Environmental and Scientific Knowledge Around the World

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Introduction

In recent years both international organizations such as the United Nations and the International Social Science Council (Pawlik, 1991; "Human..., 1994) and American bodies such as the National Science Foundation and the National Academy of Sciences (Miller, 1992; Committee, 1994) have stressed a need for research on the "human dimensions of global environmental change." Many important environmental changes such as the greenhouse effect, ozone depletion, and increases in local toxicity and radiation levels are in large part the product of human activities and technologies (e.g. the burning of fossil fuels, the manufacturing of chlorofluorocarbons, discharges from industrial and weapons production). Moreover, dealing with these environmental disruptions will largely depend on human recognition of the problems and a willingness to take appropriate steps to understand and alleviate them.

Knowledge is needed on two levels to handle the environmental changes. First, there is a need to thoroughly study the biological, physical, and chemical processes involved and to develop scientific solutions. That is, we need to advance our scientific understanding at the highest and most advanced level. Second, there is a need for more scientific and environmental knowledge among the general public. General public knowledge is needed so that people acting as voters, consumers, and parents can be wise stewards and make intelligent, informed decisions about the environment. Furthermore, since the environmental changes are global, information is needed for people in nations around the world (Skrentny, 1993; Rasinski, Smith, Zuckerbraun, 1994; Bloom, 1995; Miller, 1995; Dunlap and Mertig, forthcoming; Dunlap, 1995; Witherspoon, Mohler, and Harkness, 1995; Diekmann, Franzen, and Preisendoerfer, 1995).

This paper examines the current state of scientific and environmental knowledge around the world. It considers 1) the level of knowledge across topics and across countries both overall and for specific items and 2) what individual- and country-level variables explain differences in knowledge within and across countries.

Study of Scientific and Environmental Knowledge

In 1993 the International Social Survey Program (ISSP) conducted a study of public knowledge and attitudes towards the environment in 21 countries (See Appendix: Participating Organizations). In each country an in-person probability sample of adults living in households was carried out (Zentralarchiv, 1995).[1]

As part of these surveys a 12-item measure of scientific and

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[1]In America the items were asked on both the 1993 and 1994 General Social Surveys of the National Opinion Research Center. Only the 1993 GSS data are part of the merged ISSP data set analyzed here.

environmental knowledge was developed. The 12 items making up the scale tap a number of general topics and a range of difficulty (Table 1). Three deal with radiation (A - man-made origins of, F - exposure and death, and G - decay of radioactive waste), three with medicine and disease, including two concerning cancer (B - antibiotics, E - cancer and man-made chemicals, and J - pesticides and cancer), three with atmospheric conditions, including two explicitly about the greenhouse effect (H - hole in atmosphere, I - burning hydrocarbons, and L - automobile pollution), two items on natural history (D - evolution and E - extinctions), and a single item about astrology (C).[2] The knowledge items were presented as opinion items in order to reduce test anxiety on the part of respondents. For each statement respondents were asked to indicate which response came "closest to your opinion of how true it is." The response options were Definitely True, Probably True, Probably Not True, Definitely Not True, and Can't Choose.

Overall Knowledge Levels

Knowledge ranges from 84% knowing that radioactive waste remains dangerous for thousands of years to only 20% correctly saying that the greenhouse effect is not caused by a hole in the atmosphere. Knowledge is unrelated to the general topics covered. For example, the radiation items are first, seventh, and ninth in correctness and atmospheric items are third, fifth, and twelfth.

A major factor separating items on correctness was the direction of the questions. The five items with true as the correct answer had four of the five highest scores (% correct = 62.3-83.8; average=69.7) while the seven items with false as the correct answer had six of the seven lowest scores (% correct = 19.8-61.1; average=39.3).[3] That means the % correct on the true items exceeded the % correct on the false items by an average of 30.4 percentage points. While it is possible that the true items were simply objectively easier than the false items, it is unlikely that such a large and consistent difference would have been unintentionally built into the scale. It is more likely that people tended to guess true as the correct response more than they guessed false and these

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[2]A slightly different typology was used by Holbrook (1995) - Nuclear Energy (A, F, G), Biomedical (B, E, J), Environmental (H, I, K, L), and General Knowledge (C, D).

[3]Here and elsewhere "false" is used in place of "not true" which is the response category actually employed. True items refer to questions for which the correct answer was the true response; and false items to those for which the correct answer was the false response.

correct guesses inflated the correct responses to true items.[4]

Some support for the directional guessing hypothesis comes from an analysis of definitely correct vs. probably correct answers. The ratio of definitely-to-probably correct answers should be higher when answers are more certain. Certainty should increase when more people know (or at least think they know) the correct answer and fewer people are guessing. Thus, the ratio should increase as the % correct rises since the higher % correct should result from more people knowing the correct answer and few people guessing it. (For a very easy item almost 100% would know the correct answer and most would be definite about it, thus a high ratio. For a very hard item many of the few correct answers would be lucky guesses and these would probably be expressed as probably rather than definite, therefore a low definite-to-probable ratio.)[5] In general, the data confirm this pattern. The items with top five % correct have a definite-to-probably ratio of 0.91:1 compared to 0.82:1 for the bottom five.

In addition, one would also expect that the ratio of definite-to-probable responses would be higher for false items than for true items. People who are attracted to true responses are rewarded on true questions by getting more correct answers because of their guesses. However, if they are consciously being drawn to the true responses by directional preference rather than by assured knowledge, then they should be more likely to say "probably" rather

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[4]A way of testing this would be to try to ask the same facts, but with the correct answer flipped from true to false or vice versa. However, such reversals are often difficult to construct. Attempts to do this for other scales have often produced reversals that are either more awkward than the originals or not truly equivalent. For example, "The greenhouse effect is caused by a hole in the Earth's atmosphere" could be reversed inserting "not", but that changes the question from a positive to a negative. It could be made true by changing either the front part to "Chlorofluorocarbons cause a hole..." or the back half to "the burning of fossil fuels." However, both of these formulations fundamentally change the question. A third possibility would be to take the same two atmospheric phenomenon and put them together in a true statement such as "The greenhouse effect and the hole in the ozone layer are different atmospheric conditions" or "The greenhouse effect and the hole in the ozone layer are mainly caused by different gases." But it would be hard to know if these reformulations were equally as difficult as the original, net of any directional (i.e. true/false) effect.

[5]While this should be true on average, it would not always be true. Knowledge on a particular topic might be widespread, but shallow thereby leading to a high % correct, but a lack of certainty. Or knowledge may be extensive, but the question may phrased in a way that obscures the matter or otherwise lessens people's certainty.

than "definitely." This expectation is borne out by the fact that the definite-to-probable ratio averages 0.91:1 for false items and 0.79:1 for true items.

Moreover, since we find that the ratio rises with % correct and true questions tend to produce a higher % correct, the ratios are lower than predicted based on the % correct. Having only 12 observations and minimal overlap in % correct between the true and false items, it is not possible to fully separate out these factors. However, two true items and one false item do have approximately the same % correct (58% for antibiotics (true), 62% for evolution (true), and 61% for cars not being an important source of pollution (false)). For them the definite-to-probable ratio was 0.705:1 for the true items and 1.33:1 for the false item. This suggests that the difference between true and false questions is substantially greater than the observed 0.91:1 vs. 0.79:1 ratios which do not control for % correct.

Inter-country Differences in Knowledge

Table 2 lists the overall ranking of the 21 countries on the knowledge scale.[6] Heading the list are the most developed nations of Western Europe and their off-shoots that have high gross national products per capita and advanced educational systems (Dunlap and Mertig, forthcoming). These countries occupy 8 of the top 10 positions. Within this elite group the Anglo countries do especially well with Canada first, Great Britain third, and New Zealand fourth followed by the United States at eighth and Northern Ireland at ninth. Also, in the top group is Japan at seventh.

