Commentary

P | U | S

Public Understanding of Science
1–8

DOI: 10.1177/0963662517711058
journals.sagepub.com/home/pus
SAGE

The problems of increasing transparency on uncertainty

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Abstract

Public regulators (such as European Food Safety Authority, European Medicines Agency, and European Centre for Disease Prevention and Control) are placing increasing demands on scientists to make uncertainties about their evidence transparent to the public. The stated goal is utilitarian, to inform and empower the public and ensure the accountability of policy and decision-making around the use of scientific evidence. However, it is questionable what constitutes uncertainty around the evidence on any given topic, and, while the goal is laudable, we argue the drive to increase transparency on uncertainty of the scientific process specifically does more harm than good, and may not serve the interests of those intended. While highlighting some of the practical implications of making uncertainties transparent using current guidelines, the aim is to discuss what could be done to make it worthwhile for both public and scientists.

Keywords

public knowledge, regulators, scientific practices, transparency, uncertainty

'That's another thing we've learned from your Nation', said Mein Herr, 'map-making. But we've carried it much further than you. What do *you* consider the *largest* map that would be really useful?'
About six inches to the mile.
'Only *six inches*!' exclaimed Mein Herr. 'We very soon got to six yards to the mile. Then we tried a *hundred* yards to the mile. And then came the grandest idea of all! We actually made a map of the country, on the scale of a *mile to the mile*!'
'Have you used it much?' I enquired.

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> 'It has never been spread out, yet', said Mein Herr: 'the farmers objected: they said it would cover the whole country, and shut out the sunlight! So we now use the country itself, as its own map, and I assure you it does nearly as well'.
>
> Lewis Carroll (1894)

In this humorous excerpt from Lewis Carroll's book 'Sylvie and Bruno Concluded' an ever increasing desire for map making precision took the object further away from its intended function to the point that it was rendered useless. This is an exaggerated illustration of two critical points that this piece will focus on. First, that if we imagine scientists supporting policy- and regulatory decision-making are the map makers in the story, then they potentially face many impracticalities in response to the regulator's demands for ever more transparency on uncertainty in the steps of scientific research. Second, that in seeking to be ever more transparent about uncertainty at every step of the scientific process, it instead serves only to obscure the conclusions and seed unwarranted doubt in public perceptions. In the above example, the public are the map users. The more that uncertainty around evidence is elucidated to them, the harder it is to understand what to do with the evidence. While we agree on the need for scientific uncertainties to be communicated where they exist, the demand for the detailed information currently required by regulators encumbers the scientist and obfuscates rather than empowers the public. We address two questions. Where does the need for transparency in uncertainties in scientific decision-making come from? Whose interest is it designed to serve? In answering these questions, this piece examines the implications of scientists making uncertainties around their evidence more transparent, and considers what needs to be done to make transparency worthwhile.

1. Initiatives for greater transparency, where did it all start?

Moves toward greater transparency in information for public consumption reflects shifts in political, social and cultural attitudes (Meijer, 2009). Some commentators have proposed that the political origins came with the establishment of Freedom of Information (FOI) laws (Berliner, 2014) granting public access to private data, and now found in over 80 countries and many of which came into force since the 1990s; we pick up this point again later. Others have claimed that increasing demands for access to data from institutions is the consequence of the growing availability and use of data on the Internet (Margetts, 2011). Increasing data accessibility gives further impetus to the need for even greater transparency. However, it has been suggested that increasing transparency does not necessarily increase trust in the judgment of public officials and public institutions (De Vries and Sobis, 2016). Trust in experts has declined in recent years, though trust in scientists is much higher than in public officials and has remained fairly stable over time (Gauchat, 2012; Ipsos MORI, 2016).

