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## SPAIN

### Evolution and professionalisation of science communication

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#### 1. Introduction

The development of modern science communication (SC) in Spain is the result of numerous individual events, both great and small, participated in by many people, some famous and others completely unknown, and countless activities and actions, some meticulously planned and others completely random. This chapter will not be exhaustive. Our aim is to improve the overall understanding of the evolution of SC over recent decades (modern SC or public communication of science and technology), and how the narrative of Spain complements our understanding of SC in other countries in the world. The evolution of scientific communication in Spain cannot be understood without paying attention to its relationship with the rest of European Union countries, especially its neighbours France and Portugal, as well as its close connections with Latin American countries, with whom Spain shares a language and a huge number of cultural elements. After a brief historical introduction, this chapter reviews the sociopolitical context in Spain during the 20th century and how changes in that context influenced the emergence and evolution of ‘modern science communication’. It is difficult to set a precise starting date for this, although there was more attention to scientific issues in the media in the 1970s and 1980s. This coincides—and not by chance—with an intensification and an internationalisation of science itself, as well as with an opening of the country to the world.

We review the respective roles played by mass media, museums, universities, professional associations and administrations (national, autonomous and local). Although Spanish scientific communication has experienced growth and recession phases since the 1970s, it has never stopped professionalising. Good examples are the offer of specific university studies on science communication (mainly master's and postgraduates courses); the growth of professional associations in number of partners and in their activities; the creation of collaborative networks (such as units of scientific culture, museums and science centres, etc.); the emergence of research groups dedicated to the analysis of this field; and the consolidation of major professional events.

## 2. Science and SC in Spain before the 1970s

The need to recount great happenings is something inherent in the human condition and even before printing had been invented, the public communication of news or events was already taking place. Epidemics, plagues, weather forecasts, environmental disasters, wars and their technological implementations, and quarrels between wise men (or among wise men, mages and monks) are examples of issues that have been present in the 'public arena' throughout history. Nevertheless, SC was transformed in Spain with the printing press and technological advances, as well as scientific revolutions and the institutionalisation of science. Scientists themselves (engineers, doctors, astronomers, naturalists etc.) for centuries acted as disseminators in Spain (López-Ocón Cabrera, 2000).

The amassing of artefacts and the 'culture of the curio' (Bolaños, 2008, p. 44), common to all countries with a colonial past or that commissioned great scientific expeditions, formed the basis for some of the first science museums in Spain. Examples include the country's National Museum of Natural Sciences, founded in 1771 on the basis of the collections of Pedro Franco Dávila or, towards the turn of the century, today's Museum of Natural Sciences in Barcelona, based on the collections of Francesc Martorell.

Science news in the press is as old as the press itself. SC historians have found records of science news dating back to the 17th century in France and England. Unfortunately, research into the history of SC in Spain is so scant that we have nothing on record regarding these periods, but there is every reason to think that Spain also published this kind of article in the same period. This is particularly so given the fact that the country was at its cultural zenith (the so-called 'Golden Age' of Spanish hegemony in Europe, spanning the 16th and 17th centuries), with writers such as Cervantes and painters like Velázquez. Spain has some of the oldest universities in the world and in

this period Spain enjoyed significant development in science and technology in areas associated with naval activity, geographical expansion and medicine, partly as a result of the legacy of Arab culture.

Studies of the 18th century give some insight of the coverage of science issues in newspapers (Martín Melero, 2008). Guillamet i Lloveras has mentioned the efforts of the editor of the newspaper *Diario de Barcelona* to introduce science subjects on a regular basis during 1792–1810; from the very first day, these subjects were announced as a means of contributing to ‘general instruction and common utility’ (Guillamet i Lloveras, 1998, p. 119). Other examples over the course of the 19th century include *La Crónica Científica y Literaria*, edited by José Joaquín Mora and later renamed *El Constitucional* (Cruz Seoane and Saíz, 1983). Mora, like other Spanish liberals of the 19th and 20th centuries, ended up in exile in Latin America. In the second half of the 19th century, the reciprocal influence between Spain and Latin America, particularly between intellectuals and artists, was quite strong. Publications such as *La América*, *Crónica Hispano-Americana* and *El Museo Universal* mirrored this desire for communion between Spain and the countries of Latin America (López-Ocón Cabrera, 1990). These journals reflected Latin American cultural and political life, and also featured scientific content (Martín Melero, 2008; Graiño Knobel, 2014).

The common language made it easy for Spain and Latin American countries to share stories across media outlets. This has increased in the present era, since digital media in Spanish has a great diffusion across the Spanish-speaking world, regardless of the country where it originated.

We have an even greater understanding of the individuals and the media that ensured science coverage in the press of the first half of the 20th century. Worthy of note is the work of Odón de Buen who edited the weekly journal *El Mundo Científico* from 1903 (Calvo Roy, 2013); and the regular contributions of Josep Comas I Solà (Roca Rosell, 2004) and Miguel Masriera to the newspaper *La Vanguardia* (de Semir, 2014).

