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Balancing research excellence and media impact: a multistage approach

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Abstract

The communication of research in an electronic age presents numerous opportunities to engage with the general public and/or industry that might directly benefit from new findings. The use of social media outlets typically has a narrative of better enabling connection between people, independent of distance or socio-economic factors. Recent USA-based research suggests that despite drops in the frequency of people who trust elected officials or the media to act in the best interests of the public, there remains a constant and considerably higher confidence in scientists. This suggests that direct communication from scientists can enable better public outreach on important issues. Drawing on several well-known historical examples of how high impactful science has been previously conducted and communicated, we provide a model of how combining quality peer review and a multi-stage communication strategy enables effective and constructive communication. Key to this is a capacity to engage with skilled journalists and the general public via several platforms to explain findings in an unambiguous fashion that enables translating the complexity required in a scientific journal into a digestible accurate representation. This model of research communication can enable end users to evaluate, process and apply information without filters that may intentionally bias findings.

Introduction

In a hypothetical, parallel world, if Galileo Galilei, Alexander von Humboldt, Charles Darwin or Albert Einstein were to put out social media disseminations about their respective key research findings, what might this look like? Certainly, it is beyond question that their findings have had a long lasting and impactful outcome on the world (Hawking 2002; Wulf 2015). It is also well documented that Humboldt was an excellent communicator in several languages, and was a prolific letter writer during the pursuit of his collaborative research that included a multi-year journey (1799–1804) to the South American continent to collect extensive portfolios of data (Wulf 2015). Humboldt was also one of the first researchers to organise an academic conference (Wulf 2015), and indeed communication of science through the networks of the Alexander von Humboldt Foundation continue well into the 21st Century. Albert Einstein was also a prolific communicator about science and society, and extensive archives of his communications (Einstein Archives Online 2020) still serve as a source of inspiration for providing insights into the thinking

about his scientific innovations. Centuries earlier Galileo Galilei had chosen to write his influential book *Discourses and Mathematical Demonstrations Relating to Two New Sciences* in vernacular Italian rather than the more specialised language of Latin. This decision by Galileo to publish in a more widely read language better allowed the general public at that time to readily access the new information. Galileo himself had incurred some resistance to the sharing of his research findings by authorities within Italy at that time, and so had to enable the work to be published in Holland (Galileo 1638). The findings of Galileo went on to become instrumental to the development of scientific progress for centuries to come, and indeed in the book *On The Shoulders of Giants* by Stephen Hawking he quotes Einstein as saying "Galileo … is the father of modern physics" (Hawking 2002).

Good communication allows others to benefit from and drive innovation. Having been inspired by the exploratory travels and communications of Alexander von Humboldt, Charles Darwin travelled extensively on board the HMS Beagle to collect large amounts of empirical data to subsequently develop his theory of evolution. Simultaneously, Alfred Wallace was collecting data in the tropics on the geographical distribution of animal species and had quality data to independently arrive at a theory of evolution through natural selection. The independent findings were published as a co-authored manuscript (Darwin and Wallace 1858) and revolutionised the study of natural history and biology. A year later Darwin also published his famous book *The Origin of Species*, making the scientific findings readily available to a wide general audience around the world (Darwin 1859). A common theme on the research conduct of these giants of science is that they balanced scientific excellence with open and good communication, well before almost instantaneous global communication was made possible by the digital revolution.

In the mid 1990s several user-friendly web browser tools like Netscape and Internet Explorer began to enable a broader range of people to start using the internet for communication. Popular, easy to use search engines like Yahoo and Google were released between 1995–1998 quickly allowing information to be sourced by millions of people worldwide. Social media networking tools like LinkedIn started to gain popularity in 2002, and over the next decade new platforms including MySpace, Facebook, YouTube, Twitter, Instagram and Snapchat quickly gained widespread use due to the rapid improvements in computer power, accessibility and reducing costs for technology (McCullough 2018). By 2018 the use of social media communication tools had reached in excess of 2 billion people (Iyengar and Massey 2019). Thus, in a relatively short period of time since the 1990s there has been dramatic changes in world-wide communication networks, including how research is communicated and discussed in a digital world (McCullough 2018; Iyengar and Massey 2019).

