accept familiar information as true.	Theoretical

2018	Bonney, K. M. (2018). Fake News with Real Consequences: The Effect of Cultural Identity on the Perception of Science. The American Biology Teacher, 80(9), 686-688.	the greater the ordinary science intelligence, the more likely the students were to demonstrate an understanding of climate science by agreeing with the statement; for very conservatives / strong republicans, the higher their ordinary science intelligence, the less likely they were to hold correct beliefs about climate change (Kahan, 2015). + a positive correlation between science intelligence and reported understanding of evolution was only observed in people scoring less than one SD below the mean ("below average religiosity"), but not in those scoring higher than one standard deviation above the mean ("above average religiosity") + perceptions of vaccine risk were greatly skewed by political affiliation and cultural identity (Kahan, 2013).	Theoretical
2017	Mele, N., Lazer, D., Baum, M., Grinberg, N., Friedland, L., Joseph, K., ... & Mattsson, C. (2017). Combating fake news: An agenda for research and action. Retrieved on October, 17, 2018.	Source credibility profoundly affects the social interpretation of information and humans are biased information-seekers and prefer to receive information that confirms our existing views. These properties combine to make people asymmetric updaters about political issues. Individuals tend to accept new information uncritically when a source is perceived as credible or the information confirms prior views. And when the information is unfamiliar or comes from an opposition source, it may be ignored.	Theoretical

2017	van Prooijen, J. W. (2017). Why education predicts decreased belief in conspiracy theories. Applied cognitive psychology, 31(1), 50-58.	STUDY 1: Higher education was associated with decreased belief in conspiracy theories, as indicated by the negative regression weight. Three out of four mediators were significant: Feelings of powerlessness predicted increased belief in conspiracy theories; subjective social class predicted decreased belief in conspiracy theories; and belief in simple solutions predicted increased belief in conspiracy theories. Self-esteem was not a significant predictor of belief in conspiracy theories. STUDY 2: it revealed that the mediating role of belief in simple solutions is due to the relationship between education and analytic thinking skills. TAKEN TOGETHER, these studies suggest that the relationship between education and belief in conspiracy theories cannot be reduced to a single psychological mechanism but is the product of the complex interplay of multiple psychological processes. Particularly cognitive complexity and feelings of control are independent processes through which education predicts belief in conspiracy theories.	Experiment
2016	Uscinski, J. E., Klofstad, C., & Atkinson, M. D. (2016). What drives conspiratorial beliefs? The role of informational cues and predispositions. Political Research Quarterly, 69(1), 57-71.	The more predisposed people are toward conspiratorial thinking, the more likely they will be to accept a specific conspiracy theory when given an informational cue that makes conspiratorial logic explicit. Political socialization and psychological traits are likely to be the most important influences that drive predisposition toward conspiratorial thinking.	Observational survey data

2015	Yeo, Sara K, Michael A Xenos, Dominique Brossard, and Dietram A Scheufele. 2015. "Selecting our own science: How communication contexts and individual traits shape information seeking." The ANNALS of the American Academy of Political and Social Science 658 (1):172-191.	They find that when individuals are exposed to information that lacks clear ideological cues, they are significantly more likely to avoid news that comes from sources inconsistent with their attitudes and predisposition.	Experiment
2014	Nau, C., & Stewart, C. O. (2013). Effects of Verbal Aggression and Party Identification Bias on Perceptions of Political Speakers. Journal of Language and Social Psychology, 33(5), 526–536.	Politicians who use verbal aggression were perceived as less competent than others; consistent effects for verbal aggression leading to lower perceptions of communicative appropriateness.	Online experiment
2014	Oliver, J. E., & Wood, T. J. (2014). Conspiracy theories and the paranoid style (s) of mass opinion. American Journal of Political Science, 58(4), 952-966.	Less educated respondents routinely score higher on all the predisposition scales, but, beyond this, the predictors vary more according to individual traits and the particular predisposition in question. For example, blacks, conservatives, and the less politically knowledgeable are more likely to agree with the End Times statement, even when controlling for their greater religiosity. Liberals are less likely to believe in supernatural phenomena, Republicans and authoritarians more likely. Predispositions are not a uniform expression of any one demographic or psychological characteristic (beyond being less educated).	National representative survey
2014	Cacciatore, M. A., Yeo, S. K., Scheufele, D. A., Xenos, M. A., Choi, D. H., Brossard, D., ... & Corley, E. A. (2014). Misperceptions in polarized politics: The role of	White Americans had a 24.6% probability of believing that President Obama is a Muslim; the probability among nonwhite respondents was 14.8%. Strong liberals have a 9.8% probability of misperceiving Obama as	National representative survey

	knowledge, religiosity, and media. PS: Political Science & Politics, 47(3), 654-661.	a Muslim, whereas conservatives had a 36.1% probability. Individuals who considered themselves "born-again" or evangelical Christians had a 25.8% probability of having this misperception; alternatively, the probability among nonevangelicals was 19.1%. Only one media-use variable significantly predicted misperceptions of Obama's faith: respondents who paid little attention to political news had a 23.9% probability of thinking that President Obama is a Muslim, whereas respondents who paid high attention to political news had a 16.5% probability. The results reported in this article are largely consistent with previous research on this topic.	
2007	Brossard, D., & Nisbet, M. C. (2007). Deference to scientific authority among a low information public: Understanding US opinion on agricultural biotechnology. International Journal of Public Opinion Research, 19(1), 24-52.	Transmitted to citizens by the educational system and popular culture, deference to scientific authority as a value predisposition means that when science controversies do occur, deference likely generates among Americans an almost natural pro-science or pro-technology view. Indeed, the result of our study indicates that deference to scientific authority is the strongest total influence on support for agricultural biotechnology.	National representative survey
2005	Bogart, Laura M, and Sheryl Thorburn. 2005. "Are HIV/AIDS conspiracy beliefs a barrier to HIV prevention among African Americans?" JAIDS Journal of Acquired Immune Deficiency Syndromes 38 (2):213-218.	Greater endorsement of HIV/AIDS conspiracy beliefs would be associated with more negative attitudes about condoms	Telephone survey

2001	Heaven, Patrick CL, and Sandra Bucci. "Right-wing authoritarianism, social dominance orientation and personality: An analysis using the IPIP measure." European Journal of Personality 15, no. 1 (2001): 49-56.	Right-wing authoritarianism (RWA) and social dominance orientation (SDO), which have been found to predict racial and intergroup prejudice, are aligned with different personality traits (Big Five) leading to different psychological profiles of authoritarians and dominators.	Online survey experiment