Perceptions of science in Catalan society

Cristina Ribas and Johanna Cáceres

Public Understanding of Science 1997; 6; 143
DOI: 10.1088/0963-6625/6/2/003

Public Understand. Sci. **6** (1997) 143–166. Printed in the UK PII: S0963-6625(97)81796-1

Perceptions of science in Catalan society

Cristina Ribas and Johanna Cáceres

The project 'Perception of Science by Catalan Society: Sociological study 1995' used a questionnaire to determine: the level of interest in science among Catalans; which channels the public uses to find out about scientific matters; attitudes towards science as an element of culture; the level of scientific knowledge of the Catalan population; and the sociological profile of the population according to its level of scientific culture. Compared with the results of a similar study carried out in 1989, knowledge and interest in science in the Catalan population has increased, and may be connected to the increase of the portion of the population with secondary or university education. Although interest has increased among women, those with highest levels of 'scientific culture' are well educated, socially active young men. Other socio-demographic features and patterns of media use suggest that more effective diffusion of scientific information might be achieved if particular types of information were aimed at specific groups through particular media.

Introduction

Scientific activity, both as its technological application and as basic research, has a notable impact on social and economic life. Investment in R&D is currently one of the measurements of the competitiveness of a specific community. Moreover, investment in technical-scientific research and the transfer of its results to industry and to consumption are greatly influenced by the level of scientific culture of the population in which it takes place, since this is the element which shapes the degree of social acceptance of specific practices, innovations or changes.

Interest in the public understanding of science has increased in Western societies over recent decades: it is considered to be of value in democratic societies, and something on which their future development in part depends.[1] This interest from public and private institutions, as well as from academic areas such as sociology and media studies, has been reflected in various multidisciplinary studies where the object of the research tends to be quite clearly defined: it often surveys the perceptions (images, knowledge, interests and attitudes) of the general public in relation to the actors involved in science and technology (the scientific community), in relation to the results of their activities (theories, images, applications), and in relation to their impact on culture, social institutions and nature.[2] This kind of survey has been carried out mainly in the United States, and subsequently in Europe and Japan. Despite the fact that the focus has evolved in both space and time, the

0963-6625/97/020143 + 24$19.50

general lines have not undergone major variations. This is because, in some cases, it has been of interest to maintain the format of a series of studies over time which, in spite of its shortcomings, allows changes to be observed. In other cases, it has been necessary to conserve the format in order to make comparisons between different cultures. The present study is thus a survey within the framework of this area of research, and is the continuation of an initial survey study carried out six years ago.[3]

Objectives

The objectives of the study reported in this paper, which was entitled 'Perception of Science by Catalan Society: Sociological study 1995',[4] were:

(a) To determine the level of interest in science within the general framework of media information; and to catalogue the different subject areas of science and arrange them by level of interest.
(b) To determine which channels the public uses to find out about scientific matters; and to assess the effectiveness of the different media in spreading scientific knowledge.
(c) To assess attitudes towards science as an element of culture. It is interesting from an explanatory point of view to recognize the fact that people have different attitudes to science, just as they have to many other aspects of their lives. It is therefore probably necessary to design different strategies to diffuse scientific knowledge depending on the different attitudes of the public.
(d) To determine the level of scientific knowledge of the Catalan population.
(e) To determine the sociological profile of the population according to its level of scientific culture, with a view to designing planned strategies of action for the diffusion of scientific knowledge.

Methodology

This type of research has traditionally been approached through surveys of the population to be studied, so that it is representative for the demographic and cultural characteristics considered relevant.

Between 19 and 29 June 1995, a survey was carried out by means of telephone interviews with members of the Catalan public aged over eighteen years. A sample of 800 people was established, with quotas of age, sex and place of residence, with random distribution (margin of error ± 3.5 per cent for the overall data, with a confidence level of 95.5 per cent on the assumption of maximum uncertainty where $p = q = 50$ and $K = 2$). Those quotas were distributed in the sample so as to reproduce the actual composition of Catalan society, as it is statistically defined by the Catalan National Census. The proceedings of the fieldwork did not influence the structure of the sample. Once a call was made and somebody picked up the phone, he/she was asked, for example, whether a man aged over 64 lived at that address. If the answer was negative, another phone number from the same area was tried.

The questionnaire used was based on a UK survey published in 1989.[5] However, some modifications were introduced to accommodate the objectives of the present study. This is why not all the questions are subject to comparison. Despite this, a large part of the questionnaire was unchanged to allow for comparison of the most important aspects.

Results

Socio-demographic profile

Although the socio-demographic data was already defined by the quotas used to design the sample, there is one aspect which is essential when it comes to explaining the results regarding the population's interest in and knowledge of science. This criterion is the level attained in formal education. The relationship between the level of education and the interest in and knowledge of science has been mentioned by various authors, who at the same time point out the importance of primary and secondary education as a generator of attitudes and interests favourable to scientific activity.[6] Although, even now, over 50 per cent of the Catalan population has only primary education or lower, the percentage of people without formal education has diminished by twelve percentage points since 1989, and the group with secondary education has increased from 18.6 per cent to more than 32 per cent over these six years.

This increase in the average level of education of the Catalan population has not been uniform for all age groups. Half of university graduates and those who have completed secondary school are under 34 years of age, and 88 per cent of people without formal education are over 50, as shown in Table 1. (The data in all tables is expressed as percentages, and bold type means statistical significance above the mean.) In Spain, compulsory free education did not become generally available until the 1970s, with the implementation of the Ley General de Educación (General Education Law). Thus young people have a higher level of formal education than their parents. There is certainly a divide between an older, less academically educated population group and a younger, better educated group, at least as regards theoretical knowledge, as will be seen below. Nevertheless, the increase over these six years in the number of young people with formal education can be interpreted, in the Spanish context, as a confluence of precarious labour conditions among this group and the increasing demand for training on the part of employers, in both the public and private sectors.

Table 1. Level of education in Catalan society.

Ages	Total	Education			
		None	Primary	Secondary	University
18–24	14.7	1.3	5.4	**26.5**	**23.1**
25–34	19.5	–	10.8	**30.0**	**32.3**
35–49	25.6	10.3	28.9	25.4	26.9
50–64	21.9	**34.6**	**31.3**	11.9	10.0
65+	18.3	**53.8**	**23.5**	6.2	7.7
Base:	800	385	332	260	130

Interest in science

The media are the main channels for the diffusion of information on various subjects, and science is no exception. In this respect, science is an 'information product', and its place in the information market will basically depend on two factors: the interest of the audience—reader, listener or viewer—and the adaptation of the media products to the demands of this audience. For this reason, it was considered important to discover the place occupied by

science in relation to other 'information products' such as culture, economy, politics, sport and human interest (this section is called 'Sociedad' ('Society') in Spanish papers). Two types of questions were used for this:

(a) Open question: in reply to the question 'With regard to questions linked to information, in which subject or subjects are you most interested?', the interviewees answer, without any suggestions from the interviewer, with the first thing that comes to mind. This identifies the unconditionally interested groups of people, i.e., the most probable consumers of information products related to the subjects mentioned spontaneously. Therefore, these answers were interpreted as 'spontaneous interest'. Field researchers, i.e., the people who made the phone-calls, were provided with a list of topics they were to use to classify the answers of the open questions. The list was the same as the classifications used in the closed question (see below), but was a little more detailed. The topics were: 'politics', 'culture', 'science', 'sport', 'economy' and 'human interest'; 'medicine and health' and 'the environment' were also included, as was 'specific geographic area'. This last topic included answers such as 'I am interested in international/local/national news'.
(b) Closed question: in reply to the question 'How interested are you in the following subjects?', the interviewees rate on a predetermined scale (not at all, not very much, average, fairly, very) their own interest in the subjects which are proposed to them. In this case, the reply does not identify the groups of 'faithful' for the different subject areas, but shows the level of interest of the overall population in each of the subjects. This is what is referred to as 'suggested interest' in this study. The percentages of people interested are always higher when the question is closed or suggested.

The results for the two types of questions, and the evolution in interest since 1989, are shown below.

