The Expert You Are (Not)

Citizens, Experts and the Limits of Science Communication

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Abstract. Considering any democratic government, it goes without saying that the more knowledgeable the citizens are, the better the democratic process will work. Therefore, leveraging scientific information among laypeople is intuitively linked to the growth of an educated population; some factors, though, taint this positivist account. Amateurization as an explicit stance on the one hand, "edutainment" matched with the ever-growing complexity of scientific matters on the other. In this paper we argue that while encouraging the diffusion of a general "love for science" should inspire an appetite for more robust scientific knowledge, it also foster the emergence of problematic cognitive situations, as the propagation of the so-called epistemic bubbles or the progressive belittlement of the role of experts in society.

Keywords. Science Communication, Democratic Culture, Amateurization, Expert Epistemology, Epistemology of Ignorance, On-line communities, Cognitive Niches, Affordance, Epistemic Bubble, Black Box Arguments

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Introduction

With respect to any democratic government, it goes without saying that the more knowledgeable the citizens are, the better the democratic process will work: in case of direct participation (for instance through referendums) or by representation (e.g. elections), they should be enabled to vote for the most sensible policies (still according to their political views). Leveraging scientific information among laypeople is intuitively linked to the likelihood of one voting for the best, just as sheer ignorance is responsible for poor political choices. Knowledge leverages the ownership of our own destiny.

Some factors, though, taint this positivist account. Amateurization as an explicit stance on the one hand, "edutainment" matched with the ever-growing complexity of scientific matters on the other.

The Web 2.0 fostered the emergence of what Keen (2007) defined the "cult of the amateur", a positive obsession for user-generated material as opposed to the establishment-generated one. This lead to a systematic mistrust of the traditional expert in favor of self-appointed or crow-appointed ones. Social Networking Websites increased the ranks of users producing and reproducing content, and so the diffusion of pseudo-scientific or incomplete information that is often confused with the bona-fide sharing of scientific results. Also, the ever-more complex nature of the scientific endeavor and its results turns scientific information into ever more extreme forms of "edutainment", sometimes striving to show exciting tidbits that can be enjoyed within the attention span of casual web-surfing, such as in the case of the famous blog "I fucking love science". We argue that while the encouraging aim of this attitude is to grow an appetite for more robust scientific knowledge (also at a layperson's level), the risk is to trigger the opposite result

and foster the emergence of epistemic bubbles and ignorance bubbles, situations in which an agent is unable to tell the difference between what she knows and what she ignores. Thus, instead of (in)forming better citizens, edutainment might fall short of its aim and produce citizens that think they are expert in science, medicine, ecology, economics and so on: they refuse the advises and indications of recognized experts and can be manipulated by politicians who, like in La Fontaine's fable about the Crow and the Fox, praise them as knowledgeable repositories of the "truth".

1 The Golden Age of Electoral Democracies?

Most nations known as "occidental liberal democracies" are electoral democracies. This definition means that the democratic form is indirect, as opposed to the direct model of democracy (for instance the historical Athenian model): in a direct democracy, citizens hold the power to the extent that they have their say on everything concerning the life of the state. It is so, and it must be so. In an indirect democracy, citizens perform their democratic right/duty by electing the lawmakers (and, in certain frameworks, the heads of state as well): in turn, the democratic process directly intended affects the elected lawmakers.

In electoral democracies, once the will of the people has been expressed in the elections, decision making rests in the hands of the elected representatives. By "decision making" we do not merely refer to the executive branch in Montesquieu's famous separation of power, but in general to the process of deciding on the life of the country, which is instanced by the legislative and judicial branches as well.

Elected members of the government can be seen as epistemic representatives, since – together with their mandate – they are supposed to get informed, and be knowledgeable in the

relevant areas, on behalf of their citizens. Of course, representatives are human beings and cannot expected to be knowledgeable about everything, and that is why they typically rely on advisors, permanent domain-competent organisms, state-funded research and, occasionally, on ad-hoc panels. Some forms of direct democratic involvement still remain in electoral democracies, for instance referendums. Upon certain matters that are perceived to transcend the mandate of the elected government and legislators, citizens may be asked to express their opinion by answering a precise question, usually in the form of a YES/NO answer. According to the juridical frameworks, referendums may be or may not be binding for the government of the nation.

