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Mapping Perceptions of Science in End-of-Century Europe

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This article offers an alternative to the dominant approach for analyzing public perceptions of science. The authors seek first to clarify to what extent the public at large holds defined attitudes toward science, proposing an "index of cognitive and evaluative distance." They then present a map of perceptions of science in end-of-century Europe based on correspondence analysis, which displays some of the most salient elements of how science was appropriated in the culture of the time. The map shows that shared social and cognitive characteristics across nations act as unifying forces in public perceptions of science, while the nation variable conserves important singularities. Knowledge of science plays a very significant role in accounting for differences in value judgments about science. "Reservations," not "promise" items, divide the perceptions of different social groups, suggesting that more weight should be given to the former in future studies.

Keywords: *perceptions of science; map of perceptions of science; knowledge and value judgments about science*

One of the main components of the field of public understanding of science (PUOS) is the measurement and analysis of attitudes toward science, encompassing both general views on science and, more recently,

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attitudes toward specific scientific or technological developments. Analytical work has mainly centered on formal questions, such as the relations between scientific literacy and attitudes, although other literature (usually in report form) has posed substantive recommendations to policy makers on how to improve understanding of certain scientific-technological advances or give "voice" to the public in the policy-making process. Few articles in the field have ventured to link specific analyses of science attitudes with studies of the culture, values, and other characteristics of the societies of the last quarter of the twentieth century (among the few we can cite are Bauer, Durant, and Evans 1994 and Durant et al. 2000). The literature on the cultural reception of science and technology is primarily qualitative and historiographic (Handlin 1964; Hard and Jamison 1998; Hecht 1998; Holton 1993, 1995a, 1995b; Hughes 1989; Marx 1964, 1988; Shapin 1990), although we also find a few sociological pieces based on surveys predating the PUOS field. These sociological contributions stand out for a theoretical focus on exploring social differences in attitudes that has since been virtually abandoned (see Etzioni and Nunn 1974).

The robustness of the canonical metric for the study of attitudes to science has moved in the medium to low range, as evidenced by summated scales with low item intercorrelations and reliability values substantially below the cutoff point of .70. Generally speaking, conceptual and methodological innovation has lost out to the preservation of variables and indicators in time series, which vary in length from country to country (the first dating back to 1957; see Institute for Social Research at the University of Michigan 1958; Withey 1959), particularly the benchmark parallel U.S.-U.K. study of 1988 (Durant, Evans, and Thomas 1989). In recent years, the work done for the Eurobarometers on biotechnology (in 1991, 1993, 1996, 1999, 2002, and 2005) and the survey of nine European countries plus the United States (2003 to 2004) on attitudes toward embryo experimentation (Solter et al. 2003) have marked a significant advance in exploring new aspects and contents of the public's reception of science (among them the perception of risk, connections with worldviews such as images of nature and "the natural," and ethical principles; Pardo and Calvo 2006).

Analyses of how the public views science have relied on "attitude theory" as a frame of reference, taking its assumptions on board without discussion. Quintessentially, that perspective presumes an evaluative continuum on which individuals can be placed and all that matters is their more or less favorable views of science. In this scheme of things, what counts for the items measuring perceptions of science is their signs or valences, that is, whether they denote positive or negative views, not their actual content (e.g., the effects of science on the environment and science and religious or moral beliefs). This approach contrasts with the work being done on the study of values (notably the series known as the World Values Survey and the European Values Survey), which seeks to identify the types of substantive values dominating in each society and generational cohort and also the relationship between each society's values and its socioeconomic profile (Inglehart 1997; Inglehart et al. 2004).

Most PUOS analyses have rested on a single axis or evaluative dimension with regard to scientific advances and their effects on society, bracketed by the two extremes of "total opposition" and "unqualified support." Recent studies, however, have constructed and used more than one dimension or facet of attitudes to science (Durant et al. 2000; Gaskell et al. 2000; Miller and Pardo 2000; Pardo and Calvo 2002). They have focused in the main on identifying linear (or, less frequently, curvilinear) relations between knowledge (high, low) and attitudes (positive, negative) and, secondarily, between sociodemographic variables or socioeconomic national traits and attitudes to science (estimated by parametric methods). Whether science, with its complexity and multiform nature, might not lend itself easily to the forming of predispositions or well-defined attitudes (positive or negative) is a question that has not been addressed (hence the sparsity of attempts to analyze nonsubstantive responses (NSRs; i.e., "don't know" and also "neutral" categories).[1]

This article offers an alternative to the dominant approach for analyzing existing data on perceptions of science. We seek first to clarify to what extent the public at large holds defined attitudes (positive or negative) toward science, proposing an "index of cognitive and evaluative distance" (ICED). We then examine the similarities and differences in perceptions of science between different sociodemographic groups and the different European societies at the end of the 20th century and revisit the central and most debated issue in the PUOS field: the relationships between knowledge and attitudes. In the closing section, we suggest that changes should be made in the measurement of perceptions of science, giving more weight to the different facets of the "reservations" dimension, and we advocate the greater use of multivariate exploratory techniques, combined with qualitative and historiographic analyses.

The analysis conducted flows from two basic assumptions. The first assumption is that science as a formal object of attitudes or views is extraordinarily complex, for a variety of reasons. One reason is that science is the specific activity of a research community linked by communication networks that are primarily reserved for those who have come through a strict selection and training procedure, clearly demarcated from the public at large in a process that began with the institutionalization of science in England in the seventeenth century and was increasingly formalized throughout the nineteenth century (Ben-David 1984; Shapin 1990). A second reason is because of the variety of disciplines and organizational research frameworks (civil, military, profit or nonprofit oriented, basic, applied) and the rapid changes affecting the stock of scientific knowledge in a given period, which are simply bewildering for nonspecialists. Third, people encounter science not in the form of theories or models but embedded in processes, products, and systems, operating in the background, and it is difficult for nonexperts to disentangle the strictly scientific dimension of a given product or process from its usefulness or purpose. Finally, linking back to what we have just said, there is the penetration or interaction of science with numerous social and natural domains, in continuous expansion, which are characterized by very different valences.

It is therefore reasonable to anticipate the presence of significant cognitive and evaluative barriers to the development of attitudes or views on science at large and even on more limited or specific facets of science, difficulties that will be dependent on a vast array of cognitive variables (from educational level to interest in and familiarity with, even at an elementary level, scientific concepts, principles, general ideas and how to judge whether a piece of knowledge or claim is scientifically valid). Hence the interest in quantifying NSRs (i.e., plain nonresponses such as "don't know" but also neutral responses such as "neither . . . nor"), which we can take as indicators of people's cognitive and evaluative distance from the science object. A further consequence of science's complex and multiple associations with domains characterized by very different signs and connotations (from health care to arms and the conduct of war) is that we can expect the simultaneous presence of positive and negative perceptions of science, with one view prevailing over the other according to the domain or to the specific aspect or facet evoked by a given item.[2]

The second assumption is of a more theoretical nature and refers to the decline in the advanced societies of the great omnicomprehensive ideational and belief systems (the *Weltanschauungen* of Romantic origin) as a way to explain or make sense of the world and as a framework for making and justifying decisions in the private and the public realms. Postmodernist literature on the crisis of the great metanarratives (such as scientific progress and the material progress that flows from it; Heise 2004; Lyotard 1984), the more specific politology and public-opinion literature on the belief systems of the public at large (Converse 1964), and the literature of lifestyles (Minkenberg and Inglehart 1989; Sobel 1981) all point from their different angles to the phenomenon of the fragmentation of holistic thought (and perceptual) matrixes and their replacement by piecemeal criteria adapted to each case or situation and at times even mutually inconsistent, held together by the glue of emotions or interests rather than by formal or logical structures (Fiske and Taylor 1991). Under these conditions, the broader public (not certain segments such as the "attentive public" [Almond 1960; Miller, Suchner, and Voelker 1980; Miller 1983], the "engaged public" [Gaskell, Allum, and Stares 2003], or the "better-informed public" [Sturgis, Cooper, and Fife-Schaw 2005]) can hardly be expected to display well-structured conceptual and evaluative schema, with a large degree of generality, and even less so in such a vast, complex, and fast changing system as science. A more plausible expectation would be to find "patterns" or "loose groupings" of perceptions and evaluative judgments. So instead of using an analysis method based on the additivity of items measuring attitudes or perceptions (regression analysis in which the exogenous variable is a summated scale), the preferred approach would be the application of multivariate exploratory techniques geared more to identifying patterns of association than formally quantifiable linear dependences between variables.

Our proposal is to initiate a line of analysis (complementing the conventional approach to studying attitudes to science) that seeks to map out the universe of public perceptions of science in the societies of the late twentieth century and the first years of the twenty-first century. What we intend to offer is a preliminary map of perceptions, highlighting certain fundamental vectors that have barely been explored and merit more in-depth study from qualitative and historiographic perspectives. The results obtained may also provide a heuristic path for developing more robust parametric measures of certain salient facets of science perceptions. The analysis presented here, whose main steps we set out in detail, may serve as a kind of "blueprint" for other researchers interested in this type of comparative analysis of literacy and attitude measures (nonlinear, facet oriented, pattern identification, comparing national versus sociodemographic variance).[3]

Several issues will be given close attention in the process of mapping science perceptions. One is the weight and positioning of sociodemographic groups and nations; the possible homogenizing or, alternatively, differentiating function of groups with common sociodemographic characteristics, but belonging to nations with varying degrees of economic development and highly specific histories and cultures. The idea, in other words, is to ascertain whether nation, "as the maximal social unit not only of economic and political life, but also of social organization and culture, the 'way of life' we are part of" (Worsley 1987, 50), still provides a clear differential framework for science perceptions in the closing years of the twentieth century or whether other sociodemographic traits (such as age, educational level, social status) are leveling forces of greater power than the nation structure (which tends to preserve singularities). We also want to examine the weight and significance of the specific cognitive variable of the PUOS field ("scientific knowledge") in the organization of the perceptions map, in comparison with more general social variables (age, social class). By this means, we will address the central issue in the PUOS field—the relationships between knowledge and attitudes—not in the canonical way of seeking linear relations between the two but to identify patterns or groupings in which deviations and differing degrees of associativity are accepted as the norm. Similarities and divergences of perception between sociodemographic groups in the extreme categories of the stratification system (high-low social status, high-low knowledge) on what the literature calls the "promise" of science (positive expectations) and "reservations" toward science (negative predispositions) (Miller and Pardo 2000) will help us zero in on findings that have not hitherto come to light because of the parametric approach routinely applied to the analysis of the data.

Eurobarometer Measurements on General Perceptions of Science

The literature on perceptions of science in advanced societies has one of its broadest and most solid supports in the regular studies carried out as part of the Eurobarometer series (in 1977, 1989, 1992, 2001, and 2005). The most extensively analyzed of these surveys, and the one on which we draw for our analysis, is Eurobarometer 38.1, conducted in 1992 and incorporating most of the items from the parallel U.S.-U.K. studies of 1988. Its contents were replicated with scant variations in 2001 and with a number of formal and substantive novelties in 2005 (Eurobarometer 63.1), including the split into two parallel surveys on Europeans, science, and technology and on social values, science, and technology.