Spontaneous interest

Politics is the subject most frequently mentioned in response to open questions, being the main concern of 28 per cent of Catalans. A quarter of the population does not have any specific preference, and 13 per cent are fairly or very interested in sport. Science occupies third place in this ranking, with 10 per cent interested. In other words, science interests the Catalan population more than the economy, culture, accident and crime reports, the job market or education (Table 2).

Compared with 1989, the areas of information in which interest has grown most were science, the environment and medicine, whereas it has decreased in all the others except politics (Table 3). Interest in scientific matters rose by 10 percentage points in comparison to 1989. Information areas were classified in a slightly different way in the questionnaire used for the survey carried out in 1989, so a full comparison between the two years cannot be made. Nevertheless, the results obtained can be compared in percentages because multiple answers were possible (interviewees could mention as many areas as they wished). In 1989, the answers were grouped under the following headings: 'economy', 'sports', 'culture', 'politics', 'medicine and health', 'the environment'—the same ones used in 1995—and 'labour market', 'housing', 'terrorism' and 'crime and drugs'. This increase in interest is related to the higher level of education of a considerable part of the population. The increase in young women with secondary or university education is especially remarkable; over the same time period, the number of women interested in science has tripled. The increased interest in science is not, however, only achieved thanks to the demographic increase in the

Table 2. Spontaneous interest in issues related to media information. Respondents could give more than one answer.

Subjects	Total	Gender		Education			
		Men	Women	None	Primary	Secondary	University
Home politics	28.3	**32.7**	24.1	16.7	25.6	32.7	33.1
No preference	24.8	18.4	**30.6**	19.2	**31.9**	22.7	13.8
Sport	13.2	**23.1**	4.1	6.4	8.4	**17.3**	**21.5**
Science	10.1	11.7	8.7	5.1	7.2	12.3	**16.2**
Specific region	8.1	8.1	8.2	11.5	6.0	7.3	**13.1**
Business/economics	7.3	**10.9**	3.9	2.6	4.5	**10.0**	**11.5**
Culture	6.5	5.5	7.5	3.8	3.3	6.2	**16.9**
Human interest	5.8	4.9	6.5	5.1	4.8	6.9	6.2
None	5.0	3.9	6.0	16.7	6.3	1.5	1.5
Environment	3.9	3.4	4.3	2.6	2.4	**6.2**	3.8
Medicine/health	3.0	1.6	**4.3**	–	4.2	2.3	3.1
DK/DA	5.4	4.9	6.5	**5.1**	4.8	6.9	6.2
Base:	800	385	415	78	332	260	130

Table 3. Evolution of the spontaneous interest between people interested in science (1989–1995).

Subjects	Interested %	
	1989	1995
Home politics	26.9	30.1
Science	3.4	14.5
Sport	18.9	13.7
Economics	8.0	7.6
Culture	19.5	6.8
Environment	2.8	5.2
Medicine	1.6	3.2
	126	498

educated young population, but is detected in various age groups and at various educational levels. The influence of the media may have had a reinforcing or even stimulating role in this increased generalized interest.[7] As an example, the 'Ciencia y Tecnología' ('Science and Technology') supplement of the Barcelona newspaper *La Vanguardia* began publication in 1989. The surveys prepared by the newspaper itself showed, three years later, that interest in these subjects was more than notable.[8] This implies that a specific media product can create its own demand even if initial interest is non-existent and is not detected by traditional audience surveys.

Interest in science is in any case not distributed homogeneously among the population. The more education people have, the greater their interest not just in scientific matters, but in all subjects. In this respect, the high rating given by university graduates to science stands out. As for differences between the genders, men are slightly more interested than women, but women pay more attention to medicine and health. People living in the city of Barcelona show greater interest in all subjects than people in the rest of Catalonia, which is probably due to the greater cultural activity of the city which generates its own interest. There is one exception, however: interest in the environment in Tarragona exceeds the mean

for Catalonia by 5 points. This phenomenon is perhaps explained by the importance of the major petrochemical complex located in this area in the day-to-day life of the people of Tarragona.

Suggested interest

When different subjects are suggested to the interviewees, over half declare an interest in culture (75.5 per cent), science (62 per cent), the economy (57 per cent), and matters relating to human interest (57 per cent). On the other hand, sport and politics, which were the subjects which had the most faithful followers, only interest 48 per cent and 39 per cent of the population, respectively (Table 4). That is, science now occupies second place and interests two out of every three Catalans. This data represents an improvement in comparison to 1989, when science occupied fourth place in the information preferences of the population.

Table 4. Suggested interest in various areas of information. Human interest stories include social affairs, court affairs, etc. In Spanish papers this kind of news belongs to the section 'Sociedad' ('Society').

Interest	Subjects					
	Culture	Science	Economics	Human interest	Sport	Home politics
Interested	75.5	62.3	59.6	57.4	47.6	39.4
Not very/little interested	13.6	16.1	14.6	16.8	16.1	13.2
No interest	10.9	21.3	25.4	25.8	36.3	47.3
Mean	4.02	3.59	3.51	3.43	3.17	2.84
Base: 800	800	800	800	800	800	800

As detected with the open or spontaneous question, interest in science increases with the level of education, and women are less attracted to this subject than men (Table 5). In this respect, and as has already been shown on other occasions, strategies for spreading information have to take special care with the female sector of the market, which could become increasingly isolated from science, and especially from its most technological aspects.[9]

Table 5. Suggested interest in science. The mean is calculated on a base from 1 (not at all interested) to 5 (very interested).

Science	Total	Gender		Education			
		Men	Women	None	Primary	Secondary	University
Interested	62.3	64.4	60.2	51.3	54.8	**70.8**	**70.8**
Not very/little interested	16.1	17.9	14.5	7.7	15.7	16.5	21.5
No interest	21.3	17.1	**25.1**	**38.5**	**29.2**	12.7	7.7
Mean	3.59	3.68	3.50	3.04	3.37	3.85	3.94
Base:	800	385	415	78	332	260	130

Scientific areas of interest

The same methodology—open and closed questions—was used to analyse the degree of interest of the Catalan population in different areas of science. The areas or categories used were those proposed by Göpfert.[10] The science subject that attracts most interest is medicine, which is perhaps explained by the fact that women show an interest in it which they do not show in other subjects (the percentage of women interested is almost twice that of men). Nature is the second science subject in terms of numbers of people: one out of every four Catalans declares an interest. Between 11 and 15 per cent of the population spontaneously mentions pure science, the environment or technology. The other subjects (social sciences, space, and history of science and scientific policy) do not exceed 5 per cent (Figure 1). In short, it can be confirmed that men, people with secondary or university education and, in particular, those in the age range 30–50, are the most interested in any science subject. Women only show greater interest than men in two areas: medicine and nature (see Table 6). Younger people (aged 18–24) are more interested that the rest of the population in pure science, environmental matters, technology and the social sciences, whereas medicine is the most important for the over 50s, followed by nature.

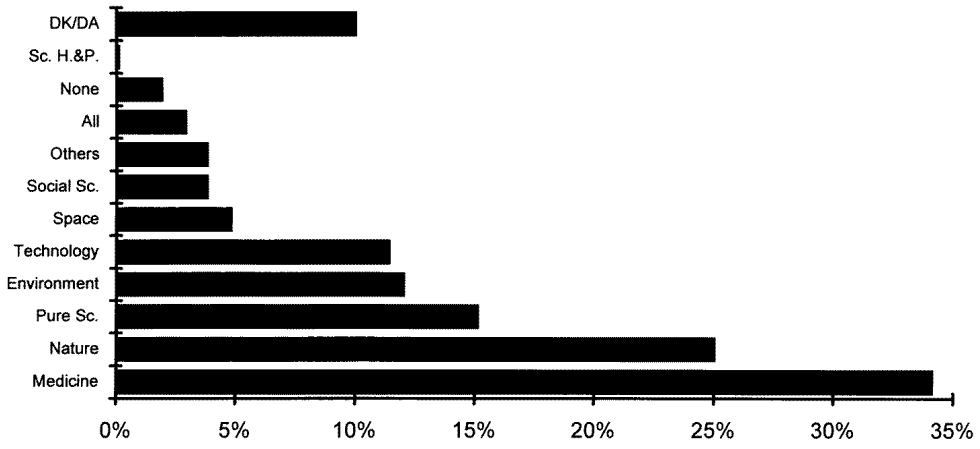

Figure 1. Interest in scientific subjects (% of respondents).