Second, comes the former Communist nations of Central Europe. These are the ex-Socialist nations that are economically most advanced and most integrated with Western Europe. This group is headed by the former East Germany at sixth, followed by the Czech Republic at 11th, Hungary at 14th, and Slovenia at 16th.

Third, falling towards the bottom of this middle range are the somewhat poorer and less developed nations of Western Europe (Ireland at 13th) and Southern Europe (Italy 15th and Spain 17th). Also, near the middle is Israel at 12th.

Fourth, they are followed by the ex-Socialist nations of Eastern Europe which are both poorer and more isolated from Western Europe than their former compatriots in Central Europe (Bulgaria is

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[6]The rankings here and in later tables are based on the mean scales scores as explained in Table 1, note a. The number of correct answers and % giving a specific item correct are also listed in Tables 1 and 2. The scale means and the number/per cent correct produce similar, but not identical, rankings. For example, in Table 1 Canada is first and Poland last on both measures, but Norway is second on the scale and fourth on the number correct count. Overall, Pearson's correlation between the two scores is -.925. In this paper the scale score is used to rank countries and in other analyses.

18th, Russia 19th, and Poland 21st). Also, among the bottom group is the only third-world nation, the Philippines at 20th.[7]

Overall, much of the inter-country differences in knowledge are explained by a simple development gradient with those countries with the highest per capita GNP and best and broadest educational systems scoring the best. Per capita GNP adjusted for purchasing power parities has a -.77 correlation with mean score in each country.[8] Being an Anglo nation is associated with more knowledge (-.55) and being a former Communist state with less knowledge (.45), but with per capita GNP controlled for, the ex-Socialist factor becomes statistically insignificant and Anglo nationality is only marginally significant.[9]

While the overall scale scores identify the average knowledge level in each country, they conceal as much as they reveal. There is considerable variation on how countries rank on individual items. Inspecting Table 3 shows that several countries rank first on some items and last on others:

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Of the 21 countries 14 rank both in the top and bottom five for at least one item. Only Russia fails to spread the rankings of individual knowledge items over more than half the positions.

While some of the variation in rankings merely reflects that fact that many countries score about the same level and represent only chance fluctuations, much of the variation in relative and absolute knowledge reflects the influence of country or region specific variables tied to differences in culture (including

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[7]A 1992 study of scientific knowledge in 13 countries using a different 12-item scale produced fairly similar rankings and comparable percents scale scores for the seven countries that appeared in both studies (National Science Board, 1993). Average % correct were: Denmark 61.5%, United Kingdom 61.0%, France 59.3%, the Netherlands 58.1%, the United States 58.2%, Luxembourg 56.7%, Belgium 53.6%, Germany 56.3%, Italy 52.7%, Spain 51.8%, Ireland 49.0%, Greece 45.6%, and Portugal 42.0%.

[8]Based on 1993 figures in World Bank, 1995. Virtually identical associations came from using GNP per capita in 1989 and the 1970-1989 average using the price adjusted rate of exchange for 20 countries (excluding Slovenia) (Trends, 1993).

[9]In various regressions Anglo nationality has standardized coefficients of about .22-.29 that are only statistically significant at the .09-.19 level. Using number of correct answers produces standardized coefficients of about .35 that are statistically significant at the .05-.09 level.

Country	Top/Bottom Rank on Items	Range
Germany (East)	1/21	20
Italy	1/21	20
Ireland	1/21	20
Bulgaria	1/21	20
Japan	1/20	19
Norway	1/19	18
United States	3/21	18
Hungary	3/21	18
Poland	3/21	18
New Zealand	2/19	17
Northern Ireland	2/19	17
Czech Republic	3/20	17
Canada	1/17	16
Germany (West)	4/20	16
Great Britain	1/16	15
The Philippines	6/21	15
Israel	4/18.5	14.5
Spain	6.5/20	13.5
The Netherlands	2/15	13
Slovenia	8/21	13
Russia	9/17	8

history), educational systems, and language. By examining outliers (items on which a country scores well above or below its average ranking), we can identify such factors.

A. All radioactivity is made by humans.

This was the most difficult item in Japan and Japan ranked 15th on this item while it finished 7th overall (a shift in rank of -8). It is likely that the atomic bombings of Japan in 1945 and the subsequent strong opposition in Japan to nuclear weapons focuses respondents' attention on man-made radiation associated with nuclear weapons.

B. Antibiotics kill bacteria, but not viruses.

This was the third easiest item in Bulgaria and Bulgaria ranked first on this item compared to 18th overall (+17). We have no ready explanation for Bulgaria's leading position. Several countries did much worse than usual on this item. Great Britain was 10 positions lower than its overall rank, Japan 13 lower, and West Germany 15 lower. Since there is less difference between the top and bottom countries on this item than on any other, changes in position represent relatively narrow shifts, some due only to chance. In addition, variation in the meaning of the translations of fairly technical terms (antibiotics, bacteria, viruses) may explain some of these differences, but this does not explain why the British scored relatively poorly.

C. Astrology - the study of star signs - has some scientific truth.

Most former Socialist countries scored relatively poorly on this item, although most drops in rankings were small to moderate (the Czech Republic -9, East Germany -7, Slovenia -5, Hungary -2, Bulgaria -1, Russia +1, Poland +7). Given that Poland is the one ex-Socialist state in which religion remained relatively strong and active during the Communist era, this suggests that superstitions were stronger where religion was suppressed.[10] Conversely, countries with strong Catholic traditions show relatively high knowledge (Italy +14, Spain +9, the Philippines +3, Ireland +2). This also probably explains Poland's relatively good score.

D. Human beings developed from earlier species of animals.

Countries with a large fundamentalist Protestant segment have relatively low ranks on evolution knowledge. The United States, with the strongest fundamentalist sector, ranks last on knowledge, down 13 positions. This is followed by Northern Ireland (-10), the Netherlands (-10), New Zealand (-9), and Canada (-7.5). In the United States fundamentalists are much less knowledgeable on this item than non-fundamentalists are (Smith, 1995b). In addition, they have succeeded in watering down the teaching of evolution in the schools, so the knowledge of even non-fundamentalists is impaired.

It is also noteworthy that the United States scored lowest on the scale score by a good margin (-.15) even though it was only 19th rather than 21st on % correct. This was because most fundamentalists were quite certain that evolution was incorrect and in the United States the definite-to-probably false ratio was 2.5:1 compared to 1.25:1 in other countries.[11]

E. All man-made chemicals can cause cancer if you eat enough of them.

There are few outliers on this item, but both Germanies did rank lower (East -9, West -4) which suggests some language or educational factor may be involved.

F. If someone is exposed to any amount of radioactivity, they are certain to die as a result.

There are only moderate deviations for this item, but Hungary

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[10]Russia does not show a lower overall position, but astrology is 12th within Russia.

[11]Evolution is the only item in which the definite and incorrect outnumber the probably and incorrect (1.33:1). For the other 11 items the highest ratio is 0.72:1 and the average is 0.47:1.

does rank 11 positions higher. We have no explanation for this pattern.

G. Some radioactive waste from nuclear power stations will stay dangerous for thousands of years.

There is considerable variation from the average for this item. Bulgaria (+14), Italy (+13), and Ireland (+12) show large relative gains and Norway (-17) a big drop. Knowledge is high and fairly uniform for this item. This in part explains the high variation in rankings. There are also probably some country specific reasons for these difference, but we do not discern any general pattern.

