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Science and communicating to its public

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ABSTRACT
What does it mean "communicating science to its public" and how to accomplish it? What science we can try to communicate? Different communication - different media. Is it possible a correct communication? Communicating science implies different fields: from cultural contexts to ethical problems; how do we approach understanding science and its relationship with society.

Key words:
science and society, communication, different publics, ethical problems, cultural contexts, media.

RIASSUNTO
Comunicare la scienza al pubblico.

Che cosa significa comunicare la scienza al pubblico, e come farlo. Esistono differenti pubblici e differenti scienze. Quale scienza possiamo comunicare? Una comunicazione diversa per ogni medium. Comunicare la scienza coinvolge campi e tecniche molto diverse fra loro: dai contesti culturali ai problemi etici. Quale approccio per comunicare la scienza e comprendere i suoi rapporti con la società.

Parole chiave:
scienza e società, comunicazione, pubblici diversi, etica, contesti culturali, media diversi.

SCIENCE AND SOCIETY[1]

In the past months, two events made me think about the role of science communication and more in general about science and society interconnections. The first, an international event, was the 200th anniversary of the birth of Charles Darwin, the father of modern evolution theory. The second happened in Italy at the beginning of the year 2009. A political, ideological, and ethical battle was fought in a painful and unseemly manner, around the body of a 38-year old woman, Eluana Englaro, who had been kept alive by means of artificial feeding and hydration for seventeen-odd years. Both the events show how deeply science and society are intertwined and how a scientific theory on one side or a dramatic medical episode on the other can become a way to speak of something else. Thus, both also illustrate limits and problems of science communication.
These two episodes indicate how little politicians, journalists, lawyers, jurists, and sometimes even historians and critics know about science. Or, at least, they point out how easy it is to use a certain theory and to exploit it from one point of view or another, when society at-large is primarily ignorant concerning the main scientific issues while, ironically, these scientific issues themselves are heavily dominated by social and political choices.

A VAST SUBJECT

The main scope of this paper is to open a discussion about the importance of communicating science to its public and how to accomplish this; that is, how do we approach understanding science and its relationship with society. This is a complex task in the age of big science, industrial exploitation of biotechnology, and of mass media. It is also a vast subject with an even larger literature so at present we will not deal with all its aspects. What we want to attempt is to address some of the primary means of how the mass media work and to what audiences, conferences, articles, books, films, and exhibitions the messages are usually targeted. At the outset, it is also important to stress there is no single entity called "science," as there is no singular "public" for science. Both are complex categories that change over time. (Turney, 1998) Thus, the modes and the goals to achieve a public understanding or awareness of science are complex.

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DARWIN: AN EVENT

Darwin's anniversary has been and is being celebrated worldwide in a variety of different venues, approaches, and formats. These include the following: a week-long festival in Cambridge (UK); a major exhibition at the American Museum of Natural History of New York in collaboration with the Museum of Science of Boston, the Field Museum of Chicago, the Royal Ontario Museum of Toronto, and the Natural History Museum in London; exhibitions in France, Italy, and Germany; lectures of all kinds including for a large public, for young students, for learned people, and for scientists; articles in daily newspapers (for instance "The New York Times and The Financial Times"), in magazines under the "science and technology" section or under "books and arts" (see the "Economist" from 24 January and 7 February), in literary magazines like the "Times Literary Supplement (UK) and Books -L'actualité par les livres du monde" (Wade, 2009; Cookson, 2009; The Economist 2009 a,b; Dawson, 2009; Dawkins 2009; Books - L'actualité par les livres du monde, 2009); TV programs and documentaries; and at least twenty original books published to coincide with the anniversary. And this list does not mention a host of facsimiles, reprints, diaries, poems, and even Mrs. Darwin's recipe book (Bateson & Janeway, 2008) - or the hundreds or thousands of books about Darwin and his theories that have already been published over years. The approaches behind these productions are as variable as one can imagine, from examining the man himself and his family, to discussions of his friends and enemies, and even his travels. There is even an article dealing with the importance of botany for Darwin as pointed out by Oliver Sacks in "The New York Review" of books in the article "Darwin and the Meaning of Flowers" and by David Kohn in "Darwin's Garden: An Evolutionary Adventure."(Sacks, 2008; Kohn, 2008) A novel edition of his letters from his trip round the world on the HMS Beagle (Burkhardt, 2008) has appeared and there have been several efforts to connect his life with that of Abraham Lincoln, both of whom share the same birth day, 12 February 1809. And of course there is some renewed attention concerning whether Darwin's ideas, especially that of natural selection, can be read in political terms, including re-examinations of social Darwinism and eugenics, imperialism, racism, and National Socialism.