The twenty-three questionnaire items designed to tap Europeans' views of science and technology are included in questions Q62 and Q66, with wording as follows: "I would like to read you some statements that people have made about science, technology or the environment. For each statement, please tell me how much you agree or disagree." These questions were applied using the split-half technique such that half the sample (split A) was offered the following five response categories: 1 = *strongly agree*, 2 = *agree* *to some extent*, 3 = *neither agree nor disagree*, 4 = *disagree to some extent*, 5 = *strongly disagree*, and 6 = *don't know*. The other half, split B, was not offered the midpoint option (3 = *neither . . . nor*), in an attempt to push their answers toward agreement or disagreement. For reasons that are discussed in the literature, we confine ourselves here to the data from split A, which accommodates respondents lacking strong or elaborated views, either because they feel distant from the statement they are being asked to evaluate or because more complex reasons incline them to a neutral evaluative stance (Faulkenberry and Mason 1978; Krosnick 2002; Pardo and Calvo 2002; Schuman and Presser 1996; Thiessen and Blasius 1998).[4]

Table 1 reproduces the literal wording of the items, with plus signs indicating that agreement denotes a positive view of science and minus signs indicating that agreement denotes a negative view. The rationale behind the construction of the battery of items shown in Table 1 was not to formally explore the different facets of science as perceived by the public but rather to select a number of impacts presumably representative of all the major practical consequences of scientific research, whose aggregate score would provide a measure of attitudes to the "science object." One fundamental flaw of this battery is that, except for one item (referring to support for basic science, itself a label most people would find hard to grasp), it leaves no room at all for views of science as a way of knowing the world. The evaluative standpoint embedded in the battery is purely instrumental (transformation and control of the world), a shortcoming that should be corrected in future studies. With this proviso, examination of Table 1 provides an initial snapshot of which consequences of science meet with approval (the plus-sign items, for which the percentage of agreement exceeds that of disagreement, and the minus-sign items, for which disagreement exceeds agreement, which we group here for ease of reading in two blocks of favorable and unfavorable impact).[5]

In fifteen of the twenty-three items, the percentages obtained indicate positive "views" or attitudes toward science in the European Union as a whole (in nine of thirteen items with positive wordings and six of ten items with negative wordings), while the other eight clearly indicate the existence of critical positions (four of the thirteen items with positive wordings and four of the ten items with negative wordings). However, evaluative judgments (both positive and negative) exhibit a large variability. This characterization, which is merely descriptive, could usefully be supplemented by the identification of the aspects or domains in which "reservations" or critical perceptions are most salient, that is, suggestive of the existence of facets that for broad segments are problematic or clash with other values and principles.

Table 1
Perceptions of Impacts and Facets of Science (in percentages)

Item	Agree	Disagree	Neither . . . Nor	Don't Know
Favorably evaluated				
"Scientific and technological progress will help to cure **illnesses** such as AIDS, cancer . . ." (+)	83.8[a]	4.2	6.7	5.3
"Science and technology are making our lives healthier, easier and more **comfortable**" (+)	75.8[a]	8.3	12.6	3.3
"Even if it brings no immediate benefits, scientific research which advances the frontiers of knowledge is necessary and should be supported by the **government**" (+)	73.3[a]	6.6	12.1	8.1
"Only by applying the most modern technology can our **economy** become more competitive" (+)	67.6[a]	9.3	12.6	10.5
"Thanks to science and technology, there will be more opportunities for the **future** generations" (+)	63.0[a]	12.6	17.1	7.3
"Most scientists want to work on things that will make life better for the **average person**" (+)	60.6[a]	16.1	17.0	6.4
"The application of science and new technology will make **work** more interesting" (+)	54.1[a]	16.6	21.0	8.3
"The **benefits** of science are greater than any harmful effects it may have" (+)	52.1[a]	13.5	23.9	10.5
"New **inventions** will always be found to counteract any harmful consequences of scientific and technological development" (+)	47.3[a]	22.3	18.1	12.3
"Scientific and technological research do not play an important role in **industrial** development" (–)	13.5	68.9[a]	9.4	8.2

(continued)

Table 1 (continued)

Item	Agree	Disagree	Neither . . . Nor	Don't Know
"Scientific and technological research cannot play an important role in protecting the **environment** and repairing it" (–)	21.2	59.5[a]	12.2	7.2
"**Computers** have made the use of bank services more complicated" (–)	29.5	51.4[a]	11.7	7.4
"**New technology** does not depend on basic scientific research" (–)	18.6	50.9[a]	13.1	17.5
"For me, in my **daily life**, it is not important to know about science" (–)	33.1	47.3[a]	15.4	4.2
"Some numbers are especially **lucky** for some people" (–)	35.9	36.0[a]	19.2	8.9
Negatively evaluated				
"On balance, computers and factory automation will create more **jobs** than they will eliminate" (+)	14.8	65.0[a]	14.1	6.1
"Scientists should be allowed to do research that causes pain and injury to **animals** like dogs and chimpanzees if it can produce new information about serious human health problems" (+)	28.2	53.9[a]	13.6	4.3
"Thanks to scientific and technological advances, the Earth's natural **resources** will be inexhaustible" (+)	22.7	52.9[a]	16.2	8.2
"Technological **progress** will make possible higher levels of consumption and at the same time an unpolluted environment" (+)	31.0	36.3[a]	21.8	10.9
"Because of their knowledge, scientific **researchers** have a power that makes them dangerous" (–)	58.4[a]	20.3	14.4	6.9
"Science makes our **way of life** change too fast" (–)	54.5[a]	21.3	19.0	5.2

(continued)

Table 1 (continued)

Item	Agree	Disagree	Neither . . . Nor	Don't Know
"Scientific research does not make industrial **products** cheaper" (–)	46.4[a]	25.1	16.9	11.6
"We depend too much on **science** and not enough on faith" (–)	41.9[a]	30.6	21.9	5.6

Note: Items for which agreement denotes a positive attitude toward the corresponding aspect of science are denoted with plus signs; items for which agreement denotes a negative attitude toward the corresponding aspect of science are denoted with minus signs.
a. Modal percentage (i.e., the highest percentage out of the four response options in each item, remembering that "agree" groups the responses "strongly agree" and "agree to some extent," while "disagree" groups the responses "strongly disagree" and "disagree to some extent").

One natural way to achieve a synthetic image of perceptions of science is the construction of "summated scales," which are assumed to neutralize measurement error and singularities, capturing a latent common dimension of interest (Spector 1992). The examination of their distribution with reference to selected exogenous variables is a straightforward process. This indeed is the analysis strategy most prevalent in the literature, although its effectiveness is modest only, because of the limitations of current measures of science perceptions and for substantive and methodological reasons set forth later in this article.

The Problem of NSRs

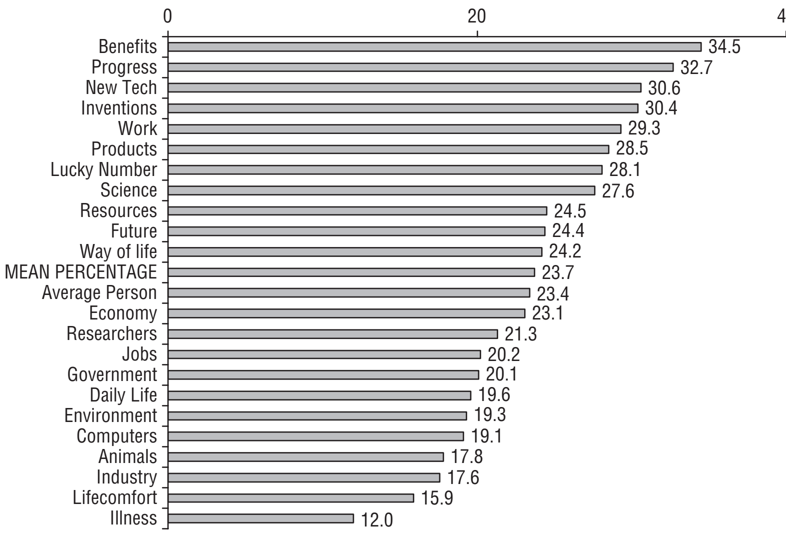
Explicit "don't know" and neutral ("neither . . . nor") responses to questionnaire items suggest that the cognitive stimulus, for a variety of reasons, is insufficiently strong, accessible, well defined, or meaningful to the respondent to produce a clear evaluative response to the attitude object, in our case science (Converse 1977; Faulkenberry and Mason 1978; Francis and Busch 1975; Krosnick 2002; Schuman and Presser 1996). Among the possible reasons for the lack of a substantive response (i.e., "agree" or "disagree"), we can single out the low salience for particular segments of the public, or even the public at large, of some aspects of the science-society interaction, their complexity or cognitive barriers, and, secondarily, an ambivalent perception on the part of the respondent (typically choosing in this case a "neutral" response, which has been characterized as a "substantive response with less meaning [than a typical substantive response]"; Thiessen and Blasius 1998). The content (salience, complexity), the format of the items (presence or absence of a filter, range of the scale), the procedure for gathering the responses (face to face, telephone, mail, online questionnaires), and, in comparative studies, the so-called house effect (i.e., the companies carrying out the fieldwork in different periods or countries) have an impact on the level of NSRs, but so too do the characteristics of individuals preferring these types of responses to the substantive ones.[6]

We do not claim that "neutral" ("neither . . . nor") responses are fully equivalent to plain "don't know" responses, but something of a more limited nature: both can be considered as different types of NSRs, distinct from agreement or disagreement responses. There is certainly a degree of overlap between the two response options, among other reasons because one of the factors behind "don't know" responses to attitudinal items is item ambiguity and the difficulty or ambivalence respondents feel in choosing either the agreement or disagreement side of the evaluative scale (Krosnick 2002). Moreover, in contrast to dichotomic or binary scales that capture direction only (agreement, disagreement), scales that also accommodate intensity of feeling ("strongly" agree or disagree, agree or disagree "to some extent") offer individuals an evaluative space in which to locate themselves. It has to be said, though, that the far-from-abundant literature on this critically important topic is not conclusive about respondents' interpretations and selection of middle categories (Harkness 2003). Our proposal is to focalize the analysis on a data matrix made up of defined agreement or disagreement responses, discarding those respondents who have opted to acknowledge their cognitive and/or evaluative distance from the items proposed following a brief characterization of the specific profile of each response type.[7]

The average percentage of NSRs per item (summing "neither . . . nor," 15.6 percent, and "don't know," 8.0 percent) works out to 23.6 percent for the total twelve-country sample (i.e., about one of every four interviewees could not or would not report an explicit or firm judgment on the facets or impacts of science and technology offered in the Eurobarometer; Figure 1). But NSRs exhibit a strong variability according to the item in question.

The items with the highest percentages of NSRs are "benefits," "progress," "new technology," and "inventions," which all top the 30 percent mark. It bears mention that three of these items require especially complex judgments, such as weighing the benefits and risks of science as a whole, the possible future discovery of scientific-technological solutions to the problems science may be creating in the present, and whether scientific progress will enable an increase in consumption while reducing its environmental impact. The fourth

Figure 1
Percentage of Nonsubstantive Responses



item refers to an issue that is opaque for the public at large as well as a debating point among specialists: the relation between new technologies and basic science (see Freeman and Soete 1997; Price 1975; Rosenberg 1982). Sixteen items elicited more than 20 percent of NSRs in the total sample. No differences were observed in average NSRs between "positive" items (agreement denoting a favorable view of science) and "negative" ones (agreement denoting a negative view), which stood at 23.7 percent and 23.6 percent, respectively.

The items with the lowest percentages of NSRs were "illness," "lifecomfort," "industry," and "animals," all with less than 18 percent. This shows that the relations "science" and "healthcare," "science" and "daily comfort," "science" and "industrial development," and the "use of animals" in scientific experimentation for biomedical purposes are issues on which few people have no opinion (at least as measured by the Eurobarometer).

Recourse to NSRs (Table 2), as we might expect, is significantly higher among those of a lower social status and cultural level—low income (29.9 percent of NSRs), leaving education at age 15 or younger (29.4 percent of NSRs), not interested in science (28.1 percent)—and, most saliently, among individuals with low levels of scientific knowledge as gauged from

Table 2
Percentage of Nonsubstantive Responses per Sociodemographic Variable in a Sample of Items

Variable	Age of Leaving Education		Scientific Knowledge		Income		Interest		Total Item
	Up to Fifteen Years	Twenty Years or Older	Low	High	Low	High	No Interest	Strong Interest	
Benefits	40.3	28.1	48.1	24.6	40.1	24.0	40.4	25.8	34.5
Work	37.3	24.2	43.5	23.5	38.2	21.0	33.9	21.6	29.3
Future	29.0	19.8	33.2	19.4	31.9	16.9	28.8	16.5	24.2
Average person	27.7	19.6	34.3	18.4	29.6	14.8	27.3	16.8	23.4
Lifecomfort	19.1	12.0	23.4	11.6	23.0	10.6	19.6	11.1	15.9
Illness	18.7	5.8	24.0	5.4	18.7	3.9	15.5	7.9	12.0
Science	26.9	24.9	32.4	24.0	28.3	27.4	30.2	23.4	27.6
Way of life	24.1	19.5	29.9	21.6	25.0	20.6	27.7	19.3	24.2
Researchers	25.3	15.1	33.1	15.7	25.8	13.7	25.7	14.8	21.3
Computers	24.3	13.5	30.3	12.9	25.3	12.0	22.9	12.8	19.1
Progress	39.3	21.9	46.6	24.5	39.4	20.3	37.6	26.4	32.7
New technology	45.5	14.2	58.9	13.7	44.4	16.3	38.0	18.6	30.6
Inventions	39.5	21.3	46.4	23.7	37.6	21.9	35.1	22.9	30.4
Environment	28.2	10.8	35.7	8.7	27.1	11.2	25.3	10.1	19.3
Industry	27.9	7.5	36.7	7.1	28.0	8.5	23.3	8.5	17.6
All twenty-three items	29.4	17.1	36.3	16.6	29.9	16.3	28.1	16.9	23.6

Note: The first six items correspond to positive judgments (from "benefits" to "illness") and the next four to critical ones (from "science" to "computers"). The last five items (from "progress" to "industry") exhibit the largest percentage differences between nations or between the extreme categories of sociocultural and cognitive variables.