H. The greenhouse effect is caused by a hole in the Earth's atmosphere.

Most Western European countries that score well overall did relatively poorly on this item (Great Britain -12, East Germany -11, West Germany -10, Northern Ireland -9.5, Ireland -8, Norway -1, and the Netherlands +3). Some high ranking countries outside of Western Europe also tended to do relatively poorly (New Zealand -10, Canada -3). Two factors are probably involved in this pattern. First, this was a difficult question in which a little knowledge could well lead people to the wrong answer (by knowing about atmospheric pollution problems, but by confusing the ozone hole with the greenhouse effect).[12] Thus, better educated and informed publics were more open to error from partial knowledge. Second, knowledge about the greenhouse effect is fairly recent and few learned about it in school. Instead most knowledge has come from the mass media. It may be that Western European coverage of these atmospheric phenomena have intertwined the two problems and created confusion in people's minds.

I. Every time we use coal or oil or gas, we contribute to the greenhouse effect.

There are few outliers on this item and fairly similar scores across countries. Italy did better than expected (+9) and the United States did worse (-10).

J. All pesticides and chemicals used on food groups cause cancer.

There are no notable outliers on this item.

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[12]Dunlap (1995) shows that in surveys in Canada, the United States, Mexico, and Portugal CFCs and/or ozone are named as a cause of global warming by more people than the use of fossil fuels are.

K. Human beings are the main cause of plant and animal species dying out.

Top-scoring, English-speaking countries had problems with this item (Canada -16, New Zealand -15, United States -13, Great Britain -13, Northern Ireland -9, Ireland -2) and occupied 5 of the 6 bottom rungs. Two factors seem to be involved. As with the greenhouse effect and the ozone hole, a little knowledge misled people on this item. People aware of the extinction of the dinosaurs and the probable role of comets or meteorites (or at least not humans) answered this item wrong. Reflecting this situation, this is the only item for which correct responses are associated with less education.[13]

This is compounded by an ambiguity in English. While the present tense in the question was meant to refer to the situation in the world today, the present tense can take on an universal or timeless reference. Thus, this item could be understood to refer to the extinction of species throughout natural history rather than just as of today. While some of the other top raters also suffer relative declines (Norway -8 and the Netherlands -7), the larger drops among the higher-ranking, English-speaking countries suggest that the ambiguity in English is greater than in most other languages.

To make up for the large drops among the leading countries in general and English-speaking countries in particular, a number of countries naturally have to gain ground. The biggest advances were made by Bulgaria which finished first (+17) and Poland which came in third (+18), followed by Spain (+10.5) and Italy (+10).

L. Cars are not really an important cause of air pollution in [COUNTRY].

There was only moderate deviation from the overall rankings with the Netherlands (-10), Japan (-10), Norway (-9), and Hungary (-7) falling the most and no country showing large relative gains. Since this item is asked in terms of each individual country, it explicitly asks respondents to consider the situation in their own country and is subject to national difference in level of automobile use and their specific contribution to overall air pollution levels. One might think that a lower absolute level of pollution from automobiles might make the item less true and therefore contribute to more wrong answers (since they would in fact be "less wrong"), but it's not clear that this pattern prevails. In the case of Hungary, translation is probably playing a role since the Hungarian word used for the English word "important" appears to be a stronger term closer to the English term "primary". This would indicate a more demanding standard in

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[13]Across all countries the correlation of extinction with education is .031/.000. For all other items more knowledge is associated with more education and the correlations average -.144.

Hungarian than in English and one less like to attract correct responses.

Overall, the knowledge is largely determined by the level of economic development and the coverage of the educational systems. That is, countries with the most advanced economies and with the highest proportion completing secondary schooling and attending tertiary education have populations that are the most knowledgeable on environmental and scientific facts. In addition, it is likely that there is more mass media coverage of scientific and environmental matters in the more developed countries. But as important as these level of development is, there are other factors that also influence either overall scores or individual items.

First, the particular content or nature of educational systems (rather than merely the distribution by level of education) makes a difference. Overall, there is the suggestion that Anglo countries do better than others. This may be related to strengths in their educational curriculums. Other single-country deviations probably result from different emphases in schools, but we lack enough detailed information on instruction and curriculum to document this.

Second, religion notably effects knowledge levels. Countries with large and influential Protestant fundamentalist segments are less knowledgeable on evolution and Catholic countries are relatively more informed about astrology.

Third, recent history shapes knowledge. Japanese knowledge of radiation appears to be lowered by a focus on the atomic bombing of Hiroshima and Nagasaki and belief in astrology seems higher in the former Communist nations of Eastern Europe.[14]

Finally, language probably contributes to differences. Ambiguity in the use of present tense in English probably contributes to problems with the extinction item and translation variation probably contributes to several other differences (e.g. the Hungarian wording of the auto pollution question).

Inter-country Differences and Measurement Issues

In part the various nation-specific factors shaping responses to individual items weakened the utility of the items as a general scale. Overall the 12-item scale had moderate reliability among countries with better scores and low to negative reliability among countries with average to worse scores.[15] (If all respondents

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[14]Because all ex-Socialist countries are also Eastern European, it is not possible to separate these two variables. However, in the one country in which religion remained largely intact under Communism (Poland), belief in astrology is not especially prevalent.

[15]Likewise reliability increases across educational groups because, as we shall see, education is associated with more correct answers. Cronbach's alpha is .29 for those with less than a high

within a country had known the correct answer to all items, the reliability would have been 1.0.) Among nine of the ten countries with the top scores, reliabilities were from .47 to .62. Among the bottom five reliabilities were from -.27 to .18.

This reflects the fact that the inter-item correlations between items are low. This results from two situations: 1) that there was probably considerable guessing, especially in the less knowledgeable countries and 2) that much of this knowledge is discrete and independent. In part, this is because these items tap a diverse and wide ranging set of facts which are not part of an integrated group of interdependent knowledge. In addition, many of the items deal with relatively recent scientific discoveries or concerns that were not covered during formal education until recently (e.g. the greenhouse effect, radioactive waste). Thus, for most older adults knowledge about these items were not obtained as part of an organized program of study, but mostly from general news consumption. Because of these factors people knowing the correct answer to one item are only slightly more likely to know the correct answer to the other items. Mean inter-item correlations ranged from -.018 in the Philippines to .118 in Canada.

Two items had negative correlations with the overall, 12-item scale in most countries. Knowledge about extinctions was negatively correlated in 19 countries and antibiotics in 15 countries. Ten countries had negative item-to-whole correlations only with one or both of these items. The negative correlations for extinctions were expected given the poor scores of most countries ranking well overall (Table 3). It is stronger for the top English-speaking countries (average = -.072) than for non-English speaking countries in the top half (average = -.022) which is consistent with the especially poor showing English speaking countries had on this item. The negative item-to-scale correlations of antibiotics was unanticipated by the item-by-item analysis of rankings. Only two other items produced a notable number of negative correlations: radioactive decay in 10 countries and hydrocarbons and the greenhouse effect in 8 countries. The negative correlations were all in countries ranking in the bottom half.

The negative correlations for these items (and to a lesser extent for extinctions and antibiotics) with the overall scale are also related to a measurement effect that is associated with whether the items had true or false as the correct response. On average for items for which the correct answer was true, there were negative correlations with 11 countries, but for items for which the correct answer was false, there were negative correlations with only 0.7 countries. This relates to the true/false framing effect discussed above and also to the factor analysis considered next.