Spanish politics took a dramatic turn in the first half of the 20th century, and this impacted every sphere including SC. Although the country did not take part in either of the two world wars, events in Spain impoverished and isolated the country for decades. The century began with a recently restored constitutional monarchy, but 1923 saw a coup d’état and the monarchy joined the dictatorship of Primo de Ribera until 1930. After a year of provisional government, the Second Republic was installed in 1931, only to be followed by a bloody civil war from 1936 until 1939. In 1939 the dictator Francisco Franco took control and dominated the country’s history for nearly

40 years. The countries that participated in World War II had difficulties in recovering, but for Spain things were even worse. The country was on its knees and its people divided by the Spanish Civil War. The political regime was based on 'autarchy' (self-sufficiency) but implemented no serious plans for the country's recovery, at least in its early decades, and the international community ceased providing support. The country was ravaged by poverty and famine, and most of its people were illiterate. Repression (both moral and political), curtailments of rights (both social and labour) and international isolation marked this period, especially during the dictatorship's early years. Many scientists emigrated, mainly to France and Latin America.

During the autarchy, scientific institutions founded before the Spanish Civil War were reopened, but research barely opened up to the new knowledge and disciplines that were emerging on the international scene. The same was the case with the country's universities. Management of scientific and academic institutions, as with all other strategic fields, was dominated by the military, certain families (those on the winning side of the Civil War) and the religious movement known as Opus Dei, of which Franco was a supporter (Sanz Menéndez and López García, 1997).

Towards the end of the 1950s, the regime began opening up to the outside world. Its last three Development Plans (between 1964 and 1975) were the key to jump-starting Spain's economic recovery. Amongst other strategies, they included clear investment in science, technology and industry, albeit only in some disciplines, industrial sectors and cities. In the 1970s, the country began to reap the economic benefits of tourism. It experienced some economic growth (in a period known as *desarrollismo* or 'developmentism'), even if it was at a rate far below that of countries such as the United Kingdom, Germany or France.

Nevertheless, Spain's science system had to wait for five closely interrelated events in order for great change to occur:

1. the definitive end to the dictatorship in 1975 following Franco's death, and the start of democracy
2. the transfer of some powers from the Spanish State to the country's autonomous communities, which had begun to be constituted towards the end of the 1970s
3. the country's entry into the European Union in 1986
4. the first Law on Science that for the first time regulated science activities and researchers' careers
5. Spain's first National Research and Innovation Plan, in 1988.

The effect was significant. Democracy facilitated entrance to the European Union, and consequently Spanish science became internationalised and able to access European funding. The Spanish autonomous communities implemented their own research, development and innovation (RD&I) plans. The Ley de la Ciencia [Spanish Law of Science] contributed to the professionalisation of research and access to regular funding. Spanish science entered the international circuit, becoming increasingly competitive. Between 1981 and 2003 the number of scientific publications indexed in ISI with Spanish authors increased from 3,382 to 24,737; and the investment in RD&I rose from 0.43 per cent to 1.1 per cent of GDP (Gómez et al., 2006). Research centres and universities, more productive in research but also competing more strongly among themselves, increased their communication to the media, through press releases and interviews, and mass media disseminated the achievements of Spanish scientists.

The 1990s and the first five years of the 21st century represented a period of great expectations for Spanish science: large science infrastructure was built, more resources were invested in research, and good working conditions attracted high-level scientists back to the country after they had left in search of greener pastures abroad, as part of the country's own 'brain drain'. This budgetary growth was halted by the economic crisis that began in 2007 and that has persisted in Spain, and its impact on the system was soon felt (Regalado, 2010). The new Law on Science of 2011, proposed a raft of actions to ensure that research is given enough resources and autonomy, but many of the key points have not been complied with and the Spanish science system remains economically weakened (Pain, 2013).

The history of SC in Spain closely mirrors that of science itself. Although the 1960s and 1970s had some journalists and communicators dedicated to the subject and the (sole) television station broadcast some science and nature programs, terms such as 'science communication' and 'the public communication of science' were practically unknown in the country. Expressions such as 'science journalism' and 'the museology of science' were on few lips prior to the last decade.

### **3. The role of mass media in the origin of modern science communication**

Well before the communication of research was an everyday activity of Spain's universities and research centres, the mass media were covering science news and the persona of the science journalist began to appear in the press and on television.

### 3.1. Newspapers and magazines

Ever since the press has existed it has featured news on science. For many years, scientists themselves commented upon scientific discoveries, and discussed conferences and visits by leading personalities. Occasions such as Einstein's visit of 1923, the 1929 Barcelona Universal Exposition and the arrival of humans on the moon were of particular importance in the dissemination of science news. In 1955, Manuel Calvo Hernando (1923–2012), later the undisputed pioneer of scientific journalism in Spain and Latin America, discovered his vocation for science by covering the world conference Atoms for Peace in Geneva. Calvo Hernando was known for his prolific journalistic work, but also for being one of the first who, with his books and lectures on scientific journalism, contributed to identifying it as a profession and an academic discipline. Later he played a role in professional associations in Spain and Latin America. Manuel Toharia, another pioneer of Spanish scientific communication, has said of Calvo that he was the 'inventor of scientific journalism' (at least in Latin America) (Toharia, 1999, p. 197).

