



## Supporting Online Material for

### Public Acceptance of Evolution

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## Supporting Online Material

### Data Sources and Data Collection Methods

The data for the United States for the years 1988, 1990, 1992, 1995, 1997, and 1999 were collected in national random-digit telephone surveys of approximately 2,000 respondents conducted through grants from the National Science Foundation (NSF grants SRS88-07409, SRS90-02467, SRS92-17876, and SRS99-06416). The U.S. data for 1993 were collected by telephone interviews with 1,557 adults as a part of the International Social Science Program, a cross-national program sponsored in part by the National Science Foundation. The U. S. data for 2003 were collected online using a sample of 2,066 adults from a probability-based national panel maintained by Knowledge Networks, Inc. The 2003 study was sponsored by a grant from the Foundation BBVA in Madrid, Spain, as a part of a larger 10-country study of attitudes toward biotechnology. The U.S. data for the years 2004 and 2005 were collected online using samples of approximately 2,000 adults from a probability-based national panel maintained by Knowledge Networks, Inc. Both the 2004 and 2005 studies were conducted as a part of an evaluation of two NSF-funded projects conducted by ScienCentral, Inc. (NSF grants ESI-0201155 and ESI-0206184). The U.S. Science and Engineering Indicators data are deposited at the Inter-university Consortium for Political and Social Research (ICPSR).

The 2002 data from 13,587 adults in Britain, Germany, France, Italy, Spain, the Netherlands, Denmark, Austria, and Poland were collected by personal interview by T.N.S. (Taylor Nelson Sofres) in the fall of 2002. This survey work was sponsored by the Foundation BBVA in Madrid, Spain, as a part of a 10-country study of public attitudes toward and understanding of biotechnology. Requests for access to these data should be addressed to Director Generale, Fundacion BBVA, Palacio del Marques de Salamanca, Paseo de Recoletos 10, Madrid, Spain 28001.

The 2005 data from 32 European countries was collected by the European Commission in its Eurobarometer Survey 63.1, conducted through personal interviews during the first quarter of 2005. Eurobarometer studies of all member states of the European Union are conducted twice each year. In recent years, the Eurobarometer has been expanded to include both the member states and several other nations that are

candidates for membership in the EU or are neighboring states that have decided not to join the EU. A total of 31,390 adults were interviewed in the Eurobarometer 63.1 study. The Eurobarometer data are available from the ICPSR in the United States and from national data archives in most of the member states of the European Union.

The 2001 data from Japan was collected by personal interview in February and March of 2001 and was sponsored by the Japanese National Institute of Science and Technology Policy (NISTEP). A total of 2,146 adults were interviewed for this study. Requests for access to the 2001 data should be sent directly to the National Institute of Science and Technology Policy (NISTEP), Mombukagakusyou Building, Marunouchi 2 chome, Chiyoda-ku, Tokyo, Japan 100-0005.

Although these data were collected by three different methods over a period of 20 years, comparison of responses to a set of benchmark questions involving demographic and related characteristics found no systematic mode effect. All of the survey responses were weighted to reflect the known national populations of each country, which compensates in large part for variations in participation rates among countries. A time series comparison of telephone and online responses in the U.S. time series data set found only minimal modes effects on certain items such as the frequency of visiting a public library (respondents were more likely to report no library visits online than in a telephone interview). On balance, these data appear to be valid estimates of public attitudes toward and acceptance of evolution in the countries studied.

### **Statistical Analyses**

The basic distribution of attitude toward evolution was displayed through tables and bar charts in the main body of this report. These descriptive statistics provide evidence of the isolation of the United States from the mainstream of western industrial societies. Only Turkey—a country still debating the issue of secular versus theocratic government—was less accepting of evolution than the United States.

These descriptive results are useful, but it is important to examine some of the factors that are associated with the acceptance or rejection of evolution, especially in the United States because of its higher rate of rejection. For this purpose, a two-group structural equation model (SEM) was constructed to compare the factors associated with

the acceptance or rejection of evolution in the United States and in the nine European countries included in the larger 10-country study of biotechnology. This data set was selected because it includes a larger set of items about religious views and levels of genetic understanding than the Eurobarometer data set.

In this analysis, the dependent variable is attitude toward evolution, measured with the five category question—definitely false, probably false, not sure, probably true, or definitely true. The distribution of responses on this variable was discussed in the main text.

A significant body of research has focused on attitude toward evolution in the United States because of the decades of controversy about the issue. From this literature and taking into consideration the variables available in the 10-country biotechnology study, a set of nine independent variables was selected to predict attitude toward evolution in the United States and in the nine European countries (combined for this analysis).

