CHAPTER 2

How to undo stereotypes about scientists and science

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2.1 Change Is Not Easy

Stereotypes are easy to create. The experiences we have and the socio-cultural environment in which we are immersed provide all the necessary circumstances to create stereotypes with little mental effort on our part. We are accustomed to categorize and to generalize about the qualities of the categories we create, we are made to be receptive to socio-cultural inputs, and not to question our experiences. But even if you understand fully how you bring stereotypes in, you might not be willing to kick them out. In fact, as observed by Schneider (2004, p. 364), "*beliefs about groups*

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of people are likely to be learned as a part of a cognitive package that includes beliefs about political, religious, and cultural matters. Therefore, stereotypes are going to be easier for you to learn (and probably harder to disavow), just because they have many connections to everything else in your mind".

This does not mean that you should consider stereotypical thinking as unavoidable and succumb to the worst of it. But you need to understand that the process of undoing stereotypes is not easy and that it should respond to some criteria, which we are going to illustrate below.

In the previous chapter we learned a lot about stereotypes concerning science and scientists. We know that a "Professor" brings to mind the image of an individual who is highly intelligent, yet socially inept; excels in the academic world, yet fails miserably in the realm of common sense; and is completely immersed in complicated experiments and processes, and busy round the clock. The idea of a scientific lab is that of a misogynist place where men are the dominant sex, full of obscure and complicated apparatus, where in some extreme cases unhinged men perform dangerous experiments. In some cases there is the idea that science is not meant for the progress of humankind but just for satisfying the curiosity and sense of power of elitist individuals.

If we want to undo stereotypes about science and scientists we should start with some basic assumptions, as observed by Schneider (2004). First, stereotypes are generally false, because of the limited experiences you have with people coming from a group you do not know well, as in the case of scientists. Often, television, movies, newspapers and magazines convey stereotypical images of what a scientist is or should be and people do not have any possibility to check the validity of this stereotypic thinking.

Second, if we want to dislodge stereotypical images of scientists, we assume that experiences, contacts and interactions with real scientists should provide clear evidence that disconfirms the stereotypes. Casual contacts with one or more scientists are ineffective, because people may consider them to be atypical individuals of the category (see Hewstone 1994; McClendon 1974; Rothbart 1996). Suppose you hold the stereotype that philosophers are boring and pedantic, and that at a party you meet one who is a lively and amusing person: will this count as evidence disconfirming your stereotype? Do you start thinking that philosophers are quite friendly people? You will actually probably decide that this person you have met is an atypical philosopher and you will place this person in a special category with only one member: the person you met, an exception to the rule. Therefore, the context in which you meet scientists, the quality of the contacts and the interactions you have with them, as well as the duration of the interaction, are fundamental aspects affecting the rejection of stereotypes.

Finally, we assume that, when people recognize that their own stereotypes are false, they will be willing to change them. This last point is a relevant aspect in the process of undoing stereotypes. Hodson and Hewstone (2013, p.83) have argued that "*there is substantial evidence that creating awareness of social categories during contacts, either by making categories explicitly salient or by presenting representative out-group members, can lead to generalized attitude change*". In other words, if you are conscious that you are interacting with a group of scientists that show qualities and behaviour very different from the stereotypical images you hold, this will provide you with sufficient information to change your beliefs and attitudes about scientists as a group. Following Craik (2008), we add that, if the contacts and interactions take place between the social group you are a member of (i.e. your group of friends, family, colleagues, classmates etc.) and the "out-group" (in this case, scientists), you will be encouraged in changing your attitudes if the whole group of people you belong to has the same reaction.

In brief, in order to undo stereotypes about scientists and science we need: contacts and interactions between scientists and ordinary people, in a favourable context, and where you are not isolated from the social groups to which you belong.

Given the aim of undoing stereotypes about scientists and science, we should define which stereotypes we intend to undo, how we want to undo them and when and where to undertake this activity. Within the framework of a project funded by the European Commission called *Light: Turn on the light on science*, we decided to tackle the most popular stereotypes about scientists. In order to be consistent with the idea that groups of people, rather than isolated individuals, should be exposed to the activity of disconfirming stereotypes, we organized big events under the European Commission Researchers' Night "action". This gave us the possibility of verifying the validity of our activities on large numbers of people. The activities we implemented were designed to reach out to everyone – not only to "science addicts". Families with children and people of any age, but young people in particular, participated in our communication events.

Among the stereotypes affecting science and scientists, we decided to tackle the following: that scientists are impersonal individuals, ready to act as "oracles" from their ivory tower of knowledge; that they are solely interested in satisfying their curiosity to discover the truth; that they are especially gifted individuals, different from "normal" people; that scientists should be men, and that science is not for women; and that scientists do nothing but work, and never have fun.