The increased volume of science communication circulated into the mass media, and the following increased scientific literacy seem extremely beneficial to electoral democracies because they resonate with Condorcet's famous Jury theorem, often assumed as a mathematical foundation of democracy. The theorem famously demonstrates that if the average probability of a single voter to reach a correct decision is greater than 50%, the chance of the whole group of voters as an entity to reach the correct decision increases with the number of participating voters. If we loosen up Condorcet's framing, allowing for situations where there is not a right and a wrong outcome at stake (for instance, political elections do not have a wrong and a right candidate to vote for, in the absolute sense), the increase of science communication should anyway foster the probability that a voter makes the "right" decision. This is true as far as political elections are concerned, and all the more true when referendums are called for: a more scientifically literate electorate should be expected to make better and better choices at referendums, elect better politicians who would in turn increase the standards of policies and new laws and so on.

But is it really so? Are we really living in the golden age of electoral democracies thanks to the impact of science communication? Without engaging in political judgements, the results of the

BREXIT referendum baffled the expectations (and the recommendations) of most competent scientists and intellectuals; furthermore, the election of Donald Trump as the 45th President of the United States, after a campaign that witnessed an unprecedented role of information circulated via social media, raises epistemological doubts on many aspects of his presidential program, and has boosted the popularity of the expression "post-truth" to indicate the state of the current politics.

Given these premises, in the rest of the paper we will attempt at answering the following question: assuming that the information is accurate, does a hyper-exposition to scientific information make one scientifically literate? In order to do so, we will take a look at the quality of actual science communication, and then at how scientific information, diffused in the current fashion, can be absorbed.

2 The Asymmetry of Science Communication

Intuitively, science communication to laymen should represent the bridge be- tween the complex, esoteric, and domain specific world of scientists and the larger, general, and civically interested public. This definition is usually born in mind with a sketch of an ideal society scenario, where scientists have time, energy, and resources to communicate in the most intuitive and straightforward way the outcomes of their work to non-specialists, without disregarding methodological explanations, trial and error results, and timelines. In the same ideal world, the laymen public stands for a diverse group of people with a medium-high level of education, who care for the welfare of the community more and above their self-interest. Notwithstanding the well-

grounded rea- sons to hope in the upcoming realization of this scenario, in the actual world the terms “science communication”, “scientific community”, and “lay public” have very different meaning. In primis, because the communication between scientists and lay public are rarely direct, also rather overlooked or harshly critiqued by scientific and academic community.

It is hardly new that, today, hard-core science is a monologue given by and transmitted to a very specific audience. The main aim of scientists is to achieve significant results, do ground-breaking research and publishing it in the top journals of their fields. These publications are valued just if they are shared, verified and approved by specialists in the same discipline and are rarely meant for or addressed to other readers. Very few important articles, published in influential journals, are transmitted to the public preserving their original contents. This happens for two main reasons.

The first reason depends on the academic system of publication that is too expensive for non-academics, takes long time between the submission of articles (the end of a scientific project) and the publication, and requires an academically specialized audience to examine and understand the products of the research. Consequently, the second reason depends on, as well-described by Christie Wilcox (2012, p. 87), “jargon walls – the barriers that keep the people we want to become more scientifically literate from understanding what we do because they do not know the terminology”. A scientific work may be understood by the public just when the technical process that led to the results is widely comprehensible; unfortunately, the terminology used in a specific field of research is seldom even vaguely accessible to a generally educated public. Scientific sectors now are so specialized that, even within the same field of research, two teams of scientists may ordinarily use different definitions for the same object.

Moreover, even if the improvement and extension of science communication to a vaster

audience would benefit citizens of any democratic state, the learning activities beyond the years of compulsory education depend on individual choices and lifestyles. Thus, in order to reach as many people as possible, science journalists apply certain cognitive principles to make science communication appealing to a miscellaneous audience: they distribute data in a fast way (short articles, brief videos, etc.), using easy or self-explanatory terms and concepts, and highlighting the potential employment of scientific products and research to make them interesting for most of the people. These features could describe the cognitive requirements of science communication, though they do not require it to match basic epistemic prerequisites, as accuracy and comprehensiveness. If science communication can be described with the words of Burns et al. (2003, p. 183) as "the use of appropriate skills, media, activities, and dialogue to produce one or more of the following personal responses to science (the AEIOU vowel analogy) Awareness, Enjoyment, Interest, Opinion-forming, and Understanding", then the balance between cognitive requirements and epistemic demands should represent the main target for science communicators. On the contrary, it is easy to imagine that by satisfying the communicative requirements and disregarding the epistemic features, public media could answer more effectively the demands of a general public. Thus, considering these not little constraints at hand, what is currently transmitted to the public media?