It should be said that, in comparison to 1989, the science area in which interest has increased the most is medicine (up 21 percentage points). Interest has also increased in technology, space and nature, while it has decreased in the environment. However, the procedures of the 1989 survey and the 1995 survey differ. In 1989 only people who stated their interest in science when asked the closed question were asked about their interest in specific scientific areas, whereas in 1995 the question was addressed to the whole sample. The 1989–1995 comparison had, then, to be made using the fraction of the sample that declared itself interested in science.

Interest suggested by area of science

The eight areas of science making up our classification were distributed in three groups, according to the interest shown by the interviewees when they were asked suggestively (‘From among the following subjects related to science, to what extent do they interest you?’, Table 7). In decreasing order, the groups are as follows.

Table 6. Which subjects related to science interest you more?

Subjects	Total	Gender		Education			
		Men	Women	None	Primary	Secondary	University
Medicine	34.1	23.6	**43.9**	26.9	34.0	**39.6**	27.7
Nature	25.0	25.2	24.8	25.6	25.6	21.9	29.2
Pure science	15.1	16.4	14.0	5.1	12.7	16.9	**23.8**
Environment	12.0	10.1	13.7	7.7	12.0	12.7	13.1
Technology	11.4	**19.2**	4.1	–	3.9	**18.8**	**22.3**
Space	4.8	6.5	3.1	3.8	4.5	4.2	6.9
Social sciences	3.8	4.7	2.9	1.3	2.7	3.8	7.7
Others	3.8	**5.2**	2.4	1.3	4.2	4.2	3.1
All	2.9	**4.9**	1.0	1.3	3.6	2.3	3.1
None	1.9	2.6	1.2	5.1	2.4	–	2.3
Science history/politics	0.1	0.3	–	–	–	0.4	–
DK/DA	10.1	6.5	**13.5**	**32.1**	**13.3**	3.8	1.5
Base:	800	385	415	78	332	260	130

Table 7. Suggested interest in scientific areas, for N = nature, E = environment, M = medicine, T= technology, SS = social sciences, Sp = space, PS = pure science, SHP = science history and politics.

	N	E	M	T	SS	Sp	PS	SHP
Interested	91.4	88.6	80.8	57.4	50.0	48.6	37.9	34.3
Not very/little interested	5.8	7.8	9.9	15.1	23.5	16.8	17.3	22.1
No interest	2.6	3.4	9.3	16.5	25.8	34.5	43.3	41.8
Mean	4.46	4.39	4.17	3.48	3.33	3.23	2.92	2.86
Base: 800	800	800	800	800	800	800	800	800

(a) Nature, the environment and medicine interest over 80 per cent of Catalans, and are the areas showing the greatest increase of interest since 1989. According to the tendency observed in the previous question, older people and women have a special interest in medicine, while this subject does not have any interest for 30 per cent of the population between 18 and 24 years old.

However, the levels of interest aroused by these three areas of science differ considerably, depending on whether the question is open or closed: when people are asked which types of scientific subject interest them most, those spontaneously mentioning nature, the environment and medicine amount to under a third of the sample. This difference could be explained by the fact that news items concerning these areas are not, in principle, perceived as matters relating to the world of science, but as having a social slant which links them more closely with the day-to-day life of the general public than with scientific activity. The fact that a high percentage of people with a low level of formal education state their interest in those three areas, but that this interest decreases in the other scientific areas, would reinforce this point, i.e., the interest is not spread homogeneously. The great popularity of nature, environment and medicine could be explained by their attractiveness to the large numbers of people with no formal education or only primary education, who are much less interested in other subjects. These areas are also those which appear with greatest frequency on television, the communication medium of greatest diffusion and the

one most commonly used by groups with a lower level of education.

(b) Technology, social sciences and space interest around 50 per cent of the population. There are, however, significant differences in the degree of lack of interest. Thus, 16 per cent of the population explicitly declares that technology does not interest them much or at all. For social sciences the figure increases to a quarter of the population, and one out of three Catalans denies being interested in space. There are also differences with regard to preferences for subjects by level of formal education (Table 8). The social sciences attract more than half of the population with no formal education or with only primary education, and technology attracts more than two thirds of those with secondary education. Technological issues, however, only interest a third of the population with no formal education.

Table 8. Scientific subjects of interest according to educational level.

Subjects	Total	Education			
		None	Primary	Secondary	University
Nature	91.4	91.0	93.7	91.2	86.2
Environment	88.6	85.9	90.7	89.2	83.8
Medicine	80.8	87.2	**87.7**	74.2	72.3
Technology	57.4	34.6	55.1	**65.0**	61.5
Social sciences	50.0	60.3	**54.2**	41.2	50.8
Space	48.6	35.9	48.5	52.3	49.2
Pure Science	37.9	21.8	40.1	37.7	42.3
Science history/politics	34.3	17.9	36.1	32.7	**42.3**
Base:	800	78	332	260	130

(c) Pure science, and scientific history and policy, only interest a little over a third of Catalans. That is, there are more people not interested than interested in these two areas.

Interest by type of scientific information

After analysing the place occupied by scientific subjects within the context of general information and assessing the interest of the population in the different areas of science, an analysis was carried out to see whether this interest in science is conditioned by the kind of scientific information offered by the media. Lewenstein has suggested three basic categories of science in the media,[11] which were those used for this study:

(a) Practical science. This is the type which affects day-to-day life most directly. For example, how to avoid illnesses, the practical use of technology, what everyone can do for the environment, etc.
(b) Scientific policy. This refers to the policy regarding and management of public resources destined for research and scientific and technological applications. This is the type of information necessary for people to be able to assess public investment in this field, i.e., which lines of research are promoted, the advantages of mass vaccination against malaria or Spain's participation in scientific research in the Antarctic, etc.
(c) Science as high culture. This is related, among other things, to the theories on the origin of the universe, the origin of life, relations between the components of an ecosystem, etc.

This section was composed of twelve questions distributed among four subject areas (the ozone layer, AIDS, telecommunications and genetic manipulation). Each subject area was examined in three questions, one for each of Lewenstein's categories. The questions are given in Table 9.

Table 9. Questions used in this chapter. Questions were mixed in the questionnaire.

Which one of these headlines interests you? ((a) practical science; (b) scientific policy; (c) science as culture)

Ozone layer
- (a) Air conditioning in cars is worse for the ozone layer than sprays
- (b) Spanish government wants to assess whether the ozone layer affects North Africa
- (c) A group of scientists proves that the proportion of ozone in the atmosphere has changed the evolution of life

AIDS
- (a) AIDS infection via heterosexual contact increased by 60% in Catalonia
- (b) Social welfare studies suggest possibilities of excluding the AIDS test
- (c) American scientists discover a new protein in the AIDS virus

Telecommunications
- (a) Shopping centres offer new shopping system by personal computer
- (b) Spanish telephone company has a new material to replace optical fibre
- (c) Every day millions of scientists communicate by computer

Genetic engineering
- (a) Genetic engineering allows distribution of vaccines to the population by eating fruit
- (b) Catalan parliament makes a law forbidding any genetic manipulation in Catalonia
- (c) Biologists have discovered more than 1000 human genes in two years

The main conclusion is that the subject focus has priority over the category of scientific information dealt with, and, indeed, no significant differences in interest are observed between the categories. Thus AIDS, a current issue relating to health which could affect people's day-to-day life, is the subject which arouses the most interest, independently of the focus. And telecommunications, which is perceived as a distant, cultural issue, irrespective of the specific aspect which is dealt with, appears as the least popular (Table 10).

Table 10. Mean interest according the type of scientific information, on a scale from 1 (not at all interesting) to 5 (very interesting).