Scientists are called upon to conduct research by public bodies to help guide policy decisions (Löfstedt and Bouder, in press; Van Asselt and Vos, 2008), and the demand for making transparent the uncertainties around scientific evidence can be traced to reforms around regulatory decision-making. The European Commission underwent significant reform between 2000 and 2004 in response to growing political concerns around administrative ethics, and during that period the European Transparency initiative was born (Cini, 2008). The initiative was initially inwardly focused on improving ethical standards and integrity in European Union (EU) institutions, but subsequently impacted regulatory agencies such as European Food Safety Authority (EFSA) and European Medicines Agency (EMA). These agencies have produced guidance documents for scientists on a whole range of areas surrounding uncertainty, notably on how to analyse and communicate uncertainties in assessment of food standards (Löfstedt and Bouder, in press) among others.

2. How does one make uncertainties around scientific evidence transparent?

Demands for greater transparency have triggered initiatives that encourage scientists to conduct structured uncertainty analyses (Bouder et al., 2015; Gupta, 2010; Gupta and Mason, 2016; Reffstrup et al., 2010; Rozet et al., 2007; Speigelhalter and Riesch, 2011; Webster et al., 2003) which regulatory bodies make accessible on their websites without the need for FOI requests. Here, we refer to uncertainty (epistemic) following Knight's (1921/2006) distinction between that and risk. In the latter case, outcomes can be fully specified and probabilities assigned to each, and in the former case, the probabilities are not known, and in extreme cases, it may not be possible to fully specify the outcomes (Meder et al., 2013). To make things practicable, a sleight of hand is made, to operate 'as if' it is possible to assign numerical probabilities to every conceivable outcome, thus converting an uncertain scenario into a risky one. The relevance of uncertainties then becomes an issue of the basis on which the probabilities are assigned to various outcomes (e.g. the probability of a toxic substance in food causing harm over a given time period). Regulatory bodies such as the EFSA recommend that information of this kind should be made publicly available.

Any scientific endeavour involves factors limiting the conclusions because of pressures on time and resources, as well as knowledge that was either unavailable or unknowable at the time of testing, not to mention ontological issues regarding the nature of knowledge itself. Though not new (Morgan et al., 1992), uncertainty analyses are frequently now compulsory in work for regulatory bodies like the EFSA, the form of which is quite prescribed. Not only must the findings from the experiments be made transparent, but so must the uncertainties at *each stage* of conducting a scientific experiment. The EFSA guidance document lists six main steps a scientist should undertake when setting up an experiment in support of urgent policy responses: (1) identifying uncertainties, (2) describing uncertainties, (3) assessing individual sources of uncertainty, (4) assessing the overall impact of all identified uncertainties on the assessment output, taking account of dependencies, (5) assessing the relative contribution of individual uncertainties to overall uncertainty, and (6) documenting and reporting the uncertainty analysis (EFSA, 2016).

What does this type of analysis look like in practice? The document presents a test case to show how uncertainty analyses could be implemented. When, in 2008, the European Commission requested urgent advice on the potentially negative health effects of the presence of melamine in food stuffs, especially those containing milk products imported from China, EFSA asked scientists to examine worst case scenarios for exposure to the substance. A recommendation on the matter was needed within 5 days of initiation of the study. Inevitably there were limits on what factors were included in the scientific assessment that contributed to the EFSA's subsequent published guidance statement.

The challenges facing the scientists were multiple. They were working to an extreme deadline, and the outcome of their findings was highly consequential. They did not possess all the data with which to conduct a full set of tests, which also presented limits on what could be concluded. Some of the limiting factors they identified when preparing the report included the absence of data on actual levels of melamine in powdered milk and data on consumption of Chinese chocolate (which contains whole milk solids), and there were no established figures of the toxicity of melamine or tolerable daily intake (TDI). Nevertheless, practical solutions were found for these limiting factors, and the scientists drew appropriately qualified conclusions.