3 Scientific Facts as Black Box Arguments

According to Miller (2010), civic scientific literacy is a concept that aims at representing the level of understanding of science and technology citizens need in order to act freely and responsibly in a modern industrial society. It defines a threshold level more than an ideal level of understanding

and it is seen as a result of a continuous update of citizens education within and beyond the standard educational channels. To make sure that the lay public achieves this level, mass media are the most convincing tool to communicate scientific and technological advancements to lay public. But since civic scientific literacy is a constantly in-progress goal and the media have to consider as potential targets people of different generations and environments (both college freshmen that have recently studied the properties of neutrino particles and over 65-years-old men that once nearly finished high school), they need to apply cognitive strategies that can appeal to a broad and diverse audience instead of a narrow and specialized one: using, for example, the so-called black box arguments, analyzed by Jackson. Specifically, she defines a black box argument:

> […] a metaphor for modular components of argumentative discussion that are, within a particular discussion, not open to expansion. […] A black box argument is very like any other appeal to authority, and what might be said about any particular form of black box will turn out to be a particularized version of what might be said about evaluating arguments based on authority. In another way of looking at black box arguments, they are a constantly evolving technology for coming to conclusions and making these conclusions broadly acceptable. Black boxes are to argumentation what material inventions are to engineering and related sciences. They are anchored in and constrained by fundamental natural processes, but they are also new things that require theoretical explication and practical assessment (Jackson, 2008, p. 437).

Thus, using black box arguments instead of complete explanations, public media offer to the laymen public what the latter is looking for: mere information wrapped in an authoritative fashion.

Black box arguments embed the function of informing without fully explaining and are able to deliver the same amount of data to academics and retired carpenters alike. Thus, the oversimplified narratives that are used by mass media to cover some technological and scientific advancement are appreciated because they help to update fast and clearly the beliefs of the public every time they switch on the tv or read a newspaper. This applies also even if they do not explain the complicated process that drove scientists to some conclusion.

Therefore, the easy adoption of black box arguments in mass media is a double-edged sword that can be describe in two points:

a) it increases knowledge of some sophisticated scientific and technological topic in a vast population;
b) it increases the sense of knowing of the public, making some information seem affordable to common people, as it displays some issues in ordinary terms and without extensively displaying the complicated generation and defense of some theories.

The point a) implies that, in certain curated environments (as national news, accredited newspapers, scientific-oriented journals), committed science journalists will provide to the vastest public accurate (even if not open to expansion) data that depend on the reliability on the expert figure. Moreover, while the transmission of data is limited by the cognitive constraints of good communication (as it is as fast, easy, and interesting as possible), in curated environments science journalists are considered accountable for the information they display and so they are also responsible for the level of accuracy and comprehensiveness of the data. Black box arguments employed by these specific figures that manage the mass media are just rhetorical tools that permit

a balance between the cognitive affordability and the epistemic features of scientific information for a vast public. Instead, the positive features of the employment of black box arguments to discuss scientific issues disappear when people are no longer accountable for the information they discuss and share. So, the consequences of point b) emerge without the possibility of controlling their effects.

Indeed, in communication environments where there are no epistemic constraints that link the distributors of information to a certain level of accountability, the leveled relationship between public and scientists (just apparently leveled: black box arguments are still not open to expansion, even if they are discussed in laymen's terms) makes scientific issues appear as debatable, and not only by specialists. In other words, even if black box arguments rarely increase actual comprehension of complicated topics, they raise the participation of laymen in the discussion, belittling the difference between scientific facts and personal opinions.