Factor analysis revealed fairly similar factors in 14-17 of the 21 countries. In this predominant cross-national pattern, the first factors for 17 countries consisted of positive loadings on 4

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school degree, .47 for those with a high school degree, and .55 for those with a college degree.

to 6 false items and either no true loadings or one true item with a negative loading. The second factors for 15 countries had positive loadings on 3 or 4 true items and either no loadings on false items (7 countries), 1 negative loading on a false item (5 countries), or one positive loading on the false item on cars (3 countries). The third factors were more variable, but typically consisted on two or three variables (car - 14 countries, evolution - 10, astrology - 10, and antibiotics - 9). The car and antibiotics items were part of a third measurement factor (see below) and evolution and astrology were based on special patterns in a sub-set of nations. Evolution appeared in 10 countries including all six English-speaking countries and in all 5 countries (the United States, the Netherlands, New Zealand, Northern Ireland, and Canada) that had notable lower rankings due to the fundamentalists as noted above. Among countries following the general factor pattern, astrology was in the third factor mostly for Western European countries (West Germany, Northern Ireland, Italy, Ireland, Norway, Spain + Israel). Except for their regional proximity, no reason for astrology loading onto a third factor was apparent.[16]

Four countries (Hungary, the Czech Republic, Russia, and Japan) showed patterns that resembled the overall pattern, but the false and/or true factors were a little less clear and a fourth factor sometimes emerged (Hungary and the Czech Republic). The countries that deviated most from this general pattern (East Germany, Poland, Bulgaria) each showed distinctive patterns unlike any other countries. Most of the partly or completely deviating countries were ex-Socialist states with low knowledge levels.

Across all countries the factors that emerge are shown in Table 4.[17] The first factor consists of five of the seven false items. The second factor of three of the five true items. The third factor can be interpreted in several different ways. On one hand it has two positive loadings for false items and two negative loadings for true items. This suggests a bipolar methods factor that is similar to the first two methods factors. Alternatively, the only two items with notable loadings (.6+) are astrology and evolution. The country-by-country item analysis above suggests that these tap two distinctive religious elements: a post-Socialist (or Eastern European) superstition vs. Catholicism dichotomy on astrology and a fundamentalist Protestantism vs. others division on evolution. That leaves the weakly loading true antibiotics (-.38) item and false car item (+.38).

Rather than items that are unrelated to each other and poorly correlated to the other items as a whole, these items are connected

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[16]Great Britain is the only Western European country for which astrology did not load on a third factor. But similarities were greater than this makes it appear, since astrology loaded on the first factor at .52 and on the third factor at .46.

[17]Separate factor analyses excluding all Don't knows and using equal country weights produced very similar factors and loadings.

by being the only two negatively framed items. The latter is a straight-forward negative item ("Cars are NOT really an important cause of air pollution..."), but the former also has a negative formulation ("Antibiotics kill bacteria, NOT viruses."). Support for the idea that these items form a third methods factor is suggested by separate factor analyses by three levels of education (less than secondary complete; secondary complete; and college complete - Table 5). Among the college-educated three, clear methods factors emerge: 1st: 6 false-items, positively stated, 2nd: 4 true-items, positively stated, and 3rd: one negatively-stated true item and one negatively stated false item that both load positively. Among the college educated there are no sign of any substantive or topic related factors. People tend to answer items framed in three different manners in similar ways. This suggests that people who know the correct answer gave that and beyond that items group together purely due to method of presentation.

Among the less educated the first two factors emerge almost as cleanly, but the slippage creates a third factor that differs from the negatively framed factor that emerges for the better educated. For both those with incomplete secondary education and those with complete secondary education the two religion related items, evolution and astrology, are the main, but not sole, loaders. Three circumstances probably contribute to the differences between the better and less educated. First, knowledge is lower among the less educated and both more incorrect knowledge and more guessing lowers reliabilities and in general makes patterns (even methods patterns) less structured among the less educated. Second, the better educated tend to be less religious and the quasi-religious factor may not emerge in a less religious group. Finally, the segmentation by education also strongly shifts the composition of the sample from the Philippines and Eastern Europe towards Western Europe and a few other advanced countries. Since some of the observed differences on evolution and astrology were inter-country, this reduces variation across these variables.

It is also useful to note what did not emerge. In none of the countries did factors emerge that corresponded to the original separation in questionnaire into five items about science (A-E) and seven items about the environment (F-L). Nor did factors match the four topics covered (radiation, medicine and disease, the atmosphere, natural history). Neither did hard/easy factors emerge as on other scales about knowledge of World War II (Smith, 1995a) or on the General Social Survey vocabulary test (Smith, 1986; Alwin, 1991).

In sum, knowledge about the science and the environment varies greatly from country-to-country and from item-to-item. Level of economic development is a major factor explaining cross-national differences, but knowledge is not monolithic and country rankings on individual items varies considerable depending on culture, history, language, and other factors. Since scientific knowledge is limited and fragmented, people often try to figure out the correct answer by looking at the format of the question. People favored true responses as guesses over false responses which probably

explains the difference in knowledge items across the true versus the false items.

Correlates of Scientific an Environmental Knowledge

Based on earlier work on environmental and scientific knowledge (Smith, 1994; Gendall, Smith, and Russell, 1995; National Science Foundation, 1993; Miller, 1995) as well as related work on political and historical knowledge and verbal ability (Smith, 1986; Smith, 1995a; Smith, 1995b), we proposed the following hypotheses:

Scientific and environmental knowledge will be greater among:

1. men, because women are less likely to pursue science education and to work in scientific fields.[18]

2. younger adults, because a number of items tap emerging topics of knowledge that were either not known or not typically covered when older adults were educated.

3. the better educated, since knowledge increases with level of education.

4. the less religious, since a) some scientific knowledge is opposed to certain religious teachings and b) an interest and involvement in religious matters would be associated to less interest and involvement in science. This should mean less knowledge among those who attend church frequently, believe in God, and have a religious identification. In addition, the item-specific analysis above suggests some additional difference between specific religious faiths (e.g. Catholicism and astrology and Protestant fundamentalism and evolution).[19]

5. those with higher incomes, because those with more resources tend to consume more upscale and educational media and acquire more information about the world in general.

6. those working in the natural and physical sciences and as teachers, because of their specific education and continuing exposure to information about the sciences.

7. those in major urban areas, because exposure to

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[18]Alternatively Stern, Dietz, and Kalof (1993) suggest that women have different beliefs about environmental matters than men because of underlying differences in value orientations.

[19]In addition Greeley (1989) argues that Protestants and Catholics have different ways of imagining and processing information about the world. Greeley (1993) also shows religious differences in attitudes.

environmental and scientific information would be greater in information centers.

Table 6 shows the basic bivariate associations relating to these seven hypotheses. Overall there is widespread support for all of the hypotheses. The associations are consistently in the hypothesized direction, almost always statistically significant, and appear in almost all countries. The few exceptions generally occur in low knowledge countries (e.g. the Philippines, Russia, and Bulgaria) where the lower scale reliabilities attenuate relationships with these predictors.

Education shows the strongest association (averaging -.308) with income effectively tied for second place (-.214).[20] Belief in God co-occupies second place (-.217) with the remaining religion variables showing weaker relationships (no religious affiliation .151 and attending church -.118).[21] Age averages .168 and gender .124. Then comes being employed in a scientific or teaching occupation (respectively -.121 and -.099).[22] Living in a large urban center has the weakest average association (.083) and significant relationships occur in only 10 of the 15 countries that included such a measure.[23]

Table 7 examines the net impact of these variables in

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[20]Since those with more knowledge have lower scale scores (see Table 1), those with more education, income, etc. have negative correlations with our scale.

[21]Belief in God is measured by the following item: Please check one box below to show which statement closest to expressing what you believe about God. 1. I don't believe in God. 2. I don't know whether there is a God and I don't believe there is any way to find out. 3. I don't believe in a personal God, but I do believe in a Higher Power of some kind. 4. I find myself believing in God some of the time, but not at others. 5. While I have doubts, I feel that I do believe in God. 6. I know God really exists and I have no doubts about it.

