1

The Dialogue Between Science and Society

The word is there because the problem is there.
The word is awkward because the problem is awkward[1].

Yves Jeanneret (1994, p. 20)

Communicating science to the layperson is a complex subject. There have been many kinds of popular science initiatives since the origin of the "popularizing project" (Schiele 1983). It is therefore important to briefly recall the definition, the denominations and the designations devoted to this project.

1.1. The popularizing project

Popularization can be defined as "making something (that is difficult to understand) easily understood by ordinary people"[2]. When applied to science, it is a complex process that gives rise to a wide variety of mechanisms and materials. Jeanneret summarized them as follows: "Popularization of science is part of a continuum of forms of communication that goes from preprints, reserved for a small number of peers, to the mainstream press" (Jeanneret 1994, p. 176). Between these two opposite poles, there are a range of other materials, such as museum catalogues

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1 The "awkward word" is the French term "*vulgarisation*" (see explanation in section 1.1.1). Original French version: *Le mot est là parce que le problème est là. Le mot est gênant parce que le problème est gênant*.

2 WordReference Random House Learner's Dictionary of American English © 2023 (https://www.wordreference.com/definition/popularization).

and documentation, training manuals for students, popular science magazines (*Science et Avenir*, *La Recherche*, *The Scientist*, *Scientific American*, etc.) and a number of other media making scientific information accessible to non-experts. Authier described this activity as "conveying scientific information towards the outside, based on knowledge that has already been produced and is circulating within a more restricted community" (Authier 1982, p. 34).

Here, we look back on some of the terms used to describe these practices.

1.1.1. *How we talk about popular science*

Different lexical forms are used to refer to this field of study, without necessarily being equivalent to one another: popularization, divulgation, vulgarization, publicization, scientific communication, science for the layperson, science in the media, scientific mediation, etc. Some terms are favored by specific languages or cultures (such as popularization, or popular science in the English-speaking world, *divulgación* in the Spanish-speaking world). In French, *vulgarisation* is the generic term used for these practices. From an etymological point of view, it is forged from the Latin root *vulgaris*, which is derived from *vulgus* ("the crowd"). Based on this etymology, it has progressively taken on a depreciatory connotation (Jacquet-Pfau 2021). Thus, because of its name and its very purpose, "vulgarized" science has always raised questions in the Francophone world. Some authors see it as an unrealistic undertaking, in the face of an excessively large gap between the world of science and another "ordinary" world. In reading various publications on the subject, it becomes clear that certain designations are tinged with negativity; for instance, they may refer to an artificial culture ("culture de synthèse" in French), an imitation of culture (*"ersatz" or "culture alibi"*), a parody of learning, serving to perpetuate a kind of scientific illiteracy and lack of culture. In describing the position of its detractors, Jeanneret reminds us that in communicating scientific expertise to the layperson, knowledge may lose some of its purity and be considered as degraded (Jeanneret 1994). This passage between two worlds, which some present as a process of translation[3], or even betrayal[4], potentially refers to the shift from a "pure" world to an "impure" world.

Critics claim that the popularization process transforms both the form of knowledge and its substance. Roqueplo (1974) takes up some of Bachelard's (1938)

3 Moles, A. and Oulif, J. (1967). Le troisième homme – Vulgarisation scientifique et radio. *Diogène*, 58, 29–40.

4 In reference to the French expression "belles infidèles" ("beautiful betrayal"), used by the poet Gilles Ménage in 1648, about the translation of a text written by Lucien de Samosate, a Greek writer (second century), by Nicolas Perrot d'Ablancourt (1654).

arguments in the well-known publication *La formation de l'esprit scientifique*, describing the "showcasing" of knowledge isolated from scientific practice. He argues that "it is impossible to truly transmit objective knowledge through the mediation of a discourse/spectacle *alone*, implying a unilateral form of communication and excluding any effective practice"[5] (Roqueplo 1974, p. 220).

Thus, a common critique of popular science is that it "substitutes representations for knowledge" (Schiele 1983, p. 164), and incarnates a "myth of scientificity" (Jurdant 1973, pp. 97–107), insofar as what is transmitted is not "real knowledge".

Nevertheless, considering popular science as sharing scientific knowledge with a non-specialist audience is an ambitious objective, and inevitably leads to a defeatist conclusion (Jacobi 2005). We agree with many authors who wish to "dispel, once and for all, the issue of the scientific illiteracy of citizens" (Schiele 2005, p. 50), to which popular science would be a remediation process. The vocabulary used to describe this process shows how distant it is from scientific knowledge in the true sense (narrative approach to science, showcase approach to science, publicization of scientific issues, etc.)[6]. Popular science, and science in the media even more so, consist of ignoring certain aspects of scientific work in order to "make it understandable as a social activity" (Jeanneret 1994, p. 112).

We now present different perspectives that tend to recognize the virtue of the dialogue between science and society and look at encouraging prospects for the popularizing project.