The pace of developments picked up when newspapers created their first regular (usually weekly) science sections and supplements. In the 1970s, for example, a well-known television personality Manuel Toharia edited the science section of the newspaper *Informaciones*. In 1982, *La Vanguardia* published its first supplement dedicated to science, making it the first of the many Spanish dailies to do so in the 1980s and 1990s (Lopez and Olvera-Lobo, 2017). The supplements clearly showed how SC is the sum of events both great and small, of grand plans and coincidences. More specifically, they are closely intertwined with the history of *The New York Times*, the computerisation of the press in the 1980s and the personal trajectories of two childhood friends: de Semir and Wagensberg.

Between 1970 and 1975, *The New York Times* saw a severe decline in its readership and a significant fall in its advertising revenue due, amongst other reasons, to competition from television. The business initiatives taken to halt this decline included the creation of themed supplements to increase the news draw for potential readers, build loyalty bridges and open up new advertising markets. This included the creation in 1978 of *Science Times*, a weekly science section published every Tuesday. The supplement not only helped the paper overcome its crisis but also became a model to be followed by many other dailies around the world, making it one of the cornerstones of the consolidation of science journalism. In Spain, the first newspaper to follow the model of *The New York Times* was *La Vanguardia*.

*La Vanguardia's* vocation for scientific dissemination could be seen almost from the newspaper's beginnings. Its first issue was published in 1881 and Camille Flammarion made his first contributions in 1892 (Voltes Bou, 1988). Traditionally this daily, like others, commissioned famous doctors and scientists to comment on science (Roca Rosell, 2004). From 1962, it featured a weekly section on medicine, also edited by doctors. Such a section came as no surprise in a city boasting a long tradition in the medical and pharmaceutical sectors (Duran and Piqueras, 2006). At the beginning of the 1980s, *La Vanguardia* embarked upon the process of modernising its production system. Among those responsible for the renovation of the newspaper was the journalist Vladimir de Semir (one of the authors of this book chapter). In a providential conversation with his childhood friend Jorge Wagensberg, who directed the Science Museum of La Caixa Foundation (created in 1981), he understood that science could be a topic of great interest to the public. Wagensberg encouraged him to think about the idea of a specific section or supplement on the subject. De Semir convinced the newspaper's directors and 1982 saw the birth of *La Vanguardia* science supplement (de Semir, 2014). For the very first time, the person responsible for coordinating the paper's science news was not a scientist, but a journalist (Morales, 2007). The supplement was published until 1997 and its work in consolidating the position of science journalism in Spain has been widely acknowledged. In 1986, the Spanish National Research Council (CSIC) created the first Science Journalism Prize in Spain; *La Vanguardia* won the inaugural award.

Other leading newspapers had their own science sections or supplements in the 1980s. The *Futuro* [Future] section of *El País* was one of the most widely read, and at one point had a large group of staff journalists and outside contributors. It enjoyed widespread recognition (being awarded the CSIC Science Journalism Prize in 1987) and a long life. *ABC*, which, alongside *La Vanguardia*, is one of Spain's oldest dailies, had a science supplement and boasts a long history in covering science news (Lopez and Olvera-Lobo, 2017). Others, like *El Mundo*, also covered science and, particularly, health news. The boom in science supplements took place between the 1990s and the first five years of the 21st century. However, the financial crisis, exacerbated by the press's poor response to the growth of the internet, put an end to most science supplements in Spain as in other countries. With the closing of these sections, journalists covering science were moved to other sections or made redundant (some moving to institutional communication jobs). However, science sections and supplements had already had a decisive effect on the recruitment and consolidation of readers. Some were attracted by science and others became used to reading the information offered in these supplements

weekly: it was well worked, had good sources and were often accompanied by infographics with very good graphic support. This interest made the science news cease to be something strange and allowed them to progressively get into daily affairs, in the regular sections of the newspaper (de Semir and Revuelta, 2017).

Today, even though science (and especially medical and technology) news receives a lot of coverage in the press, neither native online newspapers nor those that began life offline boast amongst their workforces the number of specialist journalists they had at the end of the last century and the beginning of this one. Therefore, it is worth highlighting the case of the supplement *Tercer Milenio* [Third Millennium] of *El Herald*, which has survived for more than 25 years, first with weekly updates—on Tuesday, like *The New York Times*—and now with daily ones and a presence on social media networks (Perla Mateo, 2018). Their editor, Pilar Perla, was one of the first women journalists in Spain to head science sections in the press (previously, Malen Ruiz de Elvira had been responsible for *El País's Futuro*).

Science magazines also fostered the dissemination of science in Spain. The situation in the country is paradoxical. On the one hand, the number of science magazines and their readerships have always been smaller than countries with a greater tradition in the field, such as France and the United Kingdom, something that has led to the failure of a number of magazines that enjoyed a fleeting existence for a few years. On the other hand, Spain boasts a magazine with a presence comparable to that of the most popular magazines (such as *Hola*), something truly exceptional not only in this country but, indeed, anywhere in the world. We are talking of *Muy Interesante* [Very Interesting], which has not only survived for well over 30 years, being first published in 1981, but is also a leading voice on Twitter with more than 8 million followers. In a 2004 interview, its editor explained that the basis of the magazine's success was its use of suggestiveness, humour, inquisitiveness and even 'naughty' takes on science news (Islas, 2004).

