Comment

Supplementary information to:

Five rules for evidence communication

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Supplementary Materials

Evidence Communication: A different way to communicate science

(This is an expanded version of the main article: Five rules for evidence communication).

Researchers are often taught how to be persuasive, with advice such as: tell a good story, be clear and unambiguous, aim for only one take-home message.

It's good advice... if persuasion is indeed the aim. But these techniques come almost entirely from marketing and rhetoric, and should be applied directly to science only with care.

Science is not a product to be sold. Scientific findings change constantly. They come with considerable uncertainties. Decisions based on them - taken, for example, by policy-makers or patients - are often subtle and multi-faceted and not easily boiled down to simple, sellable answers. They often have knotty implications: economic, environmental, health and social; and incorporate personal or subjective values and difficult trade-offs (such as weighing up economic costs against health benefits, quality of life over risk of death, environmental costs against societal benefits). When presenting scientific findings, therefore, there is a case for a different type of communication - one that we call 'evidence communication'.

Before elaborating, let's recognise that in a communications arms-race, the techniques of persuasion often win out. Those who use every trick in the communication handbook are more likely to change hearts and minds or grab attention. We also recognise that all researchers are "partisan advocates of the validity and importance of their work" according to a recent study of the sociology of science[1]. But we need only look to academic publishing and the replication crisis to see how incentives to sell ourselves and our ideas can go wrong. A world in which science communication is at the mercy of rhetorical wrangling is a dangerous one. Like a juggernaut heading over the crest of a hill, we need brakes, or we risk a crash in public trust. Therefore, we propose a form of brake-testing, or critical reflexivity: a set of questions to ask yourself as you embark on any kind of scientific communication.

1. **Ethos**: **What principles guide your communication?**

   What is your personal ethical standpoint? What are the red lines that you will not cross?

It's easy to say that we would like to be trusted, but as the philosopher of trust Onora O'Neill[2] points out, the real aim should be to demonstrate trustworthiness: 'trustworthiness' is now the first pillar of the Code of Practice for Official Statistics for England and Wales. This means we need to reflect on our own integrity and authenticity, consider specific ethical principles and, crucially, be honest with

ourselves. Our audiences are acutely attuned to our motives and ethics, which means that we must be too.

Many professional organisations have guidelines outlining robust ethical principles. We suggest that now is a good time to reflect on them, and put them at the heart of what we say, with the aim of increasing both the trustworthiness of - and thereby trust in - the communication of scientific evidence.

2. Aims: What are the specific aims of your communication?

Be clear about your objectives, in particular where they lie on the spectrum from information to overt persuasion.

For many researchers, for example those advising governments, courts or patients, the aim is explicitly to provide clear information that will empower people to make decisions that allow them to feel that they were at least properly informed, even if with hindsight the decision doesn't turn out well for them.

For example, the ethics of informed consent in medical care require that a decision be voluntary, informed, and made by someone with capacity, and many codes of conduct for medical professionals explicitly state that although a doctor can express an opinion about treatment options they must give their reasons for doing so and cannot put pressure on a patient to accept their advice.

Similarly, the duty of an expert witness in court is to provide "unbiased and objective" evidence. They are also allowed to give an opinion, but must justify it and stay within their sphere of expertise. Their role is not to form a case or persuade others.

In the pharmaceutical industry, codes of practice, like that of the Prescription Medicines Code of Practice Authority in the UK, are carefully designed to separate research reporting from marketing and guide what is allowed in each.

Others researchers, however, might aim to change behaviour or beliefs, for example those producing public health messages. They may decide that it is within their ethos to encourage their audiences towards a 'preferred option' (justified, say, through scientific consensus, or reasonable professional judgement, and in the best interests of most well-informed citizens).

Naturally, the distinction between 'inform' and 'persuade' is not always clear-cut. For example, a researcher may want to persuade audiences to take notice of the evidence by making it vivid and engaging, but not necessarily to take a particular course of action. They may also want to persuade their audiences of the credibility of the evidence. These can all be legitimate aims.

What matters is that we are aware that we have choices in the way that we communicate - and that we make them consciously. It can help to think of these on a spectrum from *informing* to *persuading.* At the 'inform' end, we might begin with:

a) Encouraging engagement with the idea that there is a decision to be made, and improving understanding about alternative options.
b) Correcting misunderstandings about scientific knowledge.