In their article *Scientific communication in a post-truth society* Iyengara and Massey (2018) discuss the contributions of social media to society and warn that within America there has recently been a decline in public confidence for several publicly funded institutions, potentially including science. In particular, the authors discuss how for some scientific fields like climate change, vaccines, and genetically modified foods there is a

growing disconnect between the views of scientists and some sections of the general public. Interestingly however, underlying survey data on public confidence shows that trust in science has remained constant over the past couple of decades, and perhaps even shows a slight rise in recent years (Funk and Kennedy 2019), whilst there has been a steady decline in trust for both media reporting and also politicians. Interestingly, as a result of these changing perceptions on how research is communicated, there is much higher trust in scientists to act in the best interests of the public (Fig. 1). Thus, any disconnect on important issues like climate change are likely fuelled by unscrupulous actors (Iyengar and Massey 2019) with ulterior motives that may benefit from spreading misinformation (circulation of materials to confuse issues) and disinformation (circulation of information with the intention to deceive).

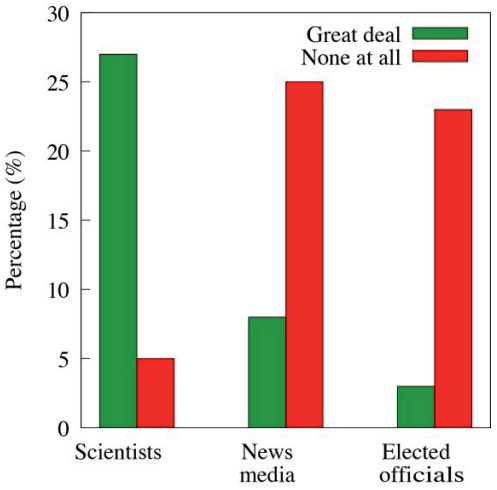

Figure 1: The percentage frequency of USA adults who say they have either a "Great deal" or " None at all" confidence in how scientists (left hand columns), News media (middle columns) or Elected officials (right hand columns act in the best interests of the public. Data from Funk and Kennedy (2019).

How then can the promise of social media enabling connection between people be used constructively to enhance the public understanding of work done in research to improve our understanding of the complex natural world? The promise of social media may allow better direct communication with the public and industry stakeholders, and avoid the possibility of misinformation highlighted above, if other sources relay important information that can have several background actors pulling strings. However, such direct communication must be done with care to maintain the scientific integrity of research findings: much like the giants of old did when they enabled good communication of their impactful research that changed our world.

Below we present a case study of a successful research project to solve important questions of broad benefit to several sectors of society, and a multi-stage communication process that was developed in tandem with the research to use social media to enable clear circulation of information to a very broad audience. This is not the only way to use social media to provide direct communication, but the model was successful and may provide useful insights for developing research dissemination strategies.

Our collaborative research sought to address important questions of what size of animal brain is necessary to enable the processing of mathematical type problem-solving. This was an important research question as classically it had been assumed that a capacity to process numerosity concepts should require both a human brain, and a reasonably sophisticated culture to enable the development of maths skills (Núñez 2017a, b). However, in recent times independent experiments have shown that

several other vertebrate species like fish and birds also have a capacity to process numbers, including a concept of zero (Nieder 2005, 2016a, 2016b, 2017).

We thus wished to experimentally determine through carefully controlled behavioural experiments, if an invertebrate could solve problems that required mathematical type thinking. The European honeybee (*Apis mellifera*), in particular, is an accessible animal model for testing research questions due to their lifestyle of individual bees collecting food rewards for the entire colony, which enables long training and testing. Following a series of careful experiments with individually trained bees using both established and innovative methodologies (Nieder 2016b; Nieder 2018), our findings were presented at scientific conferences to receive critical expert feedback that was then incorporated into manuscripts. Following a full peer review of manuscripts by journals, the research was next published in leading journals including *Science* (Howard et al. 2018a), *Science Advances* (Howard et al. 2019a), *Proceedings of the Royal Society* (Howard et al. 2019b) and other top journals (see Giurfa 2019 for review). The important step, especially in the context of this current manuscript, is that simultaneous with the official publication data for each of the respective detailed peer reviewed research papers, we prepared resources suitable for a broad general audience to digest the information. We additionally, where resourcing was available, made our research open access including all raw data linked to the original studies, and for studies like Howard et al. (2019b), reviewer comments and author responses were also made public to increase transparency of the entire peer review process.