Structured uncertainty analyses in this case required documentation of procedures in data gathering and analysis – which in and of themselves involve estimates of uncertainty around the likelihood/confidence in the findings; furthermore, provision of estimates of uncertainty around what scientists did not know at the time and how that might impact their conclusions, in addition to

description of individual aspects of what they did not know and how these uncertainties might each impact conclusions (Osman, in press). This raises several problems. Describing what one does not know around specific pieces of evidence is difficult enough, but attaching this description to a probability scale or a colour code from red (being highly speculative), through amber, to green (being highly certain) is artificial and subjective. It remains to be established empirically what the best form of presentation of probabilities ought to be in the context of such uncertainty analyses, for the reason that in different contexts different representational formats might be easier to interpret than others, regardless of expertise of the audience (Spiegelhalter and Riesch, 2011) and it will be important to investigate this in future work.

Assuming, however, that the current form of EFSA analyses are meaningful, there exists no benchmark of comparison, so they represent merely a subjective judgment about how unsure scientists are about aspects of the research, using a frame of communication not chosen by the scientists themselves. Of course, such subjective judgments could be liable to many biases, not least because certainty is rewarded over uncertainty (Post and Maier, 2016). Indeed, except when it is drawn upon as a motivator for new research, uncertainty will be downplayed by scientists (Peters and Dunwoody, 2016), and for the obvious reason of not casting doubt upon their own work.

Aside from the biases affecting scientists, biases can occur in policy makers' interpretations of the analyses, not to mention in journalistic communication (an area receiving recent attention in the literature) (see Guenther and Ruhrmann, 2016; Kohl et al., 2015; Lehmkuhl and Peters, 2016; Simmerling and Janich, 2015). Once evidence is generated with accompanying uncertainty analyses, both must be considered by the decision makers that requested them. The interpretations of the evidence alongside uncertainty estimates are susceptible to what is known as the *uncertainty paradox* (Van Asselt and Vos, 2005). Policy makers, risk managers and regulators show uncertainty intolerance and tend to communicate certitude around their decisions. Uncertainty expressed by the scientists, therefore, is transposed and repackaged to convey certainty (Van Asselt and Vos, 2008; Verdonck et al., 2007). This would be akin to a prosecutor asking an eye-witness to give evidence about a crime and how unsure they are that they witnessed the crime, and then reframing the evidence in terms of surety that the crime was committed, thus leading to biased jury decisions.

Scientists have a duty to communicate evidence as accurately as possible, but the processes described here reveal two levels of distortion. First, by conducting uncertainty analyses, scientists might be biased towards downplaying uncertainty in their evidence (Post and Maier, 2016), and which could lead to a distortion in the conclusions that are drawn. Second, decision makers are concerned primarily about certainties in order to make clear decisions, so even if the uncertainty analyses provided by scientists are accurate, they are distorted for the sake of promoting certainty in the conclusions of the decision makers. If such uncertainty estimates are at best meaningless and at worst reframed into certainties they may not serve purpose.

3. Whose interest does transparency of uncertainties around scientific evidence serve?

Assuming the many practical problems of carrying out uncertainty analyses are eradicated, what form should the analyses take? Many experts and policy makers struggle to adequately grasp basic concepts around uncertainty analyses (Pappenberger and Beven, 2006), and for the public to derive a clear understanding they cannot appear in raw form. What is needed is a translation into a type of confidence level in the evidence which expert and non-expert alike can interpret (Löfstedt and Bouder, in press) and that feels natural for the scientists. Who should be responsible for translating the details of uncertainty analyses to the public? Thus far, the outcomes of uncertainty analyses are primarily for the benefit of regulatory agencies like the EFSA, and it would seem to be the job of

the regulators to provide this. If they have an uncertainty bar by which they assess an acceptable level of uncertainty around a piece of evidence, and which they use to form a decision on policy and guidance, then they should make the information transparent.

