EMBO reports

science & society

To hype, or not to(o) hype

Communication of science is often tarnished by sensationalization, for which both scientists and the media are responsible

Andrea Rinaldi

Scientists love to hate the media for distorting science or getting the facts wrong. Even as they do so, they court publicity for their latest findings, which can bring a slew of media attention and public interest. Getting your research into the national press can result in great boons in terms of political and financial support. Conversely, when scientific discoveries turn out to be wrong, or to have been hyped, the negative press can have a damaging effect on careers and, perhaps more importantly, the image of science itself. Walking the line between 'selling' a story and 'hyping' it far beyond the evidence is no easy task. Professional science communicators work carefully with scientists and journalists to ensure that the messages from research are translated for the public accurately and appropriately. But when things do go wrong, is it always the fault of journalists, or are scientists and those they employ to communicate sometimes equally to blame?

Hyping in science has existed since the dawn of research itself. When scientists relied on the money of wealthy benefactors with little expertise to fund their research, the temptation to claim that they could turn lead into gold, or that they could discover the secret of eternal life, must have been huge. In the modern era, hyping of research tends to make less exuberant claims, but it is no less damaging and no less deceitful, even if sometimes unintentionally so. A few recent cases have brought this problem to the surface again.

The most frenzied of these was the report in *Science* last year that a newly isolated bacterial strain could replace phosphate with arsenate in cellular constituents such as nucleic acids and proteins [1]. The study, led by NASA astrobiologist Felisa Wolfe-Simon, showed that a new strain of the Halomonadaceae family of halofilic proteobacteria, isolated from the alkaline and hypersaline Mono Lake in California (Fig 1), could not only survive in arsenic-rich conditions, such as those found in its original environment, but even thrive by using arsenic entirely in place of phosphorus. "The definition of life has just expanded. As we pursue our efforts to seek signs of life in the solar system, we have to think more broadly, more diversely and consider life as we do not know it," commented Ed Weiler, NASA's associate administrator for the Science Mission Directorate at the agency's Headquarters in Washington, in the original press release [2].

Walking the line between 'selling' a story and 'hyping' it far beyond the evidence is no easy task

The accompanying "search for life beyond Earth" and "alternative biochemistry makeup" hints contained in the same release were lapped up by the media, which covered the breakthrough with headlines such as "Arsenic-loving bacteria may help in hunt for alien life" (*BBC News*), "Arsenic-based bacteria point to new life forms" (*New Scientist*), "Arsenic-feeding bacteria find expands traditional notions of life" (*CNN*). However, it did not take long for criticism to manifest, with many scientists openly questioning whether background levels of phosphorus could have fuelled the bacteria's growth in the cultures, whether arsenate compounds are even stable in aqueous solution, and whether the tests the authors used to prove that arsenic atoms were replacing phosphorus ones in key biomolecules were accurate. The backlash was so bitter that *Science* published the concerns of several research groups commenting on the technical shortcomings of the study and went so far as to change its original press release for reporters, adding a warning note that reads "Clarification: this paper describes a bacterium that substitutes arsenic for a small percentage of its phosphorus, rather than living entirely off arsenic."

"The vast majority of scientific work can wait for some independent validation before its importance is trumpeted to the wider public"

Microbiologists Simon Silver and Le T. Phung, from the University of Illinois, Chicago, USA, were heavily critical of the study, voicing their concern in one of the journals of the Federation of European Microbiological Societies, *FEMS Microbiology Letters*. "The recent online report in *Science* […] either (1) wonderfully expands our imaginations as to how living cells might function […] or (2) is just the newest example of how scientist-authors can walk off the plank in their imaginations when interpreting their results, how peer reviewers (if there were any) simply missed their responsibilities and how a press release from the publisher of *Science* can result in irresponsible publicity in the *New York Times* and on television. We suggest the latter alternative is the case, and that this report should have been stopped at each of several stages" [3]. Meanwhile, Wolfe-Simon is looking for another chance to prove she was right about the arsenic-loving bug, and Silver and colleagues have completed

Fig 1 | Sunrise at Mono Lake. Mono Lake, located in eastern California, is bounded to the west by the Sierra Nevada mountains. This ancient alkaline lake is known for unusual tufa (limestone) formations rising from the water's surface (shown here), as well as for its hypersalinity and high concentrations of arsenic. See Wolfe-Simon *et al* [1]. Credit: Henry Bortman.

the bacterium's genome shotgun sequencing and found 3,400 genes in its 3.5 million bases (www.ncbi.nlm.nih.gov/Traces/wgs/?val=AHBC01).