**Age.** Age was included because older adults tend to be more religious and because the exposure to science education may have been greater for younger adults. Given the substantial national investment in science and mathematics education in the last 50 years, it would be reasonable to expect that younger adults would be better educated about science and more likely to accept evolution.

**Gender.** Gender was included because women are generally more religious than men and because science was viewed as a “male” subject for many years, although there is evidence that this disparity has decreased significantly in recent years.

**Education.** The level of educational attainment should be positive related to exposure to science instruction and to acceptance of evolution. Earlier work has shown that the number of college-level science courses is a positive predictor of scientific literacy and use of informal science learning resources.

**Genetic literacy.** The 10-country study included a set of 10 items to measure genetic understanding. All of the items used the same five-category response set as was used for the evolution question—from absolutely false to absolutely true. A confirmatory

factor analysis found that all 10 items loaded on a single factor for respondents in all 10 countries. The Index of Genetic Literacy (IGL) is based on the following items:

Ordinary tomatoes do not have genes, whereas genetically modified tomatoes do. (F)

Genetically modified animals are always larger than ordinary animals. (F)

Cloning is a form of reproduction in which offspring result from the union of sperm and egg. (F)

Today it is not possible to transfer genes from humans to animals. (F)

If someone eats a genetically modified fruit, there is a risk that a person's genes might be modified too. (F)

All plants and animals have DNA. (T)

Today it is not possible to transfer genes from animals to plants. (F)

Humans have somewhat less than half of the DNA in common with chimpanzees. (F)

It is possible to extract stem cells from human embryos without destroying the embryos. (F)

All humans share exactly the same DNA. (F)

Each respondent received one point for each of the 10 items that he or she answered correctly using the absolutely true or absolutely false response, as appropriate. Each respondent received a half-point for each probably true or probably false response, as appropriate. The Index of Genetic Understanding (IGU) ranges from zero to 10 and has good psychometric properties.

**Religious belief.** A four-category ordinal variable was constructed to reflect a typology of current religious belief. The four categories are (i) no religious belief, (ii) some religious belief but a strong belief in human control, (iii) belief in substantial divine control but infrequent prayer, and (iv) belief in substantial divine control and frequent prayer. There is substantial variation in personal religious belief within countries and across countries. Adults in Poland, the United States, and Italy were most likely to believe in substantial divine control and to pray frequently. Adults in Britain, France, and Denmark were the least likely to believe in divine control and to pray frequently.

**Attitude toward life.** This is a simple index of the number of agreements that each respondent had about three issues involving the beginning of life and the moral and legal status of embryos. One item asked about when life begins and those respondents

selecting “at conception” as an answer were coded as having a “pro-life” attitude, in the language of contemporary American politics. A second item concerned the moral status of a human embryo that is a few days old, and each respondent was asked to indicate which of four statements they agreed with most. The statements ranged from “A human embryo that is a few days old is a mere cluster of cells, and it makes no sense to discuss its moral condition” to “A human embryo that is a few days old has the same moral condition as a human being.” Respondents who agreed that a human embryo a few days old is either “closer in its moral condition to a human being than a mere cluster of cells” or the same as a human being was coded as holding a “pro-life” attitude. Finally, each respondent was asked to judge whether all stages of life—embryo, fetus, child or adult—should have the same legal protection and whether later stages of life should have greater protection than the earliest stage. Individuals who indicated that all stages should have the same protection or that earlier stages should have greater protection were coded as having a “pro-life” attitude. The Index of Pro-life Attitudes is a simple count of the number of pro-life attitudes expressed in response to the three questions and ranges from zero to three. Approximately 30% of American adults hold strong pro-life attitudes compared to 23% of adults in the nine European countries.

**Attitude toward science and technology.** Previous studies have found that attitude toward science and technology in Canada, Japan, the European Union, and the United States is not a single dimension, but rather is best measured as a two-dimensional construct. One dimension reflects a belief in the promise of science and technology to improve human life and conditions. The other dimension reflects reservations about actual or potential negative consequences from science and technology. In the United States, these two dimensions are negatively correlated at the -0.3 level and in the E.U. the same two dimensions are nearly uncorrelated (*SI*). For this analysis, separate variables were constructed to reflect each of the two dimensions.

**Belief in the promise of science and technology.** In this analysis, a set of five items was used to estimate each respondent’s belief in the promise of science and technology. Each respondent was asked to rate the contributions of scientists, engineers, and physicians (separately in three items) to the improvement of “people’s lives” on a zero-to-10 scale. Two additional items asked each respondent to express his or her agreement or

disagreement with two statements using a zero-to-10 scale: “Thanks to science, we enjoy a high level of health and physical well-being” and “On balance, the benefits arising from science and technology are overall much greater than their harmful effects.” The Index of Belief in the Promise of Science and Technology is the mean score from the five statements and ranges from zero-to-10. A majority of both American adults and European adults hold positive attitudes toward the benefits of science and technology.