Thus, while science communication in mass media should aim at promoting commitment to scientific knowledge, especially by engaging the experts on the field, the use of black box arguments in de-authorized environments promotes the emergence of overconfidence in laypeople, together with a fallacious reliance on decontextualized data. De-authorized environments are, for example, on-line communities, that are now the major substitutes of traditional mass media devices for scientific information distribution.[2] Indeed, the Internet is one the most powerful resources of

[2] To clearly represent distribution of information in on-line structures, we should briefly recall a terminological clarification that we introduced in (Arfini et al., 2017). We use the term on-line communities in order to employ the most general definition to embrace different types of Internet-based frameworks, as social network websites, newsgroups, forums, blogs, and miniblogs. We use this term in order to take a target broad enough to support different references as social media, digital frameworks, and social networks, without being general

information currently available. Last year, the Pew Research Centre reported that more than two thirds of the American population use social media, the vast majority to get news about politics, science and technology. At the same time, also a distribution of disinformation occurs in these networks.

In the next section, we will discuss the consequences of the distribution of scientific information as black box arguments in on-line communities and the cognitive features that makes these digital environments dangerous media for science communication.

4 Discovering Information On-Line: Produsers, Filter Bubbles, and Self-Made Experts

It is easy to think about social networking websites and on-line communities focusing only on their role as social aggregators. Originally, as commented in (Bertolotti et al., 2017), social media were indeed designed as personal spaces to gossip and share personal information, but now the amount of news, scientific data and political statements that are distributed on their platforms should force even the most skeptic person to consider them common venues for sharing – and consuming and commenting – external content with one's (actual and virtually extended) network. Indeed, on-line communities could be powerful instruments for education, but the current distribution of fake or, at best, "oversimplified" scientific reports, political facts, and news in on-line platforms are the main reasons to consider social networks actual ignorance spreaders.[3] Indeed, on-line communities

enough to hold the equivalence with traditional media, as newspapers and television programs.

[3] In our analysis, we will consider a very broad definition of the term ignorance. We claim that ignorance as

distribute misinformation as well as news and the problem regarding this double diffusion is the lack of epistemological tools the users have in order to distinguish what is relevant and accurate and what is not. But how did social oriented tools develop into mechanisms for sharing news and data that can also easily distribute misinformation and hoaxes as well?

First of all, on-line communities do not equally distribute the same amount of information to all their users. Ranking algorithms work under the fabric of websites in order to give out specific information to specific types of user, according to their previously manifested choices and preferences. These algorithms increase the personalization of websites, filtering the information that the users can actually access. The employment of these kinds of software was an answer to

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generally understood by analytic philosophers as a "lack of knowledge" fails to understand the employment of the term in ordinary situations. Lack of knowledge, indeed, refers to only a particular state of the ignorant cognition: the one that does not possess enough information or the right information to be considered in a "knowledge state". The problem of this definition is evident if we consider cases where all the relevant information is offered to the subject, who refuses to believe in the truthful data, or misinterprets it, or fails to understand it. Ignorance, in our definition, is not limited to the situation where the agent has not all the relevant information to gain a particular epistemic goal, but encompasses also the situations where the agents lacks the epistemic tools to recognize and employ the relevant, true, or useful information and, even if she has those data, she fails to believe in them or refuses to use them to reach her epistemic goals. The lack of epistemic tools can be included in the definition of ignorance as lack of factual or procedural knowledge to gain knowledge. In this sense, misinformation, fake data, biased beliefs, and inaccurate statements are rightfully designated as instances of ignorance: they are misinterpreted data, incomprehensible information and false statements that are not recognized as such by the agents. And in the development of the digital era, the diffusion of ignorance through social media not only affects the analysis of ignorant people, but also the proper philosophical definition of informed citizens that we should adopt.

the increasing amount of information that was distributed on-line and initially they were implemented by programmers of web search engines, with Google being the first to establish personalized filters for the searches.

Since the implementation of this feature in 2009, different people have been accessing different contents when googling the same term, depending on more or less personal information Google has stored (where the users were logging in from, what browser they were using and their browsing history, etc.) In on-line communities, when a ranking software was used in order to compact the social networks feeds into personalized frames, it affected not only the sense of social gathering that these websites promoted, but also the contents that the users shared. On Facebook, for instance, the algorithm that now implements the personalization of the default page of the site is EdgeRank, which ranks every interaction on the site. In other words, if you have more contacts with a person through Facebook or pay more attention to her profile – chatting with her, commenting her posts, liking her photos, spending time to check her profile, and so on – the more likely it is that Facebook will show you more of her updates.