DARWIN AND SOCIETY

Of course, many of these discussions concerning Darwin and society have been debated over the long history since 1859 and they are now being debated again (for example, see Jurgen Moltmann, a Protestant theologian writing in the Italian Catholic newspaper "Avvenire" about the "deathly outcomes of Darwinian evolutionism…", Moltmann, 2008). Others have revisited Darwin in terms of investigating human nature; is the species inherently bad or is it adaptable in new social settings? Not surprisingly, Darwin's theory remains controversial and challenging in the spheres of religion, politics, and education even if the theory is relatively easy to explain in biological terms that are comprehensible to the general public. Among the many new titles with this focus, one exemplary book is "Why Evolution is True" by Jerry Coyne (Coyne, 2009), a professor of ecology and evolutionary biology at the University of Chicago. Intriguinely, Coyne argues that his book should not have been needed since it is no longer necessary to persuade people that the theory of relativity, the germ theory of disease, the atomic nature of matter, or that DNA are true. But in November 2008 a conference entitled "Scientific Insights into the Evolution of the Universe and of Life" was held at the Vatican, illustrating the need for books like Coyne's. As John Bohannon reported in Science, "Vatican Science Conference Offers an Ambiguous Message" (Bohannon, 2008), the messages at the conference were contradictory and mixed. With the Vatican meeting as an example, it is not surprising that in the United States more than 40% of the population still believe that "life on Earth has existed in its present form since the beginning of time."

AN UNIFYING THEORY

So what has gone wrong? Darwinian evolution, and more specifically the theory of natural selection, is considered by scientists as the essential unifying theory for contemporary biology. At the same time and despite an enormous amount of communication within the public sphere, many people are still dubious. Indeed, the recent rise of intelligent design arguments indicates the continued resistance to classic evolution theory. So, we might ask, is the message correct? How are we to communicate it to the lay public? What is the story we want to tell?

"The communication process, the functions - intended and otherwise - of popularization, conceptualizations of the public as potential recipients of scientific information and, indeed, the notion of public understanding of science itself are just some of the complexities that are, perhaps too readily, taken for granted" (Gregory & Miller, 1998). Obviously, there is a need to ask about what kind of science is represented. Furthermore, each type of media, including conferences, documentaries, exhibitions, books, or articles, has a different audience and, consequently, the story is told following different rules. For instance, the science that goes into a newspaper has to follow journalistic rules to be accepted; that is, it has to be newsworthy. An event becomes news "if it is on a large enough scale to get over the threshold of news interest". A story has to be

meaningful: it "has to mean something to the readers for them to understand it" (Gregory & Miller, 1998). When possible, events should be linked to a story that is already current. "The Gulf War - for instance - was a major media event, and on the back of that came many technology stories, pollution stories, and health stories." (Gregory & Miller, 1998).
Other considerations are also important for newspapers, including the frequency, unexpectedness, or continuity of a subject, just to mention a few. The same story told in a different context, a documentary for example, might appear rather different, however. Working practices, professional values, the type of information in the scientific world and in the media, are all different. The problem for any journalist will always be how to make accessible and readable news out of science.

WHAT ARE WE TALKING ABOUT

What science is in the media is another good question. Are we speaking about theories, people, institutions, and discoveries? How is science represented? And does how the media represent science make a difference to how people think about science? We still have no real answers to many of these questions. Nevertheless, in today's modern world it remains critical to understand how non-scientists interpret or make sense of what they believe is happening in science.
Returning to Darwin, I soon began to realize that there was more than one story being told. The audiences and the authors are, of course, very different and have different goals and expectations. Let's take the example of a lab dealing with evolution theory everyday through its studies on larvae, the expression of DNA in sea-urchins, and simple or more complex organisms in their environment. This lab decides to communicate to the public, realizing the importance of the public linkage. But what type of information should be given to the public? Why should this material be communicated? What kind of media should be selected? Is the motive for public relations or is it to serve a didactic end? It is to create a public or political consensus? Or, is it a matter of conveying power?

A CONSUMER CULTURE

To understand scientific communication today and what social role it plays, all these factors need to be considered. Furthermore, we need to know "who owns science", who makes decisions concerning how science is pursued, and who speaks - or should speak - about science? In other words, how is a public awareness of science created and how can we evaluate the value and quality of research in a social context?
At the same time, it needs to be emphasized that science has been part of a consumer culture for a long time. Two Indian visitors to London in 1841 wrote about their visit, "We saw nothing in London, nothing in England, half so good remembering the enthralling steam-powered machines and the enormous diving bell at the Royal Polytechnic Institution". There is nothing unique in the comment of Aileen Fyfe and Bernard Lightman about the consumption of science that "we ourselves are surrounded by in our bookstores, on our television channels, and in our toy shops…" (Fyfe & Lightman, 2007). The power of consumer choice has already been established.