Some of Spain's science magazines enjoying a longer life and now benchmarks in modern SC are *Mundo Científico* [Science World] (the country's version of France's *La Recherche*), published from 1981 to 2003, and *Investigación y Ciencia* [Research and Science], the country's oldest (first published in 1976). Some emblematic magazines have not only been sold in Spain, but also in Latin America. This reflects their authors' origins, often from both sides of the Atlantic. For example, the journal *Investigación y Ciencia*, in addition to content from *Scientific American* and its international editions, includes articles and original sections written by researchers from Spain and Latin America.

### 3.2. Television

Science has had little presence on television either during the dictatorship or the Spanish democratic era (Toharia, 1990). The first ‘face of science’ for many Spaniards was Lu s Miravittles who, between 1959 and the end of the 1970s, directed and presented science programs on TVE (including *Visado para el futuro* [Visa for the future], from 1963 to 1965). Radio experienced a similar trend: there were very few examples of radio programs specialising in science. It is difficult to find documentation about the pioneer science radio programs, but one of them was *Los progresos cient ficos* [Scientific Advances], conducted by Manuel Vidal, and broadcast for first time in 1941 (Guions de R dio Barcelona, n.d.).

The most successful television program was *El Hombre y la Tierra* [Man and the Earth], a wildlife and nature program broadcast weekly from 1974 to 1980 in a good timeslot. Directed by F lix Rodr guez de la Fuente, the program became so successful that many schools used it as teaching material for their natural science classes. It was also sold abroad, something unheard of for a program produced in a Spain that had only recently emerged from its international insolation (Salcedo, 2011; Alberich-Pascual and Aguirre Salmer n, 2015). But the director’s accidental death put an abrupt end to the series. The program’s success and its director’s popularity are truly exceptional, and all 181 episodes are still viewed today on the TVE website (RTVE, 1975).

The early 1980s saw the start of programming by the ‘autonomous broadcasters’ (i.e. the public television undertakings of the autonomous communities into which Spain is divided), and in 1988 the country permitted private television channels (from the end of the 1990s the number of channels, including pay television ones, would explode). TVE no longer enjoyed a monopoly. It has been said that ‘the appearance of competition in the Spanish television market encouraged the neglect and marginalisation of science programming aimed at the general public’ (Guti rrez Lozano, 2002). However, some autonomous broadcasters, such as those of Catalonia (TV3) and Andalusia (Canal Sur), featured science programming from the very start (Toharia, 1990). Canal Sur’s environmental information program *Espacio Protegido* [Protected Area] is one of the best-quality and longest-lived programs, on air for more than 20 years. One of the best-known television science programs was *Redes* [Networks], broadcast by TVE between 1996 and 2014 in a low-audience timeslot. Although the program dealt with important issues and enjoyed the input of top-class researchers, it also often featured pseudoscientific content, making it the butt of wide-ranging criticism amongst the scientific community and science communicators (Carmena, 2002). In all these years, science has had very little presence in television news (Le n, 2008; Francescutti, 2010).

The arrival of the internet in the mid-1990s and the advances in information and communication technologies have radically changed the ecosystem of scientific communication in Spain. Blogs, video platforms and other initiatives in social networks have as many followers as ‘traditional’ media. But the main change has to do not only with the competition from these initiatives, but also with the change that social networks have brought about in the distribution of information. The commercial algorithms on which this new distribution is based have affected the visibility of articles and journalistic pieces produced by the media (native or traditional), so these are in a continuous adaptation to the new rules of the game.

Here again is the connection between Spain and Latin America in the distribution flows that mark social networks and large digital platforms (Google, YouTube, etc.). Many of the major Spanish media have greatly increased the number of readers resident in Latin American countries, which further narrows the cultural divisions between these two worlds.

#### **4. Science centres and science museums**

Aside from the mass media and popular science books, the 1970s also saw SC finding a place in museums. Generally these were associated with former natural science collections (dead or inert) or with scientific/technical devices. The field was rounded off by the zoos and botanical gardens. Some had begun as a private initiative based on collections and curios, but had at some stage become public property and the responsibility of municipal governments or science societies and institutions, such as the CSIC. These museums have often been dubbed ‘showcases’, since their function was more to conserve and preserve heritage, and particularly to display it, rather than share knowledge or interact with visitors.

The first ‘interactive’ science museum (or ‘science centre’) in Spain was the Barcelona Science Museum, founded in 1981. It would later be rechristened CosmoCaixa to highlight the profile of the La Caixa Foundation, the bank foundation that created it and has ensured its position for almost 40 years as one of the city’s leading cultural centres and one of the world’s top science museums. Barcelona’s was similar to other ‘science centres’: opening at the end of the 1970s (and over the 1980s and 1990s in other parts of the world) with the emphasis on interactivity and a ‘please *do touch*’ ethos. The science centres, with the San Francisco Exploratorium as a precursor (inaugurated in 1969), also had in common their focus on the explanation of scientific concepts, so they did not need to contain collections or specimens

(Páramo Sureda, 2009). Instead, they contained exhibition modules created specifically with didactic and playful functionality, often based on the incipient computer and audiovisual technologies then proliferating.