Subjects	Total	Practical science	Scientific policy	Science as culture
AIDS	4.09	4.05	4.06	4.24
Genetics	3.69	3.83	3.66	3.53
Ozone layer	3.53	3.69	3.64	3.98
Telecommunications	2.85	2.25	3.02	3.41
Mean	3.54	3.45	3.59	3.79

Channels for diffusion of science

Once the interest of the Catalan population in science had been studied, we focused on the habits of the population as far as consumption of information products is concerned, and on the assessment that people make of the media, the main channels for diffusing science on a large scale.

Table 11. Which channels do you use to obtain information about scientific issues? Respondents could give more than one answer.

	Total	Gender		Education				Reads papers	
		Men	Women	None	Primary	Secondary	University	Yes	No
TV	66.1	59.2	**72.5**	**87.2**	**72.9**	63.1	42.3	53.8	**81.6**
Press	39.8	**48.3**	31.8	14.1	33.1	**45.8**	**60.0**	**55.2**	20.3
Science magazines	15.0	**19.0**	11.3	1.3	7.2	**20.4**	**32.3**	**20.2**	8.5
Books	12.9	14.8	11.1	2.6	11.4	15.0	**18.5**	**15.0**	10.2
Radio	11.4	8.3	**14.2**	**23.1**	**16.3**	6.2	2.3	9.0	14.4
Other magazines	5.3	4.4	6.0	3.8	4.2	6.2	6.9	7.0	3.1
Other sources	1.5	1.6	1.4	–	0.6	2.3	3.1	1.6	1.4
None	0.5	0.5	0.5	–	1.2	–	–	0.2	0.8
Conferences	0.1	0.3	–	–	–	0.4	–	0.2	–
Telematics	0.1	0.3	–	–	–	0.4	–	–	0.3
Publicity	0.1	–	0.2	–	–	0.4	–	–	0.3
Base:	800	385	415	78	332	260	130	446	354

Television is the medium most used by the overall population (66 per cent) to find out about scientific subjects, followed by newspapers and specialized publications (magazines and books), while radio is a source of scientific information for only 11 per cent of Catalans (Table 11). If we compare the data from 1989 with the 1995 data, the main conclusion is that the importance of the printed and specialized media has decreased, as has that of radio, whereas the importance of television has increased by more than 12 percentage points.

The type of channel used for information regarding scientific news is, like the majority of questions relating to science, greatly determined by the level of education. Firstly, the higher the level of education, the more diversified the sources of information. Secondly, the audiovisual media predominate among people with a low level of studies—a group which includes many women—and the printed media among people with secondary-level or university education. In fact, slightly more than half of the people who read a daily newspaper use television to find out about scientific matters, whereas for those who do not regularly read newspapers, the proportion reaches 82 per cent. In this respect there is a visible need to define specific strategies for diffusing scientific information for each of these different groups within the public, taking into account their level of education and the medium that they use to obtain information.

Of note is the fact that only ten people out of our sample of 800 used the Internet to obtain information on science, and all of them had secondary-level education (for university graduates, the Internet was not a source of information in 1995). Neither is attending conferences used as a way of obtaining information about science.

In comparison with 1989, television has become more important as a medium for obtaining scientific information (again, the basis for the comparison 1989–1995 regarding the sources of scientific information is restricted to those who declared their interest in science), although the patterns of consumption of media products by gender remain unchanged, i.e., women use television more than men, and more men use the press and specialist publications. At first sight, this increase in television viewing is surprising, bearing in mind that over these six years, the average level of education of the Catalan public has also increased. However, television currently offers more products relating to science than in 1989, which would help to explain its growth as a source of scientific information. In 1991,

commercial television began to operate in Spain, which has led to specialization on the part of the different channels, especially the second channels of public television. The effect of competition has been a greater number of programmes on science-related topics, especially nature documentaries.

Recollection of scientific news

With regard to the news which people find easiest to remember, one of the data to highlight is that the majority (53 per cent) of Catalans are unable to remember any scientific news. Of the 15 news items mentioned most often, six are related to medical subjects and five to the environment—which are, moreover, the science subjects most often covered in the media (Table 12). Given the spread of answers, the recalled news items were put together under a single topic provided at least 20 people mentioned them.

Table 12. 'What is the latest scientific news item(s) that you remember?' Respondents could give more than one answer.

	Total %	Gender		Education				Reads papers	
		Men	Women	None	Primary	Secondary	University	Yes	No
Medicine	7.0	5.7	8.2	6.4	4.5	8.8	10.0	8.1	5.6
AIDS	6.4	6.2	6.5	1.3	4.8	7.7	**10.8**	7.6	4.8
Technology	3.9	**6.0**	1.9	1.3	0.9	**7.7**	5.4	4.7	2.8
General space	3.8	**5.7**	1.9	1.3	1.8	**5.8**	6.2	**4.9**	2.3
Ebola	3.4	**4.7**	2.2	–	2.1	**5.4**	4.6	4.5	2.0
Genetics	3.4	4.2	2.7	–	1.8	5.0	6.2	**4.5**	2.0
Other	3.3	2.3	4.1	2.6	3.0	2.7	5.4	2.5	4.2
Patarroyo	3.1	**4.7**	1.7	–	3.0	2.3	6.9	4.5	1.4
Cancer	2.8	2.3	3.1	3.8	2.7	1.9	3.8	3.1	2.3
Environment	2.5	**3.6**	1.4	–	2.1	3.5	3.1	3.1	1.7
Nature	2.1	2.3	1.9	1.3	1.2	1.5	6.2	2.0	2.3
Ozone layer	1.8	1.8	1.7	–	2.7	1.9	–	1.8	1.7
Legal	1.5	1.6	1.4	–	0.9	1.5	3.8	1.8	1.1
Nuclear energy	1.5	1.6	1.4	3.8	0.6	1.5	2.3	1.3	1.7
Marine environment	1.1	1.8	0.5	–	0.6	1.9	1.5	1.1	1.1
General energy	0.9	0.3	1.4	–	1.2	0.8	0.8	0.7	1.1
Hubble	0.6	0.8	0.5	–	–	0.8	2.3	1.1	–
None	52.7	45.5	**59.5**	**78.2**	**67.8**	41.2	22.3	44.8	**62.7**
Base:	800	385	415	78	332	260	130	446	354

Among those people who explicitly declare their interest in science subjects, the percentage of no recollection decreases by 13 points, from 60 per cent in 1989 to 47 per cent in 1995. Moreover, the fact that there is a higher percentage of women who do not remember any news reflects the lower level of education of women in the population. On the other hand, among the women with higher education there are practically no differences with respect to the male average. This again leads us to suggest that a higher level of education is translated into a greater capacity for recollection. Parallel to this, regular readers of newspapers are capable of remembering news 18 points above those who do not read newspapers regularly. This fact is related to the higher level of education of the readers of newspapers, but also to the fact that recollection of printed news is greater than recollection of news transmitted audiovisually.

Greater interest in a subject could reasonably be assumed to lead to greater recollection. Thus, and in accordance with the data described in the previous section, men remember news items relating to technology and space better than women. Among university graduates, replies relating to AIDS increase, and among people with only secondary education, those relating to technology, space and the Ebola virus increase. The readers of newspapers also remember the news about space better than the rest of the population, in addition to news referring to the Colombian doctor Manuel Patarroyo, who has received widespread coverage in the Spanish printed media since the end of the 1980s.

The treatment and assessment of scientific information

As regards the Catalan population's perception of the products offered by the media, the majority consider that culture and science are given scanty treatment, economics and society are treated adequately, and sport and politics are given too much emphasis. In this respect, 68 per cent of Catalans believe that there could be better scientific information with a greater presence in the media (the 1989 survey did not consider this aspect) (see Figure 2).