Special attention was given to gender stereotypes in science. We know that the image of a scholar is mainly that of a middle-aged man. Some of the elements of this stereotype are certainly true, because women are still under-represented in many areas of STEM and are a minority at the top of the hierarchies of academic and scientific institutions.

The unconscious bias penalizing women in science because of their gender should be overcome because it is a matter of equity as well as the fact that part of society's investment on education would be wasted. Bearing this in mind, we decided to deal with gender stereotypes in science in the following ways: on the one hand we wanted to demonstrate that women are as good as men in all fields of science; on the other hand we wanted people to experience what it means to be a woman working in scientific research, going through the difficulties women are faced with because of the gender structure of the research system.

2.2 Dismantling The Ivory Tower

When scientists are portrayed in movies and television, they are often shown isolated in laboratories, alone with their complicated apparatus, sometimes with a big blackboard filled with equations behind them. This can make science look like a solitary exploration of the world and give the wrong impression of scientists trapped working in their laboratories, detached from reality. This is especially true when scientists are interviewed by journalists during television news broadcasts, mainly to explain natural catastrophes, virus epidemics, food contamination and other alarming events. On these occasions, scientists provide the "experts' interpretation" of reality. This is not bad per se, but the image conveyed in this way to the general public is far from positive, because it reinforces the stereotype that researchers are somehow cold individuals removed from the messiness of real life.

As a matter of fact, scientists work in busy labs, surrounded by other scientists and students. They often collaborate on studies with other scientists all around the world, and even the rare scientist who works entirely alone depends on interactions with the rest of the scientific community to scrutinize his or her work and get ideas for new studies. Nevertheless, it is true that, over the centuries, science has become institutionalized, with solid structural boundaries separating professional scientists from ordinary people.

In order to dismantle the stereotype that scientists are elitists who refuse to leave the comfortable confines of their ivory towers, we should bring the labs to the people. We are convinced that the opposite, i.e. bringing people into scientific labs to see how scientists work, is not fully effective in breaking down stereotypes about scientists and might have unwanted side effects on people's minds. When you enter an environment that you do not know and do not understand completely, your first reaction is a mix of awe and disorientation. Even if you feel curiosity and interest about the topic, lab visits are not enough to overcome feelings of being intimidated by complicated and obscure matters, and more often than not the idea that scientists are super-gifted isolated people remains unaffected.

On the contrary, however, visiting labs and learning more about science is an important activity for young children, because the stereotypes we learn as children influence the attitudes, beliefs and social expectations about science and scientists we later hold as adults. A long line of studies – see for example van Tuij and Walma van der Molen (2016); Bandura et al. (2001); Gottfredson (1981) – show that stereotypes play a relevant role in shaping children's occupational aspirations and choices, especially for girls.

When stereotypes are deep-rooted in the minds of adults, they cannot be dismantled simply through visiting labs and looking at scientists as if they were museum pieces. As long as science is carried out in windowless buildings and the front door requires a badge, it is inevitable that the stereotypes surrounding the ivory tower remain an insurmountable barrier and the public continues to regard academics as out of touch or distant.

There are many ways to connect scientists to ordinary people. A very popular way is the organization of Cafés Scientifiques. The founder of Café Scientifique was Duncan Dallas, and the first Café was held in Leeds in 1998. Cafés Scientifiques take place in casual settings such as pubs and coffeehouses, are open to everyone and feature an engaging conversation with a scientist about a particular topic.

Since 1998, the Cafés have spread across the world: around 300 Cafés, adapted to different cultures and audiences, are now established in 40 countries. Some countries have also established Junior Cafés in schools to promote youth engagement with science. Café Scientifique, Science Café, Science Exchange, Caffèscienza, Chai and Why, STEM Café, Wissenschafts-Café, Science in the Pub are all names indicating the possibility for a variety of audiences to meet face-to-face with local researchers. It is surprising that an initiative from a city in the north of England aimed at connecting academic research to the public has spread around the world so rapidly. We know that science can no longer rely solely on government support, and that it needs the support of the public as well. Ranganathan (2013) has issued the following call: "*Scientists: do outreach or your science dies*". Thus, Cafés Scientifiques are a step forward in bringing together scientists and the general public in a friendly environment and are a good start to break down the stereotype of the ivory tower.

The Cafés Scientifiques vary in size, frequency, number of science speakers and choice of food and drinks, but they must all comply with an unwritten protocol: the expert must introduce the topic and then the microphone is offered to the public for questions. As observed by Grand (2012), in the organization of Science Cafés there is now a tendency towards applying the academic, themed conference format. There are Cafés where the audience sits neatly in rows, the speaker stands behind a table (sometimes with a lectern), slides of bullet point notes are projected and members of the audience use a microphone to ask questions one at a time. The warm and friendly atmosphere of a discussion in a coffeehouse or pub may therefore disappear and the goal of sending friendly signals from the ivory tower may fail to be achieved.