However, Barcelona is characterised by its minimal reliance on information technology and its use of real objects, some highly valuable, in addition to those museum resources typical of a science centre (Wagensberg, 1997). Jorge Wagensberg (1948–2018), a physicist, directed the museum for decades and was also responsible for its renovation and expansion in 2004. He had a large influence on the design and planning of science centres that sprang up in the 1990s in Spain, Latin America, Europe and other parts of the world. His ideas on the role of museums in society led him to affirm that they should be the cathedrals of the 21st century (Wagensberg, 2001). Some idea of his international influence can be gained from the fact that for the first issue of the journal *Public Understanding of Science*, he was invited to be a guest author on science museums (Wagensberg, 1992). On his death in March 2018, the Association of Science and Technology Centers stated that ‘Jorge Wagensberg was not only a remarkable physicist, but a visionary in science communication who was able to see the importance and beauty of real objects and how to make them part of an interactive museum’ (Staveloz, 2018).

The year 1983 saw the creation of the Casa de las Ciencias [House of the Sciences] in A Coruña, an initiative of the city council, but under the clear leadership of Ramón Núñez. He was director for many years and was also behind the science centres created there in subsequent years (La Domus, the Acuarium Finisterrae and the MUNCYT Coruña), making this small Galician city a focal point of scientific communication.

Wagensberg and Núñez had differing visions of what science centres should be, but both were a great influence on the development and expansion of science museology from the 1980s. Just 15 years after the first interactive museum, those of Alcobendas, Tenerife, Murcia, Málaga, Las Palmas, Cuenca, Extremadura and Valladolid had opened or were about to open, along with Granada’s Science Park and the planetariums of Pamplona, Castellón and Madrid (Núñez, 1997). In 2009, the expansion of science centres had become a ‘gray tide’, where (as the Science Park of Granada Director explained) the term ‘tide’ refers to a trawling movement and ‘gray’ (instead of black in the popular expression ‘black tide’) indicates that what moves in this process is gray material—that is, intelligence, knowledge (Páramo Sureda, 2009, p. 250). This boom was not limited to Spain: other countries saw a similar tale, showing the cross-fertilisation typical of the modern globalised world. In the same period, traditional museums reacted, modernising themselves

and introducing interactivity and more participative activities in their programming. Today, the boundaries between the ‘old-school’ traditional museums and the ‘new’ interactive ones have become blurred.

The year that saw the start of the economic crisis also, paradoxically, marked the greatest celebration of science that Spain has ever seen: ‘2007, the Year of Science’, an initiative that witnessed the start of the country’s Science and Technology Museums Network. By 2016, this network was made up of 24 entities of varying types (López García-Gallo, 2016), a figure that shows the scale of the activities in the sector. Since the start of the crisis, growth has slowed and investment fallen off, despite the fact that many centres have become a core asset in the teaching of science and become some cities’ key cultural and even tourist hotspots (Páramo Sureda, 2003; Pérez and Gómez, 2011; Revuelta, 2014).

## **5. Key science communication events and associations**

The first SC meeting in Spain was held in Madrid in 1958, as part of the XXIV Luso-Spanish Congress for the Progress of Sciences (Avogadro, 2005). The first big SC encounters to take place in Spain were closely associated with Manuel Calvo’s trips to Latin America and his relationships with science journalists. By the 1960s there had already been debates on science journalism in countries like Chile and Ecuador. Manuel Calvo and Aristides Bastida founded the Asociación Iberoamericana de Periodismo Científico [Iberoamerican Association of Scientific Journalism]. After the first conference of this association in Caracas in 1974, Madrid hosted the second conference in 1977. In 1973 the Asociación Española de Periodismo Científico was created (also presided over by Manuel Calvo). The organisation, now named the Asociación Española de Comunicación Científica (AECC) [Spanish Science Communication Association], has seen impressive growth over the last 10 years, and now (as of 2018) boasts more than 400 members. Its president is currently Antonio Calvo Roy and it is a member of the European Union of Science Journalists Association (EUSJA) and the World Federation of Science Journalists (WFSJ). The year 2018 saw the association returning to the Ibero-American spirit that characterised its beginning.

Despite these pioneering encounters of the 1970s and 1980s, real growth in SC in Spain did not take off until the 1990s and, above all, in the 21st century. Barcelona, La Coruña and Granada, apart from Madrid, were particularly active in this field. The year 1990 saw the creation of the

Associació Catalana de Comunicació Científica (ACCC) [Catalan Science Communication Association], founded by a large group already very active in the field in Catalonia (media journalists, science popularisers and institutional communicators, in the main). ACCC has had six presidents since then, two of them women (Mercè Piqueras and Cristina Ribas), something always worth highlighting in a world where much work is still to be done in terms of gender equality. Again in 1990, Barcelona hosted the International Symposium on Science Journalism, organised by the Dr Antonio Esteve Foundation, a non-profit organisation that has always played a very active role in promoting science communication.