1.1.2. *Promoting popularization*

Historically speaking, popularization has also been perceived as somewhat virtuous, disseminating a form of "scientific culture" to the common people, so as to compensate for their ignorance "imped[ing] the progress of the Enlightenment" (Jeanneret 1994, p. 45). In the French-speaking world, the term "*culture scientifique*" ("scientific culture") has slowly been replacing the French term "vulgarization" since the 1980s (Raichvarg 2016). It is, however, important to clearly define what is meant by the term "culture" in this phrase, and in the so-called "cultural" approach to popular science. Jacobi reminds us of its ambiguous meaning, whether the approach is anthropological, literary or artistic (Jacobi 2005, p. 70).

5 Original French version: "*Il est impossible de transmettre vraiment le savoir objectif par la seule médiation d'un discours/spectacle impliquant une forme unilatérale de communication et excluant toute pratique effective*" (Roqueplo 1974, p. 220).

6 Wolton (2011) even speaks of "cultural emancipation" (p. 39), illustrating the distance with a real "knowledge-sharing" process.

However, the term *culture* is no less ambiguous when combined with "scientific and technical"[7].

Over the course of the 20th century, this desire to make science accessible to society led to the creation of museums devoted to scientific discoveries (the "Palais de la Découverte" opened in 1937 in Paris), or to "Science centers" (such as the Ontario Science Centre[8], the "Cité des sciences et de l'industrie" in Paris[9], etc.). These facilities innovate by proposing "interactive devices, intended to be both recreational and educational in order to capture, focus and hold the visitor's attention" (Schiele 2005, p. 46). Shiele describes this as the "social project" of scientific and technical culture, the objective of which is not only to (re)enhance the image of science but also to involve the public in the scientific world. It is also a political project, with, for example, the French government launching a series of initiatives in this area since the 1990s. In 2004, the government created a national plan aiming to develop and modernize the ways scientific information is disseminated[10]. In 2012, the French National Council for Scientific, Technical and Industrial Culture (CNSTI) was created, with the ambition of creating an advisory body on these subjects[11]. Two French reports have specifically focused on government initiatives in the area of scientific culture: the OPECST report (2014)[12] and the CNSTI report (2017)[13], the latter being conducted over five years and incorporated into the White Paper on higher education and research.

In order to encompass all of these approaches, Wolton adds an alternative to the list of terms mentioned above, that of *valorization* of scientific research (Wolton

7 This ambiguity can be illustrated by the fact that the emblematic place for making science more accessible to everyone in France (the Cité des sciences in Paris) has been placed under the dual supervision of the ministry in charge of cultural issues and the one in charge of research since 1998 (see Information Report No. 384 (2006-2007) [Online]. Available at: https://www.senat.fr/rap/r06-384/r06-384.html [Accessed November 1, 2023]).

8 See: https://www.centredessciencesontario.ca/parlons-de-nous/qui-sommes-nous [Accessed November 1, 2023].

9 See: https://www.cite-sciences.fr/fr/accueil/ [Accessed November 1, 2023].

10 See: https://www.vie-publique.fr/discours/147667-communique-commun-de-mme-claudie-haignere-ministre-deleguee-la-recher [Accessed November 1, 2023].

11 See: https://www.enseignementsup-recherche.gouv.fr/cid134437/le-conseil-national-de-la-culture-scientifique-technique-et-industrielle.html [Accessed November 1, 2023]; https://www.legifrance.gouv.fr/jorf/id/JORFTEXT000025747676 [Accessed November 1, 2023].

12 Olivier, M. and Leleux, J.-P. (2014). Faire connaître et partager les cultures scientifiques, techniques et industrielles, un impératif. Report, OPECST, Paris [Online]. Available at: https://www.senat.fr/notice-rapport/2013/r13-274-notice.html [Accessed November 1, 2023].

13 See: https://www.vie-publique.fr/rapport/36586-strategie-nationale-de-culture-scientifique-technique-et-industrielle [Accessed November 1, 2023].

1997, p. 41). All of these perspectives have come to public attention thanks to the Unesco Kalinga Prize, which has been awarded since 1951 to the best popular science projects at the international level[14].

A consensus seems to be emerging on the positive mission of popular science, "as a device to educate the greatest number of people" (Jacobi 1986, p. 29). This "non-formal education" is therefore seen as being complementary to traditional education, as was already emphasized in 1958, during a conference on the popularization of science. François Le Lionnais[15] considered it to be more flexible than the teaching of science, and therefore "of national interest":

> Science is moving fast; it is moving faster than education […]; no matter how good the educational reform is, it will soon be overtaken by science. We therefore need complementary devices and materials. […] Alongside national education, there must be popular science, which gives teaching more flexibility (Le Lionnais (1958), quoted by Schiele (2005, p. 14))

Both criticized and promoted throughout its history, popularizing science remains, by all accounts, of major importance today. Indeed, its success is in the interest of all those involved in this dialogue.