Cafés Scientifiques were the first attempt to create a direct contact between scientists and ordinary people; many others followed over time and came to life in a range of different places: schools (primary or secondary), universities, leisure centres, museums, local public halls, public squares and natural sites, just to name a few. In Europe, every year, the European Commission gives out funds to organize the Researchers' Night, which takes place in more than 300 European cities and is a very popular science communication event.

When you decide to organize a science week, a science festival, a Researchers' Night or any science communication event conducted outdoors, it should be clear in your mind that the target audience of different initiatives is not the same, because it depends on the venue, which plays an important role. For example, if you organize a science outreach event at a university campus, your target audience will be probably be high school students, teachers and maybe families with children, and the activities will consequently be aimed at stimulating public knowledge and excitement for the disciplines represented in the university departments. In the case of a science fair or festival in a public space, you will be faced with a diverse audience of non-experts with different interests and levels of attention.

If your objective is to dismantle the stereotype that scientists are cloistered within the academic ivory tower, by definition your activity should take place outside the walls of science centres, research institutions or university campuses. In our experience, the venue is extremely important both for attracting people and for the effectiveness of your action, which is aimed at breaking down the stereotype that scientists are shut off inside their labs. The venue should have high usability and accessibility by car, bus or underground; have a good capacity in terms of number of visitors to be hosted; and be attractive per se. The last point is extremely important.

Our *Light* science communication event managed to attract 15,000 to 20,000 visitors per location in a limited number of hours. The venues were the Museum of Roman Civilization and the Planetarium in Rome, the Botanic Garden in Palermo, the Museum of the Present in Rende, Cosenza, and the headquarters of the offices of the Province of Benevento, located in a medieval fortress. The public was attracted by the science communication activities, by the presence of many scientists available to talk with the public and by the opportunity to visit sites that are generally closed to the public or need a paid ticket to be visited. The objective of undoing stereotypes about scientists and science was not openly communicated to the public, but it was the final goal of the Researchers' Night we were organizing.

In our experience streets or squares are not suitable places for changing people's minds towards scientists and science. Obviously streets or squares are by definition outdoor places, but people who come to interact with scientists at the booths you place along the street or in the square are not really interested in listening to, or entering into dialogue with researchers. Some of them will be, but the majority will be people passing by for different reasons, just stopping for a few moments by curiosity and then immediately forgetting the message you are delivering. It is important that people be exposed to the activities you organize for a time of on average one and a half to two hours in order for the activities to have some effect on the stereotype you intend to dismantle. If scientists interact with the general public for too brief a period of time, we are just treading water and not making any significant breakthrough with the change of people's beliefs and misconceptions. The members of the public should be receptive and prepared to become captivated by the marvellous things scientists are doing and as a result be ready to change their opinion about researchers. Otherwise, you are wasting time and money.

Once you have selected the venue, you have a crucial problem to solve: how to create a real two-way communication between scientists and the public. This is not a trivial issue, because, despite a general agreement among science communicators that the top-down model of "teaching people science" is inappropriate, there are still many scientists who operate in this way when communicating their results.

As observed by Jenkinson, Sain and Bishop (2005), the messages you deliver should be meaningful, in order to have the expected positive effects, but the derived meaning might differ from the intended one. The unity of meaning can be improved through two-way communication, bearing in mind that any change encounters an initial degree of resistance and can only happen if people believe that they (individually and/or collectively) will benefit from it (Jenkinson, Sain and Bishop 2005). Therefore, real two-way communication is essential for making sure that your message has been correctly received.

The majority of communication events or occasions for scientists to meet and explain to ordinary people what they are doing continue to use the academic style. Also, when hands-on activities are organized, the "deficit model" is implicitly present, because there is no willingness to overcome the material and psychological barriers between experts and non-experts.

Scientists and ordinary people are like strangers to each other: they have never met before (or very rarely), they are not able to understand each other's language, and they are driven by different goals, values and interests. Nevertheless, they can enter into a dialogue and have profitable communication, based on an interactive process of learning together. Ballantyne (2004) has argued that mutual understanding can take place even when the parties agree to differ; scientists and non-scientists are aware that they differ, and they may be willing to talk and listen to one another because of the recognized differences.