In 1991, the CSIC headquarters in Madrid hosted the second conference of what would formally become known as the Network for the Public Communication of Science and Technology, or PCST Network. At the time, the group did not have the statutes or the organised structure it has today but was rather an informal network of professionals and academics interested in sharing experiences, highlighting the value of SC and, above all, looking to the future. The first PCST Network event took place in Poitiers in 1989 (Fayard, Catapano and Lewenstein, 2005), and the idea behind the initiative came from Pierre Fayard, then a professor at the city's university. This made Fayard, whose doctoral thesis was entitled 'L'émergence médiatique et la professionnalisation de la communication scientifique à destination des non-spécialistes' [The emergence of the media and the professionalisation of scientific communication aimed at non-specialists], one of the network's founding fathers. Vladimir de Semir would, after the Madrid conference and, above all, that in Montreal in 1994, play an essential role in the network's consolidation and in its promotion in Spain and Latin America (the presence of Spanish speakers at all its conferences is notable). Spain is the only country to have hosted PCST conferences twice: Madrid in 1991; and, in 2004, Barcelona welcomed more than 700 participants to the eighth conference, hosted by the Barcelona City Council and Pompeu Fabra University (de Semir and Revuelta, 2004).

The last international meeting of the 1990s was the first conference on the Social Communication of Science, held in Granada in 1999 and organised by the Parque de las Ciencias, UNESCO, the University of Granada, the Government of Andalusia and CSIC. In this case, participants hailed from Spain and many other Latin American countries. The conference was a great success, leading to its being held again in different cities in subsequent years. The AECC has, since the 10th conference (in 2017 at the University of Cordoba), been the entity responsible for organising this international event. Other SC conferences held regularly in Spain and dealing with the profession are Campus Gutenberg, organised by the Pompeu Fabra University –

BSM (since 2011); Ciencia en Redes [Science in Social Media] (since 2012), currently organised by the AECC; and the Jornadas de Divulgación Innovadora [Innovative Outreach Meetings], organised by Zaragoza Foundation of Knowledge (since 2013).

One cannot close this section without mentioning the events and celebrations of SC directed to the public. One of the oldest and longest-lasting celebrations is the Biology Week of the University of Murcia, launched for the first time in 1987 and celebrating 31 years in 2018. As in other European countries, in the 1990s some autonomous communities (in Catalonia since 1995) started celebrating Science Week. In 2001, the Spanish government extended the celebration throughout the country, coinciding with the creation of the Spanish Foundation for Science and Technology (FECYT). FECYT is a public agency dependent on the Spanish government with two missions: to encourage Spanish research and its communication. Both the FECYT creation and the nationalisation of the coordination of science week occur in a political context in which dissemination and communication were being promoted by the Spanish government itself, an administration that until then had shown little interest in science communication promotion. The ministry on which science depends (sometimes the Ministry of Science, at other times the Ministry of Education) had not clearly engaged with scientific communication until then. In 2004, the Spanish government issued a public call for scientific communication and dissemination actions for first time, in the form of a national program like the rest of the competitive calls for research grants (Comisión Interministerial de Ciencia y Tecnología, 2003). This new funding source stimulated the proliferation of communication and outreach activities in the country, especially from universities and research centres. In 2007, the impact of such funding was decisive, as we will see below. The Spanish government, therefore, joined SC late, but when it did, its contribution was decisive.

The biggest celebration on science that has taken place in Spain was named '2007, El Año de la Ciencia' [2007, the Year of Science]. Here again, coincidences and personal stories would have a lot to do with the development of events. During his time as councillor of the City of Knowledge, in the City Council of Barcelona, Vladimir de Semir with Gema Revuelta (also one of the authors of this chapter, and at that time Director of Scientific Culture at the Barcelona City Hall) devised the initiative '2007, Barcelona Year of Science'. De Semir proposed to the Secretary of State for Science of the Spanish government that the initiative be extended throughout Spain. Both had known each other for years, since they directed the two pioneering scientific communication master's degrees (Revuelta, 2007). The celebration was endowed by the Spanish government with an unprecedented budget for

universities and research centres to carry out scientific dissemination activities throughout the year. In addition, for the first time a call was opened for these entities to hire personnel for communication and science promotion in what were called Units of Scientific Culture and Innovation, or UCC + I (units that, since then, have been fundamental in the dissemination of Spanish science). The Spanish Network of Science Museums was created during the Year of Science, as well as a network of local administrations active in SC. The Year of Science is considered a moment of inflection in the country's scientific communication (Lopez and Olvera-Lobo, 2017). This celebration, together with the initiatives led by the FECYT and the national funding programs for the promotion of scientific culture, added to the activities that had been developing since the previous decades, acting as a trigger for those who had not yet started and as a multiplier for those who had long careers.

From 2007 on there are numerous initiatives in scientific dissemination that focus on a mass-event format. The Naukas science festival in Bilbao, related to the blog with the same name organised from the project of Miguel Artime, Antonio Martínez and Javier Peláez (since 2011), is one of the most popular events. The Spanish version of the Famelab contest, organised by the FECYT (since 2012) and the performance of a group of comedian scientists called Big Van Ciencia (since 2013), are also widely publicised.

## 6. The role of universities and research centres

Universities have played an essential role in the expansion and consolidation of scientific communication. Their influence has been exercised at three levels: research, training and communication.