Moving along the spectrum towards 'persuade' might entail:

c) Changing attitudes towards the 'preferred option'
d) Changing intended or actual behaviour by choosing the 'preferred option'.
e) Issuing instructions for action, possibly with legal sanctions, such as evacuation or mandatory lockdown.

We reiterate that a choice to move along the spectrum should be overt and conscious. For those who feel that their role is one of advocacy - maybe by raising the profile of an issue, or raising funding for their research or research field, or for a particular policy - it will be important to ask if these opinions or preferences arise entirely from study of the evidence, or through an intersection of values or beliefs with evidence (eg. the relative importance of major considerations such as environment and wildlife, poverty, inequality, health, education), and not to blur the lines between these motivations, which should be clearly communicated and justified.

3. Who: Who are your target audiences?

Listen to your audiences' concerns, understand their priorities and their prior beliefs. How have they come to hold particular views and why?

The economist Anand Menon once spoke in northern England about the potential costs of the UK's exit from the European Union in terms of UK Gross Domestic Product (GDP). A woman famously shouted: "That's your bloody GDP, not ours." A national average statistic was not, for a region that had already been disproportionately disadvantaged, appropriate evidence to justify a policy.

Understanding our audiences is the only way to serve them. If you are truly trying to inform people, you need to know what they already understand or misunderstand; what decisions they might be making; and what information - in what format - would best support that decision. For example, doctors on a ward with limited wifi might need information about the potential benefits and harms of different treatments in a simple numerical table in an app that does not require a constant internet connection.

Trying to find opportunities for dialogue is the best way to be able to understand audiences better: citizen assemblies, user-centred design, co-production - different fields have developed different ways to listen to and be guided by their audience.

4. What: What to communicate?

Persuasive communication often omits some information in order to favour a point of view. But take care this is compatible with your ethos and professional guidelines. If your aim is to inform, there are four things to ensure:

Balanced treatment of potential harms and benefits

Faced with a personal decision, such as a medical treatment or a personal financial decision, the benefits and harms may be relatively easy to define and describe. Where this is the case, there's a strong and obvious obligation to communicate both sides. As the ramifications of the decision grow to affect others - such as in the case of vaccination or a lock-down policy - they become harder to quantify and communicate. Policies will generally have winners and losers: electric cars may benefit the environment for some, but obtaining the lithium for the batteries may harm others[3].

Note too that just because there are multiple sides to arguments does not mean that each has equal weight. Similarly, just because a decision may seem obvious does not mean that counter-arguments or evidence shouldn't be presented: leaving out information can undermine trust.

Completeness of the summary of the evidence

Short of deliberate falsehood, selective presentation of evidence is the easiest way to make a persuasive argument. Take a study claiming "dramatic rates of decline that may lead to the extinction of 40% of the world's insect species over the next few decades"[4]. But the authors had explicitly searched only for papers that mentioned a decline: "We performed a search on the online Web of Science database using the keywords [insect*] AND [declin*] AND [survey], which resulted in a total of 653 publications." What they did not say was that a similar Web of Science search for [insect] AND [survey] AND [increa*] would have resulted in 2,345 publications.

Trustworthy evidence communication, by contrast, is as complete as possible. Of course, this raises dilemmas. The implications of some decisions, especially around policies, may be long-term, highly uncertain, and affect different subgroups differently. Here the communication challenges are acute: where does one draw the line when it comes to the implications of, say, lockdown during a pandemic? It might affect the health and livelihoods of many sub-groups within the country very differently, affect the economy not just of the country being locked down but of many other nations, affect regional and global environments, and the lives of individuals around the world who would expect to travel and trade with that country.

With so much information to consider, how much is too much - for the audience and for any decisions that they need to make? There is no easy answer, and the solution can only be found through research with the audience in question - something that can be difficult in a fast-moving situation - inevitably leaving the researcher to make more subjective decisions.

Ensure you are giving people the information they need

The information that your audience wants may not be the easiest to measure. For example, mortality is a lot easier to quantify than quality of life, and yet many people are more interested in extending the quality of their life than its length. 'Secondary'

measures may also be of prime importance to the audience, such as the likelihood and severity of side effects of a medical treatment. Some outcome measures of interest to the audience may not be obvious, or seem unimportant to the researchers, but ignoring people's wishes is not only paternalistic but could cause the audience to lose interest or lose trust, and suspect your motives.

Asking the audience about their information wants, however, does not mean giving them only what they ask for. Sometimes, there will be information they're unaware of, but which they will need to reach an informed decision or opinion. This is the responsibility of the researcher and will, once again, inevitably be subjective.