**Reservation about science and technology.** A set of seven items was used to estimate the level of reservation held about the impact of science and technology. Using the same zero-to-10 scale (with zero meaning complete disagreement and 10 meaning complete agreement), each respondent was asked to indicate his or her agreement or disagreement with the following statements:

Science and technology destroy people’s moral values.

Technological progress creates a completely artificial and inhuman way of life.

Science and technology have created a world that is full of risks for people.

Science and technology make our way of life change too fast.

People would be better off if they lived a simpler life without so much science and technology.

Technological progress is one of the main reasons for the current high levels of unemployment.

One of the negative effects of science and technology is that it destroys people’s religious beliefs.

The Index of Reservation about Science and Technology is the mean score from the seven statements and ranges from zero-to-10. Although a majority of both American adults and European adults hold moderate views of the possible risks of science and technology, a higher proportion of European adults hold high levels of reservation than American adults.

**Political ideology.** Each respondent in the 10-country study was asked to place himself or herself on a zero-to-10 scale, with zero meaning “very liberal” and 10 meaning “very conservative.” Traditionally, partisanship in the United States has been measured by a seven-point scale ranging from Strong Republican to Strong Democrat, but this metric does not work with European respondents. In the last two decades, American political parties have become more ideological, with the Republican Party becoming

more consistently conservative and the Democratic Party becoming more consistently liberal. For this analysis, the zero-to-10 political ideology scale was used as an indicator of each respondent's general political ideology. A slightly higher proportion of U.S. adults classified themselves as conservative than did European adults.

**A structural equation model.** A structural equation model (SEM) allows an examination of the relationship between several variables simultaneously on one or more outcome variables (*S2*, *S3*). In this model, the nine independent variables described above were used to predict attitude toward evolution (see Fig. *S2*). A SEM requires the specification of a chronological or logical order to the independent variables. For example, an individual has a gender and an age at birth, and both of these variables are treated as exogenous variables in this model. These variables are placed at the left hand side of the model, indicating that no other variables in the model predict them. In both Europe and the United States, the level of education attained may be influenced at least in part by both gender and age. Education, in turn, may influence an individual's level of genetic literacy and his or her religious beliefs. The combination of these factors may influence an individual's general perceptions of science and technology, including the two dimensions discussed earlier. And all of these nine variables may influence attitude toward evolution.

In the path model shown in Figure *S2*, each path (arrow) indicates that the two variables are significantly related. The path coefficients may be thought of as standardized partial regression coefficients, holding constant the other variables that precede or parallel the variable from which the path originates. The path coefficient from age to education, for example, is 0 to 0.10 in the United States and  $-0.33$  in the nine European countries, indicating that older adults are likely to have completed less formal education than younger adults and that this disparity is stronger in Europe than the United States. The path coefficient from gender to education in the nine European countries is  $-0.04$ , indicating that in these nine countries women are likely to have completed slightly less formal education than men. The absence of a path from gender to education in the U.S. sample means that the distribution of educational attainment for men and women is essentially equal, holding constant differences in age.

By multiplying each of the coefficients in a series of paths and summing all possible paths from any independent variable to the dependent variable, it is possible to compute the total effect of each of the independent variables in the model on the outcome variable—attitude toward evolution. The model to predict attitude toward evolution in the United States accounted for 46% of the total variance in that variable (see Table S1). In the nine European countries included in this analysis, the SEM accounted for only 18% of the total variance in attitude toward evolution. The lower level of predictive power in the model for the nine European countries is largely a reflection of the higher degree of acceptance of evolution among European adults, significantly reducing the amount of variance to be predicted by the model. In addition, the variables included in the model were selected primarily because of their prior or expected role in predicting attitude toward evolution in the United States. No European country has experienced the politicization of the evolution issue that has occurred in the United States in recent decades.

### **References and Notes**

- S1. J. D. Miller, R. Pardo, F. Niwa, *Public Perceptions of Science and Technology: A Comparative Study of the European Union, the United States, Japan, and Canada* (BBV Foundation Press, Madrid, 1997).
- S2. L. A. Hayduk, *Structural Equation Modeling with LISREL* (Johns Hopkins Univ. Press, Baltimore, 1987).
- S3. K. Jöreskog, D. Sörbom, *Lisrel 8* (Scientific Software International, Chicago, 1993).