Eurobarometer questions (36.3 percent).[8] This finding shows how important it is to have measures of cognitive proximity to science (interest and patterns of information acquisition) and understanding of science (concepts, methods, and the institutional dimension of scientific practice) to estimate value judgments or attitudes toward it. "Scientific knowledge," even if only deficiently measured, is a meaningful explanatory variable for attitudes to science (in this case "nonattitudes"). NSRs in this low status group split almost evenly between "don't know" and neutral ("neither . . . nor").

Conversely, individuals of higher social and educational status record significantly fewer NSRs; 16.3 percent of the high-income group, with the group leaving education at age 20 or older at 17.1 percent, and the high-scientific-literacy group at 16.6 percent. It bears mention that the composition of NSRs in the subset of high social and educational status differs markedly from that of the subset at the other extreme, in that approximately 80 percent of NSRs correspond to neutral responses (“neither . . . nor”) against only 20 percent to “don’t know” responses (equating in direct percentage terms to 14 percent of “neither . . . nor” responses and only 3 percent of “don’t know” responses). These readings suggest that true neutrality or evaluative indifference to the prompt may be the source of most NSRs in high-status groups, whereas neutrality and cognitive distance record similar scores among the low-status groups.

In specific items, the large differences in NSR levels indicate a serious gap in respondents’ ability to evaluate the science domain or, more precisely, certain aspects of the domain. The difference in NSRs between the extreme groups on the scientific literacy axis (“high,” “low”) extends to twenty-four points in “benefits,” thirty points in “industry,” and forty-five points in “new technology”; similarly, the highest and lowest income groups are at a distance of seventeen points in “work” and nineteen points in “progress.”

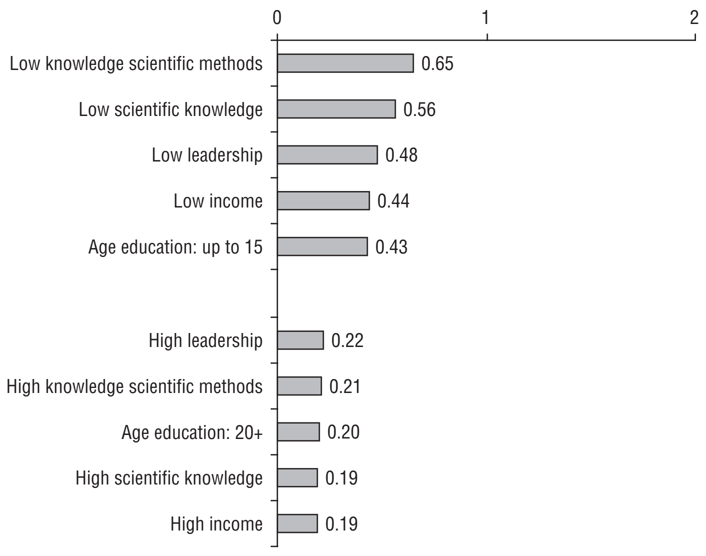
Moreover, NSR levels exhibit wide variations within each group or social segment according to the nature of the subject item, which tend to reproduce the abovementioned distances, that is, some aspects of science are hard to evaluate even for high-status groups and those with a greater understanding of science: for example, in the high-income group, the “illness” item had an NSR rate of just 3.9 percent against the 27.4 percent of the “science” item, and in the high-scientific-knowledge group, the 5.4 percent NSRs of “illness” contrasted with the 24.5 percent of “progress” and the 25.6 percent of “benefits.” It appears that even individuals cognitively closer to science encounter difficulties in evaluating abstract statements or complex views about the effects of science that involve weighing various positive and negative factors in a single mental operation.

Moving on from groups of individuals to the aggregate standpoint of the nation, we also find marked differences in the average levels of NSRs. Portugal ranks first by this measure with 36.0 percent, followed by Greece with 28.8 percent, Spain and Belgium with 26.7 percent, and Italy with 25.1 percent. Below the 21 percent mark stand the United Kingdom with 20.4 percent, the Netherlands with 19.5 percent, and, the lowest scoring, Denmark, with 16.6 percent. Among the less advanced nations (Portugal, Greece, Spain, and Ireland), the percentage of “don’t know” answers exceeds that of “neither . . . nor,” while the breakdown runs the other way in all remaining countries. In general, the rule holds true that less advanced countries and groups of lower status, education, and scientific literacy record the highest levels of NSRs or, put another way, "cognitive and evaluative distance" with respect to science.

We can obtain a synthetic metric of the difficulty of evaluating science by constructing an index of cognitive and evaluative distance (ICED) for each individual, sociodemographic group, and nation. The algorithm for constructing and computing this index, split initially into its two components (cognitive distance and evaluative distance), comprises the following steps (convertible, e.g., into SPSS syntax commands): (a) An index of cognitive distance (ICD) variable is created for each case in the data matrix, with initial value zero. (b) After automatically screening each subject and item (in our case twenty-three items) for the presence of the "don't know" code, a value of one is assigned to the ICD variable for each item with "don't know" responses present and a value of zero to cases showing no "don't know" responses. The total number of "don't know" responses will determine the score of each individual on the said index. (c) An index of evaluative distance (IED) variable is created for each case, likewise with an initial value equal to zero, then the screening of all subjects and items for the presence of a "neither . . . nor" response, and assigning of the value one for each item where it is found and the value zero for cases where it is absent. The sum of values of one will give the individual's score for the IED variable. (d) The fourth step has two possible variants, depending on whether the preference is to give each component the same weight in the final ICED score (simply adding together the ICD and IED scores of each individual) or to give a differential weight to one or another NSR category (i.e., weighting the score obtained in the corresponding index before adding the two together). (e) The score obtained for each individual using either of these two variants can be easily transformed into a new value indicating that person's propensity to offer an NSR by simply dividing it by the number of items. (f) To determine the NSR propensity of a given sociodemographic group or nation, sum the scores of all the individuals belonging to that group or nation and divide by the size *n* of the group or nation. The resulting ICED range will run from zero (no individual responding "don't know" or "neither . . . nor") to the value of the differential weight (provided it is greater than or equal to one).

For the purposes of this analysis, we sum the average percentages of "neither . . . nor" and "don't know" responses, assigning a differential weight to the express recognition of "no opinion" or cognitive distance (weight of two) and to the "neutral" responses indicative of a cognitive and/or evaluative distance (weight of one), recognizing that this last type of

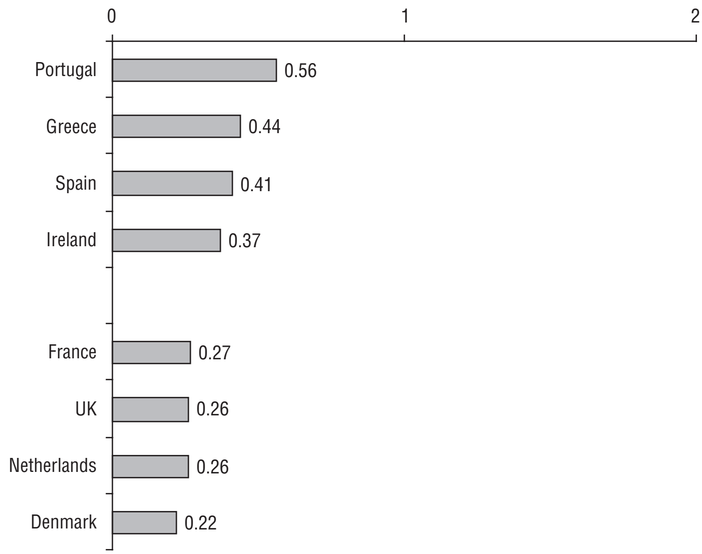
Figure 2
Index of Cognitive and Evaluative Distance by Sociodemographic Group



NSR may have various explanations. The resulting range is accordingly from zero to two.

Each group's distance from or proximity to the attitude object, as measured by the ICED, tends to depend more on the exogenous variables we can label cognitive (some generic cognitive variables such as education level and, above all, others specific to the PUOS field, such as "knowledge of methods" and "knowledge of concepts") than on conventional sociodemographic variables (income, social class, age, gender). Both the low-status and low-knowledge groups and the less advanced nations turn out to be furthest away from the attitude object (i.e., from the different facets of science; Figures 2 and 3). More specifically, the difference in ICED readings between the high-knowledge and low-knowledge groups in what is known in the literature as the methodic dimension of science[9] stands at 0.44 points across the sample, the difference between the high- and low-knowledge groups in scientific concepts is 0.37 points, and, finally, the difference between those aged twenty or more when leaving education and those aged fifteen or less comes to 0.23 points. None of the main sociodemographic

Figure 3
Index of Cognitive and Evaluative Distance by Nation



variables (gender, subjective social class, leadership) produces such pronounced differences (the sole exception being the "income" variable, which stands near the values found for "age of finishing education," namely, a difference of 0.25 points between the high and low category, still a long way behind the more specific cognitive variables).

Among nations, the highest ICED readings correspond to Portugal, Greece, and Spain (0.56, 0.44, and 0.41, respectively) and the lowest to the United Kingdom, the Netherlands, and Denmark (0.26, 0.26, and 0.22, respectively). Note that differences between nations were found to be more modest than between social groups in the sample as a whole.

Examining the "nation"–"social group" interaction in the ICED, we find that this pattern holds true for each European society. Namely, it is the groups with low social status and low knowledge levels that have the most difficulties evaluating science. These social and cognitive differences are also greater between extreme groups (high, low status; high, low knowledge) in the less advanced than in the more advanced nations, evidencing a greater stratification between groups in the former regarding their ability to judge the science object. The most illustrative cases are Portugal, with a difference of 0.65 points between low- and high-knowledge groups and a difference of 0.62 points between low- and high-income groups, Greece (differences of 0.52 points and 0.51 points, respectively), and Ireland (differences of 0.54 points and 0.31 points, respectively), compared with the Netherlands (differences of 0.32 points and 0.19 points) or Belgium (differences of 0.21 points and 0.07 points).

The pattern of a larger difference in knowledge-based ICED readings was observed in almost every case, which stands as an indirect indicator of the explanatory force of the cognitive variables proper to the PUOS field in interpreting attitudes to and perceptions of science. It is to be expected, therefore, that more sophisticated and metrically more refined measures of the "scientific knowledge" variable will provide richer and statistically more powerful analyses of such central issues in the field as the relationships between knowledge and attitudes.

A Correspondence Analysis (CA) Map of Perceptions of Science

The statistical technique chosen here to characterize public perceptions of science is simple CA, a multivariate analytical tool used for exploratory purposes. Unlike other techniques, it imposes virtually no assumptions about the underlying structure of the data (Greenacre and Blasius 1994) and, accordingly, requires neither linear relations between the variables in question nor the measurement of variables at an interval or ratio level. CA is a versatile method of the family of data visualization statistical tools, primarily applied to cross-tabular data (contingency tables), whose results are a "map" of points representing the rows and columns of the table. Similarly to principal-component analysis, CA is also a method of dimension reduction, although with the difference that the distances are chi-square distances and the points have masses (or weights given to each point proportionally to the marginal frequency). Each row or column of a frequency table defines a different "profile" (a set of relative frequencies or frequencies expressed relative to their total), and it is precisely these profiles or coordinates of a point that are represented in a CA map (Greenacre 1993).