ABOUT OUR CONSCIENCE

Eluana Englaro was 21 when she had a car accident that left her severely injured. For three years doctors expressed hope for her recovery. However, hope for her - from a medical and scientific point of view - to regain any sort of life, from consciousness, sensations, ability to move or communicate, gradually eroded to become close to zero. Medical treatment, mainly hydration and nourishment, was continued. Her father, as soon as all the medical and scientific consultants declared that there was no hope of recovery, requested the suspension of all the mechanical aids that keep her body "living". The request was based on the testimony that before the accident a similar situation happened to Eluana's friend, leading her to declare that she did not want to undergo a similar process of "therapeutic persistence". But it was only this year, after seventeen-odd years of struggling, an Italian court ruled that the medical treatments could stop.
The political, religious, and ethical debates surrounding Eluana were arduous and confusing. Indeed, they often went well beyond any human sense of dignity for the body and respect for the person. In particular, the Vatican's intervention was very persistent as was that of the Italian right-wing government. Even physicians became adversaries in the battle pitting the "defense of life" and "against life". It was a regrettable affair with perhaps only Eluana's father maintaining a dignified composure.
I do not want to go into the details of the sad story, but what was most shocking was the use of public communication to convey a specific use of technology and the lack of public communication about the limitations of those instruments themselves and the methods applied. In February 2009, Eluana's father and the doctors who suspended the mechanical "therapy" were denounced as participating in an "assassination". It is not germane to discuss what life is, but it is important to point out how a specific medical situation was used for political, religious, and ethical ends. The Italian prime minister Silvio Berlusconi said, among other things, "Her brain is not dead because she breathes… in hypothesis she could even have a

son, …without a state intervention I would feel responsible of not having helped someone in danger of life, …the vegetative state could change". and he defined the suspension of mechanical treatments, which were declared completely legal by an Italian Court, as "A practice of killing". Certainly, popular bioethics (I am using the definition to refer to what has been written and said in Italy in relation to the Englaro affair) could benefit from more candid scientific and medical information about how the body works. A number of articles, commentaries, broadcast productions, and television programs shows, created the impression that there is a great ambivalence concerning the medical interventions related to the extension or termination of life in these types of situations (Englaro, 2009; Flores D'Arcais, 2009; Rodotà, 2009; Defanti, 2009).

NEED TO KNOW

As this case demonstrates, it is becoming more important to understand the new technological powers that have been developed in laboratories and hospitals before they are put into practice, especially in terms of their actual role to assist a patient to live. This is not to argue that we must know about what consciousness is or what the basic knowledge of how the brain actually operates, but just about what non-scientists need to know about the science behind these life-extending interventions.

Many of the prevailing images of science - particularly of the life sciences - as they are depicted in mass media are contested by scientists. Geneticists, especially, feel that their work is often portrayed in a negative light (Turney, 1998). So, once again, we come to the point of how to communicate science. What science is and what it means in contemporary society should be the first step in this communication effort. The so called top-down model (the expert passing his experience to the lay people) is widely challenged today. So is the image of science as a fixed set of knowledge. Science, or should we say formal science, is seen as a social construction, in the sense that "the knowledge that emerges from scientific situations-laboratories, observatories and soon and the technologies that emerge from scientific knowledge are constructed and contingent, based on when and where it was made. That is, scientific knowledge is not discovered, uncovered, or found, but is actively made through the actions and interactions of scientists and engineers using the resources that surround them. It therefore opposes a long-standing view of scientific knowledge as "out there" waiting to be "discovered" or "uncovered" by talented individuals" (Erickson, 2005).

AN OFFICIAL STORY

The scientific knowledge produced by formal science activities is communicated through scientific journals, academic text books, and sometimes sanctioned congresses. The story told is the official one, a rational developing of the subject - the research - from its beginning to its natural conclusions. It resembles the army headquarter report after the battle has been won. The reality in a lab is very different: a rational line of research is very rare, mistakes and dead-ends are very common. Furthermore, ideologies and values of different types are important components of research (Sismondo, 2004).

The first classic example of science communication is formal and informal science education at school. It is normally done in traditional ways. At a second, very important level, there are mass media: newspapers and magazines, popular science publications, radio and TV programs, and documentaries. All follow more or less standard approaches even if the normal model of popularization (top-down or deficit model) is - as previously stated - strongly criticized. Their communication strategy normally follows the rules of journalism. Today this increasingly means making any story appear spectacular: that is, looking for aspects that can attract large audiences.