Scientific communication as a field of research does not appear until the 1990s. However, since the 1970s we can find books and research papers on scientific journalism. Manuel Calvo Hernando is the forerunner in the analysis of this topic (Moreno Castro, 2002) and probably the most cited author in Spain and Latin America in the early decades. Despite his influence on academic research, Calvo Hernando published most of his work outside the university (Calvo Hernando, 1977, 1982, 1999), since it was not until the mid-1980s that he began teaching at San Pablo University-CEU.

In the bachelor's and postgraduate degrees in communication and journalism, it was rare to include subjects of scientific journalism. Research groups focused on these topics have not abounded either, and until the 1990s there is very little literature on SC. The first doctoral thesis in scientific journalism is defended by María Alcalá Santaella Oria de Rueda at the Complutense

University of Madrid in 1992. Two other PhD theses followed at the same university, in 1992 and 1994 (Moreno Castro, 2002). During the second half of the 1990s several theses were presented in different universities. Manuel Calvo himself defended his in 1999, at the age of 75 years.

The first university centre in Spain dedicated specifically to scientific communication was the Observatory of Scientific Communication of the Pompeu Fabra University (UPF), founded in 1994. The centre soon became a reference for SC in Spain, publishing the first academic journal in Spanish specialised in SC: *Quark, Science, Medicine, Communication and Culture* (1995–2007). The UPF also launched the first SC master's degree. It played a fundamental role in the international projection of Spanish SC, being the first university group in the country to participate in European SC projects (The ENSCOT Team, 2003) and to publish in the first international journals of the field (Ribas and Cáceres, 1997). The Observatory of Scientific Communication inspired the creation of other similar centres in Europe, and was an initiative of Vladimir de Semir, professor of scientific journalism at the UPF since 1992. De Semir directed the centre for almost two decades with Gema Revuelta, the sub-director. In 2014 both left the observatory and created the Science, Communication and Society Studies Centre, also at the UPF (CCS-UPF). This time Gema Revuelta directs the centre, while de Semir is the chair of both the Social Council and Scientific Council of the Center of Studies on Science Communication and Society. The CCS-UPF continues and extends the research and training projects that both have led for two decades.

In the University of Valencia, a specific course in science and technology for students of journalism was launched at the beginning of the century (Moreno Castro and Gómez Mompert, 2002). Carolina Moreno is responsible for the course and is one of the first professors specialised in scientific journalism in Spain (along with Carlos Elías, from the Carlos III University of Madrid). The University of Valencia has also been a reference in the SC for other reasons. Thus, if *Quark* had been the first journal on SC in Spanish, the magazine *Mètode* from this university was the first one of its type in Spain (although originally it was only published in Catalan). Directed by the biologist and writer Martí Domínguez, it celebrated 25 years in 2017 and is currently published in Catalan, Spanish and English. At the beginning of the 21st century, the first professorships dedicated to the SC emerged. The first ones started at the University of Valencia (2002), followed by the University of Valladolid (2005), the University of Girona (2008), the University of Zaragoza (2009) and the University of Basque Country (2010) (Lopez and Olvera-Lobo, 2017).

Universities have also played a fundamental role in training in scientific communication for new generations of professionals. UPF launched the first master's degree in scientific communication in Spain in 1995, a program that has been offered continuously since then and that now has two simultaneous versions (on-site and one online) (de Semir, 2009). Another of the pioneering universities is the University of Salamanca, whose master's degree, directed by Miguel Ángel Quintanilla, was offered for the first time in 1998. During the first decade of the 21st century, other universities offered similar training (master's or postgraduate courses), such as the University of Valencia, the Carlos III University of Madrid, the National University of Distance Education, the University of Oviedo etc. (Lopez and Olvera-Lobo, 2017). However, after a period of boom, excessive competition and the economic crisis caused a number of these training programs to close. At the moment, only six universities offer SC training in the form of master's degrees.

During PhDs or master's degrees on science topics, it is not unusual to include workshops or courses on communication skills, relations with the media or other issues related to SC. However, it is unusual in undergraduate studies. In this sense, UPF was also a pioneer for including a subject of scientific communication in the curriculum of a bachelor's degree in science. Since 1998 the bachelor's degree in human biology includes the subject 'scientific communication', in which students not only learn how to improve their communication skills but also undertake public engagement activities and learn to design, organise and evaluate them. Some other bachelor's courses offer communication courses, but not many.

Finally, it is necessary to explain the role that universities have played in communicating their own research. This experienced a first impulse from the internationalisation of Spanish science at the end of the 1980s, and also later when universities were competing to attract the best students. The universalisation of schooling in Spain, coinciding with the generation of the baby boomers, produced a massive influx of students to the university classrooms in the 1970s and 1980s. One of the first bachelor's degrees to impose an access limit was medicine (since 1979 only students with very good grades can register). During the 1980s this practice was extended to all areas of knowledge, so that at the beginning of the 1990s all universities competed to be chosen by the best students (the system is mainly public). Faced with this new situation, universities were forced to improve their communication strategies. They soon discovered that research carried out by the professors is one of their main assets to 'sell' their institution to the general public. The large universities expanded their institutional communication teams to include people specialised in research dissemination, and graduates trained in scientific communication with master's degrees had an excellent reception. The scientific

journalists affected by the staff reductions of mass media also found new jobs in institutional communication. Small universities were encouraged to join this trend when the Spanish government created a fund for the establishment of Units of Scientific Culture and Innovation in 2007. This transformed the landscape of science communication in Spain.

