CHAPTER 1

The most common stereotypes about science and scientists: what scholars know

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1.1 When Illusion Becomes Reality

Each of us has a biased world view because we are all limited to our personal perspective on reality. We can only see what is before us, we can only hear what is around us and we can only recognize, order and process what we have seen, read or heard about before. It is useful to categorize reality because it allows us to manage large blocks of information concerning complex social elements. Who will ever have the opportunity (and take the time) to gain first-hand knowledge of all the aspects of the surrounding reality, i.e. the different kinds of individuals and facts, or the

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whole variety of social groups? Stereotypes help us in the complex task of simplifying our world by sorting everyone and everything into tidy categories. It is an abstract but clear and simple mental process.

In his work on the theory of social identity, Tajfel highlighted the close relationship between simplification and distortion of reality. Stereotypes are basically generalizations concerning social groups, aimed at binding the cognitive process to the cultural context. In order to do that, stereotypes emphasize and overestimate the characteristics of a social group that make it different from the others (Tajfel 1974).

Among the stereotypes concerning scientists, there are those considering scientists a group of clever, bright, reserved, socially clumsy people, devoted only to their work – all characteristics that make them different from ordinary people. Altogether, these images convey the message that scientists are somehow "different" from ordinary citizens. Needless to say that this is a stereotypical image of scientists, developed and simplified within our social and cultural context; an image conveyed and continuously reinforced in the mass media or based on reputations passed on by parents, peers and other influential agents of socialization.

Stereotypes give us a standard idea of the world that is very easy to understand; they organize a standard reality that resists criticism. As observed by Lippmann (1991), stereotypes are the products of cultural and groups' ideas, play the role of categorizing social elements and in the majority of cases produce inaccurate and biased social judgements, whose incorrectness would be impossible to verify. Even when the validity of a stereotype is verifiable (for example when you meet a scientist who in his or her free time is a chef, or a musician, or a keen sportsperson), this first-hand knowledge does not contribute to the stereotype's

refutation, and you will continue to hold it unless you perceive positive effects of the stereotype's removal on your personal situation or on your social group.

A stereotype is a rigid perspective on the world. It is based on bias. It represents beliefs that are not necessarily negative but certainly irrational, and may result in very negative attitudes and behaviours, as for example in the case of racism and xenophobia. Stereotypes are also potentially dangerous because they may generate judgements that are not based on first-hand experience.

A typical stereotype concerning scientists held by ordinary people is that scientists are responsible for many environmental catastrophes (think for example about the Fukushima Daiichi nuclear disaster on the 11th March 2011) and consequently that they are irresponsible people, willing to sacrifice everything in order to make experiments or lacking concern for the consequences of their actions – a very damaging stereotype that may make citizens more suspicious of scientists and less supportive of the policies that scientists personify.

Bourdieu (1998) speaks of *hidden persuasion*, which shows up in different forms of socially recognized aestheticism; a form of "symbolic violence" that is transmitted with culture, limiting personal freedom and our cognitive horizon. The order of things and the abstract characteristics of social groups are examples of social persuasion, supporting stereotypes (Bourdieu 1998). A good example are gender stereotypes within science, which influence the image of scientists and their career developments.

From childhood, individuals are exposed to cultural biases concerning their role in society. These biases generate beliefs that are deep-rooted and difficult to break because they reflect a wide social consensus, and which contribute to the creation of expectations concerning appropriate life choices on the basis of the sex of

the individuals. As noted by Tintori (2015), people inherit gender stereotypical ideas as *reality* – a *generalist reality*, based on the "natural" roles of men and women in society.

Science is considered a masculine world and the so-called "ivory tower" remains a male dominated place. A superficial look at the national, European or international statistics on researchers broken down by sex is enough to understand that there is a clear prevalence of men in senior and leadership positions. Merton speaks about a *self-fulfilling prophecy*, when individuals perceive cultural norms as obvious and prescriptive (Merton 1948). According to Tintori (2013), women are considered unsuitable for science because of their main – "natural" – role as family caregivers, which cannot be combined with work as challenging as science. Thus, women and mothers are more likely to join the ranks of the second tier, or to drop out of academia and scientific labs, perpetuating the stereotype that science should be a men-only profession (Tintori 2013).