ADVERTISING PRESSURES

Television channels all over the world are more and more intimately connected to advertising pressures, looking often to have greater numbers of viewers at all cost. This often results in coverage of the easy aspects of research, or to examinations of angles that make scientific news more compelling (a new gene of longevity, new molecule to fight obesity, a new drug for intelligence, and so on), or often to the fragmentation of the stories. Museums, technological parks, observatories, and science centers produce more and more scientific information. Most aims at a young audience, is not primarily educational or popular, but it is a mass cultural industry with all the implications this entails. Indeed, the term "edutainment" (education and entertainment) is often used.

Often these communication practices are not only information or knowledge to transfer to an external public. As Y. Castelfranchi and N. Pitrelli point out in a small interesting booklet about science communication are knowledges and practices shared by subjects and groups that buy and sell information, transform it in news or in entertainment, they trade, rebuild, rediscuss and exploit it for their own cultural, economic and political objectives (Castelfranchi & Pitrelli, 2007).

We have posed many questions but the basic issue remains, how to communicate science? Science and

technology permeate our everyday lives in the form of computers, mobile phones, a melange of electronic devices, medical technologies, biotechnologies, digital pictures, etc. However, most people do not know how these gadgets work and on what scientific theories or facts they are projected and built. For example, who realizes that DVD or COD formats are based on laser technology that come from investigations into quantum mechanics?

THE INTEREST IN SCIENCE

At the same time, if asked many would say they are more or less interested in science, but is this accurate? Most often, popular scientific knowledge comes from TV series about doctors or police investigations where reality is mixed with fiction. Complicating this source for science are other popular venues, sometimes emphasizing paranormal phenomenon, such as the famous X files series. Given this reality, what can be done to enhance the understanding of science in the mass media? Over the past years, I have struggled with this question while writing and making documentary films about science. My answers, therefore, are very personal and are based on direct experience.

The first step needed is to make people fascinated by and attracted to science. Indeed, from fascination can come real interest. Images can often provide this fascination. Close-up pictures of a sea urchin laying eggs, or of a squid changing colour, or of an octopus learning to open a box, can attract varied audiences, ranging from children to learned adults. The transmutation of an unsightly larva into a beautiful butterfly excites the imagination, as does an accelerated image of the growing flower. Images may also be used to show where science takes place including the 27 kilometres of the LHC located one hundred metres under the Mount Blanc at CERN near Geneva, or the large dome with thousands of lamps to capture neutrino rays under the Gran Sasso Mountain, or the space telescope revolving above planet Earth.

THE ROLE OF IMAGES

Such images have always been very important to science as a means to understand, interpret, and represent the natural world. In fact, modern science has used images in the form of drawings or in the form of instrumental representations from astronomical lenses or microscopes to communicate. Imaging techniques allow us to see how inaccessible parts of the body operate and digital techniques create captivating hybrids merging the real and the fantastic. To capture images of science in action is to demonstrate that science is not just real, but it is vastly interesting and comprehensible; it is not the mysterious world of Frankenstein. Furthermore, such media offers the potential for a larger audience to meet researchers conducting their everyday scientific tasks. Thus, they become the real people who create science. These depictions not only introduce scientists to the public, but they help to explain what scientists do.

WHO DECIDES WHAT

Another level of interest to communicate to the public is that of decision making. Who decides what research to be done? Why should specific research projects be pursued? From where will the financial support for a specific question come? People always want to know where their tax money goes, what they can expect from it in return. At the same time, it is important to emphasize that pure research has produced unexpected practical results. For example, in the case of the internet, the "www" protocol was first adopted by scientists at CERN to communicate among themselves, then it migrated to the military, and finally became the revolutionary public tool it is today.

Similar public suggestions can be useful to the formats of conferences, TV programs, or popular articles. Why is it important to study small flies or a sea-urchin? This question can be used as a springboard to explain that mechanisms regulating the growth of an organism are similar in simple organisms, like the sea urchin, and in humans. Of course, it is much easier to study these phenomena within the lab and with animals. Additionally, the study of marine organisms is also important in its own terms, since more that 70 % of all the species on earth live in marine environments. A great variety of species also means a great variety of chemicals and molecules that have adapted to diverse and sometimes arduous environments. Some of these biological materials have been found to be beneficial to humans, including assisting in the fight against cancers. By illustrating such examples, people are connected to research through everyday problems. But even these examples have an inherent problem, since the language of science is often conveyed uncritically. And, of course, the appropriate language is important. A good rule of thumb is always to explain any apparent technical term when it is used.

Thus, a reference to DNA should also include its definition as a large molecule inside all cells that contains the information for the essential operation and development of an organism. Many public presentations to a general audience forget about the importance of such basic considerations behind effective communication. As a result, science has lost a lot of its allure on the public level. Now is the time to reverse this trend and rebuild the public's interest in science. The task is not easy but the challenge for those of us involved in conveying science to the public is great and rewarding.

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