[22]Occupations were assigned based on the International Standard Classification of Occupations or similarly detailed national occupational schemes. Scientific occupations include physical and natural scientists, engineers, doctors and nurses, mathematicians and statisticians, architects, airplane pilots, and similar technical occupations. It does not include such occupations as social scientists, lawyers, accountants, machinists, or craftspersons. Teachers include from primary schools to college-level education.

[23]Definitions varied somewhat from country-to-country, but urban centers generally had to have a population of at least 100,000. Alternative, country-specific measures of urbanness showed an even lower correlation overall (average r=.066 in 15 countries).

multivariate models. Model1 includes all individual variables that were asked in all countries. It keeps all 21 countries in the analysis and maintains the maximum sample size, but greatly restricts the number of variables in the model.

Model2 uses all of the hypothesized variables except urbanness. It is based on 15 of 21 countries. The Philippines, Hungary, Japan, Italy, the Czech Republic, and the Netherlands are excluded because there is missing information on one or more of the included variables (see Table 6 for what variables are available from which countries). Urbanness is not included since it would also have eliminated Britain, Northern Ireland, Canada, Russia, and Israel from the analysis and models based on the remaining 10 countries did not show urbanness having a statistically significant effect. Likewise, the religion variable is restricted to dummy variables for the Eastern Orthodox, Catholics, Protestants, those with no religion, and those with other religions (the omitted, reference group). Fundamentalist Protestants were not used as separate group because only 12 countries had a minimum of 25 fundamentalists in their samples and only 8 countries had 150 or more.[24]

Model3 uses all countries and the same individual-level variables as Model1, plus four country-level variables: per capita gross national product (as used above), Anglo nationality (Britain, Northern Ireland, Canada, New Zealand, and the United States),[25]

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[24]Fundamentalists had lower correct scores on the evolution item in all of these 12 countries. A multivariate analysis of these sub-sets of countries (not shown here) found that Fundamentalism was significantly, but weakly, associated with less knowledge on the overall scale. Examining Fundamentalists separately also indicated that being a non-Fundamentalist Protestant was associated with more knowledge.

[25]In an alternative formulation Ireland was also counted as Anglo. Because the influence of Anglo culture is less in Ireland than in the other countries and because the models with Ireland included explained slightly (but not significantly) less variation, we excluded Ireland from the Anglo group.

We also looked at British Canadians vs. French Canadians (based on ancestry, not language use). Knowledge is greatest among British Canadians outside of Quebec (28.4). It is lower and similar for French Canadians both inside and outside of Quebec (respectively 30.2 and 29.9) and for British Canadians inside Quebec (30.2). Thus, both French ancestry and residence under a French government is associated with lower knowledge, but the effect is not additive.

Interestingly Diekmann, Franzen, and Preiseddoefer (1995) found that French-speaking areas of Switzerland were less knowledgable than non-French speaking areas controlling for education, income, and other variables.

ex-Socialist (Russia, Poland, Slovenia, Czech Republic, Germany (East), Bulgaria, and Hungary), and Northwestern Europe (Germany, Britain, Northern Ireland, Ireland, Norway, the Netherlands).

Model4 uses the same countries and variables as in Model2, plus the country-level variables in Model3. Finally, Model5 is like Model4 except that specific country variables with Norway as the omitted reference country are introduced instead of the grouped country-level variables used in models 3 and 4.

Model1 indicates that knowledge is greater among the better educated, the less religious (i.e. those who attend church less), and men. Age is not related to knowledge. Model3 however finds that knowledge is higher among younger adults, as well as being related to more education, less religion, and being male. In addition, knowledge is greater among countries with a higher per capita income, in Anglo nations, and in Northwest Europe. It is not related to being a former Communist nation.

Model2 looks at all individual-level variables and finds that knowledge is greater among the better educated, the less religious (not believing in God and attending church less), Protestants and those without any religion (and less among the Eastern Orthodox) compared to the reference category of non-Christian religions, those in scientific or teaching occupations, and those with less income. Entering the country-level variables changes these results in two notable ways (Model4). First, income becomes unrelated to knowledge and of the specific religions only not having a religion is related to more knowledge. Among the country-level variables high per capita income, being Anglo, and being in Northwest Europe remain related to more knowledge and now being an ex-Socialist nation is significantly related to being less knowledgeable.

In the second page of Table 7 Model4 is compared to Model5 which introduces countries as a series of dummy variables (with Norway as the omitted reference country). By allowing all inter-country differences into the model, Model5 increases the r^2 from .31 to .33. The listing of countries also shows why the grouped variables in Model4 explain a significant share of the variance. The listing of the country variables in Model5 shows that 4 of the top 5 countries are Anglo nations, that 6 of the top 8 are in Northwest Europe, and that the bottom 4 are ex-Socialist countries.

Model5 also differs from Model4 in the way several individual-level variables work. In Model5 church attendance is unrelated to knowledge (having had only a weak association in Model4). However, Protestants and Catholics emerge as less knowledgeable and those without any religion have no association with knowledge. The Protestant outcome is particularly surprising since in both the bivariate analysis and in Model2 Protestants were more knowledgeable. This relationship disappeared in Model4 and actually reverses in Model5. Model5 thus suggests that Protestantism and Catholicism may actually reduce knowledge. However, since these relationships emerge in only the country-specific Model5 and not in the country-grouped Model4, this relationship is not robust and should be considered uncertain.

Overall, these models indicate that at the individual level, knowledge is first of all strongly related to level of education and exposure to up-to-date science education. Knowledge is greater among those employed in a teaching or scientific occupation (education in science and continuing use of that training), the young (being recently educated), and males (receiving more science education). Second, knowledge is greater among those who do not believe in God. Church attendance and specific religious affiliation do not have a clear and consistent association with overall knowledge (relationships differ between Model4 and Model5).[26] Finally, income is not related to knowledge.

At the country level, knowledge is greater among the more developed countries and also higher among Anglo countries and Northwest Europe (and less among ex-Socialist states). We speculate that Anglo countries and those in Northwest Europe have stronger science curriculums than other countries.

Conclusion

Scientific and environmental knowledge around the world is limited and fragmented. Even in the most developed nations in Northwest Europe and among their colonial off-springs, the general public gives the correct answer to only about 60% of the questions. In the ex-Socialist states of Eastern Europe and in the Philippines the % correct averages only 35-50%. The difficulty that the general public has with these scientific facts is underscored by the evidence that there is considerable guessing and that the linguistic framing and direction of the items influence how people answer them. Moreover, the low correlations between items indicates that understanding is not integrated and systematic.

Scientific and environmental knowledge is enhanced by three broad factors. First, level of national development increases understanding. This shows up most clearly in the association between per capita GNP and knowledge, but probably is also related to the relatively strong showing of Northwest Europe and Anglo nations (and the poor showing of Eastern Europe). These countries probably have stronger science curriculums and more mass media coverage of science.

Second, at the individual level more education improves knowledge. This shows up directly in the strong association between level of education and understanding, but also indirectly through the association of greater knowledge with being younger (more recently educated), male (more exposed to science education), and employed in science and teaching occupations (trained in and continuing to utilize science education).

Finally, religiousness reduces scientific and environmental knowledge. In some cases religious beliefs oppose certain scientific teachings. However, religious denials of specific

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[26]Specific religious affiliation does have an impact on some individual items in the scale (e.g. evolution).

scientific findings do not seem to be the major factor at work. Even fundamentalist Protestants who are very likely to reject evolutionary theory and therefore miss the item on evolution score do only slightly worse on the overall scale than non-fundamentalists. Instead it may be that religious belief offers an alternative paradigm from science for understanding the world and an alternate area for study and engagement that leads more to a neglect of science than to its rejection.