A simple or a stacked table is thus projected as points on a map, which lets us visually examine the differences and similarities between variables and/or categories of variables. The proximity on the map of variables or categories indicates associativity, similarity, or confusion between them, while variables or categories of variables standing far apart on its horizontal or vertical axes indicate a differential nature. The points (variables, categories) furthest away from the origin can be read as having a high degree of specificity versus the others appearing on the map, particularly near the origin of the coordinate system. Only vertical and horizontal, not diagonal, distances are meaningful or interpretable. With these few simple rules for reading factorial maps, and some quantitative indicators of the map's quality of representation of the table, an analyst can interpret the general meaning contained in or deducible from the data matrix.

The first step before the analysis proper is to create a general data matrix, in this case a stacked table (or "supertable," a kind of table of tables) formed by thirty-nine rows (twenty-seven sociodemographic groups and twelve nations) and thirty-two columns or categories (see Table 3). Sixteen of these columns show the agreement percentages (collapsing the "strongly agree" and "agree to some extent" categories) of each row with the sixteen items in the science evaluation battery, while the other sixteen give the percentages of disagreement (collapsing "strongly disagree" and "disagree to some extent") with the same sixteen items. These percentages factor only the subjects in each group or nation providing a valid response; that is, they exclude all those giving NSRs ("neither . . . nor" and "don't know"). The resulting matrix displays the judgments in favor or against of those individuals able and willing to evaluate the science facets or aspects posed in each item.

The last three rows of Table 3 (rows 40 to 42) are occupied by what are known as supplementary points, which neither influence nor mathematically alter the representation of the other thirty-nine rows (known as "active" rows) on the factorial map but can be projected onto the map on the basis of their profile. The map position of these supplementary points can therefore be interpreted in relation to the "active" points (see Greenacre 1993). In this case, the last three rows contain the percentages obtained in different items or categories by three respondent groups labeled "high status," "intermediate status," and "low status" according to the possession of certain preset characteristics (as documented below).

The aim of this analysis is to gain a global understanding of the information through a small number of axes or factors, which graphically extract most of the statistical meaning from the data matrix. Each row (in our case, sociodemographic group and nation) and column (perceptions of science items) gets a given score in the coordinates or axes and is assigned a position on the factorial map. In this map, the points clustered around the origin (coordinates 0, 0) have more similarities with the average profile (rows or columns of relative frequencies, usually in percentage form), while those

Table 3
Evaluations of Science Matrix (thirty-nine rows, thirty-two columns)

Rows: Sociodemographic Groups and Nations		Columns: Items[a]
Gender	Knowledge of scientific method	1. Lifecomfort ag
1. Male	18. Lowest (zero methods)	2. Science ag
2. Female	19. Middle (one or two methods)	3. Animals ag
Age	20. Highest (three methods)	4. Progress ag
3. Fifteen to twenty-four years	Interest in science and technology (two themes)	5. Researchers ag
4. Twenty-five to fifty-four years	21. No (in zero themes)	6. Work ag
5. Fifty-five and older	22. Middle (in one theme)	7. Daily life ag
Income	23. High (in two themes)	8. Average person ag
6. Lowest quartile	Age of education	9. Way of life ag
7. Middle quartile	24. Up to fifteen years	10. Future ag
8. Highest quartile	25. Sixteen to nineteen years	11. Jobs ag
Leadership	26. Twenty or older	12. Government ag
9. Low	27. Student	13. Industry ag
10. Middle	Country (weight V8)[b]	14. Economy ag
11. High	28. France	15. Illness ag
Social class	29. Belgium	16. Benefits ag
12. Working class	30. Netherlands	17. Lifecomfort dis
13. Middle class	31. West Germany	18. Science dis
14. Upper-middle class	32. Italy	19. Animals dis
Knowledge of scientific concepts	33. Denmark	20. Progress dis
15. Low (score zero to five)	34. Ireland	21. Researchers dis
16. Middle (score six to nine)	35. United Kingdom	22. Work dis
17. High (score ten to twelve)	36. Greece	23. Daily life dis
	37. Spain	24. Average person dis
	38. Portugal	25. Way of life dis
	39. East Germany	26. Future dis
	Supplementary points	27. Jobs dis
	40. High status	28. Government dis
	41. Intermediate status	29. Industry dis
	42. Low status	30. Economy dis
		31. Illness dis
		32. Benefits dis

Note: The rows are occupied by thirty-nine sociodemographic groups and nations (plus three supplementary rows), and the thirty-two columns by the agreement (ag) and disagreement (dis) categories of sixteen items measuring perceptions of science.
a. The original wording of each of the items whose abbreviated versions appear here can be found in Table 1.
b. Sample sizes were weighted by variable V8 of the Eurobarometer (labeled "Weight result from target") that reproduces the real number of cases for each country.

located further away, particularly on the periphery and extremes, will be those deviating from the average response profile of other groups or nations or other items. To reiterate, the proximity and distance of such points will be suggestive of their similarity or association or, alternatively, their dissimilarity or distance. If one of these peripheral points representing a given group (or nation) is close to another point representing an item, it means that there is a "kinship" or close association between the two, that is, that the group (or nation) in question is evaluating the item (high or low percentage of agreement or disagreement) in a distinct way from other groups or nations. The proximity of two or more points representing groups (or nations) will indicate a fairly similar evaluative behavior. Finally, the proximity of two or more items will mean they were similarly evaluated by the groups (or nations).

The CA described in the following pages thus rests on the visual interpretation of proximities and distances between the points plotted on the factorial map, combined with an examination of the formal statistical aspects of the representation or the quality of the "solution." Of these aspects, we can highlight the different explanatory power (explained inertia) of each axis or factor and also the contribution of the axes to each point (in our case social group, nation, and item), also known as "relative contribution."[10] The analysis is then rounded off by a direct exploration of frequencies (stated here as percentages).

The Strength of Sociodemographic Variables in the Factorial Map

The central goal of the analysis is to characterize the behavior of different sociodemographic groups and European nations in their evaluation of science, without imposing linearity restrictions and the corresponding metric constraints on these relations. The groups intervening in the analysis respond to the canonical social variables (age, gender, subjective social class, income, leadership, education) and other, cognitive variables germane to our present study and the PUOS field at large (interest in science and technology, knowledge of scientific concepts, knowledge of scientific methods). All variables are represented by three values or categories, except for gender (two categories) and education (four categories). The "nation" variable, pivotal to our analysis for its supposedly decisive influence on perceptions of science, comprises twelve categories corresponding to the same number of countries. Of the twenty-three items included in the science attitudes questionnaire, sixteen

Table 4
Explained Inertia per Dimension

Variable	Factor I	Factor II	Factor III
Eigenvalue	0.09228	0.00371	0.00198
Percentage inertia	46.1	20.0	10.7
Percentage cumulative inertia	46.1	66.1	76.8

were selected for the analysis because of their substantive interest and statistical distribution (see Table 3).

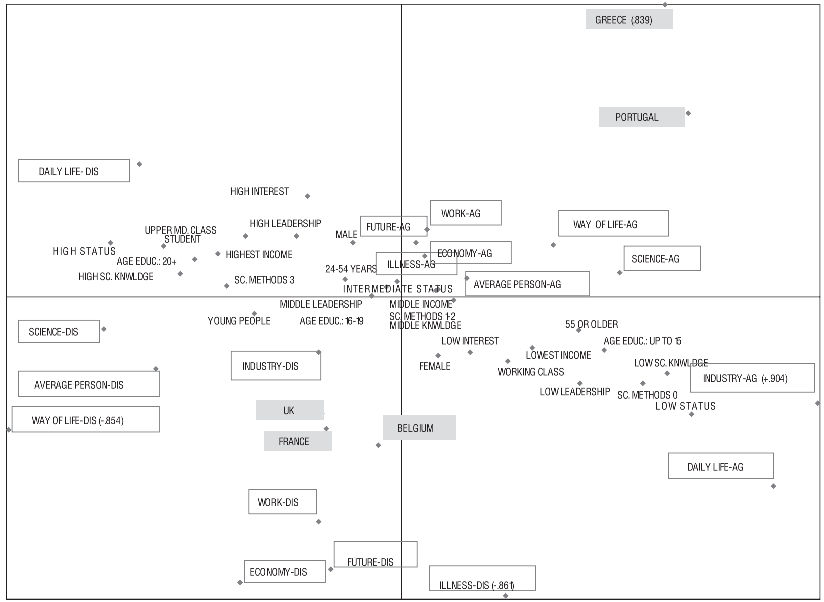
In this section, we identify the dominant associative patterns between perceptions of science on one hand and the set of sociodemographic categories and nations on the other. We then examine the role or relevance of each type of variable (i.e., sociodemographic vs. nation, classical sociodemographic vs. cognitive variables) in the factorial map. Figure 4 and Table 4 give the most relevant statistical results of the simple CA carried out on the 39 (rows) × 32 (columns) matrix.

The "inertia"[11] explained by a three-factor solution comes to 76.8 percent, indicating the presence of affinity blocs between subject groups and nations with certain subsets of item categories (agreement, disagreement). Figure 4 (in which factors I and II are represented) shows well-differentiated factorial locations, evidencing the structure and content of axes (factors), which in turn capture the "meaning" of the data matrix.

Factor I, on the horizontal axis, accounts for a sizable percentage of total inertia, namely, 46.1 percent compared with the 20.0 percent of factor II and the modest 10.7 percent[12] corresponding to factor III. On the left of the first factor lie the disagreement categories of five items. Four out of the five are negatively worded (such that disagreement denotes a positive perception of science) and deal with important aspects of the science-society interaction: the social change caused by science is too fast, too much dependence on science instead of religious faith, knowing about science is unimportant for daily life, and scientific and technological research have no relevance for industrial development. The fifth is positively worded (agreement denotes a positive view of science) and affirms that scientists work to improve people's lives.[13]

Positioned close to the disagreement categories of these five items are the highest socioeconomic status and high-scientific-knowledge groups. This proximity is because these are the groups exhibiting the largest percentages of disagreement in the five items, particularly compared with the groups located on the factor's opposite side. On the right side of the factor,

Figure 4
Correspondence Analysis Map of Table 4

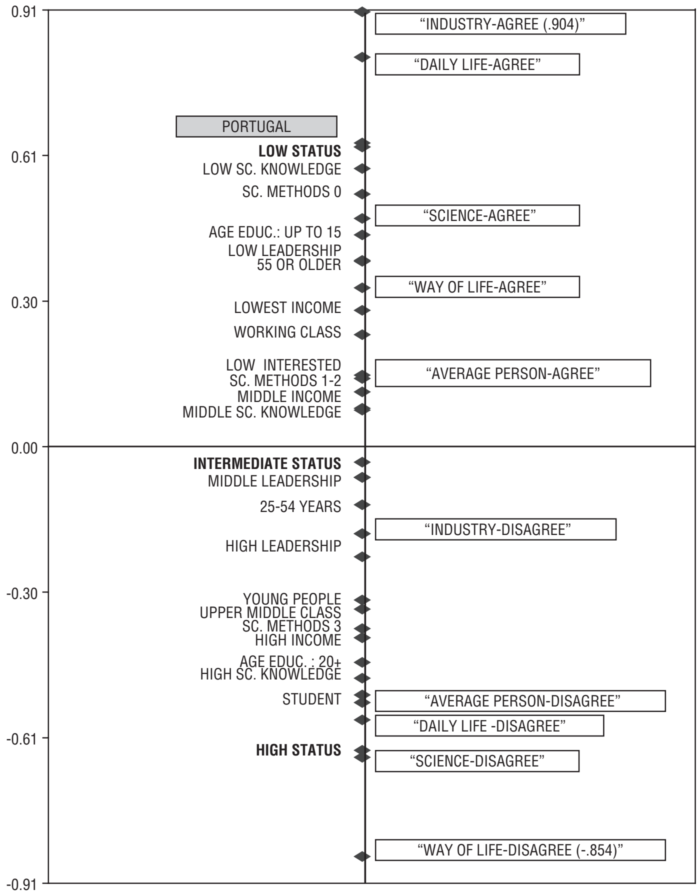


Note: Thirty-nine active rows, three supplementary rows, sociodemographic groups and nations, and thirty-two columns, sixteen “agreement items” and sixteen “disagreement items,” including only groups, nations, and categories (agreement, disagreement) considered significant according to the following double threshold: exhibiting an overall explanatory power (relative contribution in the three-factor correspondence analysis) higher than .510 and higher than .350 in any of the three factors. There are only two exceptions: the “middle-income group” (relative contribution .482) and the group corresponding to “middle scientific knowledge” (relative contribution .428), whose contributions are mainly concentrated in factor I.

