OPINION ARTICLE

Not Communicating science? Aiming for national impact

[version 1; peer review: 1 approved with reservations, 2 not approved]

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Abstract

Communicating science to wider lay audiences is of increasing importance and is becoming an ever larger part of a scientist's remit which also offers important opportunities. We discuss here the current state of science communication in the field of the natural sciences in the UK, and the enormous improvements that could be achieved through putting more weight on objective-driven long-term initiatives, ideally in the form of interdisciplinary networks, to achieve higher impact. We describe the barriers that stand in the way of such developments and make a number of suggestions how funding organisations in particular could play a major role in overcoming these barriers.

Keywords

Science communication, funding, natural sciences

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1. **Viviane Callier**, Ronin Institute, Montclair, USA
2. **Massimo Caine**, University of Geneva, Geneva, Switzerland
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Any reports and responses or comments on the article can be found at the end of the article.

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Communicating science: importance and opportunities

From the various media outlets one could get the impression that natural sciences and engineering have never been more popular; however, is this true and, if not, do we do enough to raise awareness and encourage participation? A Public Attitudes to Science survey in the United Kingdom, conducted by Ipsos MORI in partnership with the British Science Association (Castell *et al.*, 2014), reported a clear deficit amongst the general public, with only 45% of respondents (n=1749, age >16) feeling aware of science in general and 51% stating they received too little information. A recent report led by the Wellcome Trust (TNS BMRB & PSI, 2015) found that public engagement is more firmly embedded in the context of the arts, humanities and social sciences than it is among researchers in Science, Technology, Engineering and Mathematics (STEM) subjects. Do STEM scientists communicate their science effectively? Do they miss out on important opportunities to engage lay audiences (i.e. not only non-scientists, but also those who are not particular experts in a certain field.) with their research - in spite of the fact that many funding bodies worldwide made it an obligation, over a decade ago, that researchers explain their research to lay audiences (see *e.g.* Holbrook, 2005)? In this article we will discuss our view of the current practice of science communication in the UK, focussing on the natural sciences. Here we use the term 'science communication' as an umbrella term to avoid confusion about other descriptors commonly used, such as outreach, public engagement and widening participation activities (Illingworth *et al.*, 2015). We will discuss desirable standards, barriers to improvement, and make suggestions on how to overcome these barriers. But first, we will briefly summarise why science communication is an important and worthwhile activity for scientists in general.

One of the most popular arguments for effective science communication is that the general public has a right to be informed about the scientific research which is paid for by tax money or charity funds. There is also a moral obligation to ensure that political discussions are based on sound scientific evidence. For this, active science communication can be an important means to counter existing misconceptions in the public sphere, to explain the pros and cons when scientific opinion is divided, and to promote trust in science and education policies and practices (Bubela *et al.*, 2009; Scheufele, 2014). Failing to establish effective two-way communication can result in public consensus establishing opinions that are then difficult to revert, as exemplified by the public debate on genetically modified crops and geoengineering (*e.g.* Borch & Rasmussen, 2005, *e.g.* Luokkanen *et al.*, 2014). As a more direct incentive for scientists, effective science communication can also help to raise the visibility of a subject, paving the way towards wider acceptance and generating opportunities to exert sustained influence on public opinion as well as policy makers, and to impact positively on political funding decisions (Rowe *et al.*, 2010).

As discussed elsewhere (Baram-Tsabari & Osborne, 2015), science communication and science education are two sides of the same coin, hence science communication can contribute to the improvement of science education, thus achieving a greater

understanding within a scientifically more literate and better informed public, ultimately impacting positively on society and innovation (Rull, 2014).

Science communication can also be of important professional and personal benefit to the scientists. Well-designed science communication activities can become a valuable time investment; communication with lay audiences encourages deeper thinking, by compelling researchers to find the phrases, terms and images that can help to engage diverse audiences in their science. Finding such language can have a positive impact on scientific perspectives and communication strategies towards fellow scientists, with arguments fundamental enough to convince and excite lay audiences, also powerful in presentations, publications and funding applications aimed at expert scientists (Patel & Prokop, 2015).