From the very beginning, we were convinced that the spatial context (i.e. the setting and design of the science communication event space) might act as a catalyst for undoing stereotypes about scientists and science, creating an agora for the potential shift in non-scientists, away from their misconceptions on scientists. In order to provide such a space, we had many meetings and profitable discussions with the event designers and architects at our project partner Triplan Ltd, who were experts in event organization and planning. We succeeded in creating a channel for reciprocal comprehension about the activities best adapted to the public and to the objective of dismantling the ivory tower stereotype, and feasible with the means at our disposal. The final setting and design of the events organized with the European Commission funds reflected this mutual understanding.

We identified three fundamental interaction characteristics that may favour the interaction between scientists and ordinary people: interaction experiences should be social, not isolating; they should touch people' s hearts and minds; and they should offer that which cannot be found elsewhere. The first two qualities depend on the setting; the third one is related to the content of the event.

We organized the event space without booths or scientists standing behind tables. Scientists and non-scientists were both protagonists of a two-way communication and exchange of opinions on different topics. There were different "corners" where people could interact with scientists; visitors could move freely from one corner to another without waiting for something to happen. When furniture was needed to support equipment such as microscopes, we favoured round tables or work desks around which people could crowd. In order to maintain a friendly exchange of opinions, no one used microphones. The experiments, discussions and hands-on activities engaged groups of people in order to avoid isolating experiences. We wanted people to feel reassured, in changing their opinion about scientists, by the fact that their friends, their family members or the visitors they might occasionally meet and talk to during the event expressed the same new feeling towards scientists and what scientists do.

A wide range of tools were used to create a welcoming atmosphere and at the same time an interactive space, after the model of a science fair. Event designers facilitated dialogue using a variety of devices to engage attendees in a way that permitted and even encouraged social interaction with scientists. For example, touchscreens were avoided, because they favour an isolated experience

Figure 1. Set-up of the event (All Rights Reserved © IRPPS-Institute for Research on Population and and Social Policies).

for visitors, while big screens were placed in every science corner so that everybody could see what was happening there and be drawn into taking part in the activity. All science corners were highly illuminated in contrast to corridors or passages, in order to capture people's attention towards the "light of science"; every science corner was identified by an attractive name and a gigantic coloured banner and backdrop that explained the content of the corner with images, as shown in Figure 1. The whole venue was purposively set up for the event, and to some extent thus became "contaminated" by science. Lights, coloured carpets and music were introduced to give it a friendly and pleasant atmosphere.

Furthermore, we did not want people to feel disoriented by being immersed in a world they did not know well and overwhelmed by many different experiments, without a clear thread linking all the activities. We are convinced that an event theme is necessary and that the choice of the theme should be made carefully.

The theme sets the general tone of the event and it lets the attendees know what they should expect from coming to it and participating in the activities you organized. It is a kind of title, broad enough to leave room for a wide range of topics. In our opinion, themes such as "Sustainability", "Imagination" or "Equilibrium", as we saw in some science festivals, are unclear for the general public and not really attractive, while other themes directly connected to academic disciplines such as "Health and medicine" or "The future of physics" are too specific and will attract only an audience interested in those disciplines.

In our events we used themes that made reference to recent facts reported on breaking news broadcasts and in newspapers. Television and other media are the major channels of information on science. From time to time, on breaking news reports scientists are invited to comment for a handful of seconds on natural catastrophes, climate changes and other alarming events. In some exceptional cases, scientists themselves make the news. This happens when researchers are called upon to illustrate the scientific advancements they achieved in specific sectors, such as new cancer treatments, the discoveries of new planets or the experimental detection of the Higgs boson. Whatever the reason for the interview, people get superficial information listening to experts' explanations on TV, and still have a lot of unanswered questions and unsatisfied curiosity.

The themes we selected for our *Light* event were "Science on breaking news" (*Light'12* theme), "What's up with science?" (*Light'13* theme) or "Real science and TV series" (*Light'11* theme). The last theme was inspired by the fact that TV series (e.g. *House*, *Numbers*, *CSI* etc.) convey an image of scientists as socially inept, downright eccentric or even completely antisocial and maverick, thus contributing to the production of a distorted image of scientists in popular culture. There is no doubt that television viewers understand that the show is fiction and that things are exaggerated or altered to suit the story; but after watching a drama with scientific content, they accept certain events as being realistic and internalize an image of researchers and their work that may be incorrect or biased.

For the activities related to the theme, you have to choose topics that fit both your theme and people's interests. We offered people many different experiences, from "creating a tornado" to "identifying your DNA". Scientists were present to explain, entertain and answer questions in a non-academic style. The "why" of the scientific discovery or experiment they were illustrating was as important as the "how", so that people could understand that what is driving scientists is not their curiosity but the achievement of social benefits for everyone. At our *Light* event, different disciplines were mixed together and several senses were engaged at the same time: vision, smell and taste. We wanted people to feel that scientists are not trapped in ivory towers and that they are very happy to engage in discussions and dialogue about their work with non-experts. We also wanted people to develop a visceral passion for the progress of science, just as we scientists have.