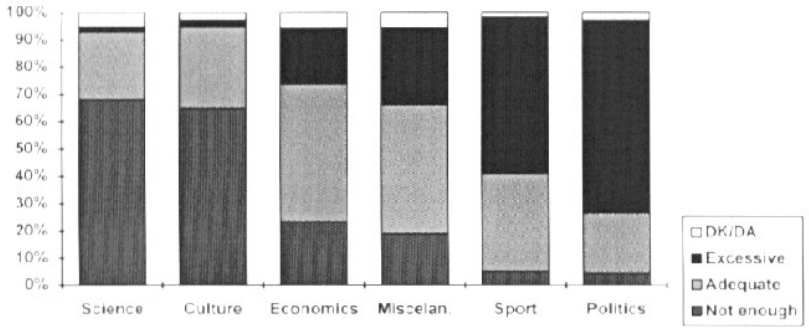

Figure 2. Media treatment of information products.

Table 13. In which way do you think that the media treats scientific information?

Science	Total	Gender		Education				Reads papers	
		Men	Women	None	Primary	Secondary	University	Yes	No
Not enough	68.1	**71.9**	64.6	47.4	59.6	**80.0**	**78.5**	**72.0**	63.3
Adequate	25.0	23.4	26.5	**34.6**	**28.9**	18.8	21.5	23.3	27.1
Excessive	1.5	1.0	1.9	2.6	3.0	–	–	1.1	2.0
DK/DA	5.4	3.6	**7.0**	15.4	8.4	1.2	–	3.6	**7.6**
Base:	800	385	415	78	332	260	130	446	354

The assessment of scientific information depends to a great extent on the possibility of understanding, as demonstrated by the fact that the groups with less education consider coverage to be adequate while the most highly educated think it is too low (Table 13). In general, though, science mostly has a positive, prestigious connotation: over 80 per cent of the population considers scientific information to be useful and necessary, and 79 per cent describes it as arousing curiosity. In spite of this, it is incomprehensible for almost 40

per cent of the population (including 21.5 per cent of the group with a university degree), and around a quarter of Catalans considers it to be boring and superficial. There are no significant differences by groups, except, perhaps, that almost a quarter of men consider it superficial. Boredom can be a factor when the explanation is simple and unsurprising and does not satisfy the expectations of new information. The way the information is presented is also fundamental in this respect: perhaps the method used for diffusion of science is not the most suitable for attracting the younger sectors of the public, or those with a shorter attention span. The concept of superficiality is, therefore, closely linked to the foregoing: an explanation is superficial because it does not thoroughly examine the subject, i.e., it does not offer new information or it does not offer sufficient information for it to be comprehensible. In short, this suggests that it is necessary to make a considerable effort to diffuse scientific information in an entertaining and intelligible manner (Table 14).

Table 14. Assessment of the scientific information received.

	Total	Gender		Education				Reads papers	
		Men	Women	None	Primary	Secondary	University	Yes	No
Necessary	86.0	84.9	87.0	74.4	81.9	**91.9**	**91.5**	86.5	85.3
Useful	84.1	84.2	84.1	71.8	80.7	87.3	**93.8**	84.8	83.3
Arouses curiosity	79.0	81.8	76.4	69.2	77.1	**86.2**	75.4	**81.8**	75.4
Incomprehensible	39.1	31.4	**46.3**	**57.7**	**44.9**	35.0	21.5	38.1	40.4
Boring	25.3	22.3	28.0	23.1	25.6	**30.0**	16.2	25.6	24.9
Superficial	21.3	**24.4**	18.3	16.7	23.5	19.6	21.5	22.0	20.3
Base:	800	385	415	78	332	260	130	446	354

It is becoming a constant that the more education people have, the greater their positive perception and awareness of the usefulness of science. For example, the usefulness of and need for scientific information is especially noted among people with secondary or higher education, while incomprehension increases among people without formal education or with primary education only who, in turn, are the least interested and become most bored by scientific news. They do, however, see science as necessary and useful. This is also the case with women: scientific news is incomprehensible for almost half of Catalan women, although they accept that it is necessary and useful.

Attitude towards science as a cultural element

In general, Catalans give science a fairly prominent position in their lives. This is shown by the link which they make between science and day-to-day life (Table 15). In this respect, over 87 per cent of Catalans believe that scientific activity forms part of culture and that scientific discoveries influence the way in which we live. Moreover, there is still a majority (68.1 per cent) which believes that it is necessary to have some scientific knowledge in order to give an opinion on, for instance, nuclear power or environmental pollution.

These perceptions have not varied significantly since 1989. What has varied, though not spectacularly, is the practical or more instrumental view of science, while, at the same time, both reverential and negative attitudes toward science have waned. Currently, 52.7 per cent of the population believe that technology is the main objective of the study of sciences, whereas in 1989 the corresponding percentage was only 42.9 per cent. Greater importance is thus given to scientific application and a lower assessment to basic research, although, in spite of everything, opinions are divided.

Table 15. Assessment of science as an element of culture.

Statement	% Agrees	
	1989	1995
Scientific activity is a part of culture	86.9	87.5
Scientific discoveries influence our way of living	88.5	87.6
It is convenient to have some scientific knowledge to be able to form an opinion on nuclear power or on environmental pollution	69.0	68.1
Technology is the main aim of scientific studies	42.9	**52.7**
It is necessary to have some scientific knowledge to be a cultured person	49.1	52.0
I am more interested in practical applications of scientific knowledge than in basic research	–	50.8
Scientific development makes society less human	**54.8**	50.6
With a view to the future, scientific knowledge is more important than arts knowledge	**48.1**	37.4
Science entails more dangers than advantages	**37.4**	23.1
Base:	800	800

On the other hand, the perception of technical-scientific risk has reduced (from the 37 per cent who in 1989 agreed that science offered more dangers than advantages, to 23.1 per cent in 1995), as has the perception of science's dehumanizing action (in 1989 54.8 per cent of Catalans thought that scientific development made society less human, while in 1995 only 50.6 per cent held this opinion), although in the latter case it is clear that opinions were also very divided.

The decline in fear of scientific activity as knowledge increases—which in this study might be explained by, above all, the increase in the level of education—has already been remarked on by many authors,[12] and has been used as an argument to indicate that the active diffusion of information on scientific events and applications which provoke the most fear is precisely the most necessary.[13] It has, however, recently been revealed that, depending on the socio-cultural environment, greater knowledge may not lead to greater acceptance but rather to a more critical attitude.[14]

In any case, Spain seems to be one of the countries in which the greater level of knowledge leads to an overcoming of fear, while there is also a tendency not to see scientific knowledge as special. The percentage of people who think, with a view to the future, that it is more important to have knowledge of science than of the arts has decreased. Thus, all knowledge tends to be assessed equally.

With regard to segmentation by level of education (which, as we have already seen, is closely linked to age and sex), the higher the educational level, the lower the assessment of the technological object of science and, at the same time, the lower the belief that science is dangerous or that it dehumanizes society, which corroborates the argument presented above (Tables 16, 17 and 18).

Scientific knowledge of the population

Assessing the scientific knowledge of a population by means of questions of the kind 'does the Sun revolve around the Earth?' has been greatly criticized over recent years.[15] The fallacy of dividing the population into experts and non-experts—revealed by, among others, Lévy-Leblond—in which personal and individual interests are removed, has been one of the major criticisms of such questionnaires.[16] In spite of this, many studies still use this method as a means of indicating trends in successive surveys, as in the case of this study. On this

Table 16. 'Technology is the main aim of scientific research.' The mean is calculated on a scale from 1 (completely disagree) to 5 (completely agree).

	Total	Education			
		None	Primary	Secondary	University
Agree	52.7	52.6	**57.8**	52.3	40.8
Neither agree nor disagree	12.5	3.8	8.7	**16.9**	**18.5**
Disagree	22.3	7.7	15.4	**26.9**	39.2
DK/DA	12.5	**35.9**	**18.1**	3.8	1.5
Mean	3.45	3.84	3.70	3.35	2.96
Base: 800	800	78	332	260	130

Table 17. 'Scientific developments make society less human.' The mean is calculated on a scale from 1 (completely disagree) to 5 (completely agree).