we find the same five items, only this time in their agreement categories and, associated to them by proximity, the lowest socioeconomic status and low-scientific-knowledge groups.[14] The groups occupying the upper reaches of the stratification by "social status" and "scientific knowledge" (or cognitive proximity to science) stand out from the rest and, most pronouncedly, from those lodged at the other extreme of the social and cognitive scale, in their lesser appreciation of the reservations or side effects of science (though they also tend to manifest most disagreement about the final motivation of scientists, perhaps believing that researchers are primarily interested in understanding new problems and the symbolic and material rewards that this may bring, rather than in obtaining practical results "for the average person," a perception that would merit further examination in future studies; see Merton 1973; Ziman 1984). The composition of factor I brings to light two basic questions of substantive and methodological interest (see Figure 5). The first is the strong discriminating power of sociodemographic variables as opposed to nations (much weaker), primarily in negatively worded items. The second is that the main points separating groups in their perceptions of science must be sought in reservations, not in promises. To put this another way, almost all groups hold similar views of the positive effects of science ("promise") mentioned in the questionnaire but diverge in their appreciation of its side effects (with the groups at the lower end of the social stratification showing most reservations with regard to the pace of social change and religious beliefs) and their views about the importance of science in daily life and for industrial development (perceived more weakly by lower status groups).[15]

These results, which point to a marked social stratification with regard to reservations toward science, can be confirmed by means of a simple typology of three large groups (high, intermediate, and low social and or cognitive status), defined according to the scores obtained in three or more variables out of a set of six. The "high-status" group is formed by respondents meeting three or more of the following conditions: having a "high income" (income variable), considering themselves "upper-middle class" (subjective social class), being "20 or older at the time of leaving education" (education), and with "high leadership" (leadership), "high scientific knowledge (9-12 points)," and "high knowledge of scientific method (3 points)." By this yardstick, 15.2 percent of the European population can be classified as "high status." The other extreme group, "low status," is formed by respondents fitting three or more conditions characteristic of those located at the base of the stratification system: "lowest income quartile," "working class," "low leadership," "15 or younger at the time of leaving education," "low scientific knowledge (0-5 points)," and "low

Figure 5
Plot of Row and Column Coordinates on Axis 1



knowledge of scientific method (0 points)." Twenty-one percent of the European population falls within this group. Finally, a clear majority of respondents are of what we might call "intermediate status." The 63.8 percent of the population falling within this group comprises all those respondents failing to exhibit three or more characteristics in either the high-status or low-status category.

Figure 6
Average Disagreement Percentages per Group in "Reservation" Items

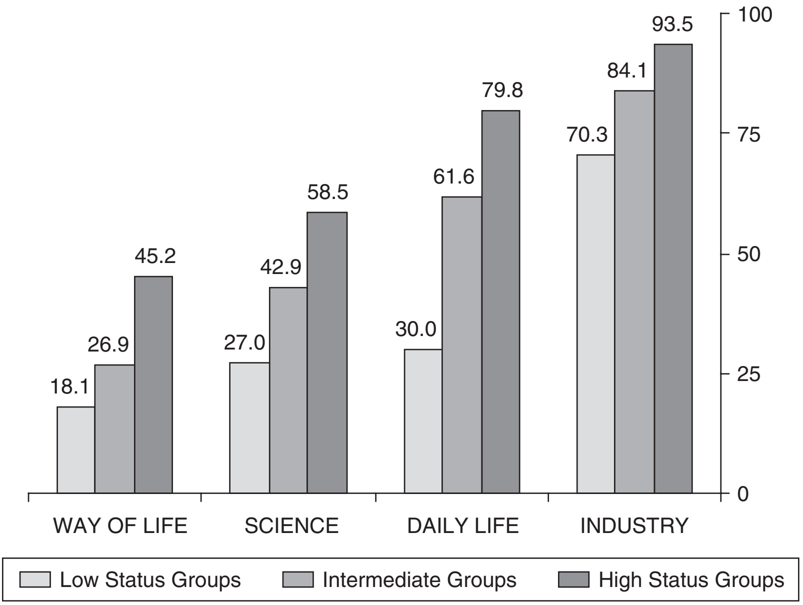


Figure 6 shows that the "high-status" group records higher percentages of disagreement in the four reservation items than the "low-status" group. Individuals with at least three "high-status" characteristics exhibit a propensity to have fewer reservations about science than those at the opposite end of the classification. This is not to say that the "high-status" subset does not feel significant reservations about some facets of science, simply that the extent of these reservations is markedly lower than that expressed by the other large group: 39.7 percent of high-status respondents agree that we depend too much on science ("science") against 72.1 percent of low-status respondents, while 54.8 percent of high-status respondents see the social change associated to science as too fast ("way of life") against 82.4 percent of low-status respondents.

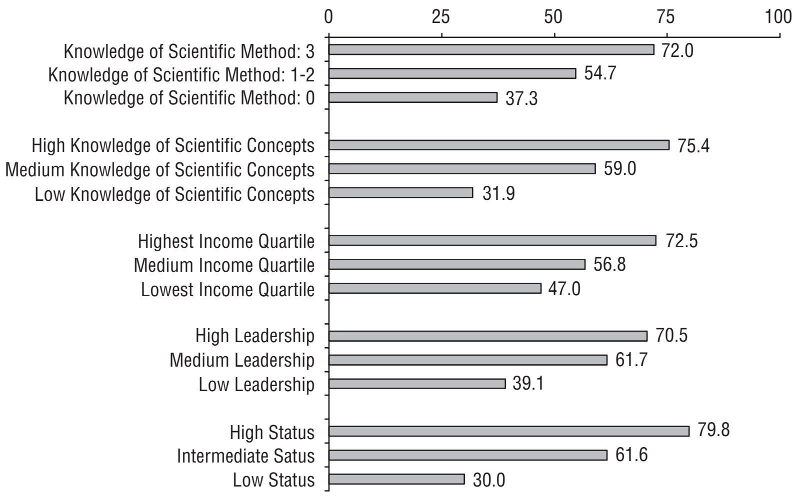
The differences between sociodemographic groups observed in the factorial map are set out in numerical form in Table 5. These readings show the greater discriminatory power for reservations of the cognitive variables

Table 5
"Disagreement" Percentages of Sociodemographic Groups in Response to Reservation Items

	Reservations			
Variable	Daily Life	Industry	Science	Way of Life
Aged fifty-five or older	40.7	80.3	31.1	19.7
Young people	70.3	86.5	51.2	35.5
Working class	48.7	77.0	37.9	22.6
Upper-middle class	70.9	90.0	50.1	38.2
Lowest income quartile	47.1	78.8	32.0	25.7
Highest income quartile	72.5	90.7	52.7	37.5
Low leadership	39.1	77.6	35.6	18.5
High leadership	70.5	88.3	47.6	31.5
Low knowledge of scientific concepts	31.9	74.1	28.1	19.0
High knowledge of scientific concepts	75.4	90.6	55.4	39.9
Knowledge of scientific methods: zero	28.7	70.9	24.6	20.9
Knowledge of scientific methods: three	72.0	90.6	51.5	37.6
Low interest in science and technology	48.6	81.9	40.2	24.7
High interest in science and technology	73.2	85.5	46.1	32.6
Age of education: up to fifteen years	39.2	77.5	29.8	19.5
Age of education: twenty or older	75.5	90.3	53.4	36.9
Student	80.1	90.9	52.4	42.4
High status	79.8	93.5	58.5	45.2
Intermediate status	61.6	84.1	42.9	26.9
Low status	30.0	70.3	27.0	18.1

that are most specific or closest to the object (the evaluation of science), namely, knowledge of scientific concepts and, above all, knowledge of scientific methods. To reiterate, this suggests that a more robust "scientific literacy" metric than we now have available could explain a greater percentage of variance in attitudes to or perceptions of science, though not necessarily in the form of linear models (Pardo and Calvo 2004).

Figure 7
Disagreement Percentages per Group in the "Daily Life" Item



Between the two groups occupying the opposite extremes lies the "intermediate-status" group and all the intermediate categories, which we can see clustered round the origin of factor I (point 0, 0 in Figure 4).[16] The statistical significance of this factorial equidistance from the high and low groups in the proposed stratification system is none other than having scored disagreement percentages (particularly in the four negatively worded items) higher than those of the high-status group, but not so high as those of the low-status group.

The evaluative position of high, intermediate, and low sociodemographic groups, and also of segments with different levels of familiarity with science, is depicted in Figure 7 (referring to the item "daily life" but extensible to the other three reservation items). Their positioning here and in the factorial map reveals the existence of an ordered scale stretching from the greater reservations of the groups at the lower end of the social and cultural stratification system to the lesser reservations of those at the top, via the midway evaluative positions of the intermediate groups. We thus have a social and cognitive segmentation structuring or shaping how people apprehend different facets of the science-society interaction. This differentiation emerges in the intensity with which the three groups perceive the reservations or side effects of science, and not its promise, as there are barely any meaningful differences by this last measure.

The absence of the nation variable in the composition of this first factor is another noteworthy finding of the present CA (the sole exception being Portugal, which is bound strongly to the factor and exhibits a high relative contribution, at .619, indicative of an evaluative behavior by the country as a whole similar to that identified for the low-status group, that is, at the lower end of the stratification). Nations tend not to display clear or constant evaluative differences with regard to the ten columns (five agreement and five disagreement categories) making up the reservations about science axis, in contrast to what occurs with sociodemographic groups. Contrary to the received wisdom, there is no conclusive evidence that nations split into two clear blocs by their perceptions of science: one comprising the more developed nations (in the center and north of Europe) and the other the less developed nations of southern Europe.

The Fragmentation of Nations

The items measuring the "promise" of science are missing from the composition of factor I, that is, the factor capturing the highest percentage of inertia or association. Specifically, ten of the eleven positively worded items (agreement with a positive evaluation of science) are absent from this factor. The issues involved are as central to the public's perception of science as the greater good than harm done by scientific knowledge ("benefits"), the possibility that science will help cure serious diseases such as AIDS or cancer ("illness"), the creation of more opportunities for future generations ("future"), the greater comfort science can provide ("lifecomfort"), the greater competitiveness of the economy ("economy"), the idea that basic scientific research should receive government funding ("government"), the power to make work more interesting ("work"), a means to increase consumption without polluting the environment ("progress"), employment creation ("jobs"), and the acceptance of research on animals (even if it causes them pain) to advance biomedical knowledge ("animals"). Only four of these promise items ("work," "future," "economy," and "illness") present a degree of affinity permitting their inclusion in factor II, associated in the disagreement category to three nations and in the agreement category to one nation only. The remaining six items stand out above all for their singularity. Four of them ("lifecomfort," "progress," "jobs," and "government") do not form part of any of the three factors, their relative contribution to the factors being less than .350, while a further two ("animals" and "benefits") form part of the weak and largely uninterpretable factor III. They figure as isolated pockets of significance, unable to exert any mutual attraction or any influence over other items, because of the relative independence of the perceptions of science implicit in their wording.

Factor II has an explanatory power of 20.0 percent of inertia and is made up along one of its sides by three countries—the United Kingdom, France, and Belgium—associated to the disagreement categories of the four "promise" items,[17] and by the group corresponding to the female gender. On the opposite side stands the factorially distant and isolated Greece, associated to the agreement categories of these same four items, along with the high interest group and the gender group male (Figure 8).[18]

There is one obvious reason why "promise" items do not find a space in the first factor: the fact that there are no significant and constant percentage differences between the three groups of high, intermediate, and low status or, more precisely, between the active variables or categories serving to define these three groups. This is illustrated by Figures 9a and 9b with reference to "future" and "economy," but the observation also holds true for the other three items. Not only are the effects of science very positively rated in the facets captured by "future," "economy," "illness," and "work," but there is also no significant variance in the perceptions of the three status groups (once again, between the categories we use to characterize each).