2.3 Scientists And The Public: Can They Talk?

When scientists talk about their research studies, they use a scientific jargon related to their discipline. As observed by Martin (1992, p. 16), jargon serves "*to police the boundaries of disciplines and specialties*", in order to preserve the security of the academy from invasion from outsiders and to block assaults from other disciplines. But jargon serves another purpose too – it separates scientists from the so-called general public: "*Academics may battle* *among themselves over knowledge, but they have a common interest in maintaining the status of academic knowledge in the eyes of outsiders*" (Martin 1992, p. 16). Thus, speaking clearly to a wide audience might be considered a challenge to scientific status.

As a result, scientists often fail to communicate their findings and to interact with the public. Some of them consider it "unprofessional", in the deep of their hearts, to explain what they do in simple terms. They appear either "too smart" or "too highbrow". Obviously nerdy scientists do exist, but there are also really "cool" ones. The stereotype that all scientists are super-smart and nerdy people was exactly the one we wanted to undo. This sounds easy to do, but for many science communication events it is the greatest challenge of all.

Some years ago a press conference was held at the Italian National Research Council (CNR) to launch a very important science communication event, whose theme was "Horizons", i.e., implicitly, scientific horizons. The press conference was open to the general public, policy-makers, stakeholders and scientists of various disciplines, including to us, the authors of this book. The main speaker was a scholar at the top level in the internal CNR hierarchy and a prominent physicist. He started speaking about unresolved physics problems, using slides full of graphs and equations. As you know, equations are dense mathematical notations, and people are used to study equations, not to see them flashed on a screen for one or two minutes. We came out with the impression that the talk had no other purpose than to convince the audience that the speaker was really smart, science really difficult and its horizons far removed from our interests.

Though most will agree that it is important for scientists to be able to communicate with non-scientists, this type of communication is a skill that many practising scientists lack, as observed by Brownell, Price and Steinman (2013). There are scientists who have a natural gift for communication: they have lively personalities that help them interact with the public. Often, they are able to have empathy with the public, putting themselves in the non-experts' shoes or seeing things through non-experts' eyes. Their clarity of expression is well tuned to the public's listening capacity, maintaining high levels of attention and interest in people and at the same time having the precision of language that is needed in science: quoting a sentence attributed to Einstein, "everything should be made as simple as possible, but not simpler".

Many of the misconceptions about science that people harbour have their origins in the imprecise language used by scientists who try to be understood by those they consider as lacking the necessary knowledge. As pointed out by Bohren (2001), inadequate language weakens and distorts ideas, fails to create emotional responses in the minds of members of the audience and is easily transformed into nonsense by laypeople. It will then take years, if it ever happens, to purge misconceptions from people's minds (Bohren 2001).

While there are good communicators among scientists, there are also bad ones. Distinguished scientists may have difficulties abandoning their jargon or may have careless speech habits. Often they are convinced they are successful communicators because they are able to open their mouths and utter a stream of complicated words; they may have misconceptions about the capacity of ordinary people to understand and comment on what they are doing.

If you aim at dismantling the stereotype that scientists are somehow "different" from ordinary citizens, interaction, dialogue and reciprocal knowledge between scientists and the general public are essential. The idea is to show that scientists may be cool and friendly, and that, although immersed in a challenging and passionate professional life, they fit well into society; do not make the mistake to think that science is so rich and has so much interesting content that it is enough to let scientists talk and make experiments with the public. Sometimes this works, but in the majority of cases it does not.

For the *Light* event, we had to find scientists who had the necessary skills to communicate their work. The process required three different steps: scouting for available researchers who fit with the theme of the event; testing their capacity to communicate in a friendly way; and briefing them to ameliorate their natural skills.

Scouting for scientists who carried out studies or made discoveries that fit with the theme of the event was done at a national level – remember that, whatever the level at which your activity is organized (national, local, international etc.), the theme of the event should be respected even if an unrelated amazing discovery could be presented, otherwise you lose the consistency in what you are organizing. We were supported by the CNR's press office, which deals with the writing of public news releases. Many universities, research institutions and research centres have a press office, and you can benefit from their help in the process of scouting for appropriate scientists. The most important element in the decision to take on board a scientist or not is related to the possibility of creating an interactive activity from the studies he or she has carried out.

The testing of the communication skills of scientists was done over the phone. In many cases we used the format of *Famelab* (the science communication competition launched in 2005 at Cheltenham Science Festival), which tests the capacity of scientists to go straight to the point while explaining their scientific advances. The ability to highlight the social impact of their scientific study or discovery was also an important factor we considered, because if scientists are not able to describe why what they do matters to all, it is much harder to capture the attention of ordinary people.