Finally, genuine engagement in science communication improves career opportunities inside and outside of academia. For the large number of young researchers taking up careers outside scientific research (Allen, 2010), science communication offers fantastic opportunities to transcend the academic environment by developing important transferable skills, for example didactic qualities for future teachers, or experience with production, press, marketing and audience dynamics for those wanting to work in the media. Likewise, for researchers wishing to stay in academia, the additional skills in communication, teaching, project and people management can help to make candidates stand out from their contemporaries in terms of future grant and job applications (Illingworth & Roop, 2015).

The current state: barriers and scope for improvement

The overarching long-term societal goal of science communication in the field of the natural sciences (from now on referred to simply as science) has to be to bring down barriers between scientists and lay audiences, and to improve the general understanding, appreciation of and fascination for science nationwide.

Good long-term science communication strategies have been adapted by patient interest groups and disease-specific societies who naturally have very receptive, emotionally involved audiences with personal long-term interests (*e.g.* Acquadro *et al.*, 2003; Smith, 2006). In contrast, the communication of STEM-based science subjects cannot build on these personal and emotional motivations, but must utilise curiosity, risk awareness and economic gain as means to connect to their target audiences. In order to engage meaningfully with these audiences over a long-time period, the development of co-operative, long-term strategies have a number of important advantages.

First, they allow gradual and cumulative development, including the publication of high quality activities and resources, and the implementation of evaluation strategies. Second, once visible resources are building up they can generate their own dynamics and legacy; this can then develop momentum, by inspiring other scientists from the same field to use them, which may even culminate in topic-specific science communication networks of researchers. Third,

long-term strategies make it possible to widen the scope by including a broader range of activities, target audiences and partnerships, such as science fairs, interactions with schools, public presentations of any kind, art-science collaborations, media work, involvement of science celebrities, or the use of citizen science projects (Silvertown, 2009). Fourth, long-term strategies make it possible to draw in interdisciplinary expertise. For example, artists can bring new creative dimensions and appeal, whilst the conceptual view of communication processes by social scientists can encourage a greater emphasis on two-way dialogue with target groups as a key prerequisite for strategy optimisation. Expert science communicators (from now on simply referred to as communicators) can contribute their knowledge about engagement strategies (Viseu, 2015) including formative research to guide objective setting (Davies, 2008; Nisbet & Scheufele, 2009), approaches to frame-setting and media work, and awareness of a wider range of communication and impact evaluation strategies (Bubela *et al.*, 2009; Jensen, 2014). Furthermore, expert communicators can contribute expertise in production and project management, marketing, audience dynamics, and an understanding of the specific requirements for different target audiences. Any of these collaborations will raise professional standards and impact, but clearly require a long-term approach - so that a common language can be found, allowing scientists to gain an understanding of communication strategies and, *vice versa*, giving the communicators the chance to grasp and appreciate the content and importance of the communicated science and the journey of its discovery.

But what are the barriers that might stand in the way of such long-term initiatives? First of all, kick-starting a new long-term initiative and leading it to impact is hard work that requires stamina, belief, dedication and time. Therefore, the first and most obvious barriers are lack of time, issues of self-perception (status, competence) and attitude (lack of interest, viewing outreach as subsidiary to research and university teaching), as well as a lack of measurable and externally recognised reward and recognition (Andrews *et al.*, 2005; Ecklund *et al.*, 2012). These barriers lead to the often-heard view that involvement in science communication is more damaging to careers than helpful, potentially draining initiatives that may have started with great enthusiasm (TNS BMRB & PSI, 2015).

Secondly, it is difficult to secure funding for long-term projects because, in our experience, many funding organisations focus their support on creative new ideas or attractive “one-off” events rather than successful ongoing initiatives - a policy that is not well suited to drive outreach to momentum and long-lasting impact. Furthermore, even high quality applications might be turned down not because of content but simply because the proposed implementation does not align well with the current strategy of a funding organisation.

Third, even after having developed strategies and resources, their dissemination is not trivial and can become yet another barrier. Dissemination requires an extra layer of communication which we refer to as meta-communication. Vertical meta-communication involves distributing developed ideas and resources to target audiences (*e.g.* animating teachers to use the developed educational resources). Even though established dissemination platforms

might exist (*e.g.* for school resources), they often will publish new resources only if copyright agreements are signed, which can mean that resources are withdrawn from access for further development. Horizontal meta-communication is used to recruit fellow scientists to support and contribute to a science communication initiative. However, even well established science communities often don't have the means to communicate horizontally and many fellow scientists will never hear of and/or benefit from existing ideas and resources. In our view, the barriers to meta-communication are held unnecessarily high also by tendencies of funding organisations of being too selective in providing access to their dissemination machineries, and of many science journals to give low priority to articles about science communication strategies or resources.