An apparently plausible interpretation of the different groups' perceptions of science would be that "the higher the social status and scientific literacy, the more agreement with promise items and, conversely, the lower the agreement with reservation items," assuming that the opposite would hold true for the low social status and low scientific literacy groups. Broadly speaking, these are the results we get from analyzing the percentages for each category without removing NSRs ("don't know" and "neither . . . nor"). However, if we bring the ICED into play, excluding individuals with "nonattitudes" from our analysis, that is, factoring only valid percentages, we obtain the CA findings presented in this article, namely, that all the sociodemographic groups share the same views on the promise of science while, in contrast, exhibiting marked differences in their perceptions of reservation items, with the greatest apprehension corresponding to the low-status and low-scientific-literacy groups.

Factor II, as we have seen, takes in a few nations but finds no space for the majority: the Netherlands, West Germany, Italy, Denmark, Ireland, Spain, and East Germany. This is suggestive of their singularity, a quality we can even observe with regard to those science facets, the promise of science, for which, conversely, there is least discrepancy between sociodemographic

Figure 8
Location of Groups, Nations, and "Agree" and "Disagree" Items in Factor II

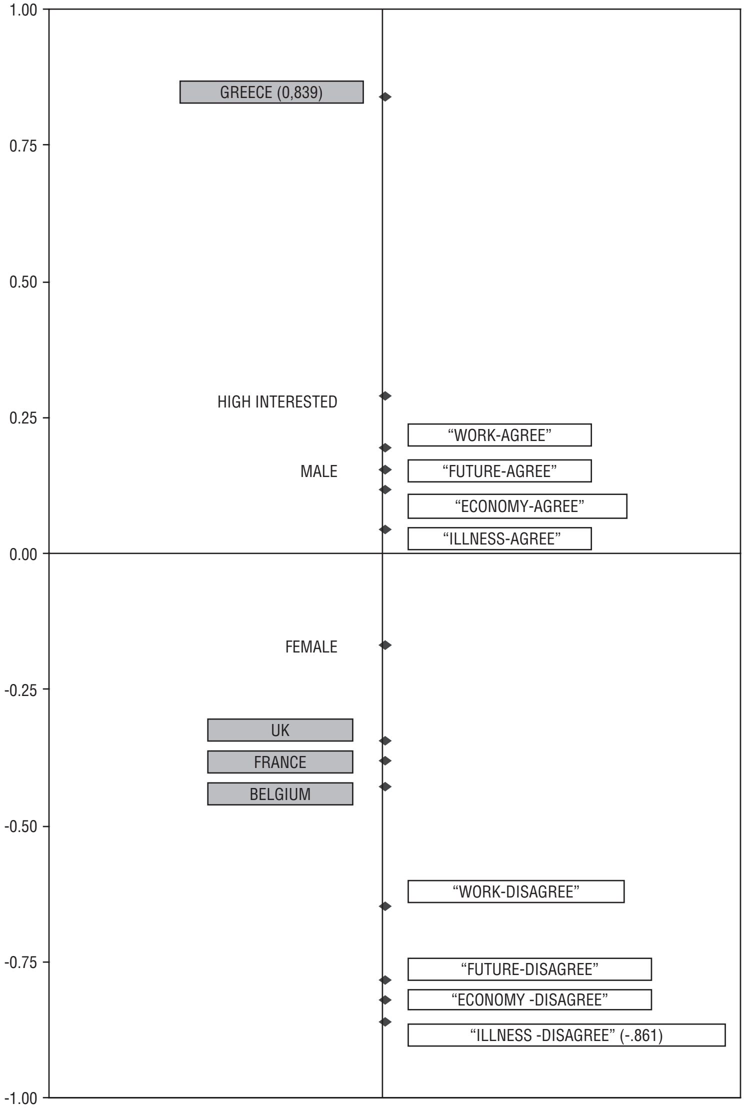
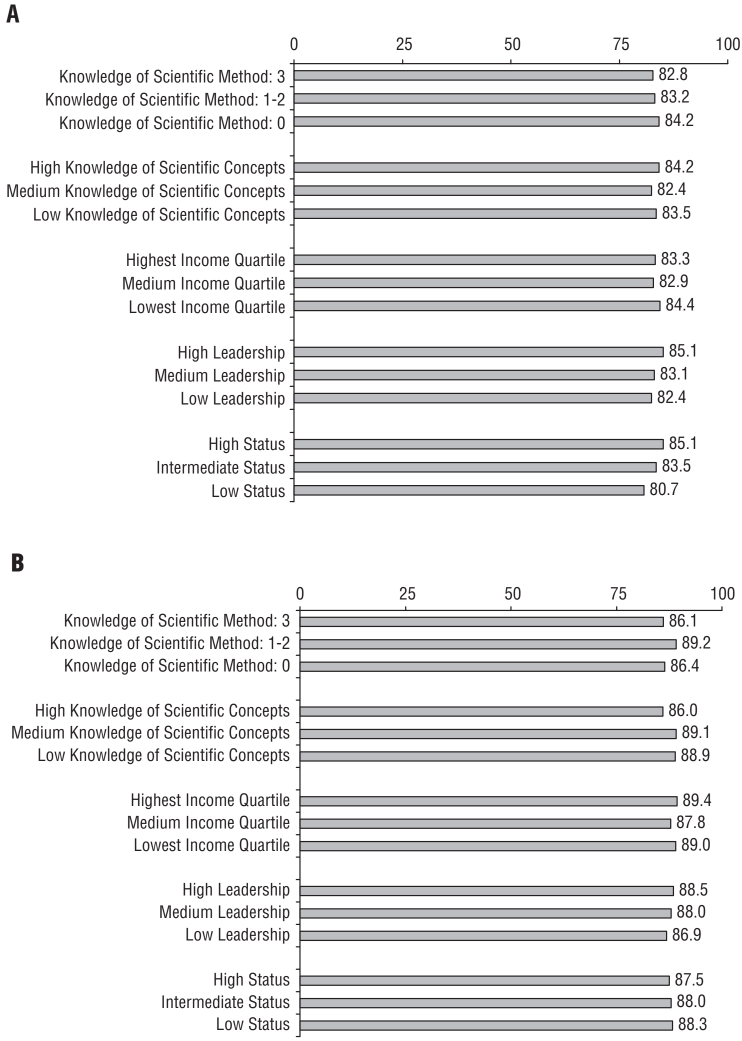


Figure 9
Agreement Percentages per Group in the "Future" Item (A) and the "Economy" Item (B)



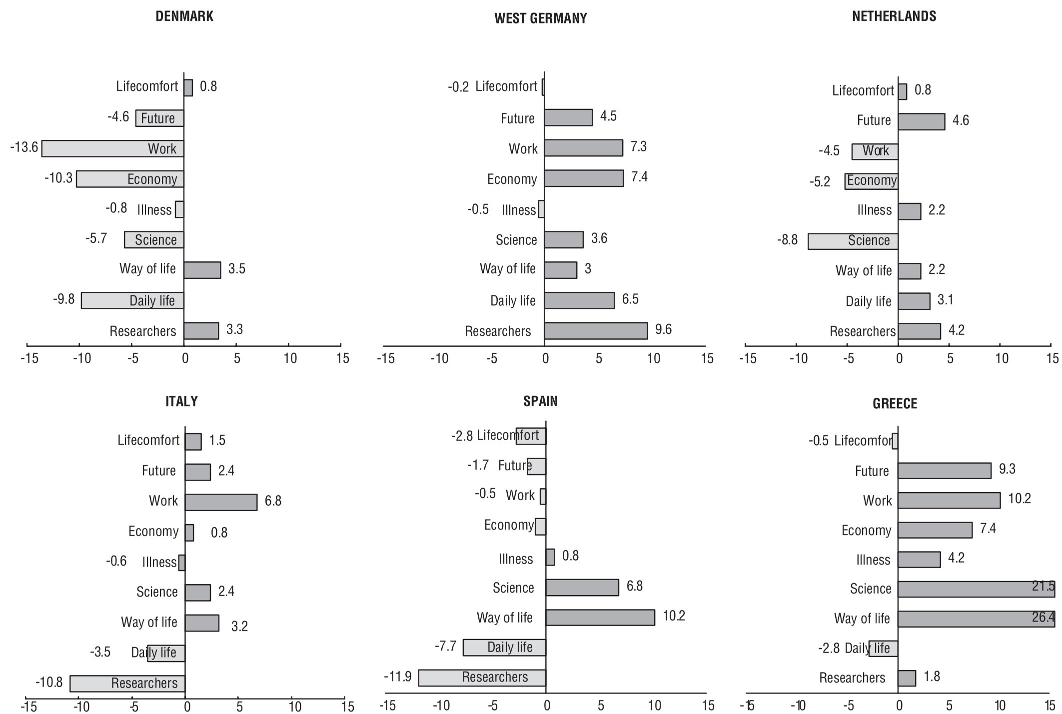
groups. It appears that the agreement or disagreement each nation reports for each evaluation item is a kind of quasi-mean of the percentage data for all the varied individuals making up that society (more or less educated, older or younger, high or low income or leadership, interest or no interest in science, higher or lower scientific knowledge). Each national finding, as such, is influenced by the kind of social stratification existing within the country that relates, in turn, to its historical track record of interaction with science and technology (what has been called "the intellectual appropriation" [Hard and Jamison 1998] of science and technology but could be more comprehensively labeled as the "integration" or "embedding" of science in each national culture). It is therefore reasonable to expect few strong similarities in their positioning with regard to science, and highly unlikely that we will find two distinct nation blocs made up of similar internal units.

The CA reported here characterizes the Europe of the end of the twentieth century as a space of nations, mostly exhibiting their own singularity in the evaluative appropriation of science and technology. This fragmentation of nations is more patent still when we compare their weak grouping ("correspondences") with the associative patterns or blocs of sociodemographic groups, which are present furthermore in the most powerful statistical and conceptual factor (i.e., factor I).

The particularities of nations in their evaluative positioning vis-à-vis science can be readily appreciated in Figure 10 (supplementing the picture given by CA), which portrays the statistical behavior of six nations and nine items (the first six positively worded and the last three negatively worded) as a representative sample of their respective sets. The deviation of their "agreement" percentages from the average percentage per item reveals each nation's particular evaluative profile with respect to the science facets posed by these nine items. Denmark's profile, for instance, looks nothing like West Germany's, and neither of the two shows many similarities with the Netherlands, Italy, Spain, or Greece (nor this last group of three southern European countries among themselves).

The nation variable, in sum, exhibits differentiating force for science perceptions but accompanied by a high degree of specificity. Laid out in space, the corresponding points resemble a mosaic of singular pieces rather than any kind of known pattern. To interpret this mosaic, the researcher of public perceptions of science would have to call on the historian and on the qualitative tradition, especially attuned to the comprehension of the domain of the concrete and specific.

Figure 10
Percentage Deviation of "Agreement" by Nation in Significant Items



Conclusions

The preceding pages present a map of perceptions of science in end-of-century Europe, which displays some of the most salient elements of how science was appropriated in the culture of the time. Few can doubt that the last third of the twentieth century stood out for the profound interdependence between, on one hand, advances in scientific knowledge and, on the other, individual and collective modes of needs fulfillment, from health care to economic growth by way of entertainment, a phenomenon that has been given the labels of "knowledge society" and "new economy." Hence the interest in discovering whether the radical transformation of material culture that simultaneously flows from and depends on science and technology has been accompanied by a similar change in the universe of symbolic culture and, in particular, in the cognitive and evaluative schema of the population. The interaction between the symbolic and socioeconomic domain is a question addressed in several sociological theories, most eminently the theory of the transition of values from modernity to postmodernity (Inglehart 1997) and the theory of the "postindustrial society" (Bell 1999). Surprisingly, these models attach only negligible importance, if any at all, to people's perceptions of science. Other social analysis lines dealing in the science-society interaction at the turn of the century, such as risk society theories, have focused almost wholly on one dimension, that of systemic risks and how society views them, to the exclusion or marginalization of all other facets of the science-society interaction (Beck 1992). The literature of the PUOS field has developed instruments for measuring the public's perceptions of science, in the process accumulating a large body of empirical evidence and offering valuable insights into both the strictly cognitive component (understanding of science) and the evaluative side (attitudes to science) of how science is received. But this literature too, with its emphasis on the cultural (cognitive and evaluative) reception of science, has significant limitations of approach and method that have narrowed its field of vision (excluding issues of major interest) and produced less than robust results that are hard to connect with those of more comprehensive social analysis approaches.