This tool powers the influence of peer opinion on these websites and the sense of being part of an actual community, making preferable for users to acquire socially filtered news. Moreover, with this implementation, the users not only see the updates of all their "friendliest" friends but, given that consuming information that conforms to one's ideas is easy and pleasurable, they are more and more pushed to see them, rather than information that challenges their opinions and questions their assumptions. In this sense, it created what Eli Pariser (2011) calls a "Filter bubble," which is an extension of the confirmation bias through the means of social networks and on-line communities. The confirmation bias is the tendency to consider and accept just the information that confirms one's precedent beliefs and opinion. Through personalized on-line platforms, this

psychological fallacy is reiterated in a web-space constructed for social aggregation but developed into an information-sharing site. On the consequences of this phenomenon, Pariser wrote:

> Partisans are more likely to consume news sources that confirm their ideological beliefs. People with more education are more likely to follow political news. Therefore, people with more education can actually become mis-educated. And while this phenomenon has always been true, the filter bubble automates it. In the bubble, the proportion of content that validates what you know goes way up (Pariser, 2011, pp. 51–52).

The distinction between the proportion of what the agent sees because it is validated by many sources, and what she sees because her friends share her same opinion is no longer visible. And the visibility of this distinction is very important for how science is communicated. For example, in "The Panic Virus", the journalist Seth Mnookin argues that Andrew Wakefield, a British gastroenterologist who alleged that the measles-mumps-rubella vaccine might cause autism, was still very successful in disseminating misleading information on vaccines through social media where it garnered fame for that, even after losing his medical license (Mnookin, 2011). His fame has been spread by supporters of this argument and, through the mediation of a confirmation-driven network, it produced a sense of validation through emotional coherence for the hypotheses of concerned parents. According to a UNICEF report, the anti-vaccination sentiment is hard to take down, notwithstanding the many scientific studies that confirm that there is no connection between inoculations and the occurrence of cases of autism: the networks that spread this information are hardly penetrable to contrary opinions.

Moreover, the fact that information navigates trough social media and spreads by "homophilia" (that is the drive to like what is similar to us), makes true what Pariser (2011, p. 7) highlights: "With Google personalized for everyone, the query 'stem cells' might produce diametrically opposed results for scientists who support stem cell research and activists who oppose it. 'Proof of climate change' might turn up different results for an environmental activist and an oil company executive". Thus, the fact that the news consumption (as information receiving and sharing) is increasing on social media platforms such as Facebook and Twitter, renders this situation more and more dangerous from an epistemological perspective. Primarily because the visibility of the information does not depend on its epistemic strength, but on the popularity of a particular argument in a particular community or on the popularity of the person who shared it. As pointed out also by Oeldorf-Hirscha and Sundar:

> The key factor is that news is coming from a trusted personal source: most news links on Facebook (70%) are from friends and family rather than news organizations that individuals follow on the site (Oeldorf-Hirscha and Sundar, 2015, p. 240).

Indeed, in a social network, users play the role of what Bruns and Highfield (2012) call "produsers": which are not simply consumers of news contents nor producers, but they exhibit a hybrid role in the on-line media networks that permit them to share information created by another source as it was their own. User-generated elaborations of news and the sharing activities on the network are proven to boost the "sense of agency" of users, the feeling that the agents have some control on the information they share. And this belief may be not utterly wrong, since the important thing about a content shared on an on-line community is who shared it, not what has been shared.

In this sense, the feeling of agency and control over the information shared on on-line media can be experienced as "epistemological power" over that information in that particular community. The emergence of "produsers" gave birth also to the phenomenon of self-proclaimed experts, who are the acclaimed leaders in social driven networks. People who shared a number of posts regarding the recent discovery of gravitational waves (posts that contain fancily disguised black box arguments) may believe that they effectively know something more than those who did not. But knowing and believing to know something are two different cognitive states and, while believing is a pleasurable condition, it is also a fallible state not always recognized by the first-person perspective of the agent.

This phenomenon is at the core of shallow understanding bubbles that abound in the net, which derive from the role of produsers that users play and the black box arguments that are distributed in the on-line communities. These conditions generate forms of "epistemic bubbles".