"I can only comment that it would probably be best if one had avoided a flurry of press conferences and speculative extrapolations. The discovery, if true, would be similarly impressive without any hype in the press releases," commented John Ioannidis, Professor of Medicine at Stanford University School of Medicine in the USA. "I also think that this is the kind of discovery that can definitely wait for a validation by several independent teams before stirring the world. It is not the type of research finding that one cannot wait to trumpet as if thousands and millions of people were to die if they did not know about it," he explained. "If validated, it may be material for a Nobel prize, but if not, then the claims would backfire on the credibility of science in the public view."

Another instructive example of science hyping was sparked by a recent report of fossil teeth, dating to between 200,000 and 400,000 years ago, which were unearthed in the Qesem Cave near Tel Aviv by Israeli and Spanish scientists [4]. Although the teeth cannot yet be conclusively ascribed to *Homo sapiens*, *Homo neanderthalensis*, or any other species of hominid, the media coverage and the original press release from Tel Aviv University stretched the relevance of the story—and the evidence—proclaiming that the finding demonstrates humans lived in Israel 400,000 years ago, which should force scientists to rewrite human history. Were such evidence of modern humans in the Middle East so long ago confirmed, it would indeed clash with the prevailing view of human origin in Africa some 200,000 years ago and the dispersal from the cradle continent that began about 70,000 years ago. But, as freelance science writer Brian Switek has pointed out, "The identity of the Qesem Cave humans cannot be conclusively determined. All the grandiose statements about their relevance to the origin of our species reach beyond what the actual fossil material will allow" [5].

…the blame for science hype cannot be laid solely at the feet of scientists and press officers. Journalists must take their fair share of reproach

An example of sensationalist coverage? "It has long been believed that modern man emerged from the continent of Africa 200,000 years ago. Now Tel Aviv University archaeologists have uncovered evidence that *Homo sapiens* roamed the land now called Israel as early as 400,000 years ago—the earliest evidence for the existence

of modern man anywhere in the world," reads a press release from the New York-based organization, American Friends of Tel Aviv University [6].

"The extent of hype depends on how people interpret facts and evidence, and their intent in the claims they are making. Hype in science can range from 'no hype', where predictions of scientific futures are 100% fact based, to complete exaggeration based on no facts or evidence," commented Zubin Master, a researcher in science ethics at the University of Alberta in Edmonton, Canada. "Intention also plays a role in hype and the prediction of scientific futures, as making extravagant claims, for example in an attempt to secure funds, could be tantamount to lying."

Are scientists more and more often indulging in creative speculation when interpreting their results, just to get extraordinary media coverage of their discoveries? Is science journalism progressively shifting towards hyping stories to attract readers?

"The vast majority of scientific work can wait for some independent validation before its importance is trumpeted to the wider public. Over-interpretation of results is common and as scientists we are continuously under pressure to show that we make big discoveries," commented Ioannidis. "However, probably our role [as scientists] is more important in making sure that we provide balanced views of evidence and in identifying how we can question more rigorously the validity of our own discoveries."

…the concern is that hype inflates public expectations, resulting in a loss of trust in a given technology or research avenue if promises are not kept; however, the premise is not fully proven

Stephanie Suhr, who is involved in the management of the European XFEL—a facility being built in Germany to generate intense X-ray flashes for use in many disciplines—notes in her introduction to a series of essays on the ethics of science journalism that, "Arguably, there may also be an increasing temptation for scientists to hype their research and 'hit the headlines'" [7]. In her analysis, Suhr quotes at least one instance—the discovery in 2009 of the *Darwinius masillae* fossil, presented as the missing link in human evolution [8]—in which the release of a 'breakthrough' scientific publication seems to have been coordinated with simultaneous documentaries and press releases, resulting in what can be considered a study case for science hyping [7].