The analysis offered here, which draws on Eurobarometer measurements, starts from substantive and methodological assumptions differing from those employed in the hitherto most widely used approach. Among the substantive assumptions, we can single out the complexity of the "science" object as a target for views and attitudes (suggesting the interest of future studies to estimate cognitive and evaluative distances from science), the fragmentation of perceptions versus compact or structured ideological positions (pro- and antiscience), the existence of ambivalence in perceptions of science, and, last but not least, the concurrence of homogenizing or convergence forces (certain shared sociodemographic and cognitive traits across all European societies) and singularizing or differentiating forces (rooted in national structures and their historical trajectories) in the cultural appropriation of science in the globalization context. Among the methodological assumptions, some associated to the substantive ones described above, we can cite the nonimposition of indicators on the basis of the additivity of existing measures (summated scales) or of parametric constraints on the analysis. We propose instead the use of multivariate exploratory techniques imposing little structure on the data matrix (integrated by direct agreement and disagreement scores). After offering an estimate of cognitive and evaluative distance from the science object, our analysis confines itself to comparing the perceptions of the population subset (whose size varies by country and sociodemographic group) able and willing to form value judgments on the different facets of science.

We have conducted our analysis without regard to certain core assumptions of attitudes theory, in particular, the existence of an evaluative continuum stretching from systematic rejection of science to the most wholehearted acceptance. In its stead, we use the conceptual system put forward in the literature (Miller, Pardo, and Niwa 1997) based on the dual schema of "promise of science" and "reservations toward science," but without collapsing the questionnaire items specific to each, that is, without giving individuals only two scores, one for promise and the other for reservations. The idea was to conserve the identity of items and observe their behavior using direct data (percentages of agreement and disagreement), their grouping patterns, and the greater or lesser discriminatory power of each item for science perceptions per group or nation. It has been found that some facets of science trigger sharply differing evaluative responses in European societies, a question that merits fuller investigation calling on historiographic or qualitative methods.

In a context of growing globalization, sociodemographic and cognitive variables exhibit greater power than the national variable in forming patterns of similarity and difference in the way people perceive and judge science. Educational level, understanding of science (however elementary), social status, and other social characteristics act as convergent forces that transcend national boundaries. In contrast, a study of the data for each nation brings to light the high specificity of each society in its judgment on and cultural appropriation of science (this is already a given in the history of science and technology; see, e.g., Hecht 1998, exploring France's particular relationship with nuclear power). This specificity in science perceptions is strong enough to negate any attempt at a simple grouping of societies into the North versus the South of Europe. Whether growing European Union integration is driving greater convergence in cultures and public perceptions of science is a moot point requiring deeper study.

As to the assumption that the perceptual divide between groups at the opposite extremes of the social stratification system would be that higher status groups are readier to apprehend the promise of science and, at the same time, show fewer reservations than the lower status groups, we have shown that the picture is a deal more complex, substantively and methodologically. There are virtually no differences in how the two groups view the positive aspects of science measured by the Eurobarometer, that is, pairings such as science and health or science and comfort, but significant distances are observable in their perception of certain (real or supposed) side effects of scientific change, such as its role in undermining religious beliefs or accelerating social change. It is the groups at the lower extreme of the stratification system that are most sensitive to such effects or impacts. The groups who, we assume, stand most to benefit from socioeconomic change driven by science and technology, and have the most influence on its direction, also have their reservations, but these tend to be far less acutely felt. In this sense, it seems warranted to talk of a social and cognitive stratification in perceptions of science at the turn of the century, albeit localized mainly on the reservations side. These findings suggest the interest of measuring other facets of reservations to science, if possible including some not covered by the Eurobarometer, such as the perceived linkages between scientific advance, the arms industry and war at the turn of the century, other impacts on the global environment or science-based risks, which may perhaps be similarly perceived by one and the other group (compared with the more classic type of reservation measured by the Eurobarometer). Clearly, negatively worded items (such that agreement denotes a critical view of science) should have their number enlarged and cover more varied facets (following a qualitative study of the reservation facets having most salience with today's public).

Without getting into the debate so widely covered in the literature on the precision and richness of the "scientific literacy" or understanding variable, we have shown that the much discussed question of the relationships between knowledge and attitudes has some straightforward answers if approached in a parsimonious manner, without making unnecessary or unwarranted assumptions about the metric nature of the data and their type of relationship with attitudes to or views of science. Regardless of the limitations of existing scientific literacy measurements, it is clear that this foundational variable in the PUOS field has greater power to detect evaluative patterns than the other broad set of sociodemographic variables, and even than a more generic but correlated variable such as educational level. First of all, the group with the highest level of scientific knowledge, as gleaned from the Eurobarometer's own (imperfect) measurements, has fewer difficulties rating science, that is, they score low in the ICED proposed in this article. They also record the highest scores in almost all promise of science items and, significantly, the lowest scores under reservations. Not only is the perception of science pattern that flows from the understanding of science variable a clear and distinct one, but the differences it reveals between one and the other group are clearly greater than those found with generic variables or those outside the PUOS field. This suggests that more sophisticated measurements, conceptually and metrically, of the public's understanding of science would provide more insight into how science is being perceived at the beginning of the twenty-first century. It is also clear that constructing higher resolution maps than that offered in these pages would require the aid of disciplines and methods particularly sensitive to the analysis of concrete processes and objects, such as science and cultural history and qualitative research techniques.

Notes

1. One of the few analyses of the meaning of "don't know" responses in public perceptions of science studies, especially to questions designed to measure textbook scientific knowledge, was conducted by Martin Bauer (1996).

2. An added problem to measuring attitudes to science is that most questionnaires have covered its various facets rather haphazardly, and some, which have been the subject of regular debate, such as the science-technology-arms connection or the conduct of war, are conspicuous by their absence.

3. This observation is taken from Martin Bauer, whom we wish to thank.

4. The sample size of split A in each nation was as follows: France, n = 497; Belgium, n = 521; the Netherlands, n = 533; West Germany, n = 499; Italy, n = 511; Luxembourg, n = 250; Denmark, n = 496; Ireland, n = 501; the United Kingdom (Great Britain and Northern Ireland), n = 690; Greece, n = 502; Spain, n = 508; and Portugal, n = 500.

5. The percentages in this table factor "don't know" responses across the sample as a whole, although later analysis is confined to the percentages obtained from valid cases (excluding NSRs, i.e., "don't know" and neutral responses).

6. The phenomenon of the house effect was pointed out to us by Martin Bauer.

7. A number of analyses conducted for this article and not shown here that use the correspondence analysis technique to examine the "neither . . . nor" response across the sixteen items on which our analysis is based find that "neutral" responses are different from substantive

responses or those involving judgments, that is, "agree" (strongly agree and agree to some extent) or "disagree" (strongly disagree and disagree to some extent). A first examination reveals that the vast majority of the population do not show a systematic or consistent inclination for this intermediate option or neutral evaluative stance (82.9 percent never use it in twelve or more items of a total of sixteen) and that the average percentage of "neither . . . nor" per item is no greater than 15.8 percent, with insignificant or weak variations between different social groups (education: to age 15, 15.4 percent, to age 20 or older, 14.4 percent; high level of textbook scientific knowledge, 14.6 percent, and low level of textbook scientific knowledge, 16.6 percent; high income, 13.6 percent, and low income, 16.2 percent; knowledge of three elements of the scientific method, 14.8 percent, and no knowledge of scientific methods, 17.5 percent). The "agree" option averages 50.4 percent for the same sixteen items and the "disagree" option 26.9 percent, in both cases with very significant differences between sociodemographic groups.

A closer analysis shows that "neither . . . nor" stands apart from the remaining options (agree, disagree, but also don't know), with the "neither . . . nor" responses in the sixteen items lying in a distant factorial location, with no connection or similarity to the other responses (in a correspondence analysis of thirty-nine rows, comprising twenty-seven sociodemographic groups and twelve nations, and sixty-four columns, comprising sixteen items, each with four response options). It makes up the sole component of factor II, with an explanatory power of just 7.9 percent. More important still in the context of this article is that "neither . . . nor" responses are nowhere near the hypothetical midway point between "agree" and "disagree" responses, and therefore their exclusion from the matrix of substantive or defined responses is warranted from a statistical standpoint.

It perhaps bears mention that an alternative route to the one taken here would be to apply a recently proposed variant of correspondence analysis, available in two statistical packages (XLSTAT and R, the free version of S-Plus) and labeled "subset correspondence analysis" and "subset multiple correspondence analysis" (Greenacre and Pardo 2006, forthcoming), permitting a more detailed exploration of certain scale categories and their similarities and differences (e.g., substantive responses or, alternatively, nonsubstantive or "don't know" and "neither . . . nor" responses):

> The idea [of subset correspondence analysis] is to maintain the original relative frequencies of the categories and not re-express them relative to totals within the subset, as would normally be done in a regular correspondence analysis of the subset. Furthermore, the masses and chi-square distances assigned to the subset of categories are the same as those in the correspondence analysis of the whole data set, which leads to a decomposition of total variance into parts if the whole data set is subdivided into disjoint subsets. (Greenacre and Pardo, forthcoming)

8. The scientific literacy indicator is constructed from the number of right answers in a scientific knowledge scale of the "know-what" type (questions Q55 and Q56, with a total of twelve items, each having two response options, "true" and "false," as well as "don't know"): item 1: "The center of the earth is very hot"; item 2: "The oxygen we breathe comes from plants"; item 3: "Radioactive milk can be made safe by boiling it"; item 4: "Electrons are smaller than atoms"; item 5: "The continents on which we live have been moving their location for millions of years and will continue to move in the future"; item 6: "It is the father's gene which decides whether the baby is a boy or a girl"; item 7: "The earliest humans lived at the same time as the dinosaurs"; item 8: "Antibiotics kill viruses as well as bacteria"; item 9: "Lasers work by focusing sound waves"; item 10: "All radioactivity is man-made"; item 11:

"Human beings, as we know them today, developed from earlier species of animals"; and item 12: "Does the earth go around the sun or does the sun go around the earth?" The sample was divided into three large groups according to the scores obtained: the low-scientific-knowledge group (zero to five points), the middle-scientific-knowledge group (six to eight points), and the high-scientific-knowledge group (nine to twelve points).

9. The knowledge of "scientific methods" indicator is based on three questionnaire items (Q59, Q60, and Q61), each of which poses a problem and offers different methodological alternatives for solving it:

> *Q59:* "Let us imagine that two scientists want to know if a certain drug is effective against high blood pressure. A: The first scientist wants to give the drug to 1000 people with high blood pressure and see how many of them experience lower blood pressure levels. B: The second scientist wants to give this drug to 500 people with high blood pressure, and not give this drug to another 500 people with high blood pressure, and see how many in both groups experience lower blood pressure levels. In your opinion, which is the better way to test this drug? A: first scientist, B: second scientist, C: don't know."
>
> *Q60:* "Suppose a machine is breaking down repeatedly. It is suspected that the material from which a particular part is made is responsible for the breakdowns. There are different ways of investigating this problem. Which one do you think scientists would be most likely to use? A: Only talk to the machine operators and get their opinion. B: Only use their own scientific knowledge to decide how good the material is. C: Make the same part from different materials, put them in the machine, one after other, and then compare what happens in each case. D: Don't know."
>
> *Q61:* "Suppose doctors tell a couple that their genetic make-up means that they've got a one in four chance of having a child with an inherited illness. Does this mean that . . . A: If they have only three children, none will have the illness. B: If their first child has the illness, the next three will not. C: Each of the couple's children has the same risk of suffering from the illness. D: If their three children are healthy, the fourth will have the illness. E: Don't know."

One point is given for each right answer, so the indicator allows us to divide the population into four groups: those with zero right answers, those with one, those with two, and, finally, those with three (i.e., those giving what is considered to be the right answer to all three questions).

10. The total inertia in a matrix of k rows and m columns is a measure of the sum of the distances of each point from their respective centers of gravity (centroids). The greater the total inertia found, the greater would be the dispersion of points in the multidimensional space. The inertia explained by each axis or factor (explanatory power of each factor) is the weighted distance to the corresponding centers of gravity of the set of points that are grouped in that factor due to their closeness in the multidimensional space. The relative contribution of each row (or column) of each factor is understood as the proportion of the row's (or column's) inertia attributable to that factor, that is, the row's (or column's) affinity to the same (see Greenacre 1993).