Finally, the possibilities for scientists to obtain training and support in science communication strategies and impact evaluation are limited (Besley & Tanner, 2011), so that valuable time is lost through learning by doing and re-inventing the wheel, rather than capitalising on well-established methods, strategies and infrastructure. Even where training is provided as continued professional development (CPD), it is not always well advertised and/or recognised by academic staff to be of value. All this said, institutions increasingly employ public engagement officers to provide support for scientists, and funders are actively demanding such provision and are often willing to consider respective support on grants. Whether this support is then efficiently capitalised on, still depends on the local institutional policies which might not necessarily be guided by in-depth understanding of the intricacies of science communication, a situation that demands better national frameworks (see below).

Improving science communication: future directions

In order to instil a solid culture of science communication and achieve a better understanding and appreciation of science, scientists themselves need to dedicate more thought to explaining the essence and importance of their own research to wider audiences, and set long-term objectives, ideally involving multi-disciplinary networks, thereby enabling them to achieve higher quality and maximised impact, as well as improved professional and personal benefit (Patel & Prokop, 2015). However, any efforts to implement good practice need to be facilitated by barrier-free and supportive environments. In our view, the most powerful means to achieve this resides in the hands of funding organisations. Here we will make a few suggestions that we believe would drive change towards an improved science communication culture:

First, an important step in instilling a culture of effective science communication would be **true collaboration across funding organisations**. A number of attempts have been made in the UK to achieve this. For example, the National Co-ordinating Centre for Public Engagement (NCCPE) was established in 2008 as part of the Beacons for Public Engagement Initiative, funded by the four UK Funding Councils, Research Councils UK and the Wellcome Trust. Unfortunately, there are no signs that this move would have led to an effective harmonisation or alignment of public engagement strategies across these organisations. The Concordat for Engaging the Public with Research signed by an impressive list of UK science funders (RCUK, 2010), has all the right intentions but stays rather vague in its statements without providing a concrete implementation

strategy. Also the science communication survey mentioned before (TNS BMRB & PSI, 2015) was a collaborative effort of UK funders of public research. Whilst providing a valuable description of the current state of public engagement, only a few conclusions were drawn within that survey, and no recommendations were made for how the current situation could be improved. In our opinion, funding organisations should take their collaboration to the next step and formulate a common strategy for improving engagement and education at the national level, based on clear, long-term objectives which aim to instil a solid, nation-wide culture of science communication and to steadily improve open resources and enhance their accessibility. Once momentum is achieved, it will be easier to sustain. Certainly, finding the right indicators to guide implementation and to measure the success of such objectives is a challenge that will need careful consideration. Perhaps government involvement is required to set the directions, extending on the code of conduct by the Council for Science and Technology, which stated the need for scientists to communicate their research to the wider society (Poliakoff & Webb, 2007).

Second, a close collaboration between funding organisations could be used to develop a **professional framework** for science communication. We need effective policies and guidelines for funders, institutions and researchers to facilitate the implementation of best practice and suitable local protocols which also consider professional reward and recognition for public engagement as a crucial motivator. The development of such a framework should be done on a national basis, and the before mentioned Concordat for Engaging the Public with Research (RCUK, 2010) would indicate that such a collaboration is feasible. However, much more would be needed to turn the principles laid out in this concordat into tangible actions. Independent bodies such as the British Science Association or the NCCPE could help as facilitators during this processes, capitalising on experiences for example from the Beacons initiative (2008 to 2012) which aimed to support, recognise, reward and build capacity for public engagement (Duncan & Manners, 2012), but failed unfortunately to leave a visible legacy. If funders, universities and independent bodies closely collaborated, this would raise our chances of developing transparent, comprehensible and effective frameworks and establish a solid culture and chartered status of science communication. Their implementation would be most effective at the institutional level, with compliance being a factor impacting on funding allocations - a procedure that has been successfully implemented by the Athena SWAN charter to address gender equality (Donald *et al.*, 2011).