But who are the actors involved? And who benefits most from popular science initiatives? It could be society as a whole, if we follow Lévy-Leblond (1992), who compares the "level of ignorance" among laypeople to that among scientists in fields in which they are not specialists. This author, himself a scientist, considers that "an expert in one field is a non-expert in almost all others and, as such, is very close to the absolute layperson as far as scientific culture in general is concerned" (Levy-Leblond 1992, p. 17).

Following these positive perspectives on the popularization of science, we will here be focusing on the beneficial or "virtuous" processes whereby a certain form of scientific culture is made available to a very heterogeneous readership, while also contributing to the evolution of science.

We must also question the purpose of this project, particularly as concerns our primary object, the media coverage of scientific issues. What exactly is being popularized?

14 See: https://fr.unesco.org/prizes/kalinga [Accessed November 1, 2023].

15 He was then president of the Association of Scientific Writers of France.

In order to answer this, we need to clearly define what is expected of the media. According to Miège, "it is important to make a clear distinction between the organizations that contribute to the dissemination of scientific culture, those that participate in the communication of science, and the 'operators' that are best able to stimulate public debates on scientific questions, which are assumed to be the mass media" (Miège 2004, p. 128).

In fact, in contrast to traditional popular science magazines (such as *The Scientist* and *Science et Avenir*), it is widely documented that people do not read newspapers, whether national or regional, to obtain scientific information or to improve their knowledge in the field of science. In this context, as Fayard specified as early as 1988, "from being a true end in itself, popular science becomes a means, a tool for issues that go beyond the mere scientific content of the message conveyed, and which situates that message in a broader social and economic context" (Fayard 1988, p. 11).

We now turn to the role of the media, particularly daily newspapers, in this dialogue between science and society.

1.2. Science in the media and the multiplicity of actors

Here, we focus on science in the media, i.e. how the daily press covers scientific subjects. The English language has no specific term to refer to the daily press coverage of information, while the French language uses the (polysemous) term "*médiatisation*" (Lafon 2019a; Miège 2019[16]). When dealing with scientific subjects, daily newspapers have a different objective from traditional popular science magazines, but they also need to "popularize" science, to make it accessible to a non-specialist audience. Let us return to the status and role of journalists in this process.

1.2.1. *From scholarly knowledge to social knowledge*

The critical discourse on popular science has clearly identified the limits of this endeavor when the media is given the overly ambitious task of transmitting scientific knowledge. The written press aims to do something slightly different, not to "*reproduce* pre-existing statements of science, but rather to *construct* a discourse on the world, informed by the activity of scholars but of a profoundly different

16 Miège (2019a) identifies four meanings for this term: mediation using technical devices, production-dissemination of content, mediated interactions or multiple informational productions.

nature" (Jeanneret 1994, p. 38). The goal here is not to "make the individual more competent" (Beacco and Moirand 1995, p. 40), but to provide information on issues concerning science and society. The media contribution to the societal debate is thus considered a "more social than scientific explanation" (Moirand 2000, p. 47), where the notion of scholarly (or "intellectual") knowledge is replaced by that of "social knowledge" (Beacco 2000).

The media thus acts as an informant; in order to appeal to its readership, it must ensure that it presents subjects of interest to its readers. Health and environmental issues have long been among the most stimulating themes in the media, as various studies on these subjects have shown (e.g. Miller 1991, 2004, in the United States). Cabedoche (2003) also cites a survey showing that the French are in favor of citizen debates and wish to be consulted on genetic research (38%), modes of agri-food production (38%), GMOs (37%) and energy choices (29%). The citizen's keen interest in science has since been confirmed by various surveys, notably in France by CREDOC[17] in a report published in 2013 on "citizens' scientific curiosity".

When it comes to dealing with these popular themes, Caune specifies that "the recourse to mediation is all the more necessary as some subjects are controversial, and some fields need to improve their conditions of acceptability […], in areas that carry socially recognized risks" (Caune 2008, p. 38).

This can be seen in any number of crises or scandals that have made the headlines, whether they be issues related to food (mad cow disease, avian and swine flu, etc.), the environment (the impact of synthetic chemical products such as DDT, pesticides and glyphosate) or industrial accidents (Chernobyl, Fukushima, etc.). Some of the latter have become "proper-name events"[18] (Krieg-Planque 2009), used as a non-neutral fixed expression that has a lasting impact on how these subjects are perceived in society.

It is also important to emphasize that since 2020, the global health crisis has increased citizens' interest in health and environmental issues, and more generally in all scientific fields related to these themes. When a subject generates significant discursive production, it then becomes a front-page news item and a "discursive moment" (Moirand 2004), likely to appeal to many readers concerned by how these

17 The Centre de recherche pour l'étude et l'observation des conditions de vie (CRÉDOC – The Centre for the Study and Observation of Living Conditions) is a research organization serving economic and social actors in society. See the study, p. 47: https://www.credoc.fr/download/pdf/Rapp/R289.pdf [Accessed November 1 2023].