1.2 Is The Frankenstein Myth Still Alive?

The most common stereotype of scientists held by many adults evokes a smart, hard-working, eccentric, workaholic man. The image conveys an idea of social isolation and of an "unbalanced" life, without family and children, friends, hobbies or interests. It also implies someone who is socially ill at ease, with limited interpersonal skills and a tendency to see things in black and white based on the data, and sometimes misanthropic and often sexist. It is to be noted that many people perceive scientists not (or not mainly) as working for the good of humankind but rather for personal gain. Why this image? There are many reasons for this.

We create stereotypes to explain why things are the way they are. As Dovidio (2009) notes, stereotypes do not have to be true to serve their purpose. The world would be chaotic if we changed our attitudes towards people too easily (Dovidio 2009). Thus, stereotypes typically evolve slowly, often becoming more complex and nuanced over time. This is the real strength of stereotypes and explains why attempts to suppress them may actually cause them to return later, stronger than ever.

Ordinary people have scarcely any opportunities to develop a personal view of scientists and their work by coming into contact with them. First-hand experiences with scientists you "know in passing" (i.e. someone you may see and interact with on an occasional or even regular basis, as in the case of neighbours) are not enough to dislodge stereotypes about the whole category, because these occasions may be considered discordant experiences or exceptions to the rule set by cultural stereotypes.

In Europe the image of scientists still takes pessimistic forms. The special Eurobarometer survey carried out in 2010 with results published in 2015 showed that a majority of European citizens (62 per cent of respondents at the EU-27 level) feel that science can sometimes damage people's ethical sense, and 53 per cent feel that scientists are too powerful and potentially dangerous. Overall, the Eurobarometer survey shows that European citizens are positive about science and technology, but over time there has been a slight shift towards scepticism compared to the 2005 survey. Although science may bring benefits, Europeans do not have too high hopes that science and technology can solve all the world's problems. Furthermore, the survey shows that the public on the whole has become less sensitive to issues about science and technology, less enthusiastic about the potential benefits and less concerned about the potential drawbacks (Eurobarometer 2015).

Since the 19th century, the master narrative of the scientist has been one of a crazy, reckless, extravagant, sometimes dangerous man. Mary Shelley's *Frankenstein* provided an imagery and a vocabulary universally invoked in relation to scientific discoveries and technological innovation that have greatly contributed to create negative stereotypes about scientists. Written by Shelley in 1818, the novel tells the story of Victor, a man obsessed with the unlimited possibilities of modern science, and therefore contemptuous of ethical rules and of the social implication of his behaviour. In this narrative, knowledge leads to the temptation to "play God", interferes with "nature" and determines who lives and dies.

Nowadays, the image of scientists conveyed in the media is often that of individuals motivated by unacceptable scientific curiosity, who become drunk with the power of knowledge, disregarding the consequences of their discoveries. *Dr. Strangelove* (1964), by Stanley Kubrick, is a famous movie that describes the events that could have happened if a mentally deranged American general had ordered a nuclear attack on the Soviet Union. Dr Strangelove is the US President's science advisor, and is a lunatic scientist whose arguments about nuclear weapons and the need of a nuclear attack are perfectly rational. The movie was released a few years after the Cuban Missile Crisis, one of the most critical moments of the Cold War: this is a clear demonstration that the stereotypical "mad scientists" tend to be working on whatever the public is afraid of at the moment, and it is interesting to see how interests in science shift with society's fears.

From Mary Shelley's day to our own, most scientists, and biomedical scientists in particular, have shown strong moral consciences: far and away they save lives, rather than threatening them. But the Frankenstein myth never dies. Turney (1998) demonstrated that

Mary Shelley's classic novel and the myth it spawned have provided images that have been incorporated into popular debates about advances in biology, from the debates of the early 19th century to the contemporary concern over genetic engineering.

