Call for papers: "Post-verità"

# No truth can come from a single scientific study

# *La verità non può scaturire da un singolo studio scientifico*

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**ABSTRACT**

Individual studies are not reliable enough and cannot be prescriptive. Disseminating their outcome will cause confusion, convince people that science is contradictory and will be a source of fake news. Science which should be disseminated is based on accrued wisdom derived from a corpus of research spanning several years and engaging numerous, independent laboratories. Showing the power of solid evidence will increase our understanding and wellbeing and will establish a rational way for disseminating scientific knowledge.

***ABSTRACT***

*Le singole ricerche non hanno valore prescrittivo e neppure valore suggestivo, dunque non ha senso usarle per informare. Divulgarle al pubblico genera confusione, induce l'idea che la scienza sia contraddittoria e produce false notizie. La scienza che merita di essere divulgata si basa su conoscenze acquisite derivanti da ricerche che durano molti anni e sono condivise da molti laboratori indipendenti. Discutere di solide evidenze scientifiche consente di aumentare il nostro sapere, migliorare il nostro benessere e stabilire una modalità razionale di divulgazione della conoscenza scientifica.*

**KEYWORDS**

Single studies
*Studi singoli*

Accrued knowledge
*Conoscenza condivisa*

Science dissemination
Divulgazione scientifica

Fake news
*Bufale*

Not long ago a series of three videos labelled Pills of Science became viral on the web (you can watch them here: http://www.frascatiscienza.it/2017/01/pillole-di-scienza-quando-un-video-diventa-virale/.) They are funny and telling; the main character is overwhelmed by the apparently contradictory medical, behavioural and scientific advice that he is receiving. For example, the voice over states that «In a British research study, evidence showed that meat is good for your brain and muscles. Another study states that red meat increases the risk of getting cancer. By 98%. But it improves sexual performance». He is therefore baffled and unable to follow any of the advice given. The message seems to be that science is not trustworthy as it offers you some facts which are soon contradicted by other opposing facts or dissenting scientists. This pattern is well exemplified by debates on the association of food with disease risks which attract considerable attention from the media. Schoenfeld & Ioannidis (2013) selected 50 common ingredients from random recipes and searched for studies that assessed the association of each ingredient with increased cancer risk or with cancer protection. Out of 191 studies addressing the issue, they found that the tested ingredients were associated with an increased risk of cancer in 103 cases. On the contrary, the remaining 88 papers apparently demonstrated a decreased risk of cancer for the same ingredients! All these effects disappeared in meta-analyses (Schoenfeld & Ioannidis 2013).

The risk of relying on single reports is demonstrated by an astute observation by Jerry Davis. He pointed out that researchers from Graz University in Austria published two papers reporting the exact same data, but paradoxically came to the opposite conclusion about eating behaviour and health parameters. In a national paper (Burkert et al. 2014a) they concluded that their results showed that a vegetarian diet is associated with better health-related behaviour, therefore invoking "public health programs for reducing the health risks associated with a carnivorous diet". In the sibling paper published on an Open Access outlet (Burkert et al. 2014b) the same authors concluded that their study showed that adults who consume a vegetarian diet are less healthy and require more medical treatment. Therefore, here they urged

for «a strong public health program in order to reduce the health risk due to nutritional factors». This testifies how easy it is to offer contrasting, perhaps misleading, advice, based on single studies, which will disconcert the public.

Presented with contrasting advice, people who want to be informed would then ask: who is right? Who is telling the truth? Does science assemble reliable knowledge to which one could serenely refer to or does it fabricate contrasting views amongst which one should choose, hoping for the best? There is a pressing need to reconcile scientific certainties with the rightful practice of doubting authoritative assurances. It is important not to confound discussions within a scientific realm, which requires rules and competence, with the venting of personal views on social networks, talk shows, or newspaper commentaries, whereby everything appears debatable and no proficiency is required nor filters applied. An adversarial approach to science is standard practice in the media, whereby – typically – scientific accrued knowledge is lessened to opinion held by disputing scientists or opinion makers venting their disagreement. This is one of the means by which fake news and distorted knowledge are forged and post-truth thrives.

Researchers are called to abide with ethical principles also when they disseminate their findings to a larger audience. For instance, the Ethical Code of the American Psychological Association states that «When psychologists provide public advice or comment via print, Internet or other electronic transmission, they take precautions to ensure that statements are based on their professional knowledge, training or experience in accord with appropriate psychological literature and practice». Similarly, the code of conduct of Italian Psychologists urges dissemination of the outcome of scientific findings accurately, avoiding desultory and stereotyped summaries.