At present, practically all Spanish universities and research centres carry out scientific communication in one way or another. Some are limited to sending press releases and publishing their research news through their different channels (websites, social networks, university digital publications or even radio stations and TV channels). Others, in addition, organise outreach, public engagement or authentic participatory activities. Many research groups also carry out their own public engagement actions (especially those that participate in European and international projects).

The growth of communication that emerges in universities and research centres, together with the experimentation around new more participative formats (such as citizen science initiatives, hackathons, social labs, etc.) have been one of the main transformations of communication of science in Spain in the last decade.

It is difficult to anticipate what will happen in the future, but if the trends that we observe today continue, we can expect that universities and research centres will intensify and professionalise their science communication activities, gaining more presence in the public sphere both by their online communication and by the organisation of face-to-face events. In parallel, some other sources of information (pseudotherapy and fake-news promoters, for instance) could also expand their visibility because algorithms that regulate social networks and big online platforms (i.e. Google, YouTube) tend to favour them.

Paper-only newspapers and magazines will tend to disappear, while it is not possible to predict what will happen with online newspapers and television channels. They need to solve their business models without damaging their editorial content quality, but it is a hard task with a distribution highly dependent on commercial algorithms.

Finally, we can expect that science communication research will continue growing and that Spanish researchers in this field will be more present on the international sphere.

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## Timeline

Event	Name	Date	Comment
First interactive science centre established.	Barcelona Science Museum (now CosmoCaixa)	1981	Later rechristened CosmoCaixa in 2004
First national (or large regional) science festival.	Feria de la Ciencia is the largest and longest science festival in Spain (apart from Science Week)	2003	Organised by Sociedad Andaluza para la Divulgación de la Ciencia and Fundación Descubre

Event	Name	Date	Comment
An association of science writers or journalists or communicators established.	Asociación Española de Periodismo Científico [Spanish Association of Scientific Journalism]	1974	Now named the Asociación Española de Comunicación Científica (AECC) [Spanish Science Communication Association]
First university courses to train science communicators.	Master's degree in scientific, medical and environmental communication, at Pompeu Fabra University – BSM (UPF BSM)	1995	A professional master's degree for graduates with a multidisciplinary background (communication, science, etc.) and a one-year degree (400 teaching hours)
First master's students in science communication graduate.	Master's degree in scientific, medical and environmental communication of Pompeu Fabra University – BSM (UPF BSM)	1995	A professional master's degree for graduates with a multidisciplinary background (communication, science, etc.) and a one-year degree (400 teaching hours)
First PhD students in science communication graduate.	Maria Alcalá Santaella Oria de Rueda	1992	In scientific journalism, at the Complutense University of Madrid
First national conference in science communication.	The first documented SC meeting in Spain was held in Madrid	1958	Part of the XXIV Luso-Spanish Congress for the Progress of Sciences
National government program to support science communication established.	Spanish Foundation for Science and Technology (FECYT). Public agency dependent on the Spanish government with two missions: to encourage Spanish research and its communication	2001	2004: For the first time the Spanish government issued a public call for proposals for scientific communication and dissemination, and in the same manner as other disciplines
First significant initiative or report on science communication.	A series of books and papers on scientific journalism, primarily by Manuel Calvo Hernando	1970s	Manuel Calvo Hernando is probably the most cited author in Spain and Latin America in the early decades
National Science Week founded.	Science Week in Catalonia	1995, 2001	Late 1990s: The week was celebrated by other autonomous communities 2001: Spanish government made it a national event
A journal completely or substantially devoted to science communication established.	<i>Quark, Science, Medicine, Communication</i> and <i>Culture</i> published by the Pompeu Fabra University (1995)	1995	

Event	Name	Date	Comment
First significant radio programs on science.	Los progresos científicos [Scientific Advances] from Radio Barcelona	1941	Conducted by Manuel Vidal
First significant TV programs on science.	Visado para el futuro [Visa for the future]	1963	From 1963 to 1965
First awards for scientists or journalists or others for science communication.	Science journalism prize awarded by the Spanish National Research Council (CSIC)	1986	<i>La Vanguardia</i> newspaper received the first award because of its supplement dedicated to science
Date hosted a PCST conference.	Spain is the only country to have hosted PCST conferences twice: 1991 Madrid, 2004 Barcelona	1991, 2004	Madrid hosted the second conference (organiser CSIC) 2004 Barcelona hosted the eighth conference (organiser Pompeu Fabra University)
Other significant events.	First subject of scientific communication in the official curriculum of a scientific degree	1998	Human Biology, Universitat Pompeu Fabra
	The biggest national celebration on science was 2007, El Año de la Ciencia [2007, the Year of Science]	2007	This began at the City Council of Barcelona and was later supported by the Spanish government and then extended throughout Spain

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