Third, funders should take a **well balanced approach**. Thus, they should continue to fund new projects and initiatives, since these are an essential breeding ground for creative innovation. In parallel, funders should look out for ongoing science communication initiatives which are driven by clear, long-term vision and objectives that match the wider societal goals of raising the general appreciation and understanding of science. We need funding policies that consider sustained funding of successful initiatives, as long as they demonstrate a creative drive and clear commitment to improve their quality, momentum and impact. Such a funding strategy would align and strengthen good practice at the levels of implementers

and funders, it would also reflect sensible long-term investment into science communication, and would help to embed science communication from the outset in a meaningful and demonstrable way. We believe that a common fund for science communication, centrally 'owned' by all of the contributors and co-ordinated with appropriate representation, would be an efficient tool to facilitate the development of new and overarching funding models that align with the fundamental societal goals of improving the general understanding and appreciation of science nationwide. Although such a common fund may initially be more difficult for the individual funding bodies to justify, it would be easier to shield from organisation-specific objectives and policies and would eventually be recognised as good practice in enhancing science communication - be it inspiring newcomers to start science communication projects, or helping successful initiatives to develop towards momentum and impact. Long-term and well thought-out evaluation studies that measure this impact are also essential.

Fourth, as explained above, certain funders already **provide professional support and advice**, *e.g.* by supporting the instalment of public engagement officers, who can help scientists to develop better science communication strategies and impact evaluation practices. However, to achieve the long-term societal goals, this practice needs to become the norm and be further improved strategically. Successful examples of collaborative science communication initiatives or any other good practices need to be shared at a national level and used to develop frameworks that foster efficient local policies. As another example, social scientists and professional science communicators should be sitting on all, rather than some funding committees, so that content and strategies of proposed science communication projects can be judged equally. They could also give constructive feedback to applicants, thus actively helping them to develop more efficient communication strategies.

Fifth, funding organisations should use their capacity and influence to **facilitate meta-communication**. An immediate improvement would be to give scientists easier access to the powerful dissemination means which are nurtured by most funding organisations, including magazines and social media - and such a service should not be offered exclusively to those who were funded by a certain institution. In the long-term, we would need the implementation of a nationally recognised central Internet platform for science communication, which would also be a powerful facilitator of disseminating frameworks and policies discussed before. Furthermore, similar to the success with open access policies (*e.g.* Harnad *et al.*, 2004), funders could use their influence to change journal policies towards opening up for the publication of scientific communication articles, which would also provide an important path towards professional reward.

Finally, funders could use their capacity to **make the jungle of science communication resources nation- or even worldwide more transparent**. For example, dedicated search engines or databases would relieve all of us from time-consuming web searches and make it less likely that the wheel is constantly being re-invented. Such infrastructure could also be used to filter out the

noise produced by low quality resources and to promote the sharing of resources and strategies, for example by showcasing the value and impact of listed resources with standardised metrics and comments.

Final thoughts

This article is an opinion piece, based on the experience of two long-standing but very different personal science communication histories and backgrounds. We recognised that there is an astonishing congruence in views and experiences and were also strongly encouraged by the very positive comments from experienced and competent colleagues (see acknowledgements), and by the numerous in-depth discussions we had with them. The main purpose of this article is therefore not to assure accuracy of every claim we make, but to provoke discussion and encourage those who already follow good practice to come forward and make themselves heard. We feel passionately about the need to improve standards and to instil a solid culture of science communication; this will require re-thinking at all levels including scientist, local institutions and national funding organisations, all of which will have to collaborate and align their efforts. We hope that this article facilitates this development and captures the most important arguments and issues that will have to be discussed and considered.

Author contributions

AP and SI both contributed equally to all aspects of this article.

Competing interests

The authors declares that there are no competing interests, either financial or otherwise.

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The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

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Kathryn B. H. Clancy

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The opinions shared in this piece were undercited, vague, and not novel.

Title and abstract: The authors should consider a title that describes the take-home message of the article. They should also decide on one way of capitalizing the title (all or nothing).

Article content: The organization of this paper was not clear, and it also wasn't clear what this opinion piece was intended to do. Was this written towards funding organizations, individual scientists? What are the actionable items that might allow for a funding organization to test out some of these ideas? A conceptual model or figure would have greatly helped clarify this.