Be upfront and unapologetic about uncertainties

If you are trying to inform, rather than persuade, it's important to admit when you don't know – not just about the future, but about facts and numbers in the past and present. Even at the best of times, the world is seldom understandable or knowable with a high degree of certainty, and the scientific process acknowledges this. So should our communication. Giving an unrealistic portrayal of certainty could make later changes seem unexpected and undermine trust.

True, decision-making is harder when information we rely on is uncertain. However, trying to make the decision-making process subjectively easier in the short term by ignoring those uncertainties can lead information to be inappropriately weighted.

If you are communicating to persuade - for example, in the case of emergency calls-to-action - then omitting uncertainty can be entirely justified: you are not expecting people to make a decision based on the information in the communication, merely to obey it. It is perhaps the line between emergency, persuasive messaging and informative messaging that has become troublingly blurred in the case of COVID-19. Where should the requirement for 'blind faith' in a policy end, and the requirement for transparency in the evidence informing a policy begin?

Many fear admitting limitations in their knowledge. This could be motivated by concern for personal status, or by perceptions of the need to appear confident, or because of the fear that uncertainty can undermine trust or even be weaponised (by so-called 'Merchants of Doubt'[5]).

Research suggests that confident communication of uncertainty need not reduce trust - neither in the information itself, nor those who produce and communicate the data[5]. Thus for informative communication, uncertainty should be communicated as precisely and confidently as possible. This applies both to the direct uncertainty of an estimate (eg confidence intervals), and to the indirect uncertainty due to the limitations in the underlying evidence used to produce the estimates. The latter can expressed as caveats, or perhaps better as an explicit rating of the quality of evidence, such as the GRADE system widely used in healthcare, or the 'padlocks' used by the Educational Endowment Foundation to indicate the quality of the evidence underlying claims about the effectiveness of different educational interventions.

Audiences are sensitive to cues of low quality evidence and (rightly) adjust their trust accordingly.

‘Innoculate’ against misinformation

The Covid pandemic has been a fertile breeding ground for misinformation, which continues to build on a long-standing movement that sows mistrust of vaccines. Having carefully listened to the concerns of audiences, communicators should be well-placed to pre-emptively counter, or ‘pre-bunk’, clear misunderstandings about the evidence, and not just wait to respond to campaigns on social media and elsewhere.

5. When: When to communicate?

When does your audience need information? When is their decision? Giving people information that is not strictly relevant now, can make it more difficult for them to understand what they DO need to know. But consider the ethics and implications of NOT sharing information.

Since the 2009 earthquake in L’Aquila, seismologists have been acutely aware of the troublesome ethics around disclosure of scientific knowledge when there are huge uncertainties. Now, the same problems are being faced by a broad range of researchers whose expertise may have a bearing on the understanding of COVID-19.

Those making decisions or forming opinions need information then and there, regardless of the state of knowledge at that particular point in time.

The most accurate answer in the face of questioning could be simply ‘I do not know, because…’. If we truly do not know, we should not be afraid to say so.

Because people have limited ability to absorb information, it can sometimes help to communicate bit by bit. However, this could potentially undermine trust if you are suspected of withholding information or patronising your audience. So the ideal, as outlined by Professor John Krebs after his experience of leading a UK government agency through several scientific crises, is to make information available in a manner that allows people to view it at a time of their choosing - whilst making it clear what an example path and timeline through it might be[6]: Krebs’ check-list for trustworthy communication in a crisis says you should tell people -

1. What you know - *knowledge*
2. What you don’t know - *uncertainty*
3. What you are doing to find out - *plans*
4. What they can do in the meantime to be on the safe side - *self-efficacy*
5. That advice will change - *flexibility*

For example, at a press conference he admitted that the FSA did not know whether BSE had got into sheep, but said they were developing a diagnostic test for scrapie

and BSE prions in sheep. In the meantime they were not advising people to stop eating lamb but, if worried, “change your diet, and we shall get back to you”. There was no panic[7].

6. How: How best to communicate your information?

Different ways of presenting the same information can give a very different impression. To achieve balance, use a range of formats and a carefully-designed layout with both a top line summary and deeper layers of information for those who wish to know more.

The appearance and ‘feel’ of the information is vital, whether printed, online or in person. Extensive research has shown that different presentations of essentially the same information can have very different effects on the audience, whether that be graphical *vs* text or positive *vs* negative framing as well as a multitude of other presentational differences. For example, a simple change from a ‘2% death rate’ to ‘98% survival rate’ can make a medical intervention seem safer.