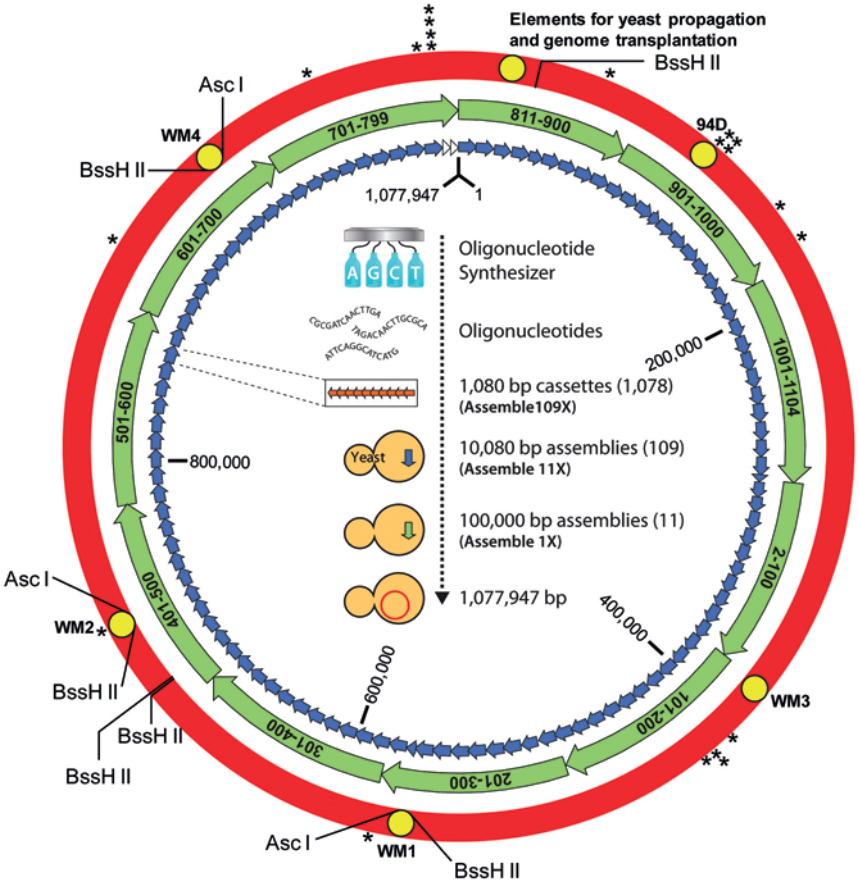
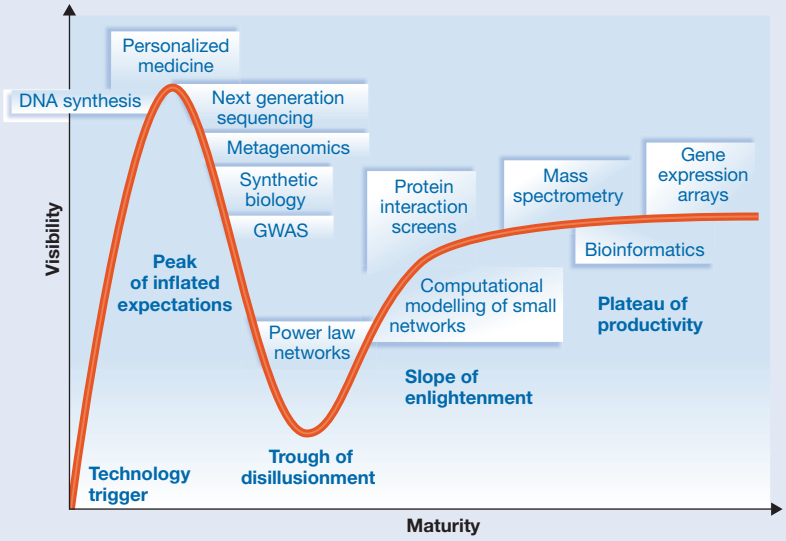


Fig 2 | Schematic depicting the assembly of a synthetic *Mycoplasma mycoides* genome in yeast. For details of the construction of the genome, please see the original article. From Gibson *et al* [13] *Science* **329,** 52–56. Reprinted with permission from AAAS.

Although there is nothing wrong in principle with a broad communication strategy aimed at the rapid dissemination of a scientific discovery, some caveats exist. "[This] strategy […] might be better applied to a scientific subject or body of research. When applied to a single study, there [is] a far greater likelihood of engaging in unmerited hype with the risk of diminishing public trust or at least numbing the audience to claims of 'startling new discoveries'," wrote science communication expert Matthew Nisbet in his *Age of Engagement* blog (bigthink.com/blogs/age-of-engagement) about how media communication was managed in the *Darwinius* affair. "[A]ctivating the various channels and audiences was the right strategy but the language and metaphor used strayed into the realm of hype," Nisbet, who is an Associate Professor in the School of Communication at American University, Washington DC, USA, commented in his post [9]. "We are ethically bound to think carefully about how to go beyond the very small audience that follows traditional science coverage and think systematically about how to reach a wider, more diverse audience via multiple media platforms. But in engaging with these new media platforms and audiences, we are also ethically bound to avoid hype and maintain accuracy and context" [9].

But the blame for science hype cannot be laid solely at the feet of scientists and press officers. Journalists must take their fair share of reproach. "As news online comes faster and faster, there is an enormous temptation for media outlets and

Sidebar A | Up and down the hype cycle



The hype cycle for the life sciences. Pedro Beltrao's view of the excitement–disappointment–maturation cycle of bioscience-related technologies and/or ideas. GWAS: genome-wide association studies. Credit: Pedro Beltrao.