One main public dissemination stage for these respective studies was the simultaneous online publication of our research in "The Conversation" for "*Bees join an elite group of species that understands the concept of zero as a number*" (Howard et al. 2018b), "*Can bees do maths? Yes — new research shows they can add and subtract*" (Howard et al. 2019c) and "*We taught bees a simple number language — and they got it*" (Howard et al. 2019d). Each of these articles was thus prepared with advice from a professional editor at "The Conversation", to ensure that the language used could reach out to a broad public audience. We also translated research into foreign languages like Spanish and Indonesian, and enabled interviews with journalists from many different language backgrounds. This vehicle of communication was then easy for newspaper, television, radio, and broadcaster journalists to access; promoting cross platform interest in our research findings whilst also giving interested readers access to both the general study overview in "The Conversation", and easily linked access to the original studies and evidence for more interested readers. In a social media age, the information is then rapidly picked up through Facebook, Twitter, and LinkedIn plus other online platforms; but readers can still source original material and even directly contact authors. This thus enables readers direct access to information they require to make decisions, potentially avoiding some gate keeper and potentially biased actor concerns that appear to have developed in the modern age (Iyengar and Massey 2019) where adults in the USA show much higher confidence in scientists to act in the best interests of the public as compared to either the media in general, or elected officials (Fig. 1). An important stage of this process is that members of the public

could use the online forums to directly communicate with us, helping to make sure that interpretations made from the work are as accurate as possible as the research impact spreads further afield.

This multi-stage approach was very successful. The example studies discussed above resulted in about 100,000 direct readers via "The Conversation" (Howard et al. 2018b, 2019c, d), then coverage worldwide by over 150 news outlets with an RMIT University media office estimated reach exceeding 750 million people worldwide. The Discover magazine[1] special issue "The Science that Matters in 2020", which highlighted the 50 most important research stories of 2019, included our research on bees and math along with NASA mars exploration and insights into how black holes work as the most important recent findings worldwide. Efficient dissemination of results and readily available access to methodological details and supporting results facilitated independent scientists to repeat the experiments and replicate the research findings in other animals, like ants being shown to also be able to process numbers including zero (Cammaerts and Cammaerts 2019).

How did we develop this plan to do both research excellence, and excellence in communication? Well, we stood on the shoulders of giants and used the strategy of (i) doing high quality research, (ii) discussing with colleagues at conferences (e.g. Dyer and Garcia 2019), (iii) writing papers that go through full peer review (Dyer et al. 2019; Howard et al. 2018a; Howard et al. 2019a), (iv) writing about the research in a form that enables the general public and other stakeholders easy access to information (Howard et al. 2018b; Howard et al. 2019c), (v) directly engaging with the public either via online forums or more traditional media like radio (e.g. see "Info and Metrics" and "Altmeric" online link for Howard et al. 2019a), visiting industry, specialist and community groups and (vii) providing online resources to enable other researchers to replicate and extend research findings (Howard et al. 2019a,b).

So, in our hypothetical, parallel and spinning world within an ever expanding universe, if Galileo Galilei, Alexander von Humboldt, Charles Darwin or Albert Einstein were to put out social media disseminations about new research findings, we think their communication strategies might be similar to those discussed above; as we actually borrowed and modified their strategies for the tools available in our digital era. Indeed, principles of good communication about research will probably remain a re-assuring constant, regardless of the medium used. Recent discoveries about how spinning stars can drag the very fabric of space and time (Krishnan et al. 2020) confirm a key element of Einstien's General Theory of Relativity, and this exciting finding enabled by standing on the shoulders of giants, was made directly available to the public via social media outlets (Bailes and Krishnan 2020). The general public wants to have access to quality information about important issues that may affect all our lives, or help all of us better understand the universe in which we live. Providing such information can enable processes to find solutions to the challenges facing our contemporary world.

[1] Discover (Jan. 2020) "The Science that Matters" www.discovermagazine.com

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