	Total	Education				Age				
		None	Primary	Secondary	University	18–24	25–34	35–49	50–64	> 65
Agree	50.6	60.3	**56.3**	45.0	41.5	34.7	34.6	54.1	57.1	67.8
Neither agree nor disagree	12.8	2.6	11.4	15.8	16.2	17.8	23.1	12.7	6.3	5.5
Disagree	31.9	16.7	26.5	**38.5**	**41.5**	46.6	40.4	29.3	29.1	17.8
DK/DA	4.8	20.5	5.7	0.8	0.8	0.8	1.9	3.9	7.4	8.9
Mean	3.21	3.61	3.39	3.02	2.98	2.78	2.92	3.30	3.33	3.67
Base: 800	800	78	332	260	130	118	156	205	175	146

Table 18. 'With a view to the future, knowledge of science is more important than knowledge of the arts.' The mean is calculated on a scale from 1 (completely disagree) to 5 (completely agree).

	Total	Education				Reads papers	
		None	Primary	Secondary	University	Yes	No
Agree	37.4	37.2	34.3	**44.6**	30.8	37.2	37.6
Neither agree nor disagree	22.3	19.2	19.0	25.8	25.4	21.1	23.7
Disagree	34.1	21.8	37.7	29.2	**42.3**	37.2	30.2
DK/DA	6.3	**21.8**	**9.0**	0.4	1.5	4.5	**8.5**
Mean	3.04	3.15	2.96	3.17	2.91	3.02	3.08
Base: 800	800	78	332	260	130	446	354

occasion the same questionnaire was used as in 1989 (which included identical questions to those formulated in other studies, such as the UK survey[5]). The reason for this was to use the results only as an indicator of the knowledge of the population and, especially, to be able to observe the evolution over this period of time.

According to the questionnaire, it is possible to affirm that the level of scientific knowledge of Catalans has increased since 1989, as the percentage of correct answers increased for all the questions asked with the sole exception of the question referring to

natural vitamins, for which there is still the same very small 10 per cent of people who answer correctly (Table 19). As with Pardo's study, the highest levels of understanding are in the areas of classical physics and astronomy, in which the information is given at school and is not subject to variability, hence the strong relation with the level of education, distributed among the population in quite specific groups of age and gender, as has already been pointed out (Tables 20 and 21).

Table 19. 'Are the following statements true or false?' The asterisk indicates the correct answer.

Statements	Correct	True		False		DK/DA	
	1995	1989	1995	1989	1995	1995	1989
Sun beams may cause skin cancer	**97.3**	89.1	97.3*	5.6	0.8	2.0	5.3
Hot air goes up	**87.6**	81.5	87.6*	6.3	3.8	8.6	12.3
The temperature of the centre of the Earth is very high	**83.0**	77.9	83.0*	6.8	4.8	12.3	16.1
All insects have eight legs	**81.3**	6.4	7.3	81.2	81.3*	11.5	12.4
Diamonds are made of carbon*	**59.4**	52.1	59.4*	14.8	11.9	28.8	33.1
The speed of sound is faster than the speed of light speed	**56.1**	29.3	28.3	50.9	56.1*	15.6	19.9
The genes of the father determine children's sex	**39.8**	41.5	39.4	30.9	39.8*	20.9	27.6
Electrons are smaller than atoms	**35.3**	30.1	35.3*	22.1	19.9	44.9	47.8
Antibiotics kill viruses and bacteria	**24.0**	68.0	63.8	19.8	24.0*	12.3	12.3
Natural vitamins are better than synthetic ones	**10.4**	80.8	80.8	10.5	10.4*	8.9	9.5
Base:	800	800	800	800	800	800	800

Table 20. 'Are the ... statements [given in Table 19] true or false?' The mean is calculated on a scale from 0 (none correct) to 10 (all correct).

	Mean correct	Base
Total	5.74	800
Education		
None	4.04	78
Primary	5.07	332
Secondary	6.30	260
University	7.34	130
Reads papers		
Yes	6.09	446
No	5.29	354

In this respect, it can be said that educational programmes are relatively successful in establishing knowledge but, on the other hand, they are ineffective at explaining how science works, as shown by the replies to the question on scientific method. This question was not included in the 1989 questionnaire, but it was present in the UK study.[5] From the replies, it can be seen that 75 per cent of the Catalan population do not connect the scientific method with the experimental method (Table 22). Although graduates answer this question most correctly, only 48.5 per cent give the correct reply, which demonstrates that, despite being the group which is most in contact with active research, they do not always know how it operates.

A new question was also added regarding the Internet, a technology which has not yet been fully incorporated in centres of education and about which information has mainly

Table 21. 'Are the ... statements [given in Table 19] true or false?' The mean is calculated on a scale from 0 (none correct) to 10 (all correct).

	Mean correct	Base
Total	5.74	800
Age		
18–24	6.67	118
25–34	6.37	156
35–49	5.85	205
50–64	5.29	175
> 65	4.71	146
Gender		
Men	6.36	385
Women	5.17	415

Table 22. 'Suppose a drug used to treat high blood pressure is suspected of not working well. Which one of these methods do you think that a scientist would use?'

Method	Total	Gender		Education			
		Men	Women	None	Primary	Secondary	University
Use their knowledge of medicine to decide how good the drug is	37.4	38.2	36.3	35.9	33.1	**46.2**	31.5
Talk to patients to get their opinions	29.1	26.2	31.8	**39.7**	**37.0**	23.1	14.6
Give the drug to some patients but not to others. Then compare what happens to each group	25.1	27.8	22.7	10.3	18.7	26.2	**48.5**
Don't know	8.4	7.8	8.9	14.1	**11.1**	4.6	5.4
Base: 800	800	385	415	78	332	260	130

been spread by the media. In spite of this, there is a very widespread ignorance of this electronic network (70.1 per cent do not know what the Internet is), although it varies between 96.2 per cent of people without formal education and 37.7 per cent of graduates. Men, newspaper readers and people under 34 are also more familiar with the Net than the rest of the population.

Another way of measuring knowledge is to record the name of the most frequently recalled scientists. The results of the present study demonstrate that over half of the Catalan population (64 per cent) is incapable of mentioning the name of any Spanish scientist, dead or alive. The two deceased scientists most frequently mentioned spontaneously are Severo Ochoa and Ramon y Cajal. In the case of scientists who are still carrying out their activities, there is no doubt that the astrophysicist and biochemist Joan Oró is the only person with social recognition, as 63 per cent of the people who answer this question mention him. With regard to foreign personalities, in the case of the dead, Albert Einstein was the most frequently mentioned name, followed a long way behind by Alexander Fleming and the Curies. Among the living, the replies focused on Steven Hawking, followed at a distance by Isaac Asimov, the late Carl Sagan and Jacques Cousteau. Those names are the same ones that were mentioned in 1989: after six years, people have not remembered any new scientists' names.

As regards the socio-demographic differences in recalling scientists, the conclusions are similar to those already discussed in this study. People with less education, older people

and women have a lower level of recollection when it comes to naming scientists. In spite of everything, the remembered names refer much more to people who appear frequently in the media than to those who are mentioned on official education programmes.

Profile according to scientific culture

The population was divided into three groups based on the scientific knowledge test: those who answered between 0 and 4 questions correctly (the least 'cultured in science'), those who answered 5 or 6 correctly (moderately 'cultured') and those who obtained marks from 7 to 10 (the most 'cultured'). The purpose of the segmentation is not limited to discovering socio-demographic differences (age, sex, education and habitat), but also, and above all, to determine the influence of different lifestyles (cultural habits, opinion leadership, solidarity, religion and familiarity with new technologies). As several authors point out,[2] the results are more informative if, instead of dealing with the population as a whole, an attempt is made to establish a relationship between the level of knowledge and formal education, age, sex, interest, attitudes, etc. That is, the fragmentation of the public—or the characterization of the different publics—offers a more reliable image of the variables which determine the interests, attitudes and knowledge relating to science. This segmentation firstly opens up a path towards the improvement of the theoretical methods from which the public perception of science is analysed, and secondly facilitates the design and the refinement of strategies directed towards increasing the levels of scientific-technological knowledge of a society.