18 For instance, if we use the word "Fukushima" in media discourse, it refers to all the disastrous consequences of such an accident, without any need to explain further.

matters impact their own lives. In the context of anxiety induced by media coverage, the citizen is thus "less eager for scientific knowledge than anxious about the consequences of 'the scandal' on their health" (Moirand 1997, p. 37)[19].

The media thus plays different roles, providing information, explanation and even reassurance, while also giving a voice to the different actors involved in these subjects. The balancing act is all the more complex as the act of popularizing science also involves the possibility of having to be a whistleblower, in the face of potentially controversial events (e.g. Chateauraynaud and Torny 1999; Chateauraynaud and Debaz 2017).

In order to enable readers to have an overall understanding of a subject (the processes, actors, issues involved, etc.) and to participate in the democratic debate in full knowledge of the facts, the media gives a voice to all the different parties involved by interviewing experts. In this multi-faceted discourse, the journalist becomes the "conductor" of multiple voices, and the "discursive manager" (Moirand 2000) between two worlds: that of science, on the one hand, and that of the presumed audience on the other. In this respect, the role of the science journalist is different from that of a non-specialist journalist who conveys not only the voice of experts but also that of other actors, and who explores the consequences of these "scandals" on society.

We will now delve further into the question of the role and responsibility of the media in the dialogue between science and society, looking in particular at how it gives a place to those considered experts.

1.2.2. *Perspectives on science and experts*

In the early 20th century, the primacy of science was considered a given, as evidenced by the slogan adopted at the Chicago exposition in 1933: "science finds, industry applies, man conforms" (Bensaude-Vincent 2018, p. 27). In many fields, the expert's opinion provides rigor and precision by contrast with laypeople's approximations (Flaysakier 1997; Laberge 1997). Experts also serve to reassure the public in the face of "messages of insecurity transmitted by the media" (Zappalà 1997, p. 183). In recent decades, the situation has changed, however, especially if we consider the image associated with science and the notion of expertise.

19 The popularization of science does not only concern emergency or disaster situations but also phenomena that require attention or prevention, for example, the risk of earthquakes, global warming and the impact of the use of technology (and screens) on health.

1.2.2.1. *The evolution of the image of science*

Various scientific fields offer a nuanced perspective, both on the "progress of science" and on scientific discourse in general. Genetic engineering or biotechnology, for example, raise questions about the impact of scientific research on human beings (or living organisms), and about the evolution of society more generally. Alongside this, media reports of issues or scandals involving science have a direct impact on the everyday lives of ordinary citizens. This can be seen in the case of the anti-diabetic drug (*Mediator*) prescribed to treat anorexia which turned out to have serious side effects[20], or the earlier example of the Thalidomide (in the 1960s), a drug marketed as a sedative and against nausea, which proved to be harmful notably for pregnant women and was withdrawn from the market a few years later[21].

In recent decades, doubt has been cast over scientific research and the associated idea of "progress", breaking the original trust people once had in science (Sicard 1997; Wolton 1997; Schiele 2005). Public opinion therefore tends to show a certain wariness (or even mistrust) towards scientific research and is "more aware of the dangers of science, more determined to challenge what are seen as being negative side effects" and now refuses to "accept risks in the name of progress" (Cabedoche 2003, p. 228).

Distrust of scientific discourses emerges as part of a flow of media information that might be considered transitory. But there appears to be a certain "family resemblance" between issues to do with health, food or the environment (Moirand 2007), as they become politicized and focus public attention on issues that are salient for ordinary people – transparency, traceability, the precautionary principle, etc. The connections between such events generate "a space for the construction of collective memory in contemporary society" (Moirand 2007, p.2) liable to result in a loss of trust in science.

This distrust is also due to the fact that citizens are faced with non-consensual, or even contradictory perspectives on controversial topics (for instance, nuclear energy, the contaminated blood scandal in France, or more recently the coronavirus health crisis). Even though some of these subjects have become less controversial, media attention on them has contributed to the emergence of a certain skepticism. Citizens can see that scientific issues may be seen through different perspectives (industrial, social, legal, etc.) and, moreover, are likely to evolve over time. There are various historical examples of such evolutions, such as commonly used industrial products

20 See: https://www.lemonde.fr/societe/article/2021/03/29/affaire-du-mediator-ce-qu-il-faut-savoir-avant-le-jugement_6074806_3224.html [Accessed November 1, 2023].

21 See: https://www.pourlascience.fr/sd/histoire-sciences/la-terrible-affaire-de-la-thalidomide-3343.php [Accessed November 1, 2023].

or popular foods which are suddenly called into question. Recent examples include bisphenol A, which was used in the composition of a large number of food containers before being banned in 2012, or even dairy products which were marketed as "friends for life" and promoted for their nutritional benefits before the 1980s before being challenged (particularly for adults). Another example might be the turnaround on health recommendations in the prevention of sudden infant death syndrome (SIDS).