Table 1

Scores on Individual Environmental and Scientific Knowledge Items Across Countries[a]

Items	Mean[b]	% Correct[c]
Some radioactive waste from nuclear power stations will stay dangerous for thousands of years.	1.82	83.8
Human beings are the main cause of plant and animal species dying out.	2.15	75.2
Every time we use coal or oil or gas, we contribute to the greenhouse effect.	2.22	68.9
Antibiotics kill bacteria, but not viruses.	2.41	58.2
Cars are not really an important cause of air pollution in [COUNTRY].	2.46	61.1
Human beings developed from earlier species of animals.	2.50	62.3
If someone is exposed to any amount of radioactivity, they are certain to die as a result.	2.83	48.7
All pesticides and chemicals used on food groups cause cancer in humans.	3.06	41.0
All radioactivity is made by humans.	3.07	39.2
Astrology - the study of star signs - has some scientific truth.	3.07	36.1
All man-made chemicals can cause cancer if you eat enough of them.	3.36	30.3
The greenhouse effect is caused by a hole in the Earth's atmosphere.	3.59	20.0

[a]Countries given equal weight.

[b]Items were scored 1=correct and definite, 2=correct and probably, 3=can't choose, 4=incorrect and probably, 5=incorrect and definite. Scores across the 12 items could run from a perfect score of 12 to the least knowledgeable score of 60. A score of 36 would both represent the score for someone who didn't attempt any of the items or someone who randomly chose between the five options (including can't chose).

[c]Giving the correct answer whether definitely or probably. The items and their scoring are:
A. All radioactivity is made by humans. (FALSE)
B. Antibiotics kill bacteria, but not viruses. (TRUE)
C. Astrology - the study of star signs - has some scientific truth. (FALSE)
D. Human beings developed from earlier species of animals. (TRUE)
E. All man-made chemicals can cause cancer if you eat enough of them. (FALSE)

Table 1 (continued)

F. If someone is exposed to any amount of radioactivity, they are certain to die as a result. (FALSE)
G. Some radioactive waste from nuclear power stations will stay dangerous for thousands of years. (TRUE)
H. The greenhouse effect is caused by a hole in the Earth's atmosphere. (FALSE)
I. Every time we use coal or oil or gas, we contribute to the greenhouse effect. (TRUE)
J. All pesticides and chemicals used on food groups cause cancer in humans. (FALSE)
K. Human beings are the main cause of plant and animal species dying out. (TRUE)
L. Cars are not really an important cause of air pollution in [COUNTRY]. (FALSE)

Table 2

National Scores on Environmental and Scientific Knowledge Scales

Countries	Rank	Overall Mean[a]	Number Correct[b]
Canada	1	29.0	7.6
Norway	2	29.3	7.2
Great Britain	3	29.4	7.5
New Zealand	4	29.6	7.5
The Netherlands	5	30.5	6.8
Germany (East)	6	31.2	6.6
Japan	7	31.3	6.2
United States	8	31.5	6.6
Northern Ireland	9	31.6	6.7
Germany (West)	10	31.7	6.4
Czech Republic	11	32.2	6.6
Israel	12	32.4	5.9
Ireland	13	33.2	6.3
Hungary	14	33.4	5.8
Italy	15	33.5	6.1
Slovenia	16	34.3	5.5
Spain	17	35.0	5.3
Bulgaria	18	35.1	4.6
Russia	19	35.2	4.8
The Philippines	20	37.0	5.6
Poland	21	37.0	4.3

Table 3

National Scores of Individual
Environmental and Scientific Knowledge Items

A. All radioactivity is made by humans.

Countries	Rank	Mean[a]	% Correct[b]
Canada	1	2.29	65.5
Great Britain	2	2.49	58.2
United States	3	2.55	56.3
New Zealand	4	2.60	55.4
The Netherlands	5	2.62	53.7
Germany (East)	6.5	2.77	46.6
Czech Republic	6.5	2.77	54.1
Germany (West)	8	2.86	44.1
Norway	9	2.90	45.6
Northern Ireland	10	2.91	42.0
Israel	11	2.99	39.6
Ireland	12	3.08	39.6
Italy	13	3.14	37.4
Hungary	14	3.19	33.4
Japan	15	3.35	29.5
Russia	16	3.56	24.0
Slovenia	17	3.58	25.5
Spain	18	3.60	17.6
The Philippines	19	3.69	25.4
Poland	20	3.79	14.4
Bulgaria	21	3.93	11.6

Table 3 (continued)

B. Antibiotics kill bacteria, but not viruses.

Countries	Rank	Mean[a]	% Correct[b]
Bulgaria	1	2.02	66.2
Norway	2	2.04	71.5
New Zealand	3	2.19	72.4
Ireland	4	2.23	68.8
Northern Ireland	5	2.31	66.2
Canada	6	2.33	67.6
Hungary	7	2.36	59.6
United States	8	2.37	67.1
Italy	9.5	2.40	57.7
Slovenia	9.5	2.40	53.6
The Netherlands	11	2.44	57.7
Czech Republic	12	2.45	53.9
Great Britain	13	2.47	63.5
Russia	14	2.49	48.1
The Philippines	15	2.50	67.9
Germany (West)	16	2.52	49.4
Spain	17	2.54	52.5
Poland	18.5	2.58	46.7
Israel	18.5	2.58	48.4
Japan	20	2.70	41.1
Germany (East)	21	2.75	41.3

C. Astrology - the study of star signs - has some scientific truth.

Italy	1	2.40	54.7
Northern Ireland	2	2.56	54.6
Great Britain	3	2.70	51.5
Canada	4	2.71	51.1
New Zealand	5	2.79	48.4
The Netherlands	6.5	2.84	43.3
Japan	6.5	2.84	34.8
Spain	8	2.85	43.7
Israel	9	2.87	41.7
United States	10	2.93	43.2
Ireland	11	2.95	41.5
Norway	12	3.01	36.1
Germany (East)	13	3.04	36.6
Poland	14	3.06	28.8
Germany (West)	15	3.08	35.7
Hungary	16	3.44	23.2
The Philippines	17	3.51	28.8
Russia	18	3.67	13.7
Bulgaria	19	3.70	10.8
Czech Republic	20	3.73	20.8
Slovenia	21	3.81	10.1

Table 3 (continued)

D. Human beings developed from earlier species of animals.

Countries	Rank	Mean[a]	% Correct[b]
German (East)	1	1.86	81.6
Japan	2	1.89	81.0
Czech Republic	3	2.04	77.6
Germany (West)	4	2.08	72.7
Great Britain	5	2.18	76.7
Bulgaria	6	2.28	60.9
Norway	7	2.43	65.0
Canada	8.5	2.45	67.5
Spain	8.5	2.45	64.2
Hungary	10	2.50	62.8
Italy	11.5	2.51	65.2
Slovenia	11.5	2.51	60.7
New Zealand	13	2.54	66.3
Israel	14	2.66	56.9
The Netherlands	15	2.67	58.6
Ireland	16	2.70	60.1
The Philippines	17	2.75	60.9
Russia	18	2.80	41.4
Northern Ireland	19	2.99	51.5
Poland	20	3.06	35.4
United States	21	3.23	44.2