5 The Appeal of Ignorance and the Epistemic Bubble

The entailments between the pleasure of believing to know something and the incapacity to distinguish it from the actual knowledge is the core of Woods' idea of Epistemic Bubble (2005). It describes the incapacity of distinguishing one's own ignorance from her knowledge. An epistemic bubble is a phenomenon of epistemic self-deception, by which the agent becomes unaware of the difference between knowing something and believing that she knows the same thing. It derives from the fact that believing to have some knowledge is a pleasurable condition for the individual: it permits her to act according to her beliefs and to relieve the irritation that the lack

of some important information may raise. Since the relief is experienced when the knowledge is acquired, "feeling relieved" is taken as a clue to the knowledge acquisition. Posting information on on-line community indeed provokes a sense of control and agency over it: this may cause also the delusion to have a special epistemic privilege over it, as to have acquired actual knowledge.

This can explain why there is a multiplication of self-proclaimed experts in on-line communities over a variety of topics. In order to make an example, we can speak again about the diffusion of anti-vaccine sentiments in Europe. One problem that agencies like UNICEF have to face is the diffusion of medically unqualified opinion leaders that guide the anti-vaccines crusades. They often have no college education, but they appear to have been well trained in alternative medicine. Some are just popular people of the show business, as Jenny McCarthy, who has presented herself as educated, "Internet-savvy" mother that aims to defy the medical establishment of information about vaccinations. Some often proclaim themselves as "experts" about vaccinations because of their experiences as religious authorities, political experts or "well-informed" parents: they especially present the vaccinations as religiously problematic or part of a conspiracy, also because they believe to be well informed experts on religious matters and conspiracy theories. Often, parents that proclaim themselves as experts in the correlation between vaccinations and the insurgence of autism highlight negative stories that focus on individual cases.

These cases, as religious impositions over vaccinations and conspiracy schemes, are black box arguments that delude opinion leaders into having acquired a particular knowledge over a sensible issue, without any reference to the medical understanding of the practice of vaccination. They are in epistemic bubbles that entraps them into the self-delusion of possessing relevant knowledge about an issue, without actually possessing it. On-line networks offer them the possibility of acting as competent opinion leaders: asking the networks' opinion, targeting specific

people and sharing sensible information, the users raise greater involvement in the relative content from the network and feel like they can be at the center of the movement for the vaccination control. Therefore, entrapped in epistemic bubbles, sharing black box argument and fomenting the anti-vaccine sentiments, instead, they only diffuse ignorance and misinformation in their on-line networks.

Summing up, the diffusion of black box arguments, the epistemic constraints imposed by the filter bubble, and the generation of epistemic bubbles in on-line communities can effectively distribute a variety of misinformation and hoaxes that can compromise the epistemic judgement of users and multiply phenomena of ignorance distribution. This obviously alters also the perception of the entitled "experts" in these digital environments: in this sense, it seems that the major science communication media is slowly turning the public in a confused, self-assured group of self-made experts.

6 Desultory Scientific Information

Since its massive diffusion, the Internet (and related technological devices) have been triggering a particular cluster of effects that, as a matter of fact, seem to range on two sides of the same fence. On the one hand, it empowered people to access any content, service, tool on demand, right on time, wherever one is – aspects that are generally greeted as positive advancements. On the other hand, it can be correlated with reduced attention spans and a general unwillingness to spend much effort in achieving what one is trying to get.

Bertolotti et al. (2011), analyzing the impact of the Internet on activism, suggested that one

of the main shortcomings is the "desultory" nature of Internet activism, that is mistaking actual engagement (with its costs) with one-off clicks supporting this and that cause. Desultory clicktivism can make people feel profoundly engaged, inasmuch as they sign (frequent) petitions and read Internet posts by political groups, NGO's and other organizations, but again, they do not display the kind of costly commitment implied by traditional forms of activism: for instance, there is not always a satisfactory correlation between the media resonance of a campaign and the funding the campaign actually receives.