Conclusions: The authors might get more traction by developing a more concrete conceptual model with testable hypotheses. This would also help them fund the work to show if their ideas would lead to improved science literacy among the general public.

Competing Interests: No competing interests were disclosed.

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

Author Response 18 Nov 2016

Andreas Prokop, The University of Manchester, Manchester, UK

What have we changed in this version?

This version of the opinion piece has been substantially edited to make the message clearer that we are trying to communicate, i.e. the need for objective-driven, long-term science

communication in the UK. We have streamlined these arguments, and present now more coherently the potential barriers to such a vision, as well as actionable suggestions for how to overcome them. We have also changed the structure and title of the paper to be more fitting to the content, and make it much clearer from the outset that this is an opinion piece and not a research article. Please, see our detailed responses below. We look forward to our further discussion.

Response to Reviewer 1

Title and abstract: The authors should consider a title that describes the take-home message of the article. They should also decide on one way of capitalizing the title (all or nothing).

- Thank you for your comments. We take your points regarding the title, and as such have modified it accordingly.

Article content: The organization of this paper was not clear, and it also wasn't clear what this opinion piece was intended to do. Was this written towards funding organizations, individual scientists? What are the actionable items that might allow for a funding organization to test out some of these ideas? A conceptual model or figure would have greatly helped clarify this.

Conclusions: The authors might get more traction by developing a more concrete conceptual model with testable hypotheses. This would also help them fund the work to show if their ideas would lead to improved science literacy among the general public.

The opinions shared in this piece were under cited, vague, and not novel.

- Organisation and objective: The paper has been edited so that it is now much clearer in terms of its objectives, and at your suggestion we have included a list of actionable items that we believe would be of benefit to funding organisations. In relation to a conceptual model with a testable hypothesis this is, in our view, not something that would sit well in an opinion piece. However, we now present some actionable items as potential solutions to overcoming the barriers that we present. In regards to the audience of this article, please, see the next bullet point.
- Novelty and target audience: This article is less aimed at academic science communicators than at STEM scientists who engage in science communication and at funding bodies that support STEM research. The aim is not to present novel ideas (although these thoughts will be novel to most STEM scientists working at the coal-face of science communication), but to alert to shortcomings and reinforce thinking about possible actionable ways in which to improve on this, many of which are being underused now or have been thought about but were never properly implemented (see last paragraph of section 3).
- Citations and vagueness: We believe that this version of the manuscript has addressed these issues. We are much clearer in the scope of the paper (identification of problem, context for why it exists, and potential solution(s)), and are also more rigorous in our use of referencing. We have now included a paragraph providing concrete examples of long-term objective-driven initiatives. We also believe that some of the solutions that we propose are novel, and that this is now easier to see given the edit of the paper.

Competing Interests: none

Reviewer Report 09 August 2016

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Massimo Caine

Microbiology Unit, Department of Botany and Plant Biology, University of Geneva, Geneva, Switzerland

This opinion article seeks to describe standards, barriers and possible initiatives that may be relevant for the development of science communication in the UK. Even if opinions concerning a certain topic (in this case science communication) may be very wide and call into consideration several aspects of the subject, I find that the manuscript lacks a clear focus, which, in turn, makes the flow of the text very hard to follow.

In particular, in the initial part of the manuscript, authors state that they “will discuss the current practice of science communication in the UK”. However, despite a very general description of the relevance of science communication practice for (i) policy making; (ii) education; (iii) scientific networking and (iv) professional development, there is a substantial lack of any description of experience, best practice, event or initiative that may have taken place in the UK. Again, when describing the several barriers that hamper a proper diffusion and development of science communication, the observations are rather general, superficial and seemingly not focused on the UK scenario (at least this is the perception I have as non-UK reader). Consequently, the suggestions on how to overcome such barriers are extremely hard to be contextualized within and they seem to me rather focused on funding agencies and their policies rather than on the good practice/development of science communication.

In light of that, despite the good will that authors put in place for the cause of science communication, I regret to say that I cannot recommend this opinion article to be indexed as it is.

Competing Interests: No competing interests were disclosed.