E. All man-made chemicals can cause cancer if you eat enough of them.

Great Britain	1	2.79	40.0
New Zealand	2	2.84	48.5
The Netherlands	3	2.87	45.4
Norway	4	2.89	43.2
Canada	5	3.00	44.2
United States	6	3.01	43.5
Northern Ireland	7	3.05	39.3
Israel	8	3.27	31.1
Japan	9	3.29	25.1
Hungary	10	3.36	32.1
Czech Republic	11	3.43	33.4
Ireland	12	3.45	28.7
Russia	13	3.51	20.0
Germany (West)	14	3.56	23.7
Germany (East)	15	3.57	23.5
The Philippines	16	3.60	28.5
Slovenia	17	3.61	21.0
Spain	18	3.68	13.4
Italy	19	3.78	21.6
Bulgaria	20	3.93	11.6
Poland	21	4.22	4.3

Table 3 (continued)

F. If someone is exposed to any amount of radioactivity, they are certain to die as a result.

Countries	Rank	Mean[a]	% Correct[b]
Canada	1	2.11	72.7
Norway	2	2.14	69.6
Hungary	3	2.33	63.4
United States	4	2.34	68.4
New Zealand	5	2.35	66.1
Great Britain	6	2.40	64.5
Germany (East)	7	2.45	58.7
Germany (West)	8	2.48	57.6
Northern Ireland	9	2.66	55.8
The Netherlands	10	2.69	52.6
Japan	11	2.71	51.3
Czech Republic	12	2.74	54.3
Slovenia	13	2.86	47.3
Spain	14	3.18	33.0
Ireland	15	3.20	37.3
Russia	16	3.35	30.6
The Philippines	17	3.37	35.7
Israel	18	3.45	33.5
Bulgaria	19	3.50	23.2
Italy	20	3.60	26.8
Poland	21	3.61	22.3

G. Some radioactive waste from nuclear power stations will stay dangerous for thousands of years.

Ireland	1	1.53	94.0
Italy	2	1.54	91.6
New Zealand	3	1.59	94.1
Bulgaria	4	1.65	77.9
Canada	5.5	1.72	90.7
Great Britain	5.5	1.72	91.5
Germany (West)	7	1.74	82.7
Israel	8	1.75	80.7
Northern Ireland	9.5	1.76	89.9
Czech Republic	9.5	1.76	84.7
Germany (East)	11.5	1.81	82.0
The Netherlands	11.5	1.81	85.1
Slovenia	13.5	1.84	83.0
Poland	13.5	1.84	82.0
United States	15	1.90	86.1
Japan	16	1.95	77.6
Hungary	17	1.96	75.3
Russia	18	1.98	75.9
Norway	19	1.99	78.2
Spain	20	2.06	81.8
The Philippines	21	2.33	73.6

Table 3 (continued)

H. The greenhouse effect is caused by a hole in the Earth's atmosphere.

Countries	Rank	Mean[a]	% Correct[b]
Japan	1	3.13	28.2
The Netherlands	2	3.16	35.7
Norway	3	3.24	32.1
Canada	4	3.29	32.5
United States	5	3.39	25.5
The Philippines	6	3.44	31.0
Hungary	7.5	3.48	16.4
Israel	7.5	3.48	16.1
Russia	9	3.49	14.1
Spain	10	3.53	14.7
Slovenia	11	3.59	16.3
Bulgaria	12	3.62	10.0
Czech Republic	13	3.63	21.8
New Zealand	14	3.67	23.3
Great Britain	15	3.74	20.2
Poland	16	3.85	8.1
Germany (East)	17	3.86	18.6
Northern Ireland	18.5	3.91	12.6
Italy	18.5	3.91	16.4
Germany (West)	20	3.95	14.5
Ireland	21	4.04	10.8

I. Every time we use coal or oil or gas, we contribute to the greenhouse effect.

Norway	1	1.89	81.6
Germany (East)	2.5	1.99	78.0
Great Britain	2.5	1.99	81.2
Germany (West)	4.5	2.02	77.4
New Zealand	4.5	2.02	81.2
Italy	6	2.05	77.8
Ireland	7	2.06	79.2
Canada	8	2.07	77.9
Czech Republic	9	2.08	73.0
Northern Ireland	10	2.11	77.7
Japan	11	2.15	71.6
The Netherlands	12	2.21	72.5
Israel	13	2.22	56.9
Slovenia	14	2.31	64.7
Spain	15	2.36	63.4
Russia	16	2.39	56.3
Hungary	17	2.40	54.8
United States	18	2.44	64.1
Bulgaria	19	2.53	41.9
Poland	20	2.54	53.4
The Philippines	21	2.76	60.8

Table 3 (continued)

J. All pesticides and chemicals used on food groups cause cancer in humans.

Countries	Rank	Mean[a]	% Correct[b]
Norway	1	2.39	60.5
The Netherlands	2	2.49	60.1
Great Britain	3	2.56	61.2
New Zealand	4	2.57	60.9
United States	5	2.68	57.7
Northern Ireland	6	2.83	50.0
Japan	7	2.84	45.6
Canada	8	2.86	51.2
Hungary	9	2.91	46.7
Germany (West)	10	2.95	45.1
Israel	11	3.02	39.8
Czech Republic	12	3.06	42.8
Slovenia	13	3.18	33.4
Germany (West)	14	3.25	34.2
Ireland	15	3.35	43.7
Poland	16.5	3.42	25.6
Russia	16.5	3.42	23.7
Spain	18	3.48	20.4
Bulgaria	19	3.49	23.1
The Philippines	20	3.72	24.4
Italy	21	3.90	17.1

K. Human beings are the main cause of plant and animal species dying out.

Bulgaria	1	1.74	87.1
Japan	2	1.75	87.3
Poland	3	1.82	84.7
Germany (West)	4	1.95	80.3
Italy	5	1.96	79.6
Czech Republic	6.5	2.02	78.3
Spain	6.5	2.02	86.6
Slovenia	8	2.06	77.4
Israel	9	2.08	76.8
Norway	10	2.11	76.2
Germany (East)	11	2.16	72.9
The Netherlands	12	2.18	74.8
Russia	13	2.21	67.7
Hungary	14	2.23	71.7
Ireland	15	2.28	73.2
Great Britain	16	2.32	71.5
Canada	17	2.34	71.1
Northern Ireland	18	2.39	68.6
New Zealand	19	2.41	70.1
The Philippines	20	2.50	68.2
United States	21	2.65	62.7

Table 3 (continued)

L. Cars are not really an important cause of air pollution in [COUNTRY].

Countries	Rank	Mean[a]	% Correct[b]
Canada	1	1.96	76.5
Germany (East)	2	2.03	75.4
United States	3	2.05	74.7
Israel	4	2.07	71.0
Great Britain	5	2.09	73.8
New Zealand	6	2.11	74.6
Germany (West)	7.5	2.17	70.5
Northern Ireland	7.5	2.17	71.0
Italy	9	2.27	67.0
Ireland	10	2.30	68.1
Norway	11	2.33	66.0
Russia	12	2.36	64.0
Czech Republic	13	2.45	64.3
Slovenia	14	2.51	59.2
The Netherlands	15	2.65	56.5
Bulgaria	16	2.73	48.2
Japan	17	2.77	51.1
The Philippines	18	2.86	49.3
Spain	19	3.24	33.2
Poland	20	3.26	29.6
Hungary	21	3.27	35.7

[a]Items were scored 1=correct and definite, 2=correct and probably, 3=can't choose, 4=incorrect and probably, 5=incorrect and definite.

[b]Giving the correct answer whether definitely or probably.