Although hype is usually considered a negative and largely unwanted aspect of scientific and technological communication, it cannot be denied that emphasizing, at least initially, the benefits of a given technology can further its development and use. From this point of view, hype can be seen as a normal stage of technological development, within certain limits. The maturity, adoption and application of specific technologies apparently follow a common trend pattern, described by the information technology company, Gartner, Inc., as the 'hype cycle'. The idea is based on the observation that, after an initial trigger phase, novel technologies pass through a peak of over-excitement (or hype), often followed by a subsequent general disenchantment, before eventually coming under the spotlight again and reaching a stable plateau of productivity. Thus, hype cycles "[h]ighlight overhyped areas against those that are high impact, estimate how long technologies and trends will take to reach maturity, and help organizations decide when to adopt" (www.gartner.com).

"Science is a human endeavour and as such it is inevitably shaped by our subjective responses. Scientists are not immune to these same reactions and it might be valuable to evaluate the visibility of different scientific concepts or technologies using the hype cycle," commented Pedro Beltrao, a cellular biologist at the University of California San Francisco, USA, who runs the *Public Rambling* blog (pbeltrao.blogspot.com) about bioinformatics science and technology. The exercise of placing technologies in the context of the hype cycle can help us to distinguish between their real productive value and our subjective level of excitement, Beltrao explained. "As an example, I have tried to place a few concepts and technologies related to systems biology along the cycle's axis of visibility and maturity [see illustration]. Using this, one could suggest that technologies like gene-expression arrays or mass-spectrometry have reached a stable productivity level, while the potential of concepts like personalized medicine or genome-wide association studies (GWAS) might be currently over-valued."

journalists to quickly publish topics that will grab the readers' attention, sometimes at the cost of accuracy," Suhr wrote [7]. Of course, the media landscape is extremely varied, as science blogger and writer Bora Zivkovic pointed out. "There is no unified thing called 'Media'. There are wonderful specialized science writers out there, and there are beat reporters who occasionally get assigned a science story as one of several they have to file every day," he explained. "There are careful reporters, and there are those who tend to hype. There are media outlets that value accuracy above everything else; others that put beauty of language above all else; and there are outlets that value speed, sexy headlines and ad revenue above all."

One notable example of media-sourced hype comes from J. Craig Venter's announcement in the spring of 2010 of the first self-replicating bacterial cell controlled by a synthetic genome (Fig 2). A major media buzz ensued, over-emphasizing and somewhat distorting an anyway remarkable scientific achievement. Press coverage ranged from the extremes of announcing 'artificial life' to saying that Venter was playing God, adding to cultural and bioethical tension the warning that synthetic organisms could be turned into biological weapons or cause environmental disasters.

"The notion that scientists might some day create life is a fraught meme in Western culture. One mustn't mess with such things, we are told, because the creation of life is the province of gods, monsters, and practitioners of the dark arts. Thus, any hint that science may be on the verge of putting the power of creation into the hands of mere mortals elicits a certain discomfort, even if the hint amounts to no more than distorted gossip," remarked Rob Carlson, who writes on the future role of biology as a human technology, about the public reaction and the media frenzy that arose from the news [10].

Yet the media can also behave responsibly when faced with extravagant claims in press releases. Fiona Fox, Chief Executive of the Science Media Centre in the UK, details such an example in her blog, *On Science and the Media* (fionafox.blogspot.com). The Science Media Centre's role is to facilitate communication between scientists and the press, so they often receive calls from journalists asking to be put in touch with an expert. In this case, the journalist asked for an expert to comment on a story about silver being more effective against cancer than chemotherapy. A wild claim; yet, as Fox points out in her blog, the hype came directly from the institution's press office: "Under the heading 'A silver bullet to beat cancer?' the top line of the press release stated that 'Lab tests have shown that it (silver) is as effective as the leading chemotherapy drug—and may have far fewer side effects.' Far from including any caveats or cautionary notes up front, the press office even included an introductory note claiming that the study 'has confirmed the quack claim that silver has cancer-killing properties'" [11]. Fox praises the majority of the UK national press that concluded that this was not a big story to cover, pointing out that, "We've now got to the stage where not only do the best science journalists have to fight the perverse news values of their news editors but also to try to read between the lines of overhyped press releases to get to the truth of what a scientific study is really claiming."