Many people acquire their perception of the Frankenstein myth solely through experiencing popular media. In the media the image of dangerous scientists re-emerges with any new discovery that appears to threaten the social or natural equilibrium. Haynes has argued that in Western literature and culture "*Victor Frankenstein is alive and well*" (Haynes 2003 p. 245). Poisons developed by industrial chemists, genetically modified fruits and vegetables, nuclear risks, the danger represented by hackers, and the cloning of the embryos of mice and of sheep – and in the future perhaps of children – create fear of the power and change that science entails, leaving many people feeling confused and disempowered.

Jurassic Park (Crichton 1990) was not the first sci-fi novel (and film) to deal with genetic tampering, but it presented fictional cloning experiments on dinosaurs' genes with a high degree of realistic scientific detail. Crichton's story finds its predecessors in books like *Frankenstein* and H.G. Wells' *The Island of Doctor Moreau* (1896) and their film adaptations; the technological details are different, but the essential idea is identical: the modern fear of genetic modification. Movies did not invent that fear, but have merely given it shape, perpetuating the idea that we cannot abandon our role as creatures to become creators, and that having the scientific ability and skills does not imply the right to do so.

The scientist described, according to Haynes (2003), as an evil and dangerous man is an easy subject for writers and filmmakers, a convenient shorthand for the simplification of the narrative; in the wider public, however, it generates confusion and a feeling of helplessness in relation to the ethical themes that people feel close

to (Haynes 2003). Scientific power is often enveloped in a shroud of mystery that gives it an dark charm. For example, *Star Wars*, the epic space opera created by George Lucas, is a great metaphor of the risk of uncontrolled scientific progress. Science and technology should be driven by the moral imperative to advance knowledge, avoiding any supposed supremacy of scientific authority.

The stereotype of scientists as clever, but untrustworthy or insane, people has generated negative feelings towards the scientific profession. Odifreddi (2012) speaks of a double misunderstanding concerning scientists and their attitude towards everyday problems. On the one hand, scientists are seen as individuals with wandering minds who are often out of touch with reality; on the other hand, this lack of "conformity" is seen as an emotional disorder, because our culture worships attention and we assume that the best behaviour is to stay focused on issues and problems (Odifreddi 2012). The truth is that you can be a nonconformist individual without being crazy, as well as being a scientist without being a genius focused on your work all day long (this is in fact closer to the normal state of affairs!).

As observed by Chambers (1983), alchemy and black magic were invoked for centuries by caricaturists with the aim of making fun of chemists. This "*image has been cleaned up and, in a sense, standardized*" (Chambers 1983, p. 255). Some years later, Eugster (2007) observed that the stereotypical image persists and scientists continue to have image problems. A bad image hurts scientists on many levels: administrators allocating research funding may be swayed by a poor image; young people with a poor view of scientists may be dissuaded from pursuing science as a career; and, finally, the general public, which interacts with technology every day, may have little or no idea about who is working to create the science behind that technology.

Movies and television are important cultural factors, and reach both adults and children. Frayling (2005) wrote a comprehensive paper on how scientists are depicted in movies and he contrasted the scientist's image from the first half of the century with that from more recent movies. He argued that, recently, scientists in the movies have become "mavericks", often fighting against the government or some unidentified institution. This "maverick" image is no better than the "mad scientist" one, and the reason is that both stereotypes are inaccurate (Frayling 2005). This makes changing perceptions of scientists really important, because if the main image of scientists is of older, white men with glasses in lab coats, girls and boys are not going to imagine themselves as scientists.

1.3 The Good, The Geek And The Ugly

A long line of studies show that the words we use affect the way we think. Language pervades social life; it is the main vehicle for the transmission of cultural knowledge, and the primary means by which we gain access to the content of others' minds. Language is implicated in attitude change, social perception, personal identity, social interaction, intergroup bias and stereotyping, and so on. It is a powerful indicator of underlying cultural values and, among other things, it is a powerful tool in maintaining and reinforcing stereotypes about science and scientists. In fact, stereotypes are not fixed and do change over time through social transmission of information, similarly to the way in which language evolves.