Although we have seen that the test in itself does not establish the category of 'cultured' in science, on dividing the population between those who answer more and those who answer less questions correctly (and analysing them with the rest of the questions in the questionnaire), it is possible to establish useful differences with a view to developing strategies for diffusing information. The first thing which has to be said is that the variable 'education' is the most important for defining the socio-demographic profile of the population according to its level of scientific culture; and that 'education' is connected to interest in what happens outside the borders of day-to-day life, and so is also related to the attitude which determines the kind of participation undertaken in intellectual, social and cultural activities.

To sum up these differences, it can be said that the group with a lower level of scientific culture (a group which represents 25 per cent of the population) has a low level of education, is comprised mainly of women and people over 49, and has more passive cultural habits. On the other hand, the majority of those forming the group with a higher level of scientific culture (36 per cent of the total) have undertaken secondary-level or university education, are under 35, are men (although the differences between genders are less than in the previous case), and are also more socially active. People in this group with a high level of 'scientific culture' declare themselves to be opinion leaders to a greater extent; they like to be up-to-date with new developments; they spend their free time more in cultural activities and they value religion a lot less (only 23.3 per cent state that religion is very important in their life, whereas among the 'less cultured' this percentage reaches 52.9 per cent). On the other hand, more than 10 per cent of people with a low level of scientific culture are not particularly motivated to keep up-to-date in any subject at all (Tables 23 to 26).

Reading habits are also clearly differentiated: a higher percentage of habitual readers of newspapers and books is observed among the most cultured. With regard to the activities carried out by Catalans in their free time, the most common, though not for a majority, are going to exhibitions, the cinema and sporting events. Visiting a science museum is, however, the least popular option. From this, the comparison by level of scientific culture

Table 23. 'Does the following statement agree with your way of being or thinking?: People often ask my opinion about different subjects.'

	Total	Level of scientific culture		
		Low	Medium	High
Yes	65.8	51.0	66.7	**75.3**
No	32.9	**46.1**	32.0	24.4
DK/DA	1.4	2.9	1.3	0.3
Base	800	204	309	287

Table 24. 'Does the following statement agree with your way of being or thinking?: I like to be up-to-date.'

	Total	Level of scientific culture		
		Low	Medium	High
Yes	92.3	86.8	93.2	**95.1**
No	6.9	**12.3**	6.8	3.1
DK/DA	0.9	1.0	–	1.7
Base	800	204	309	287

Table 25. 'Does the following statement agree with your way of being or thinking?: In my free time I enjoy having fun as much as learning new things.'

	Total	Level of scientific culture		
		Low	Medium	High
Yes	84.0	76.5	85.4	**87.8**
No	14.4	**21.6**	13.6	10.1
DK/DA	1.6	2.0	1.0	2.1
Base	800	204	309	287

shows that there is greater social leisure and cultural activity (visits to exhibitions, cinema, museums, shows, etc.) in the group with more scientific knowledge (Table 27).

This group is also more demanding of the information that it receives from the media.

Table 26. 'Does the following statements agree with your way of being or thinking?: Religion is very important in my life.'

	Total	Level of scientific culture		
		Low	Medium	High
Yes	37.0	**52.9**	39.2	23.3
No	60.9	44.1	58.6	**75.3**
DK/DA	2.1	2.9	2.3	1.4
Base	800	204	309	287

Table 27. 'In the last four months, have you done any of the following?'

People who have gone to: (%)	Total	Level of scientific culture		
		Low	Medium	High
Exhibition	39.8	25.5	39.5	**50.2**
Cinema	36.8	18.1	35.0	**51.9**
Sports event	34.9	21.1	38.5	**40.8**
Zoo/botanic gardens	29.4	24.5	30.1	**32.1**
Conferences	28.3	14.7	25.9	**40.4**
Musical events	27.4	15.7	27.8	**35.2**
Theatre	20.6	15.7	19.1	**25.8**
Art museums	17.5	11.8	16.5	**22.6**
Science museums	9.1	2.9	6.8	**16.0**
Base	800	204	309	287

For example, a higher percentage than in the population in general prefers Canal 33 and TV2, the second channels of the public television companies (state and autonomous, respectively), the contents of which are more cultural and are addressed to minority audiences. At the same time, among the less cultured, there is an increase in those who watch Tele 5, a commercial television channel. Television is almost the sole channel of scientific information for the population with a lower level of scientific knowledge, whereas the more educated use a more diverse group of sources (television, magazines and books).

Conclusions

An increase in spontaneous and suggested interest in scientific subjects is detected in Catalonia in comparison to 1989. Ten per cent of Catalans currently show spontaneous interest in scientific subjects, and form the group which could be called 'faithful to science'.

There is feedback between knowledge and interest. Both are considerably conditioned by formal education, which, this study suggests, is the element with the most influence on interest in science. Therefore the greater the level of education, the greater the knowledge and the greater the interest. The overall level of education in Catalonia has increased over the last six years, mainly because the percentage of people with secondary education has increased. It is therefore predictable that as secondary education becomes widespread, both interest and knowledge will increase. Scientific knowledge has already improved over the six years 1989–1995; and a more favourable attitude towards scientific activity has developed.

A second factor determining the growth in numbers of people interested in scientific issues has been the rising numbers of young women with at least secondary education: the female presence in the group of people interested in science has tripled since 1989.

This increase in education and in interest is not common to all areas of information. In fact science, medicine and the environment, followed by politics, are the only areas of information in which interest has increased significantly. Science is the area in which interest has increased the most: by 10 percentage points since 1989. The fields within science in which interest has increased the most are medicine (the largest increase), nature and technology. All three are identified with the science relating to daily life: practical and useful (medicine) or related to leisure (nature); and also relating to lifestyles, and to trends promoted by the media (such as a certain weariness of the environment, which has lost

followers). It should be taken into account that what is perceived as current or everyday and what is therefore of interest to a wide sector of the population is the subject rather than the focus. Technology reflects the interest of the group of younger people with secondary education which has recently been incorporated into the adult population.

This is linked to an attitude which promotes a more instrumental view of science. This attitude is, like other attitudes to scientific activity, not homogeneous: two segments can be differentiated. Scientific ignorance is linked to lack of interest: it is difficult to be interested in something unknown. This ignorance/lack-of-interest is strongly present in reverential (science as a dogma or faith) or negative attitudes (science as a dangerous activity which dehumanizes society), although this would be a feature associated with the specific cultural sphere and not something which can be generalized.

The sociological profile, or photofit picture, of the person with a higher level of 'scientific culture' represents a man, on average under 34 years of age, with at least secondary education. He is socially active, with diverse socio-cultural habits; he reads more newspapers and magazines and, in general, obtains information through different channels and is interested by many areas of information. The people with a lower level of scientific culture are mostly women, over 49, with no formal education. They are not very interested in subjects such as science, they are less socially active, and they receive their information almost exclusively from the television. Scientific information is incomprehensible for this group, although it is not possible to say that they have no interest in science (6 per cent have spontaneous interest and over 50 per cent show suggested interest). This means that there is a lack of motivation and that the strategy for diffusing scientific information is not suited to their profile. In view of this, two different strategies for diffusing information are necessary, depending on the public at which they are aimed.

A more accessible focus and channel would be necessary for the most important population group. Both the news and the scientists that are most recalled are those which have most appeared on television, or have been portrayed in films. Using television, science could be focused on more practical or day-to-day aspects, and dealt with through subjects which are far from pure science and closer to the social aspect of science, such as medicine and nature; the science could be personalized through 'communicators'.

For cultured and interested people a strategy of fidelity would be more advisable, using the new information technologies as channels to spread science directed at segmented publics. Pure science and technology subjects would be more appropriate in the printed than in the audiovisual media, provided that the incomprehension barrier is overcome.