In order to try to minimise such biases, it is best to use multiple media, frames, and formats, including text, numbers and graphics when possible, such as providing both survival and mortality rates. Of course, for communications with persuasive intent, framing can be a very effective means of manipulating your audiences’ opinions, for example by cutting the axis of a graph to make differences look more important than they are.

Choice of media is important. There is the traditional paper report, of course, but online gives more flexibility to format. However, in order to reach your audiences you may have to use other media, such as podcasts, broadcasts or in-person meetings.

Use clear lay language, avoiding jargon and terms which can be interpreted differently by people with different backgrounds (eg. ‘significant’, ‘unexpected’, ‘highly unlikely’ or other verbal equivalents for numbers, which research suggests can prompt widely different understanding[8].

Don’t underestimate the importance of good visual design which can make information much easier to comprehend and remember. That can be in the form of clearly labelled headings bringing qualitative information together under the questions that are key for the audience (eg. on medical test results forms), or in tabular form. Research has consistently shown that making a table to show potential benefits and harms of different options makes them easier to understand and remember, at least when tested in a medical context[9].

Finally, use a carefully-designed layout in a clear order, with deeper layers for those who wish to drill down - right to the data and analysis code where possible.

7. Evaluate: Are you achieving your aims, within your ethos?

For those aiming for behaviour change, evaluation can be relatively easy, as behaviour (or at least intention to change) is often measurable. It's harder to measure the extent to which someone has been 'informed', but there are a variety of scales available, particularly within healthcare[10]. In either case, it is wise to check whether your proposed communication conforms to your ethos before releasing it. O'Neill's criteria for 'intelligent information' are worth applying[11]: test whether your material is

- *accessible* to audiences,
- *intelligible* to as many as possible,
- *useable* to answer their concerns, and
- *assessable* by those who wish to check your working.

Communication rules might not generalise: if at all feasible, test your particular information with your particular audiences (or at least with a diverse bunch of friends willing to take your last-minute phone call or email). This allows you to check for (and therefore avoid or pre-empt) unforeseen misunderstandings.

Finally, remember to consider potential harms of providing information: have you given your audiences enough caveats if they want to avoid potentially disturbing information which they don't absolutely need to know (eg. public discovering their own risk of death from COVID-19), and about the uncertainties of the knowledge?

Postscript: How can professional practice in risk and evidence communication and public critique of such information be improved?

During the coronavirus pandemic (and 'infodemic') the problem of poor evidence communication has been writ large, with questions about whether science can be trusted, and confusion about what science is or means. There may also be evidence of a corresponding turn towards uncritical thinking - whether around unproven medical interventions, conspiracy theories, or poor-quality scientific pre-prints and papers. We should reflect honestly on the part played in these failures by over-confidence, dogmatism, a lack of humility about the boundaries of our knowledge, a lack of transparency about conflicts of interest and motives, the tendency to assert false dichotomies rather than recognise shades of grey[12], an 'us and them' and 'information deficit model' of communication, politicisation, motivated reasoning, and so on.

These issues are not new to the pandemic: they are as evident in everyday policy-making, in court decisions, and in medicine as they are in the current crisis, and ironically we had drafted this manuscript in January this year.

We agree with those who argue that researchers need 'reflexive subjectivity'[13] - a willingness to reflect continually on their roles as scientific investigators - and to avoid the uncritical assumption that they are simply being objective. We also believe there is a clear need for education for those dealing with scientific material of all kinds that goes beyond what has become known as 'science communication': this is not about how to 'tell a clear story' in a way that engages, this is about how to

communicate complexities, uncertainties, and tell as much of the whole truth as possible, in a timely and ethical manner.

Often, professional science journalists are better at this than scientists, and many have walked difficult paths reporting the pandemic. It's worth recognising that they have often been trained to do it, and that regulation helps them withstand the pressure of market forces. Science should not be surprised if it requires similar support.

To improve the ability of audiences to critique what they hear, we need education at all levels to identify issues with claims based on data, whether in schools or professions. The encouragement of fact-checking organisations alongside public recognition and celebration of accurate, impartial communications - a clear separation of information and opinion - would help.

But ultimately, scientific researchers hold the key and the main responsibility. We in science can choose to research and incentivise good, clear and ethical communication above popularity and unwarranted simplicity. We can ask ourselves these seven questions. Fail, and the dangers are becoming all too clear.

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