Dikmenli (2010) conducted an interesting qualitative survey of stereotypes among undergraduates using a free word-association test regarding science and scientists. Words associated with scientists included both negative and positive descriptions, and fit

into various categories: personal characteristics, activities, workplaces, technological developments and physical characteristics. Following Mead and Métraux (1957), who carried out one of the first and most influential study of stereotypes of scientists, stereotypes were identified as either "positive" characteristics (e.g. smart, highly trained, hard-working) or "negative" ones (e.g. dull, geek, nerd, dork). Each of these words generates different images in people's minds, images which are likely to come from a mix of characters seen in popular television and film.

Many stereotypes about scientists have arisen alongside the evolution of the word *geek*, an evolution which relies on the depiction of scientists in movies and television and is fostered in the collective and popular culture. As observed by Cross (2005), the term *geek* describes someone who is more intelligent than average and works outside the mainstream or behaves in a non-normative way. It is similar to the word *otaku* in Japan, which is used to tag people as addicted and isolated, and obsessed by manga (Japanese comics and cartooning).

In the past two decades, the word *geek* has evolved significantly and become almost synonymous with *nerd*, another term for awkward outsiders. In mainstream media portrayals the stereotypical nerd is, with few exceptions, depicted as male, white and enthusiastic about mathematics, computer science and technology (see for example Kendall 1999; Bucholtz 1999; Eglash 2002; Woo 2012; Quail 2011; Robinson 2014). *Nerd* also means a kind of lone wolf, reluctant to socialize. Though not interchangeable, the geek and nerd characters are somewhat indistinguishable from one another when it comes to their depiction in popular culture. However the terms are used, the words *geeks* and particularly *nerds* have an intrinsic negative connotation and speak to the "otherness" of the subjects in question.

Geek and nerd scientists are passionate about science and technology. This characteristic is not negative per se: we are all attracted by scientific discoveries and the advancements of science, and we all value curiosity and intelligence. But when the passion for science becomes an obsessive one and scientists are so personally committed to their research that they forego families, friends or romantic relationships, then the stereotype of geek scientists sends us back the image of a socially deviant individual.

A number of negative traits are often associated with the nerd/geek image: poor hygiene or posture, glasses with thick lenses and people always working at personal computers or using some sort of sophisticated technology. According to Mercier, Barron and O'Connor (2006), greasy hair and thick black glasses are images mostly associated with nerds and geeks, while unattractive, pale, thin, spectacled individuals are associated with computer scientists.

It is also a safe bet that the majority of these images are of males. As noted by Leon (2014), the very absence of female images of which to get rid of is a clear demonstration of the fact that female geeks or nerds either do not exist in the media, or exist in such a minority that they hardly merit mention. The few depictions of these women that are seen in popular culture are often merely a feminized version of their male counterpart, and still incorporate, and perhaps even amplify, negative traits such as those mentioned above (Leon 2014).

The modern-day detectives and scientists seen more and more frequently on prime-time television are geek men and women. Even within a single show like *Criminal Minds* (2005), there is a marked difference between the "good-looking" and "clever" field agent Dr Spencer Reid and Special Agent Penelope Garcia, the quirky, brainy and bespectacled woman always seated at her

computer desk. The TV show *NCIS* (2009) also offers a contrasted image between the well dressed and intuitive Special Agent Leroy Jethro Gibbs and the Forensic Specialist Abigail "Abby" Sciuto, who prefers to work alone on the computer, wearing tight pants and platform boots.

Inaccurate portrayals of men and women in science reinforce negative stereotypes about geeks, and also reinforce negative stereotypes about gender, to the point where sexism may be considered "normal" within the context of the geek and nerd community: girls cannot be into "nerdy" things because nerdy things are about science, strategy and action, which are inherently male. The rare instances where people admit that female nerds do actually exist are almost always in media representations that paint women as unattractive people, incapable to show emotions; stereotypical "feminine" traits such as beauty, fashion, social skills and sexual desirability are depicted as at odds with "male-nerd-only" traits such as intelligence, technical mastery and supposed lack of sexual desirability.