Finally, a briefing session was held prior to the event to train participating scientists to improve their communication skills and in order to make them friendly, able to answer questions easily and open to speak about their hobbies, family and children. We focused on the use of a professional but clear and understandable language to hold the audience's attention. We recommended to scientists that they shift their awareness to the public's perspective, because gaining a listener's point of view of their work makes communication effective.

The stereotype that scientists are a group of nerds isolated from the real world is a strong misconception that could be redressed. Obviously there are scientists who appear to be so, but the majority loves to be involved in communicating their own achievements to the general public and are as passionate about it as any other group of professionals. If popular beliefs about nerdy scientists are debunked, scientific research becomes easier to foster.

2.4 Scientists Do Nothing But Work

Apart from Dr House playing the piano and guitar – and Dr House is not exactly the type of character who can be described as a warm, friendly and welcoming guy! – TV series convey images of scientists as people solely interested in discovering the truth or contributing to the advancement of knowledge.

In general, scientists do not have the reputation of being fun-loving people. The stereotype that they do not have hobbies and friends (apart from their colleagues) is very frequently channelled by TV series and movies. Scientists, by and large, are seen as incapable of having fun, and as being always serious, reflective and removed from everyday commitments. McConnell (2004) has observed that in the eyes of non-scientists science continues to be considered a mind-numbingly boring profession, where work pervades in the scientists' existence, friends fade into the background and hobbies wither.

The stereotype affecting scientists is partially true: during an ongoing experiment or when they are concentrated on finding new solutions, scientists may lose track of time. But these are exceptions to the rule. Scientists tend to be practical, orderly and logical and to be successful through concentration and thoroughness, and not necessarily all the time.

Science requires a high dose of imagination. Creative people are curious, and their curiosity covers a wide range of interests – so much so that many scientists have artistic hobbies. Some are musicians, some draw or paint, some sculpt, some write. The creativity needed in the field of science they are studying or the need to have brilliant ideas to solve scientific problems is also invested in leisure time activities.

Hobbies are essential, according to Runco and Pritzker, because "*a personal correlate for success as a discoverer is hobbies and intensive leisure time activities*" (1999, p.561). In a recent article published in *Nature*, Woolston (2015) emphasizes the benefits of engaging in leisure activities outside of scientific research, because a balance of abilities, as indicated by a range of activities practised at an intensive level, might improve creativity.

When ordinary people interact with scientists during a science communication event, even if scientists are well trained on how to behave, talk and be friendly with the public, the stereotype that researchers are fully immersed in their work remains intact. We should find a way to change this misconception, in order to

Figure 2. Scientists performing at the Globe Science Theatre (All Rights Reserved © IRPPS-Institute for Research on Population and and Social Policies).

dismantle stereotypical images of scientists: what we did was to let people see what scientists do when they do not do science and when they cultivate their hobbies.

At the *Light* event we gave scientists the opportunity to show their talents while performing their hobbies. The words *science* and *fun* are not mutually exclusive, and our event provided ordinary people stimulating encounters with current art and sport practice. Artists and sportspeople performed in a purposively set-up area called the Globe Science Theatre, as shown in Figure 2. Each of the groups of artists and sportspeople on stage had to have at least one member of the performing team actively engaged in scientific research.

The scientists were extremely serious and competent in their performances and the public loved what the scientists were doing.

Following Stebbins (2014)'s definition, most of the scientists were not just hobbyists but were real amateurs, since they were involved in art, sport and entertainment together with professional counterparts. Many of the researchers were distinguished and highly regarded professors, who accepted with enthusiasm to perform in front of the public (for example, at *Light* the President of the Italian National Committee for Sciences and Technologies of Environment and Habitat of CNR danced tango, and one of the authors of this book performed a judo show).

While it is true that researchers from different disciplines spend a lot of time and energy at work – as do many other professionals – they are equally involved in many artistic activities and sports. The passion and energy that scientists put in performing arts or sports helped the public to remove the misconception that scientists are people who have no other interest than their research in their life. Scientists brought to light their human side, showed the public that they do not just live in labs and gave ordinary people the opportunity to understand that every scientific advance is achieved by a group of competent and skilled people who have families, friends and hobbies.

2.5 Breaking The Glass Ceiling

In its Plenary Sitting on 20 July 2015 the European Parliament approved a motion concerning gender imbalances in science (European Parliament 2015). It has been observed that, despite positive changes in recent years, gender equality in science and academia has still not been achieved, with the situation varying across Member States, fields of research and academic grade. In the EU-28, while women account for 59 per cent of university graduates, they account for only 18 per cent of university professors on full professorships. The strikingly low numbers of women in the highest academic and decision-making positions in scientific institutions and universities is also to be noted: this indicates the existence of a glass ceiling, that is an invisible barrier based on prejudices and stereotypes that stands in the way of women accessing positions of responsibility.