At the same time, some scientific information reported on in the media is genuinely controversial, as shown by the Sokal hoax (Jeanneret 1998; Beaudet 2000) or more recently the Séralini affair, concerning the toxic effect of genetically modified organisms on rats (Allard-Huver 2020; Domenec 2020). Regardless of the final outcome of a given study, the perspective presented, or the responsibilities of the actors involved, a seed of doubt is planted as to the reliability of scientific research (and the media coverage of it). Given the notion of risk and the fact that knowledge is fluctuating, the role of the media is extremely complex, particularly when it comes to calling on experts. In this recent context of distrust of science, which specialists are likely to speak, to explain or to legitimize the issues under debate? Here, we take a deeper look at these experts, and the evolution of their status in the media discourse on science.

1.2.2.2. *Actors, experts and multiple voices*

There are various figures of "the expert" in the media, and anyone can participate in the debate on scientific questions. An expert may be a recognized researcher, a writer, an activist or an "ordinary person", and "the testimony of the latter, in particular when he presents himself as a victim, is overvalued and immediately given credibility" (Cabedoche 2003, p. 222). The press (especially the regional press) often makes use of accounts that give value to local citizens' voices in the social explanation of events. Additionally, presumed scientific or disciplinary expertise is no longer systematically a mark of credibility. Notoriety, whether it be editorial, media or social, "creates hierarchies more than academic titles" (Delforce 2003, p. 170).

This "discursive heterogeneity (or hybridity)" (Moirand 2014) reflects a shift from a linear model of communication (from the expert to the less expert) via a mediator (in this case the media), to more complex models. Indeed, there is a gradual shift in the relationship between science and society, where more actors are involved. Wolton describes a "multiplication of actors and parameters to be taken into account in a context of communication rather than information, of debate rather than popularization" (Wolton 2011, p. 35). According to the author, we have shifted from two to four actors in these communication processes, and even four logics (science, the public, politics and communication), with a view to "ensuring a

minimum of cohesion between necessarily heterogeneous worldviews" (Wolton 2011, p. 42).

The media no longer necessarily relies on specialists to identify and explain the facts, but instead discusses the associated information and puts it into perspective with other events, topics or knowledge. Considering popularization as a type of informal education, Jeanneret (2004) speaks of a "culture of permanent debate […] in which academic, social, but also experiential knowledge is combined to produce information" (Jeanneret 2004, p. 26). This is all the more important today with the development of digital communication tools, which have given rise to new roles, for example that of the "specialized amateur", within scientific blogs or forums, illustrating the emergence of a horizontal and vertical transmission of knowledge (see Moirand et al. 2016 2016; Reboul 2020).

In order to further explore different perspectives on science and scientific communication in general, we will now address the issue of communication models that attempt to describe these interplays between science and society.

1.2.2.3. *New communication models*

One of the criticisms of the popularization of science partly stems from the initial model, which considered the gap between the knowledge of scientists and that of the public as immutable and intangible (known as the "deficit model"). This "traditional" model is based on the asymmetry between the actors in communication, and on the linear paradigm via the middleman (science on one side, the public on the other and, in the middle, the mediator who acts as a go-between). In this perspective, the public is seen as external and monolithic, and devoid of scientific knowledge (e.g. Gross 1994; Bucchi 1996; Bensaude-Vincent 2010; Brossard and Lewenstein 2010; Secko et al. 2013).

However, the last two decades have seen this model challenged. It has been criticized for the way in which public knowledge is assessed, often based on specific, out-of-context questions on specific scientific points (e.g. questioning the citizen about the rotation of the Earth around the Sun (or is it the other way around?), the time of this rotation, etc.) (Bucchi 1996). This way of assessing knowledge is controversial for several reasons. On the one hand, it gives a limited and momentary picture of the general scientific knowledge of a citizen. On the other hand, it systematically prioritizes questions that are related to natural or physical sciences for instance, thus neglecting other scientific fields that are considered as secondary. Certain researchers thus refute the principle that "hard sciences" are the most important, arguing that other perspectives are equally decisive for the interpretation of scientific facts, taking into account other issues such as society, politics, the economy and ethics (see Burns et al. 2003; Delforce 2003; Priest 2010;

Trench and Bucchi 2010; Secko et al. 2013), or defending more systemic and comprehensive approaches (see Morin 2005).

The posture and the status of the citizen in this process have also evolved. In the vein of Fourquier and Véron (1985), or Albertini and Bélisle (1988), Jeanneret (1994) refused to see simplified science as common (or basic) thought, and took the reader's modes of reasoning very seriously: "Common knowledge is not just incomplete or erroneous thought; on the contrary, it is an effective cognitive training, with respect to its own objectives" (Jeanneret 1994, p. 114). This knowledge, although imperfect, is nonetheless constructed and has social and personal relevance, prioritizing "conclusion over reasoning" (Jeanneret 1994, p. 125). Myers confirmed this position:

> We cannot understand why there are tensions about genetically modified organisms, vaccinations, or climate change if we assume that science is distinct from the rest of culture, and that the public is, on scientific matters, a blank slate (Myers 2003, p. 274).