It is not only important to think about the form that details of uncertainty analyses should take, but also what function they serve (Gupta, 2010). Scientific literacy among the public varies (Sinatra et al., 2014), and the public is not a homogenous group with the same values, beliefs and attitudes. Moreover, technical information is often, though not always, filtered through journalists. If we look to FOIs, it has often been journalists who have exposed key details from complicated and lengthy documents (e.g. MP expenses). As yet, there is no gage of public appetite for uncertainty analyses, which requires examination of exactly how often access requests are made. This should be an important focus for future research to determine the optimal way of communicating uncertainty analyses. If there is no demand for such information, then the process of producing these onerous and potentially problematic data should change. This is not a criticism of transparency of uncertainty per se, but of the current methods demanded. There exists no empirical examination of the reliability and impact of the kinds of data now required by regulatory bodies, and their encumbrance seems unjustified especially if the data are not being accessed by the public. If these structured uncertainty analyses are only used by decision makers within regulatory bodies and governments to aid their decisions, then it is perhaps transparency of how they make those decisions that is of most use to the public and not subjective assessments of uncertainty at each step of the scientific process. It may be that the public see their regulatory agencies, like their politicians, as exercising their judgment by proxy. They expect that decision makers show good judgment on their behalf. When things go wrong, they expect a clear chain of responsibility and transparency in the decision-making process. The policy makers are also responsible for choosing where to gain evidence on which they base decisions, that is, they choose and appoint the scientists. Ultimate accountability must lie with their processes and judgments, and, as surveys suggest (Ipsos MORI, 2016), the public already show much greater trust in scientists than in public institutions, so greater transparency is perhaps more urgently needed here.

Further missing from current knowledge is an appreciation of how the existing information is used by the public (Bouder et al., 2015; Gupta, 2010; Haufler, 2010). Some types of self-raised uncertainty, such as ethical concerns, do not appear to detract from trust in the source (Hendriks et al., 2016). There is also research showing that the public are capable of handling scientific evidence that carries discourse-based caveats and hedges, and that people place greater trust in scientists and journalists when such doubts are communicated (Jensen, 2008). Further evidence is needed to examine the extent to which these findings are context specific (i.e. public acceptance levels of doubt are higher for scientific evidence in which the limitations are expected, i.e. finding a cure for cancer), or generalise to complex structured uncertainty analyses like those used by the EFSA. Laypersons often look for simplicity and certainty, and they may see the added layer of complexity on uncertainty at each stage of the scientific process as casting doubt on the entire enterprise of experts (Committee on Decision Making Under Uncertainty, 2013). If it leads to obfuscation and erodes trust in scientists, then it may do more harm than good. However, as yet there is no evidence base to judge definitively, and further empirical exploration must identify the effects of different contexts, types of uncertainty information, and methods of communicating them. Only this can help us decide the overall merit of making transparent uncertainty analyses in the context of food safety, and it is important since this is likely to set a precedent for making transparent uncertainty analyses in other regulatory domains.

One way to gage whether the issues raised here are unique is to consider a comparable example of transparency such as FOI requests. There are still considerable problems in preparing information in a form that enables easy access (Wasike, 2016) which can be costly and time consuming.

Several surveys have evaluated FOI requests and found low rates of uptake across several countries (Hazell and Worthy, 2010; Worthy and Hazell, 2016). Experiences around requests for FOIs are far from efficient or necessarily positive, and this may contribute to the relatively low numbers of requests. Not all requests are granted (around 18%–20% in the United Kingdom in the first 3 years for UKCG-DATA) and, when they are, delays can go beyond the statutory deadline (Wasike, 2016; Worthy and Hazell, 2016). FOIs were thought to lead to increases in both public participation and trust in government, and neither have improved as a result of FOI (National Centre for Social Research, 2015; Worthy and Hazell, 2016). Transparency procedures are not therefore currently in a form that is always helpful and or that strengthens public trust.

4. Conclusion

The practicalities of making information transparent are by no means trivial, particularly around abstract concepts like levels of uncertainty around scientific evidence. Scientists struggle to make meaningful estimates of uncertainty using the method demanded by regulatory bodies and this is open to biases. It is not enough to advocate transparency without a clear idea of why and how it should be made transparent and what the public understanding of such information is. Otherwise, we end up with in a situation much like the excerpt at the start, in which a map is being made for ends that the map reader does not want, and in a form they cannot do anything with.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

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