The depiction of women as incompatible with nerdiness has real-world consequences, as shown in Tocci's ethnographic studies (Tocci 2007). When women are exposed to "nerdy-white-guy" stereotypes, they are strongly discouraged from entering STEM fields; stereotypes associated with that particular scientific field are often incompatible with the way girls see themselves and can steer women away from that field.

Stereotypes influence the life choices of girls, keep women out of science careers and stop women at the lower levels of the scientific hierarchy. Indeed there are females playing STEM-literate characters that are gaining more popularity in the movies or in television series; for example, Sandra Bullock stars in *Gravity* (2013) as a female astronaut or Emily Deschanel plays

Dr Temperance Brennan, who is the forensic anthropologist protagonist in the television series *Bones* (2005). But the female scientist is still an atypical image and women are being held back by stereotypes. Geek, otaku or nerd, fans of math, technology and other sciences: we always speak of very smart people, isolated, obsessive – and male.

Over the past two decades, the most positive stereotype of the scientist as hero has appeared with increasing frequency as a central character both in film and on television. This trend towards more positive images does not mean that scientists are portrayed realistically. As the communication researchers Nisbet and Dudo noted in their synthesis of studies of on-screen scientists, "*whether a nerd, a villain, or a hero, each of these archetypes are not reflective of scientists generally as a profession or as citizens*" (Nisbet and Dudo 2013, p. 242).

The recent trend has been towards presenting scientists as heroes and warriors of science; the longstanding idea that the entertainment industry produces only negative stereotypes of scientists (i.e. the "mad scientist", Dr Frankenstein, the geek) is now weakening. Nisbet and Dudo (2013) made examples of positive images that include Dr Alan Grant as the main protagonist in the *Jurassic Park* films; Spock in the 2009 version of *Star Trek*, who takes on leading-man and action-hero qualities to rival Captain Kirk, or the recent movie *The Martian* (2015), where an astronaut who was mistakenly presumed dead and left behind on Mars uses his scientific skills in his struggle to survive.

First and foremost, positive stereotyping is still stereotyping. In other words, positive stereotyping affirms the perception that scientists are different based on their exceptional skills and abilities and has the capacity to be just as damaging as the negative form of stereotyping.

The European Commission and other international and national institutions are trying to improve the image of science and scientists, but the influence of these stereotypical media stories is still very strong and takes us away from the real science. The reason may lie in the fact that the real science is still too far removed from the general public.

1.4 Why Public Perception of Science Matters

Over time, increasing attention has been given to the so-called "popularization" of science. As Hilgartner (1990) has noted, the popularization of science rests on a two-stage model: first, scientists develop genuine knowledge; second, science communicators spread polished versions of it to the public. At best, popularization is seen as a low-status task of "appropriate" simplification of scientific results, and creates knowledge gaps between real and popular science. Most popular of all, of course, is the image of eccentric academics pursuing their research with scant regard for practical matters, cut off from the rest of society in their ivory tower. The atomic bomb, genetically modified food and the extraction of stem cells from human embryos are just some of the developments that people see as having a morally dark side; as a consequence, science might not necessarily look like it is for the good of all.

As observed by Marnell (2012), the truth is that, whichever sub-discipline you consider, science is a difficult subject. Its concepts are mostly abstract ("what are gravitational waves?"), its discoveries often counter-intuitive ("how can black holes collide?") and the mathematics needed to describe its discoveries are sometimes barely understood even by university-trained mathematicians ("what are the mathematics of topology?"). This all

makes popularizing science a difficult task: make it too simple and it will inspire few; make it too difficult and nobody will be interested in it.

The difficulty of understanding the relevance of scientific discoveries and their social impact negatively affects the image of scientists. In Europe, the problem of public recognition of scientists and science persists, and the European Commission takes initiatives to change attitudes towards science and scientists. Recently we (the authors of this book) were guests in the laboratories of the National Institute for Nuclear Physics, a research centre in Frascati, a few kilometres south of Rome. During the visit a colleague showed us an historical and very important instrument: the Electron Synchrotron. Fascinated by the gigantic object, we asked what it was for. We received the following answer: "It was of no use". We later learned that the Electro-Synchrotron was an important tool for experiments in the field of particle physics: the machine was a very important particle accelerator, since the 1960s it had enabled significant scientific advances and it is fundamental for the study of electromagnetic properties. So it must have been of some use!