Table 4

Factor Loadings Across Countries

(Varimax Rotation)

	Factor 1: False	Factor 2: True	Factor 3: Other/ Religion
a. Man-made Radiation	.674		
b. Antibiotics			-.378
c. Astrology			.609
d. Evolution			-.638
e. Chemicals & Cancer	.695		
f. Radiation & Death	.763		
g. Radioactive Waste		.659	
h. Hole in Atmosphere	.411		
i. Burning Hydrocarbons		.698	
j. Pesticides & Cancer	.734		
k. Extinction		.522	
l. Cars and Pollution		(.361)	.383
Eigen value:	2.77	1.56	1.02

Loadings of .3 or greater are reported above.

Table 5

Factor Loadings Across Countries: College Educated Only

(Varimax Rotation)

	Factor 1: False	Factor 2: True	Factor 3: Negatives
a. Man-made Radiation	.695		
b. Antibiotics			.646
c. Astrology	.437		
d. Evolution		.570	
e. Chemicals & Cancer	.665		
f. Radiation & Death	.722		
g. Radioactive Waste		.495	(.407)
h. Hole in Atmosphere	.522		
i. Burning Hydrocarbons		.681	
j. Pesticides & Cancer	.715		
k. Extinction	(-.345)	.521	
l. Cars and Pollution			.611
Eigen value:	2.69	1.57	1.01

Loadings of .3 or greater are reported above.

Table 6

Correlations with Environmental and Scientific Knowledge

Countries	Variables									
	Gender	Age	Educ.	Church Attend	God	No Relig.	Income	Occ. Sci.	Occ. Teach	Place
Germany (West)	.159	.170	-.353	-.143	.215	.174	-.143	-.100	-.130	(.033)
Germany (East)	.163	.173	-.249	-.135	.205	.144	-.224	(-.053)	(-.015)	.183
Great Britain	.230	.253	-.351	-.079	.289	.179	-.379	-.118	-.128	---
Northern Ireland	.163	.254	-.428	-.149	.240	.144	-.377	-.139	-.125	---
United States	.185	.131	-.453	-.097	.293	.149	-.256	-.128	-.105	(.013)
Hungary	.120	.227	-.322	-.117	---	.106	-.175	-.114	-.089	.185
Italy	.109	.153	-.398	-.098	.196	.136	-.232	---	---	(.062)
Ireland	.101	.198	-.347	-.080	.212	.133	-.227	(-.061)	-.171	(-.045)
The Netherlands	.170	.275	-.404	-.138	.239	.197	-.161	---	---	.064
Norway	.199	.240	-.431	-.166	.265	.186	-.247	-.138	-.143	.110
Czech Republic	.183	.175	-.354	-.157	.288	.254	-.229	---	---	.086
Slovenia	.133	.205	-.352	-.203	.249	.196	-.151	-.186	-.101	.143
Poland	.136	.159	-.293	-.220	.236	.183	-.151	-.187	-.063	.156
Bulgaria	(.041)	.077	-.205	(-.052)	.155	.142	-.097	-.167	-.075	.072
Russia	(-.016)	.074	-.110	-.063	.161	.124	(-.047)	-.056	(-.020)	---
New Zealand	.113	.145	-.255	-.133	.289	.250	-.263	-.093	-.089	.072
Canada	.141	.184	-.326	-.144	.261	.167	-.294	-.121	-.180	---
The Philippines	-.050	(.026)	(-.033)	(.012)	(-.013)	-.047	---	---	---	---
Israel	.089	.126	-.314	-.218	.364	---	-.258	-.207	(-.026)	---
Japan	.173	.115	-.187	-.045	.106	.105	-.174	---	---	(.034)
Spain	.066	.158	-.299	(-.053)	.093	.088	-.203	-.065	-.118	.083
Average	.124	.168	-.308	-.118	.217	.151	-.214	-.121	-.099	.083
More Knowledgeable	Men	Young	College	Attend Less	Athe-ists	No Relig.	More Income	Scien-tists	Tea-chers	Urban
# Significant and Same Sign	18/21	20/21	20/21	18/21	19/20	19/20	19/20	14/16	11/14	10/15

Table 7

Multiple Regression of Scientific and Environmental Knowledge

(Standardized Coefficients/alpha levels)

Variables	Model1	Model2	Model3	Model4
A. Individual				
Gender	.081/.000	.088/.000	.089/.000	.088/.000
Age	.011/.085	.041/.000	.041/.000	.053/.000
Education	-.333/.000	-.273/.000	-.267/.000	-.204/.000
Attend Church	-.168/.000	-.044/.000	-.142/.000	-.022/.027
Believe in God	---	.154/.000	---	.186/.000
Protestant	---	-.185/.000	---	.011/.458
Catholic	---	-.019/.185	---	.018/.190
Eastern Orthodox	---	.078/.000	---	-.004/.739
No Religion	---	-.097/.000	---	-.041/.002
Income	---	.090/.000	---	.013/.106
Science Occupation	---	-.054/.000	---	-.060/.000
Teaching Occupation	---	-.061/.000	---	-.065/.000
B. Country				
Per Capita GNP	---	---	-.151/.000	-.080/.000
Anglo Nations	---	---	-.108/.000	-.129/.000
Ex-Socialist	---	---	.006/.569	.135/.000
Northwest Europe	---	---	-.127/.000	-.108/.000
r^2	.170	.244	.249	.310
N	24407	13379	24407	13379

Table 7 (continued)

Multiple Regression of Scientific and Environmental Knowledge

(Standardized Coefficients/alpha levels)

Variables	Model4	Model5
A. Individual		
Gender	.088/.000	.091/.000
Age	.053/.000	.054/.000
Education	-.204/.000	-.196/.000
Attend Church	-.022/.027	.010/.319
Believe in God	.181/.000	.159/.000
Protestant	.011/.458	.052/.015
Catholic	.018/.190	.052/.024
Orthodox	-.004/.739	-.002/.899
No Religion	-.041/.002	-.017/.327
Income	.013/.106	-.005/.595
Science Occupation	-.060/.000	-.056/.000
Teaching Occupation	-.065/.000	-.060/.000
B. Country		
Per Capita GNP	-.080/.000	---
Anglo Nations	-.129/.000	---
Ex-Socialist	.135/.000	---
Northwest Europe	-.108/.000	---
Canada	---	-.010/.288
Britain	---	-.002/.880
New Zealand	---	.017/.103
Nor. Ireland	---	.046/.000
Germany (West)	---	.057/.000
Germany (East)	---	.088/.000
United States	---	.092/.000
Ireland	---	.105/.000
Israel	---	.147/.000
Spain	---	.156/.000
Slovenia	---	.164/.000
Bulgaria	---	.242/.000
Russia	---	.327/.000
Poland	---	.339/.000
r^2	.310	.328
N	13379	13379

Appendix: Participating Organizations

Canada - School of Journalism and Mass Communications, Carleton University, Ottawa
Bulgaria - Agency for Social Analyses, Sofia
Czech Republic - Institute of Sociology, Prague
Germany - The Center for Survey Method and Analysis, Mannheim
Great Britain and Northern Ireland - Social and Community Planning Research, London
Hungary - TARKI, Budapest
Ireland - Social Science Research Center, University College Dublin
Israel - Department of Sociology, Tel Aviv University
Italy - Eurisko, Milan
Japan - Broadcasting Culture Research Institute, Tokyo
The Netherlands - Social and Cultural Planbureau, Rijswijk
New Zealand - Faculty of Business Studies, Massey University, Palmerston North
Norway - Norwegian Social Science Data Service, Bergen
The Philippines - Social Weather Stations, Quezon City
Poland - Institute for Social Studies, University of Warsaw
Russia - The Center for Public Opinion and Market Research, Moscow
Slovenia - Public Opinion and Mass Communications Research Center, Ljubjana
Spain - Sociological, Economic, and Political Analysis, Madrid, and Center for Sociological Investigations, Madrid
United States - National Opinion Research Center, University of Chicago

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