Disseminating the outcome of individual papers mars the public understanding of science in three ways: (i) by blurring the disparity between science (defined as the product of a collegial activity based on evidence gathering) and opinions (defined as subjective interpretations of necessarily partial information reflecting interests or personal takes); (ii) by muddling up the relationship between knowledge (the description and the explanation of the universe) and actions (the decisions and prescriptions in everyday life); (iii) by ignoring the contrast between the comprehension of science based on accrued, shared and agreed data and the discussion of single experiments or observations.

(i) Scientific facts are based on data gathered through years of investigation, modulated by peer-discussions, replicated by independent laboratories, vetted against available theories and models, and not falsified. These include the benefits for individuals and the society of mass vaccinations; the perils of global warming; the relative safety of genetically modified food; that chemtrails are just a conspiracy; the effectiveness of antibiotics, and the inefficacy of several so-called complementary treatments. Few scientists, if any, would object to these statements. Empirically sound agreed wisdom is not continuously re-examined, unless new evidence emerges from reliable new studies.

Stating that the Earth is round is hardly an opinion, and a debate with a supporter of the alternative view that it is actually flat, does not offer a fair service to the audience, who may then be left with the compromised idea that the Earth is oblong. Hence, we usually do not seek a second opinion on the flatness of the Earth, and there is little debate on the matter, even if some well-meaning ultra-doubters pour out their spleen to the contrary on Twitter. The dividing line between denial and scepticism may not always be apparent but its identification is relative easy because denial always expresses itself in the same manner (Lewandowsky et al. 2016), invoking conspiracy, personal or professional attacks on scientists accused of misconduct or bribery by ill-defined powers.

(ii) Science is descriptive and explanatory, not prescriptive. It does not tell us how or on what to act. Behavioural choices could vary, though they should be equally scientifically valid. It is not rare that a given condition could be addressed by different therapeutic solutions. Experts may hold different views on what to do, whether to advise a surgical or pharmaceutical treatment' whether to intervene promptly or wait. These options could all be justifiable and coherent with respect to the theory of reference and what it is known about the disease. In this case it would not be illogical to seek a second opinion.

This second opinion however concerns the action, not the theory. In the

case of vaccines, science concluded that they are not dangerous and that it is highly advisable that most people should vaccinate. Individuals could refuse to be vaccinated or deny vaccinations to their sons and daughters. Institutions could decide not to promote vaccinations or take measures to favour the right level of vaccination. This decision though would be in contrast with science; it cannot be taken in the name of science. On vaccines a second opinion has no place. Referring to any single study stating the opposite is groundless, such study should not be used as a basis for a decision versus a converging scientific corpus.

(iii) There are two types of research. One category of research tests specific predictions and refers to theoretic models for interpretations. The outcome of this research is relevant solely within a precise theoretical frame of reference and is pertinent only in comparison with the empirical data supporting such a theoretical model. The discussion of the results from each one of these individual studies is limited to experts in that field as they are focussed on particular details of the general construct. It is the accumulated knowledge emanating from the agreed model of reference which is meaningful for the general public and might suggest actions or applications. Applications or prescriptions may take years, even decades; the knowledge deriving from a given line of research may actually never come to fruition.

The second type of research concerns studies driven by empirical questions rather than by theoretical hypotheses. This approach characterises clinical studies, often restricted to observing phenomena, correlations or associations. These studies per se do not allow generalizations due to their intrinsic weaknesses (small sample sizes, limited geographical or social composition, specificity of the methodologies or of the procedures used, etc.). Only the accumulation of several such studies reassessed by means of thorough meta-analyses will allow us to derive conclusions and to formulate recommendations to the society and to people with the clout to impose policies. Taken in isolation each one of these studies would be interlocutory at best as their outcome cannot be reliable enough to be prescriptive (hence disseminated). Without a critical mass of data vouched by peers, conclusions cannot be derived. Individual studies do not carry any prescriptive value. They are not suggestive of gelled knowledge; hence they should not be used to inform - indeed such isolated data risks misinforming and confusing lay people.