To a degree, national laws and the internal rules of the large majority of European research institutions ensure equal treatment for men and women; regulations, however, may control behaviour, but they do not change underlying attitudes. Arguments over the need for gender equality in science continue, and they will not disappear from the academic and political agendas any time soon. The reason for the continued existence of requests for gender equality in science is simple: the fight for equality is not yet won. It is possible for research institutions and organizations to have a facade of gender inclusiveness, yet still perpetuate stereotypes and misconceptions.

Women are under-represented in many fields of science, for example in STEM, and in leadership positions. Changes come about very slowly. In Italy, for example, Palomba calculated that gender parity among academic professors (i.e. 50 per cent of women among professors with full professorships) will be reached in the year 2138, if the current rate of increase in female-held professorships is maintained; 2059 will be the year that gender parity in full professorships is reached in Finland, 2063 the year that it is reached in the UK and 2130 the year that it is reached in Belgium (Palomba 2013).

The European Commission has made considerable efforts to promote a more systematic participation of women in every sector and aspect of scientific activities and research management by ensuring gender balance in decision-making, in order to reach the target of 40 per cent of the under-represented sex in panels and groups and of 50 per cent in advisory groups. In monetary terms, Palomba (2015) calculated that, under the Sixth Framework Programme[1] (FP6), the European Commission invested almost €20 million on projects focused on the promotion of "Women in science"; the amount was increased to €40 million in the Seventh Framework Programme (FP7; Palomba 2015). All these efforts have not yet produced the expected results and women continue to be under-represented in every field of science.

As a consequence, the images of scientists in the minds of non-scientists are persistently masculine. These gender-related stereotypes are reproduced across all ages and across every social group, and ordinary people more often depict scientists as men than as women. The stereotypical images are so embedded in the "cultural brain" that people hold them without being aware of it.

The question is why all these biases persist in the face of an avalanche of evidence that women are good scientists and what can be done to dismantle gender stereotypes in the minds of ordinary people. After all, no one wants to think of themselves as a sexist these days (or at least as sexist enough to be called out for it). Female scientists themselves have difficulty recognizing gender stereotypes in science; there is a certain amount of denial – "It doesn't happen to me" – and female scientists need help recognizing existing gender biases in their department or scientific field.

Over time, in order to describe gender stereotypes in science and their effects on women's careers and achievements, a number of metaphors have been created to represent these gender biases

1 Framework Programmes or abbreviated FP1 to FP7 are funding programmes created by the European Commission to support and foster research in the European Research Area. FP6 run for five years from 2002 to 2006; FP7 run for 7 years from 2007 to 2013

and prejudices in the scientific world. The metaphors are the following: the *leaky pipeline*, representing the fact that women disappear from the career track at some point; the *sticky floor*, to describe a discriminatory pattern that keeps women at the bottom of the scientific career ladder; and the *glass ceiling*, the invisible barrier which blocks the advancement of women in science.

Furthermore, there is a constant, unrelenting message sent to women and girls by families, peers, friends and society in general, that is: "You will never be good enough for science. It is too hard for you". After years of hearing this message, it is hard not to internalize it.

We were aware that to address gender stereotypes in science words, numbers or percentages demonstrating how good women are and how much they are penalized while entering or advancing in scientific careers were useless. Plenty of reports, publications, books, articles, public speeches and exhibits on the issue have not significantly changed the situation; the awareness of the gender biases that exist in science has not had obvious effects on academic behaviour.

At the *Light* event, we had to convince ordinary people that women were very good at science, although not being fairly rewarded. We decided to implement two different activities in order to remove existing gender stereotypes about scientists. On one side, mixed-gender teams animated the science corners (in some cases, we had women-only teams), so that women and men were both interacting with the public, thus dismantling the idea that women are not good at science. On the other side, we wanted people to have a direct experience of what it means to be a woman in science, and we thus decided to realize the metaphors on women's careers in science and let people perceive without words the unfairness affecting women who work in scientific labs. All the activities aimed to dislodge the stereotype that science is not for women.

Out of the three main metaphors, we started with the reproduction of the glass ceiling: it was a great success. The term *glass ceiling* comes from the illusion the phenomenon creates: female scientists believe that there are no gender-related obstacles to arrive to top positions while on the contrary there is an invisible barrier (i.e. gender stereotypes) over their heads that prevents them from climbing the institutional hierarchy. The transparency of the glass and the presence of a concrete limit – the ceiling – represent the impossibility for female scientists to reach high-ranking positions; the barrier is not perceived, thus creating an equalitarian appearance and the illusion of an open and meritocratic competition.