Our experience demonstrates that the gap between scientific activities and communication exists. In other words, even when the progress of science might have important and positive impacts on the quality of life of citizens, these successes are not often understood by the public, because of inadequate communication. We are convinced that science should not be only for scientists, because is too important: it is the way in which we explore the natural and social world and it is the dominant – and currently the only legitimate – form of human knowledge. For the good of society, the public and scientific progress itself, science needs a broader community and its results should be communicated

to the wider public in a correct and engaging way. This idea has moved us to organize big scientific communication events to dismantle the stereotypes about science and scientists, as described in the following chapters of this book. The economic support of the European Commission was essential.

After visiting Frascati, we tried to get information on the Electro-Synchrotron; would we have done the same without our scientific curiosity? We should probably have thought the machine was something extremely expensive but useless. Often, it is difficult to understand what the practical use of scientific research might be, whether the research consists in sending a rover to Mars, exploring the genetics of fruit flies or making particles collide. However, it is vital that the processes and products of science are readily available for the public to understand and interrogate, because the stereotype of the useless science with scientists cloistered in their ivory towers of knowledge relies on the lack of appropriate communication. Scientists are considered people who think in a way that is qualitatively different from "normal" people, and therefore they are often seen as entirely rational, objective and very smart. This paints science as a near-infallible institution that does not want or require engagement from non-scientists.

A major influence on everyone's perception of science is of course the media. Television and the other mass media do more than simply entertain and provide news. They confer status on those individuals, groups and issues selected for placement in the public eye, indicating who and what is important. Those made visible through the mass media become worthy of public attention and concern; those whom media ignore remain invisible. Therefore, mass media are a relevant tool to channel a positive image of scientists; this is also even more relevant if scientists are broadcasted at prime time or on TV news programmes with a large audience.

Scientists have a crucial role in making scientific findings accessible to the media, and thus to the public. Obviously scientists should know how to communicate advances in their fields, but they should also be given consideration and be able to get a fraction of the media's attention. Important discoveries are not enough to transform scientists into communicators or to make people listen when scientists speak.

Physicists, chemists, palaeontologists or historians, for example, do not feed people's appetite for the novel and extraordinary (which leads to media coverage) as space exploration or advances in medicine do. When these types of scientists have the chance of getting media attention, they often fail in communicating their findings because they try to educate the members of the public rather than to engage with them, and maybe because deep inside these scientists consider it "unprofessional" to explain what they do. Thus, they appear either "too smart" or out of touch with the "real world", generally messing around with chemicals or scribbling notes in lab books. We tried to dismantle these stereotypes through specific outreach activities involving scientists and non-scientists, because as long as people believe that scientific careers are for passionate geniuses only, many boys and girls might not personally identify with those stereotypes or find them relevant to their life and career choices.

Scientists have much to contribute to society, and they have the right and responsibility to do so. The dialogue between science and the rest of society has never been more important. The Europe 2020 strategy makes clear the need for public recognition of science and scientists. As observed by Geoghegan-Quinn, former European Commissioner for Research, Science and Innovation, to overcome the current economic crisis we need to create a smarter, greener economy, where our prosperity will come from

research and innovation. Science is the basis for a better future and the bedrock of a knowledge-based society and a healthy economy (Geoghegan-Quinn 2012).

The stereotypes of scientists (smart, isolated in their ivory tower, focused on their work, crazy, evil and dangerous) are hard to dismantle if there is a lack of discourse and contacts between scientists and the non-scientific public. Of course, there will always be stereotypes in the media, but, ideally, through smarter engagement with the public the positive images of scientists should outweigh the negative ones. The majority of scientists are intelligent, passionate, dedicated, entertaining people, and it is possible to change the narrative about scientists and science, to let people understand who scientists are and what they do and to finally dispel the stereotypes about scientists.