11. The inertia of a contingency table is the χ^2 statistic divided by n (the total of the table).

12. Statistically, factor III forms part of the three-factor solution structure. However, its statistical and substantive contribution is of a residual nature, because very little significant content is left unexplained by factors I and II. The third factor includes only one nation, the Netherlands (relative contribution .629) associated to the "animals-agreement" category, because of its reaching one of the highest percentages of agreement (relative contribution .456), and, more weakly, to "benefits-disagreement" (relative contribution .393), for which it attains the highest percentage of disagreement.

13. The actual wording of the five items is as follows: “Science makes our **way of life** change too fast”; “We depend too much on **science** and not enough on faith”; “For me, in my **daily life**, it is not important to know about science”; “Scientific and technological research do not play an important role in **industrial** development”; and “Most scientists want to work on things that will make life better for the **average person**.”

14. Relative contributions are a high .586 plus for all items, groups, and Portugal and even reach .948 in the case of high scientific knowledge. Only “average person ag” and “average person dis” lag behind at .418.

15. If we pan out from the items included in the correspondence analysis presented here to all of the twenty-three items in the questionnaire, the pattern of similar agreement percentages in promise items still holds true with very few exceptions. More specifically, in eleven of the thirteen promise items (the eleven being included in the 39 × 32 matrix analyzed here), the groups located in the lower and upper zones of the social and cognitive stratification exhibit similar agreement percentages. In the two remaining promise of science items, “resources” (“Thanks to scientific and technological advances, the Earth’s natural resources will be inexhaustible”) and “inventions” (“New inventions will always be found to counteract any harmful consequences of scientific and technological development”), the groups with a higher social and cultural level report lower agreement percentages than the low-level groups. This deviation from the standard pattern may be explained by the fact that the scenarios these items pose do not turn on proven effects of science but on extreme expectations (“inexhaustible,” “always”). It is therefore not surprising that groups with a higher social and educational level are more reluctant to accept them, despite having a clearly positive perception of science. In the total of ten reservation items, that is, the five included in the correspondence analysis and the items “products,” “lucky numbers,” “computers,” “environment,” and “new technology,” the pattern of higher disagreement percentages (i.e., fewer reservations) among upper-level groups than lower-level groups holds true in every case.

16. Relative contributions are generally more modest, ranging from the .305 of the middle-scientific-knowledge group to the .683 of the group aged 25 to 54 years or the .681 of the scientific methods 1-2 group by way of the .448 of middle income and the .572 of middle leadership.

17. The literal wording of the four items is as follows: “Scientific and technological progress will help to cure **illnesses** such as AIDS, cancer . . .,” “Only by applying the most modern technology can our **economy** become more competitive,” “Thanks to science and technology, there will be more opportunities for the **future** generations,” and “The application of science and new technology will make **work** more interesting.”

18. The relative contribution of the four items varies from the .445 of “work” to the .674 of “future.” Belgium scores lowest on this count with .444 and Greece scores highest with .510. The high-interest group has .462, while male and female come out at a lower .367 and .405, respectively.

References

Almond, G. A. 1960. *The American people and foreign policy*. New York: Praeger.

Bauer, M. 1996. Sociodemographic correlates of DK-responses in knowledge surveys: Self-attributed ignorance of science. *Social Science Information* 35 (1): 39-68.

Bauer, M., J. Durant, and G. Evans. 1994. European public perceptions of science. *International Journal of Public Opinion Research* 6 (2): 163-86.

Beck, U. 1992. *Risk society: Towards a new modernity*. Thousand Oaks, CA: Sage.
Bell, D. 1999. *The coming of post-industrial society: A venture in social forecasting*. New York: Basic Books.
Ben-David, J. 1984. *The scientist's role in society: A comparative study*. Chicago: University of Chicago Press.
Converse, J. M. 1977. Predicting no opinion in the polls. *Public Opinion Quarterly* 40 (4): 515-30
Converse, P. E. 1964. The nature of belief systems in mass publics. In *Ideology and discontent*, edited by D. Apter, 206-61. London: Free Press of Glencoe.
Durant, J., G. A. Evans, and G. P. Thomas. 1989. The public understanding of science. *Nature* 340:11-14.
Durant, J., M. Bauer, G. Gaskell, C. Midden, M. Liakopulos, and L. Scholten. 2000. Two cultures of public understanding of science and technology in Europe. In *Between understanding and trust: The public, science and technology*, edited by M. Dierkes, and C. von Grote, 131-56. Amsterdam, the Netherlands: Harwood Academic.
Etzioni, A., and C. Nunn. 1974. The public appreciation of science in contemporary America. *Daedalus* 103 (3): 191-205.
Faulkenberry, G. D., and R. Mason. 1978. Characteristics of nonopinion and no opinion response groups. *Public Opinion Quarterly* 42 (4): 533-43.
Fiske, S. T., and S. E. Taylor. 1991. *Social cognition.* 2nd ed. New York: McGraw-Hill.
Francis, J. D., and L. Busch. 1975. What we now know about "I don't knows." *Public Opinion Quarterly* 39 (2): 207-18.
Freeman, C., and L. Soete. 1997. *The economics of industrial innovation*. 3rd ed. Cambridge, MA: MIT Press.
Gaskell, G., N. Allum, M. Bauer, J. Durant, A. Allansdottir, H. Bonfadell, D. Boy, S. Cheveigné, B. Fjaestad, and J. M. Gutteling 2000. Biotechnology and the European public. *Nature Biotechnology* 18:935-38.
Gaskell, G., N. Allum, and S. Stares. 2003. *Europeans and biotechnology in 2002*. 2nd ed. ftp://ftp.cordis.lu/pub/documents_r5/natdir0000038/s_1970005_20030319_102218_5S031970en.pdf.
Greenacre, M. 1993. *Correspondence analysis in practice*. San Diego, CA: Academic Press.
Greenacre, M., and J. Blasius, eds. 1994. *Correspondence analysis in the social sciences: Recent developments and applications*. San Diego, CA: Academic Press.
Greenacre, M., and R. Pardo. 2006. Multiple correspondence analysis of a subset of response categories. In *Multiple correspondence analysis and related methods*, edited by M. Greenacre and J. Blasius, 197-217. New York: Chapman & Hall.
Greenacre, M., and R. Pardo. Forthcoming. Subset correspondence analysis: Visualizing relationships among a selected set of response categories from a questionnaire survey. *Sociological Methods & Research*.
Handlin, O. 1964. Man and magic: First encounters with the machine. *American Scholar* 33 (3): 408-19.
Hard, M., and A. Jamison, eds. 1998. *The intellectual appropriation of technology*. Cambridge, MA: MIT Press.
Harkness, J. 2003. Questionnaire translation. In *Cross-cultural survey methods*, edited by J. A. Harkness, F. J. R. Van de Vijver, and P. P. Mohler, 35-56. Hoboken, NJ: Wiley-Interscience.
Hecht, G. 1998. *The radiance of France: Nuclear power and national identity after World War II*. Cambridge, MA: MIT Press.

Heise, U. K. 2004. Science, technology, and postmodernism. In *The Cambridge companion to postmodernism*, edited by S. Connor,136-67. Cambridge, UK: Cambridge University Press.

Holton, G. 1993. The anti-science phenomenon. In *Science and anti-science*, by G. Holton, 145-89. Cambridge, MA: Harvard University Press.

———. 1995a. The public image of science. In *Einstein, history, and other passions*, by G. Holton, 126-40. Woodbury, NY: American Institute of Physics.

———. 1995b. What place for science in our culture at the "end of the modern era"? In *Einstein, history, and other passions*, by G. Holton, 91-125. Woodbury, NY: American Institute of Physics.

Hughes, T. P. 1989. *American genesis: A century of invention and technological enthusiasm*. New York: Viking Penguin.

Inglehart, R. 1997. *Modernization and postmodernization: Cultural, economic, and political change in 43 societies*. Princeton, NJ: Princeton University Press.

Inglehart, R., M. Basañez, J. Diez-Medrano, L. Halman, and R. Luijkx. 2004. *Human beliefs and values: A cross-cultural sourcebook based on the 1999-2002 values survey*. Mexico City, Mexico: Siglo XXI Editores.

Institute for Social Research at the University of Michigan. 1958. *The public impact of science in the mass media*. Ann Arbor: Institute for Social Research at the University of Michigan.

Krosnick, J. A. 2002. The causes of no-opinion responses to attitude measures in surveys: They are rarely what they appear to be. In *Survey nonresponse*, edited by R. M. Groves, D. A. Dillman, J. L. Eltinge, and R. J. A. Little, 87-100. New York: John Wiley.

Lyotard, J. F. 1984. *The postmodern condition: A report on knowledge*. Minneapolis: University of Minnesota Press.

Marx, L. 1964. *The machine in the garden: Technology and the pastoral ideal in America*. Oxford, UK: Oxford University Press.

———. 1988. *The pilot and the passenger: Essays on literature, technology, and culture in the United States*. New York: Oxford University Press.

Merton, R. K. 1973. The reward system of science. In *The sociology of science: Theoretical and empirical investigations*, by R. K. Merton. Chicago: University of Chicago Press.

Miller, J., R. Pardo, and F. Niwa. 1997. *Public perceptions of science and technology: A comparative study of the European Union, the United States, Japan, and Canada*. Bilbao, Spain: Fundación BBVA.

Miller, J. D. 1983. *The American people and science policy*. New York: Pergamon.

Miller, J. D., and R. Pardo. 2000. Civic scientific literacy and attitude to science and technology: A comparative analysis of the European Union, the United States, Japan, and Canada. In *Between understanding and trust: The public, science and technology*, edited by M. Dierkes and C. von Grote, 81-129. Amsterdam, the Netherlands: Harwood Academic.

Miller, J. D., R. W. Suchner, and A. M. Voelker. 1980. *Citizenship in an age of science: Changing attitudes among young adults*. New York: Pergamon.

Minkenberg, M., and R. Inglehart. 1989. Postmodern structures of feeling: Values and lifestyles in the postmodern age. In *Contemporary political culture: Politics in a postmodern age*, edited by J. R. Gibbins. Newbury Park, CA: Sage.

Pardo, R., and F. Calvo. 2002. Attitudes toward science among the European public: A methodological analysis. *Public Understanding of Science* 11:155-95.

———. 2004. The cognitive dimension of public understanding of science: Methodological issues. *Public Understanding of Science* 13:203-27.

———. 2006. Are Europeans really antagonistic to biotech? *Nature Biotechnology* 24:393-95.

Price, D. J. deS. 1975. The difference between science and technology. In *Science since Babylon*, by D. J. deS. Price. New Haven, CT: Yale University Press.

Rosenberg, N. 1982. How exogeneous is science? In *Inside the black box: Technology and economics*, by N. Rosenberg, 141-59. Cambridge, UK: Cambridge University Press.

Schuman, H., and S. Presser. 1996. Measuring a middle position. In *Questions and answers in attitudes surveys: Experiments on question form, wording, and context*, by H. Schuman and S. Presser, 161-78. Thousand Oaks, CA: Sage.

Shapin, S. 1990. Science and the public. In *Companion to the history of modern science*, edited by R. C. Olby, G. N. Cantor, and J. R. R. Christie, 990-1007. London: Routledge.

Sobel, M. E. 1981. *Lifestyle and social structure: Concepts, definitions, analyses*. New York: Academic Press.

Solter, D., D. Beyleveld, M. B. Friele, J. Hólowka, H. Lilie, R. Lovell-Badge, C. Mandla, U. Martin, and R. Pardo. 2003. *Embryo research in pluralistic Europe*. Berlin, Germany: Springer.

Spector, P. E. 1992. *Summated rating scale construction*. Newbury Park, CA: Sage.

Sturgis, P., H. Cooper, and C. Fife-Schaw. 2005. Attitudes to biotechnology: Estimating the opinions of a better-informed public. *New Genetics and Society* 24 (1): 33-58.

Thiessen, V., and J. Blasius. 1998. Using multiple correspondence analysis to distinguish between substantive and nonsubstantive responses. In *Visualization of categorical data*, edited by J. Blasius and M. Greenacre, 239-52. San Diego, CA: Academic Press.

Withey, S. B. 1959. Pubic opinion about science and scientists. *Public Opinion Quarterly* 23 (3): 382-88.

Worsley, P. 1987. *The new introducing sociology*. Middlesex, UK: Penguin.

Ziman, J. 1984. *An introduction to science studies*. New York: Cambridge University Press.

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