Figures 3 and 4 show the metal and glass structure that was designed and realized by Triplan, our partner for the *Light* project. The structure might be considered a work of art. We wanted to represent the following aspects:

- Women in science face career ups and downs; they can see the road to success but perceive it as an uphill struggle.
- Male scientists start at the same level as women, but, at the end of their career, they arrive at higher levels than women. Men face a straight road without obstacles or barriers; they feel they can do it.
- Both men and women see each other, thus creating the illusion that it is possible to cross the wall between them and to change the final result.

The attendees at our event had the opportunity to experience the difference between men's and women's careers in science,

Figure 3. Walking on a career path under a glass ceiling (All Rights Reserved © IRPPS-Institute for Research on Population and and Social Policies).

Figure 4. Final steps of two career paths – one under a glass ceiling (All Rights Reserved © IRPPS-Institute for Research on Population and and Social Policies).

perceiving the difference through their senses. At the end of the experience, they were given explanations. Most of them wanted to repeat the experience from the other gender's perspective (men experiencing the obstacles faced by women; women experiencing the male perspective). It was amazing how much they learned, how many discussions arose among visitors and how easy it was to make them understand the obstacles that female scientists face.

We also planned to realize (though we never did in the end) the other two metaphors: the leaky pipeline and the sticky floor. For the former, it is enough to build two glass tubes, each long enough to create a circuit, and each ending in two transparent containers; one of the tube should have very small holes. The public can pour liquids of two different colours (for example blue and pink, just to follow current gender colour conventions) into the tubes: it goes without saying that the quantity of blue liquid that arrives into the final container from the non-leaky tube will always exceed the quantity of pink liquid that arrives into the other final container, because of the holes in the tube into which the pink liquid is poured. For the metaphor of the sticky floor we thought about creating two ramps of equal height but with different slopes, with women having to climb the steepest slope, which is also made sticky.

Coming back to the stereotype that women are not good enough for science, at the 2010 *Light* event our partner Triplan created an interesting sensorial experience, which was called "Heaven can't wait". It consisted of a 20-metre tunnel made of cloth. It was conceived as an activity aiming to let the wider public understand that gender stereotypes affecting the very nature of science can be removed. The "sensorial tunnel" revolved around the theme of women in science and their careers. The passers-by physically perceived through three senses (touch, hearing and sight) what it means to be a woman in the scientific world. They passed through *Hell*, which represented the gender-related difficulties faced in entering scientific careers, went through the *Purgatory*, which represented the problems occurring once the career has started, and finally they arrived in *Paradise*, where a woman manages to succeed in science. Voices, colours, lights and special floors, ceilings and walls created an immersive space for visitors, facilitating their tour of women's careers in science.

We are convinced that no conference, seminar, workshop or speech made by relevant people can have concrete effects in removing gender stereotypes in science. Male and female scientists themselves easily fall into stereotypical behaviours, which may unintentionally perpetuate women's subordinate status. What we did helps remove misconceptions about gender in science and helps scientists, policy-makers and ordinary people understand both how good women in science are and how many difficulties they face. Although society's message to women that they are inadequate in science is less overt today, a conscious effort is still needed to overcome problems and stereotypes about women. Changing culture takes a long time. If people perceive existing gender unfairness in science and appreciate the work done by women, a significant step forward can be taken.

2.6 Suggestions and Recommendations

Current stereotypes about scientists convey the image that scientists are somehow "different" from ordinary citizens. Scientists are considered socially awkward, isolated and without many friends and interests; science is considered a male profession. The majority of these stereotypes stem from the fact that scientists and non-scientists meet, engage in dialogue and interact very rarely. Our observations and suggestions to undo stereotypes about scientists are the following:

- occasions (i.e. science weeks, science festivals, researchers' nights, science cafés etc.) should be created to favour contacts and interactions between scientists and ordinary people;
- the interactions should be collective experiences that take place between scientists and groups of individuals;
- you should define which stereotypes to undo and the activities you want to implement in order to achieve that goal;
- the venue is extremely important both to attract people and to define your target audience;
- the set-up of the venue acts as a catalyst favouring real interaction between scientists and non-scientists and in producing the expected breaking down of misconceptions about scientists;
- the event must have a theme; the choice of the theme should be made carefully;
- the "why" of the scientific discovery or experiment presented by scientists to the public is as important as the "how";
- scientists who have the natural skills necessary to communicate their work to the wider public must be selected; they must be briefed to ameliorate their natural skills;
- speeches, role models, numbers and exhibits are not enough to eradicate gender stereotypes in science; we

suggest that there should be a number of sensory experiences so that people may have first-hand experience of the gender bias, difficulties and obstacles that women have to face in their scientific career and may form their own opinion.