Yet, is hype detrimental to science? In many instances, the concern is that hype inflates public expectations, resulting in a loss of trust in a given

technology or research avenue if promises are not kept; however, the premise is not fully proven (Sidebar A). "There is no empirical evidence to suggest that unmet promises due to hype in biotechnology, and possibly other scientific fields, will lead to a loss of public trust and, potentially, a loss of public support for science. Thus, arguments made on hype and public trust must be nuanced to reflect this understanding," Master pointed out.

Increased awareness of the underlying risks of over-hyping research should help to balance the scientific facts with speculation on the enticing truths and possibilities they reveal

Together with bioethicist colleague David Resnik, Master has recently highlighted the need for empirical research that examines the relationships between hype, public trust, and public enthusiasm and/or support [12]. Their argument proposes that studies on the effect of hype on public trust can be undertaken by using both quantitative and qualitative methods: "Research can be designed to measure hype through a variety of sources including websites, blogs, movies, billboards, magazines, scientific publications, and press releases," the authors write. "Semi-structured interviews with several specific stakeholders including genetics researchers, media representatives, patient advocates, other academic researchers (that is, ethicists, lawyers, and social scientists), physicians, ethics review board members, patients with genetic diseases, government spokespersons, and politicians could be performed. Also, members of the general public would be interviewed" [12]. They also point out that such an approach to estimate hype and its effect on public enthusiasm and support should carefully define the public under study, as different publics might have different expectations of scientific research, and will therefore have different baseline levels of trust.

Ultimately, exaggerating, hyping or outright lying is rarely a good thing. Hyping science is detrimental to various degrees to all science communication stakeholders—scientists, institutions, journalists, writers, newspapers and the public. It is important that scientists take responsibility for their share of the hyping done and do not automatically blame the media for making things up or getting things wrong. Such discipline in science communication is increasingly important as science searches for answers to the challenges of this century. Increased awareness of the underlying risks of over-hyping research should help to balance the scientific facts with speculation on the enticing truths and possibilities they reveal. The real challenge lies in favouring such an evolved approach to science communication in the face of a rolling 24-hour news cycle, tight science budgets and the uncontrolled and uncontrollable world of the Internet.

CONFLICT OF INTEREST

The author declares he has no conflict of interest.

REFERENCES

1. Wolfe-Simon F *et al* (2011) A bacterium that can grow by using arsenic instead of phosphorus. *Science* **332:** 1163–1166
2. NASA (2010) NASA-*Funded Research Discovers Life Built with Toxic Chemical*. Press release, 2 December 2010. http://www.nasa.gov/topics/universe/features/astrobiology_toxic_chemical.html
3. Silver S, Phung LT (2011) Novel expansion of living chemistry or just a serious mistake? *FEMS Microbiol Lett* **315:** 79–80
4. Hershkovitz I *et al* (2011) Middle pleistocene dental remains from Qesem Cave (Israel). *Am J Phys Anthropol* **144:** 575–592
5. Switek B (2010) *A Fistful of Teeth—do the Qesem Cave Fossils Really Change our Understanding of Human Evolution? Laelaps*, 28 December 2010. http://www.wired.com/wiredscience/2010/12/a-fistful-of-teeth-do-the-qesem-cave-fossils-really-change-our-understanding-of-human-evolution/
6. American Friends of Tel Aviv University (2010) *Was Israel the Birthplace of Modern Man?* 30 December 2010. http://www.aftau.org/site/News2?page=NewsArticle&id=13627
7. Suhr S (2009) Science communication in a changing world. *Ethics Sci Environ Polit* **9:** 1–4
8. Franzen JL *et al* (2009) Complete primate skeleton from the middle Eocene of Messel in Germany: morphology and paleobiology. *PLoS ONE* **4:** e5723
9. Nisbet MC (2009) *Backstage w/ Holland and Zimmer on Darwinius exaggeratus. Age of Engagement*, 27 May 2009. http://bigthink.com/ideas/22678
10. Carlson R (2011) Staying sober about science. *Hastings Cent Rep* **41:** 22–25
11. Fox F (2012) *Dodgy Science Headline: PR can Share the Blame. On Science and the Media*, 6 February 2012. http://fionafox.blogspot.com/2012/02/dodgy-science-headlines-pr-can-share.html
12. Master Z, Resnik DB (2012) Hype and public trust in science. *Sci Eng Ethics* [Epub ahead of print] doi:10.1007/s11948-011-9327–6
13. Gibson DG *et al* (2010) Creation of a bacterial cell controlled by a chemically synthesized genome. *Science* **329:** 52–56

Andrea Rinaldi is a freelance writer in Cagliari, Italy.

EMBO *reports* (2012) **13,** 303–307; published online 16 March 2012; doi:10.1038/embor.2012.39