Recently, a study revealed that drinking chocolate could be added to the list of treatments for dementia (Desideri et al. 2012). Chocolate is a good source of flavonoids, naturally occurring compounds which have been associated with a staggering list of health benefits, from reducing the risk of cancer to increasing neuronal strength and connectivity. The result naturally found its way into the popular press, which was keen to report the excellent news that chocolate was scientifically proven to “halt dementia” (Killin et al. 2014). It was especially excellent news for Mars Inc., which funded the study and provided the dairy-based cocoa drinks. By capturing a beneficial effect of its product, this company could capitalise on the dementia epidemic (Killin & Della Sala 2015).

For the three reasons outlined above, it is highly misleading to try to force interpretations, and, worse, advice from a single study by divulging its results, which are necessarily temporary and undependable if not utterly biased. As Andrea Ferrero (2016) cannily stated “one single study does not make a summer”.

Too often than is desirable the outcome from individual studies is spun; Ochodo et al. (2013) reported that one third of studies on diagnostic accuracy published in high impact factor journals contained a form of overinterpretation. Scientific journals and funding agencies increasingly request that articles and grant applications stress their applied impact and their immediate and direct benefits. This practice determines the overinterpretation of results and predictions unnecessarily raising expectations.

Overinterpretation of scant data gives rise to wandering guidelines which are changed when new evidence comes about. Prasad et al. (2013) perused all papers discussing a medical practice published in a high impact outlet, the New England Medical Journal, in a decade. They found that of the 363 articles testing standards of care, 146 reversed the previously established practice. Of course identifying medical practices that do not work is

paramount. However, it is staggering that over 40 per cent of medical practices had to be reverted. This indicates that too often the medical community and policy makers rely on unreliable data to suggest courses of action (see also Prasad & Cifu 2015; Sukel 2016). Outcomes from few papers not independently replicated should be kept on the back-burner until watertight evidence accumulates.

The problem of disinformation due to single studies is exacerbated by the practice of Predatory Publishing, an open access model charging authors for swift and easy publication, whereby the review process is minimised and scientific standards are disparaged (Della Sala 2017). Individual studies published in these outlets are often based on flimsy data, are still to be replicated, or methodologically questionable. However, it is difficult for non-experts to separate the wheat from the chaff, and it would be easy to fall prey to bombastic yet unsubstantiated claims.

Newsmakers fuel beliefs in tall tales by running uncritical stories advertising outlandish methods and ignoring their obvious flaws. Even well conducted studies, out of context, become a source of misinformation. However, when journalists write about a new discovery, for instance a new possible treatment for a devastating disease, even if the study reports on a possible biochemical modification obtained in mice which may or may not be replicated and is certainly light years away from being potentially beneficial for humans, they do so prompted by scientists and universities by means of inflated press releases or generous interviews. The current trend is for press releases to exaggerate the claims made in the original papers (see Sumner et al. 2014). This latter practice may be due to the brownie points scientists get if they engage with the media and increase their visibility and that of their institutions.

Science festivals are springing up in every city. However, the idea that simply discussing science publicly can counter misinformation is naïve. We posit that too often than is advisable, scientists themselves promulgate pseudoscientific thinking, so even science festivals may be counterproductive. They may participate in creating the illusion that science is easy and that mastering it does not require decades of swotting; rather intuition and inventiveness. Hence, the idea that everybody could quibble about everything. We all need to be aware of the pitfalls of disseminating the outcome of individual studies versus the need to disseminate accrued wisdom derived from a corpus of research spanning several years and engaging numerous laboratories. Bragging about every little apparently new finding will cause confusion and convince people that science is contradictory. Showing the power of solid evidence will increase our understanding and our wellbeing as well as establishing a rational way for disseminating scientific knowledge (see Box)

A BRIEF GUIDE TO AVOID THE PIT-FALLS OF DISSEMINATING RESULTS FROM SINGLE PAPERS

- Do not disseminate results from individual studies (or modulate their claims by not presenting them as “truth”).
- Avoid trivializing scientific methods by bolstering the conclusions from individual researches.
- Refer to accrued evidence or meta-analyses.
- Do not consider papers published by predatory publishers.
- Consider the sources of funding and the possible conflicts of interest.
- Check the match between data reported in original papers and claims in press releases.
- Do show the complexity of science by refraining from forcing controversy or adversarial debates without the proper cultural instruments.
- Reflect on the scope of different media: a scientific congress is a way of acquiring knowledge, a TV debate a way of seeking consensus.

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