The author illustrates this principle through the example of parents whose child suffers from a medical condition, and who must confront particular difficulties on a daily basis; he considers that to a certain extent they become specialists or semi-specialists.

Thus, other models of communication are emerging, in which the citizen is more involved in the chain of scientific communication[22]. Raising awareness among citizens, with a view to enabling enlightened participation has been a goal since the 1990s, particularly for environmental issues (Boillot Grenon 2015). This is what "citizen science" or "public participation in scientific research (PPSR)" seek to achieve, through the deliberate and active promotion of citizens' appropriation, and even production, of knowledge (Houllier and Merilhou-Goudard 2016; Catellani et al. 2021). Different models currently co-exist (community-based research, collaborative research, living labs, experiential research, etc.) as a result of the opening of scientific projects beyond professional researchers.

This conception remains increasingly important today, especially with regard to sensitive fields of study such as environmental management and agroecology (Chlous et al. 2017). In this context, the citizen's perspective becomes prominent as soon as it is associated with a personal interest or integrated within a project (Laügt 2001). Thus, the public is no longer simply passive; it is involved in the issues at

22 Although most of these models are based on scientific communication in a general way, as well as on scientific journalism, we will see that they are also of interest in dealing with science in the media in general.

stake, based on its own knowledge and socio-cultural context. The non-specialist may even have a potential for action, being able to assist scientists in their own reasoning (e.g. Bucchi 1996; Logan 2001; Delforce 2003; Leach et al. 2009; Brossard and Lewenstein 2010; Avenier and Cajaiba 2012; Secko et al. 2013). Bucchi (1996) suggests that efforts in terms of negotiating ideas and interests with citizens would even go beyond the scientists' initial intentions[23] (Bucchi 1996, p. 384).

Schiele thus reminds us of the circularity (and therefore, the positive feedback loop) between a positive attitude towards science and technology[24], and a certain amount of knowledge, which lead to a better understanding of scientific issues by the citizen (and, ultimately their capacity to engage in democratic debate) (Schiele 2005, p. 32).

There are also alternative perspectives to the traditional popularization of science, which assumes an intermediary. One of these is the "deviation" model, in which the scientist speaks directly to the public (Bucchi 1996; Cabedoche 2003; Davies 2008), thus modifying the relationships and the nature of the information reaching the target audience. We return to these issues in Part 3 of this book, focusing on the role of journalists as well as on the prior role of scientists and the subsequent role of readers, in moving toward greater public involvement.

In the interconnected challenges the mediator faces, a parallel can be made between these two approaches (science and the media), to show how they diverge as well as what brings them together.

1.3. Scientific and media approaches to popularization

We first address what differentiates the two approaches at the heart of the dialogue between science and society. This will be important for the case study presented in Part 2 of this book.

1.3.1. *Divergence between scientific and media approaches*

The following three points of divergence between the two approaches involve observation and experimentation, doubt and uncertainty, and the issue of time.

23 Source: "Efforts should instead be devoted to describing it in terms of an open-ended negotiation of ideas and related interests, and one may expect its consequences to go well beyond scientists' original intentions."

24 In this regard, he cites Miller's study (1983).

1.3.1.1. *Observation and experimentation*

The term "scientific approach" is used here to refer to both the notion of science, which generates a set of authoritative knowledge, and the notion of research, which aims to investigate questions that do not necessarily have stable or immediate answers (Klein 2020a). Even though scientific paradigms vary and evolve according to different fields of science[25], the experimentation inherent in the scientific approach is based on the search for a result that is not immediate, but rather reached through a period of observation and, potentially, trial and error. As early as 1988, Devries noted that some "medical advances took years to come to fruition, and might not have occurred at all, if their initial success rate had been the deciding factor in their development" (Devries 1988, p. 889). As an example, he mentions scientific achievements that made heart transplantation possible, which had initially failed many times. He extends this to many other medical successes such as dialysis, coronary artery bypass surgery and pacemakers, pointing out that these experiments were mostly built on failures before they brought tangible results.

The absence of such experimentation in the process of popularizing science was highlighted by Roqueplo (1974) in his book *Le Partage du savoir*, providing a nuanced image of this process. He suggests that, without scientific experimental practice, a non-specialist cannot appropriate knowledge, he can only construct a representation of it.

However, the press has a more pragmatic perspective, focusing on the impact of scientific discoveries on the citizen's (quality of) life, as noted above. Thus, "what is intended to be a long experimental series is assessed on a case-by-case, quality-of-life basis" (Devries 1988, p. 889). What ultimately prevails in the media process is the notion of useful information for the reader. Calsamiglia (2003) explains the value of the scientific object, differentiating the two approaches as follows:

> For the former (the scientists) the object has an immanent value in scientific and specialist contexts. For the latter (the public) the value is external to all the theories and methods: what is important is its application, its utility and the consequences of its use in people's lives.

25 According to the principles laid down in particular by: Bachelard, G. (1934). *Le nouvel esprit scientifique*. Les Presses Universitaires de France, Paris and Kuhn, T.S. (1962). *The Structure of Scientific Revolutions*, 2nd edition. University of Chicago Press, Chicago.