I confirm that I have read this submission and believe that I have an appropriate level of expertise to state that I do not consider it to be of an acceptable scientific standard, for reasons outlined above.

Author Response 18 Nov 2016

Andreas Prokop, The University of Manchester, Manchester, UK

What have we changed in this version?

This version of the opinion piece has been substantially edited to make the message clearer that we are trying to communicate, i.e. the need for objective-driven, long-term science communication in the UK. We have streamlined these arguments, and present now more coherently the potential barriers to such a vision, as well as actionable suggestions for how to overcome them. We have also changed the structure and title of the paper to be more fitting to the content, and make it much clearer from the outset that this is an opinion piece and not a research article. Please, see our detailed responses below. We look forward to our further discussion.

Response to Reviewer 2

This opinion article seeks to describe standards, barriers and possible initiatives that may be relevant for the development of science communication in the UK. Even if opinions concerning a certain topic (in this case science communication) may be very wide and call into consideration several aspects of the subject, I find that the manuscript lacks a clear focus, which, in turn, makes the flow of the text very hard to follow.

- Thank you for your comments. As explained in our response to Reviewer 1, we concede that the central thesis may not have come across clearly enough. We have now re-focussed and edited the paper, and we hope that we make the main objective much clearer, i.e. that there is a problem (a lack of long-term, objective-led science communication), why this problem exists, and some suggested solutions for how we might best tackle this problem.

In particular, in the initial part of the manuscript, authors state that they “will discuss the current practice of science communication in the UK”. However, despite a very general description of the relevance of science communication practice for (i) policy making; (ii) education; (iii) scientific networking and (iv) professional development, there is a substantial lack of any description of experience, best practice, event or initiative that may have taken place in the UK.

- We agree that the statement about general practice did not match well with the material provided, and it has been removed. To provide concrete descriptions of good practice, we have added a whole paragraph on objective-driven long-term initiatives that are existing in the UK and beyond.

Again, when describing the several barriers that hamper a proper diffusion and development of science communication, the observations are rather general, superficial and seemingly not focused on the UK scenario (at least this is the perception I have as non-UK reader). Consequently, the suggestions on how to overcome such barriers are extremely hard to be contextualized within and they seem to me rather focused on funding agencies and their policies rather than on the good practice/development of science communication.

- To address the critique that comments and opinions that we expressed are too general and potentially over-reaching, we have tightened these up significantly and provide now a more rigorous justification for their inclusion. However, we have still chosen to focus on the role that funding agencies and their policies play, because we believe that they are in the best position to lower barriers and facilitate effective science communication.

Competing Interests: none

Reviewer Report 04 August 2016

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Viviane Callier

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I found the article to be written in vague, abstract terms, making it difficult to extract any take-home message. The problem that was to be solved wasn't clearly articulated, nor was the proposed "solution" clear to me. I found the article to be a poor example of science communication.

Competing Interests: No competing interests were disclosed.

I confirm that I have read this submission and believe that I have an appropriate level of expertise to state that I do not consider it to be of an acceptable scientific standard, for reasons outlined above.

Author Response 18 Nov 2016

Andreas Prokop, The University of Manchester, Manchester, UK

What have we changed in this version?

This version of the opinion piece has been substantially edited to make the message clearer that we are trying to communicate, i.e. the need for objective-driven, long-term science communication in the UK. We have streamlined these arguments, and present now more coherently the potential barriers to such a vision, as well as actionable suggestions for how to overcome them. We have also changed the structure and title of the paper to be more fitting to the content, and make it much clearer from the outset that this is an opinion piece and not a research article. Please, see our detailed responses below. We look forward to our

further discussion.

Response to Reviewer 3

I found the article to be written in vague, abstract terms, making it difficult to extract any take-home message. The problem that was to be solved wasn't clearly articulated, nor was the proposed "solution" clear to me. I found the article to be a poor example of science communication.

- The brevity of this comment makes it difficult to respond to and engage with in a detailed manner. However, we take the point that there were aspects of the opinion piece that were vague, and have addressed this thoroughly, as was explained above. We hope that the new version of the article now clearly describes the problem and the potential solution(s).
- If this is not the case, then we would like to ask the reviewer to please be a little bit more constructive in their criticism, so that we can improve the manuscript further.

Competing Interests: none

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