As we already saw, a 2015 Pew research revealed that 65% of internet users use social networking websites: 63% of Twitter users and 64% of Facebook users now say each platform serves as a source for news about politics, science and technology. This means that science communication is displayed in the user's "feed" together with friends' posts, celebrity gossip, kitten gifs, advertisement and so on and so forth. This entails a twofold constraint: as we saw earlier, on the producers' side, the news must compete in relevance and in being entertaining with a lot of different content: first of all, science news has to be "new." Also, they have to be compelling, and in order to achieve this they must bypass the fact that the reader does not necessarily have the background knowledge to appreciate the content in all of its scientific accuracy, nor he is necessarily inclined to acquire it.

At this point, it seems possible to further explore the analogy with Internet- based activism: just as the latter elicits people's desire to have a positive impact on some causes they deem noble (for instance humanitarian or environmental), yet without the cost of a full-on activist engagement, so science communication relayed on the Internet answers human curiosity as for scientific matters without asking, in return, to commit to a costly scientific literacy. From this perspective, the evaluation of Internet science communication is akin to that of Internet activism: it is clearly not

an evil to be demonized, quite the opposite, it is positive to share science news just as it is positive to share information about humanitarian or environmental causes, if only because – at a relatively low cost – such activities spread commitment and knowledge. Things get awkward, though, as far as the recipients of the information are concerned: a social media user that is very keen on clic-supporting causes and sharing posts might be unable to tell his own engagement from that of an actual civic worker, or that of an activist on the field (and for instance, not feel compelled to help financially a cause, feeling that he has already done his share). Similarly, a desultory access to science communication can have negative side-effects if he things that his opinion, informed by occasional readings, is as authoritative as that of an expert that was trained in the field.

Such an evaluation must not be taken as an ivory-tower claim that the world of knowledge is black or white: either you are an expert and know and can have an opinion, or you are a layperson and should mind your business and stick to a blissful scientific ignorance. Quite the contrary, there is a most wide range of accesses to scientific knowledge, each with its own cost and merits, as long as the person who accesses them is able to take them for what they are. A 500-word long blog post on infectious diseases will give the reader some information, and it would be dangerously foolish to claim that it would be better that she did not read it at all. Still, if she watches a two-hour TV show on the same topic, she will gain a different, probably higher, knowledge on the matter. If she were to follow a series of YouTube lectures given by an intern in epidemiology, she would gain more knowledge still, as she would if she read one or more non-fiction books about infectious diseases. In some cases, a layperson could easily become an "expert" in the topic that interests her, even if that is not her professional occupation. One just needs to avoid the "epistemic populism" and be honest with oneself in accepting the self-evident truth that the level of expertise one gains is a function of what is spent on the matter in terms of time and intellectual resources.

7 Concluding Remarks

Nobel prize winner, physicist and science communicator Richard Feynman did not believe in philosophy. More specifically, he did not believe in philosophy of science. He is in fact famously reported to have quipped that philosophy of science is about as useful to scientists as ornithology is to birds.

Ornithologists cannot teach birds how to fly, and we can only speculate about the gratitude a bird may feel towards an ornithologist patching its broken wing, but ornithology is dramatically useful for birds for instance as far as conservation efforts are at stake. You might say that birds would not need conservation if men had not put their environment in jeopardy: point taken, but one has better set off from how things are, rather than how they ought to be. In an ideal Atlantis, where men can dedicate freely to science, and have all the time and resources needed to share their findings, and make sure every interested layperson gets things the way they are, then the conservationist effort of philosophy of science would be redundant.

Considering how things are, though, with scientists busy doing science or struggling for some fundings, media (public or social) trying to make an audience, and laypeople wanting to get it with the least possible effort, science might need help from philosophy of science, at least as far as its diffusion is concerned. The role philosophy of science can claim in this picture is embodied, for instance, by the stance presented in this paper. It is about fostering a minimal understanding of science communication and the trade-off between its cognitive and epistemic constraints, about recognizing the unavoidable presence of black box arguments, actually understanding how the media work and how it tampers without cognitive expectations. It also comes down to applying

the tools of critical thinking and understanding our troublesome relationship with ignorance, and the fallacious ways by which we try to avoid facing it.

This is not only good for science, and for respecting the curiosity of human beings by serving them the best epistemic product accordingly to the cognitive price they are willing to pay. This is vital because liberal democracies work on the assumption that citizens have a basic scientific literacy to help them navigate (and vote) on extremely complicated matters. A matching level of real literacy, obtained by any possible mean, is therefore a goal to achieve to make sure that democratic assumptions are not merely wishful.

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