1.3.1.2. *Doubt and uncertainty*

Science does not aim to "freeze" an object and make it immutable; instead its objects are constantly evolving. Scientific knowledge, which is always in the process of being developed, "is based on doubt, on possible ruptures in the epistemological field" (Sicard 2011, p. 67).

Conversely, media discourse does not rely on hypotheses and doubt: "It needs certainties. He who has the honesty to say 'I don't know' is disqualified. What is needed is an expert who is infallible and adaptable to all situations" (Flaysakier 1997, p. 137). A scientist who has doubts and confides them to a journalist will be discredited even though doubt is the very foundation of his own approach. As Cabedoche confirms, "unless he causes a misunderstanding and runs the risk of facing popular dissatisfaction, it would become difficult for the researcher to show this caution, this humility, this sense of nuance that usually characterizes him in scientific forums" (Cabedoche 2003, p. 218).

This was one of the difficulties encountered during the initial period of the Covid19 health crisis in 2020. Science did not have all the answers to the questions raised by the pandemic (origin, spread, protection, etc.), and furthermore, the medical community did not speak with one voice. Unable to admit a form of uncertainty or ignorance in the face of an unprecedented situation, the media relayed polyphonic[26] information[27]. Although this notion of doubt or uncertainty is acceptable in certain scientific fields, such as astronomy (Moirand 2000), it becomes problematic in other situations when scientists are faced with questions that affect citizens' health. Yet the scientific endeavor as a whole is built on doubt.

1.3.1.3. *Science in the long-term*

Although science advances relatively quickly compared to the education timeframe (see section 1.1.2), it is by nature characterized by a certain slowness, given its own characteristics (observation, experimentation, trials, errors, conferences, publications, etc.). Even though this time has been shortened by the evolution of alternative modes or models of communication (such as the deviation model, see section 1.2.2.3), science's long time frame is a necessary aspect of its approach.

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26 The notion of polyphony has been studied extensively on various subjects. See, for example, the works of Moirand (1997, 2003, 2007), Jeanneret (e.g. Jeanneret 2000), or Mondada (1995), and the numerous publications on communication about the Covid-19 pandemic.

27 Klein (2020b) calls this the phenomenon "ultracrepidarianism", which refers to giving an opinion on a subject, either by an ordinary citizen or by an expert, about a field in which he is not a specialist.

The press has a different attitude, striving to present new information as fast as possible, ideally in real time. "The media's own timeframe, accelerated by live transmission techniques, is infinitely shorter than that of science" (de Cheveigné 1997). There are numerous problems due to this necessity for speed, and the situation can thus "become dramatic, as in the case of therapeutic drug trials" (Ibid, p. 15). The health crisis, here too, revealed the confusion generated by the uncertainty associated with short time frames, whether it be around the question of hydroxychloroquine or the side effects of the various vaccines. Moreover, the institutional and technical constraints of the media leave little room for a verifiable scientific explanation and, consequently, "there is a great risk of seeing science trapped in a reductionist communication process" (Sicard 2011, p. 150).

Attempting to characterize the divergences between these two approaches, Caune sees in them two distinct cultures "which have not been able to establish links between the work of experimentation and formalization that is constitutive of the scientific theory which constructs facts, and the work of interpretation conducted by social sciences and the media, which analyzes how scientific statements propose a representation of the world" (Caune 2008, p. 46). However, these two cultures do share a form of common content, that of scientific information, thus suggesting points of convergence which we will discuss in section 1.3.2.

1.3.2. *Convergences between these approaches*

Below, we present three important notions that bring together scientific and media approaches: the quality and usefulness of the information transmitted, the multidisciplinarity and complexity of information, and lastly, communication practices.

1.3.2.1. *Quality and usefulness of the information provided*

Beyond the issues of popularization for the general public exposed above, it is important to stress the reciprocal importance of science for the media, and of the media for science. As Devries underlined, the two approaches share a fundamental principle, that of guaranteeing fair and quality information: "Neither the press nor the medical staff can be excused for the release of inaccurate information. All suffer when this occurs and all must bear the consequences, […] accuracy is non-negotiable" (Devries 1988, p. 886). This observation therefore requires cooperation between actors involved in the process, in order to avoid conveying unofficial information from ill-informed sources, and to ensure that the right information is communicated. While this cooperative principle is not without problems or risks, the absence of cooperation could, according to the author, be even

more problematic[28] (Devries 1988, p. 886). The author suggests that popularization of science allows citizens to be better informed about medical issues, in the case of the risk of stroke for example, about heart performance, the benefits of a healthy diet or the lack of physical exercise. Devries even recognizes the "dignity" of the two approaches (scientific and media) when they contribute to the dissemination of qualitative information that is useful to the citizen.