The assessment made by the public of scientific information endorses these proposals. Over 80 per cent of the population considers scientific information necessary, useful and intriguing, but 40 per cent find it incomprehensible, and a quarter boring and superficial. That is to say, almost half of potential consumers of scientific products cannot gain access to them. Sixty-eight percent of the population feel that science receives scanty treatment in the media. Indeed, it is the area of information which is considered to receive the least adequate treatment. It should be taken into account that the more cultured group is more critical and more capable of assessing the quality of the scientific information which it receives; and so it can be predicted that as the level of education of the population rises, this degree of critical demand will also increase.[17]

It would, however, be useful to further highlight the operational aspects of scientific research, and how to obtain information, and the scientific method with its limitations, without underestimating other forms of knowledge. As Lévy-Leblond states, genuine knowledge consists in knowing how, not in knowing what,[16] i.e., a good mark in the scientific knowledge test does not necessarily imply that the interviewees really know what

science is, or that they can differentiate scientific reasoning from any other type of discourse, as this study shows. A greater incidence of 'how to obtain scientific information' and 'how scientists obtain it', both in the area of the dissemination of information and in the area of education, would lead to individuals better prepared to receive information critically, particularly since the adjective 'scientific' is widely and indiscriminately used in the media as a synonym for prestigious and credible.

On the other hand, some studies on public perception of science[5] have shown that when there is a greater interest in the subject, people tend to be well informed in it, but that this only tends to be true for areas of information such as sport or politics, while it is not true for science. According to this, disseminating information on the tools, the sources and the documents which can satisfy this interest is considered very useful and even necessary, and is clearly related to service journalism, which is currently being actively developed in the United States and also in Spain. Indeed, a good part of service journalism focuses on the subjects of health, consumer affairs and the environment.[18]

References

1 Announced at the conference 'Public Understanding of Science and Technology', Berlin, 30 November–2 December 1995, under the auspices of the DG XII of the European Commission, and noted by Edith Cresson, commissioner responsible for Research, Education and Training speaking to the European Parliament on 22 November 1995. See press release on the Conference and Edith Cresson's speech (computer document), Brussels, 13 December 1995: http://www.cec.lu/en/comm/dg12/dg12tst2.html. See also the theoretical discussion by Pardo, R. A., 1997, Scientific-technological knowledge and the legitimation of science and technology in Spain. *Science and Democracy*, edited by J. D. Miller (in the press).

2 Pardo R. A., 1997, Scientific-technological knowledge and the legitimation of science and technology in Spain. *Science and Democracy*, edited by J. D. Miller (in the press).

3 Staff, L., 1989, Percepció social de la Ciència a Catalunya, (Social perception of science in Catalonia) Unpublished report to the Comissió per a l'Estímul de la Cultura Científica del Departament de Cultura de la Generalitat de Catalunya (Commission for the Promotion of Scientific Culture, Department of Culture, Autonomous Government of Catalonia).

4 Research carried out by the Science Communication Observatory of the Pompeu Fabra University with the collaboration of the Institut d'Estudis-Yankelovich (technical director: Enric Renau; methodological support: Xavier Riudor) funded by the Comissió per a l'Estímul de la Cultura Científica del Departament de Cultura de la Generalitat de Catalunya (Commission for the Promotion of Scientific Culture, Department of Culture, Autonomous Government of Catalonia).

5 Durant, J., Evans. G., and Thomas, G., 1989, The public understanding of science. *Nature*, **340**, 11–14.

6 The relationship between educational level and understanding of science is discussed in Durant, J., Evans, G., and Thomas, G., 1989, The public understanding of science. *Nature*, **340**, 11–14. According to Pardo, 'for a large part of the population, formal education at the primary and secondary levels initially shapes the structure of interest and, above all, constitutes the basic source of information about the various scientific–technological topics and dimensions of contemporary culture.' See Pardo, R. A., 1997, Scientific-technological knowledge and the legitimation of science and technology in Spain. *Science and Democracy*, edited by J. D. Miller (in the press).

7 Rafael Pardo has already mentioned this 'reinforcement of training or as an alternative to it' by the media, but taking into account that, in Spain, the media do not pay much attention to scientific and technological subjects compared with other industrialized countries. See Pardo, R. A., 1997, Scientific-technological knowledge and the legitimation of science and technology in Spain. *Science and Democracy*, edited by J. D. Miller (in the press).

8 Results published in the 'Science and Technology' supplement, *La Vanguardia*, 24 April 1993. Of the different sections published by the newspaper, the supplement is the most highly rated by readers.

9 Also highlighted in the conclusions of conference 'Public Understanding of Science and Technology', Berlin, 30 November to 2 December 1995 (consult http://www.cec.lu/en/comm/dg12/dg12tst2.html). Various economic reports in the field of technology note the problematic incorporation of women in these sectors. For example: DGXIII, 1995, Training in the information society, *Magazine News Review*; and Greenbaum, J., 1994, El club europeo del dos por ciento (The European two-per-cent club), *Open Computing* (New York: McGraw Hill).

10 Göpfert, W., 1994, Seminar 'Informations Scientifiques et Médias Européens', Poitiers (France), November.
11 Ribas, C., 1995, Entrevista a Bruce V. Lewenstein (Interview with Bruce V. Lewenstein), *Quark, Ciencia, Medicina Comunicación y Cultura*, October, 124–131.
12 This is what Pardo calls "Gothic fear", a fear which has more to do with ignorance than with actual knowledge of the possible risks inherent in a scientific process or a technological application': see Pardo, R. A., 1997, Scientific-technological knowledge and the legitimation of science and technology in Spain. *Science and Democracy*, edited by J. D. Miller (in the press). The relationship between ignorance and fear had already been shown by Durant: see Durant, J., 1989 The public understanding of science. *Nature*, **340**, 11–14
13 The case of Denmark in relation to biotechnology, included in The Hague Conference ('Biotechnology in European Society', The Hague, 21–22 November 1994) indicates that when people know what industry, the authorities and scientists are doing first-hand through a public debate—in short, when they are better informed—they value scientific activity more positively. Author and reference please to the Danish study.
14 According to the results of the Eurobarometer with regard to biotechnology, Denmark and Germany are the countries in which the population has the greatest knowledge on this subject. Despite this, Denmark is among the countries which promote its development the most, whereas Germany displays the lowest degree of confidence in biotechnology of the whole of the European Union. See Durant, J., Bauer, M., Gaskell, G., Midden, C., Liakopoulos, M., and Scholten, L., 1955, Public understanding of science in Europe. Paper presented to the conference 'Public Understanding of Science and Technology', Berlin.
15 Fayard, P., 1992, Let's stop persecuting people who don't think like Galileo! *Public Understanding of Science*, **1**, 15–16.
16 Lévy-Leblond, J.-M., 1992, About misunderstandings about misunderstandings. *Public Understanding of Science*, **1**, 17–21.
17 Also noted in the report 'El mercado de la Información en España 1993–1997' (The information market in Spain 1993–1997), Andersen Consulting-Universidad de Navarra, 1993.
18 Diezhandino, P., 1994, *Periodismo de servicio la utilidad como complemento informativo en* Time, Newsweek *y* US News and World Report, *y unos apuntes del caso español* (*Service journalism, used as a complement of information in* Time, Newsweek *and* US News and World Report, *and some notes on the Spanish case*) (Bosch: Barcelona).

Authors

Johanna Cáceres is a doctoral student and research assistant in the Science Communication Observatory, Pompeu Fabra University, La Rambla 30–32, 08002 Barcelona, Spain. She is also a research assistant at the Autónoma University, Barcelona. She holds degrees in journalism and sociology, and her research includes projects on the social impact and public perceptions of biotechnology and on the reporting of chemistry, medicine and health in Spanish papers. She is also a freelance journalist, specializing in environmental issues, for various publications, especially *La Vanguardia* and *Medi Ambient, Tecnologia i Cultura* (*Environment, Technology and Culture*), and regional and national radio.

Cristina Ribas is a doctoral student, research assistant and coordinator of the Science Communication Observatory, Pompeu Fabra University, La Rambla 30–32, 08002 Barcelona, Spain. She holds degrees in journalism and biology, and her research includes projects on professional practices in journalism specialized on science issues. She also chief editor of the journal *Quark, Ciencia, Medicina, Comunicacion y Cultura* (*Quark, Science, Medicine, Communication and Culture*), edited by the Pompeu Fabra University, and works as a freelance for some Spanish newspapers and Catalan radio and television programs.