From this same perspective, an American study by the *National Science Board* (cited in Schiele 2005, p. 31) attests to the fact that more citizens now know that antibiotics do not work against viruses, due in part to press coverage of bacterial illnesses and resistance to certain treatments. Similarly, in a recent study of media coverage of pesticides, Botero points out that the information made available in the media is likely to become "knowledge in action, transforming cognitive data into a solution" (Botero 2021, p. 116). A qualitative and efficient dissemination of knowledge becomes relevant in different ways, whether through social acceptability, education or action, thereby fighting against information that could be described as fraudulent or deceitful (Thouin and Lapointe 2016). The circulation of knowledge is at stake, and its popularization also offers the scientist the opportunity to address, in an admittedly constrained space, a specific fundamental point that was previously unspecified or ignored (Lipani and Pascal 2020). This mediation could be assumed to be even more useful and immediate when medical and political problems are associated (Zappalà 1997, p. 188), as citizens are more likely to be interested in topics that are useful in their personal lives (Burns et al. 2003; Priest 2010).

Moreover, the benefits of this communication are important not only for the image of research but also for its funding. Indeed, it is now recognized that national visibility through the media is strategically necessary to ensure adequate financial support for research (see, for example, Nelkin 1986; Devries 1988; Jensen et al. 2008; Rouquette 2011).

The virtuous circle of popularization can thus be considered from an overall perspective. The dissemination of research results leads to a better understanding of the field, which in return benefits from greater financial support given its greater visibility, and which can then develop further. Several studies also underline the positive impact of this process on researchers' careers (e.g. Jensen et al. 2008). Moreover, there are also ethical requirements to inform citizens about the impacts of research, the latter being generally financed by the public sector, and therefore by citizens themselves (Lamontagne 2016; Thouin and Lapointe 2016).

28 Source: "Cooperating with the press is more advantageous to everyone concerned than taking the opposite tack. Although cooperation may entail some bother and risk, non-cooperation may well be more troublesome."

Rouquette summarizes the situation in scientific communication as follows: “Without results with tangible implications, without a directly measurable effect on people’s daily lives, a scientific discovery has little chance of being publicized” (Rouquette 2011, p. 30). He thus sheds light on the difficulty for fundamental research to be publicized (Rouquette 2011, p. 30), even though it is indispensable as a driving force and guarantor of the quality of applied research.

1.3.2.2. *Multidisciplinarity and complexity of information*

Scientific and technical information is complex in itself. Communicating it outside the scientific field is no less complex. If we consider public health, for example, we are dealing with a multidisciplinary field by its very nature (in addition to the medical and scientific aspect, it encompasses social, economic, sociological and political concerns). This complexity is not conducive to rapid and complete processing of information (Flaysakier 1997). Thus, according to Laügt (2001), “the role of the mediator, and a ‘noble’ role in that respect, would be to no longer try to reduce this complexity but instead to try to contribute to societal debate around scientific questions, by betting on a communicational strategic action”.

Furthermore, researchers themselves potentially have “a plurality of social identities” (Delforce 2003, p. 171), as a citizen (with values and ideals) and possibly also as a member of the medical profession. We are thus “in the presence of multiple truths, held by different social actors, all of which claim to provide adequate and valid explanations of the phenomena involved, as well as legitimate goals for action” (Delforce 2003, p. 169). Jollivet confirms this situation, specifying that “in the researcher lies the citizen” (Jollivet 2007, p. 419). And behind the citizen, there is potentially a user, a victim, or an activist, possessing a form of knowledge of his own.

Lastly, we address a final point of convergence between the two approaches, which concerns communication practices.

1.3.2.3. *Communication practices and the production of knowledge*

Some consider that scientific and media approaches are opposed when it comes to “producing” something – with one producing knowledge and the other not producing it. Nevertheless, other researchers, such as Véron (1997), see them both as productive. He argues that the media “produce the social reality of which they speak” (p. 26). Charaudeau also corroborates this claim: “The media do not convey what is happening in social reality, they impose their construction of public issues” (Charaudeau 2011, p. 12). We are dealing with the production of a social reality

that is co-constructed between science and readers, through the intermediary of journalists who obtain information from specialized sources.

This takes us back to the question of knowledge production. Although the journalist does not set out to create knowledge, the same is also true of the scientist. We might assume that every scientist wishes to produce immutable and absolute knowledge able to promote "scientific progress", which can be rapidly shared with the rest of society. However, this production of knowledge seems to be more the consequence of scientific work, resulting from its fundamental objective which is to observe, understand and document the phenomena under study. According to this principle, it is difficult to criticize scientists for producing knowledge that is not always definitive, and the media for having to transmit a degree of uncertainty in this knowledge.

We must therefore keep in mind that the media approach "above all consists of ensuring encounters between actors, mindsets and legitimacy. It is this intersection of issues that scientific communication is all about." (Jeanneret 2000). As Caune rightly points out, "any culture, be it scholarly or popular, scientific or literary, cannot be dissociated from the way in which it is circulated, and exchanged" (Caune 2008, p. 46). This claim is a relevant transition towards the question of discourses on science, which is addressed in Chapter 2.