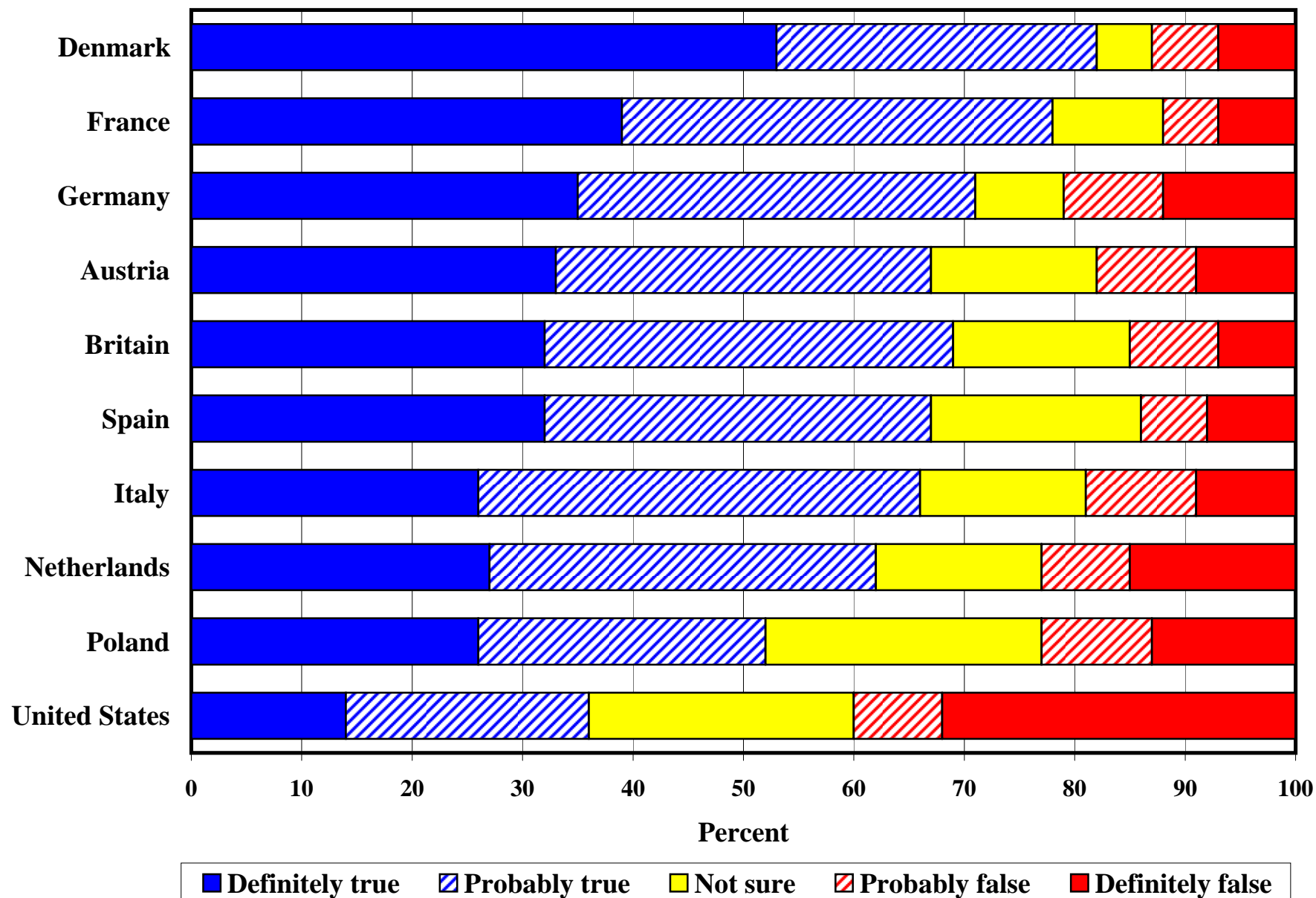
**Table S1.** Total effects of independent variables on attitude toward evolution, 2002, 2003.

<b>Total effects of ....</b>	<b>United States</b>	<b>European Nine</b>
Age	-0.10	-0.13
Gender (F)	-0.03	-0.10
Educational attainment	0.00	0.17
Genetic literacy	0.20	0.19
Religious beliefs	-0.42	-0.24
Pro-life beliefs	-0.31	-0.09
Belief in the promise of science & technology	0.00	0.14
Reservation about science & technology	0.00	-0.07
Political ideology	-0.15	0.00
<b>R<sup>2</sup> =</b>	<b>0.46</b>	<b>0.18</b>

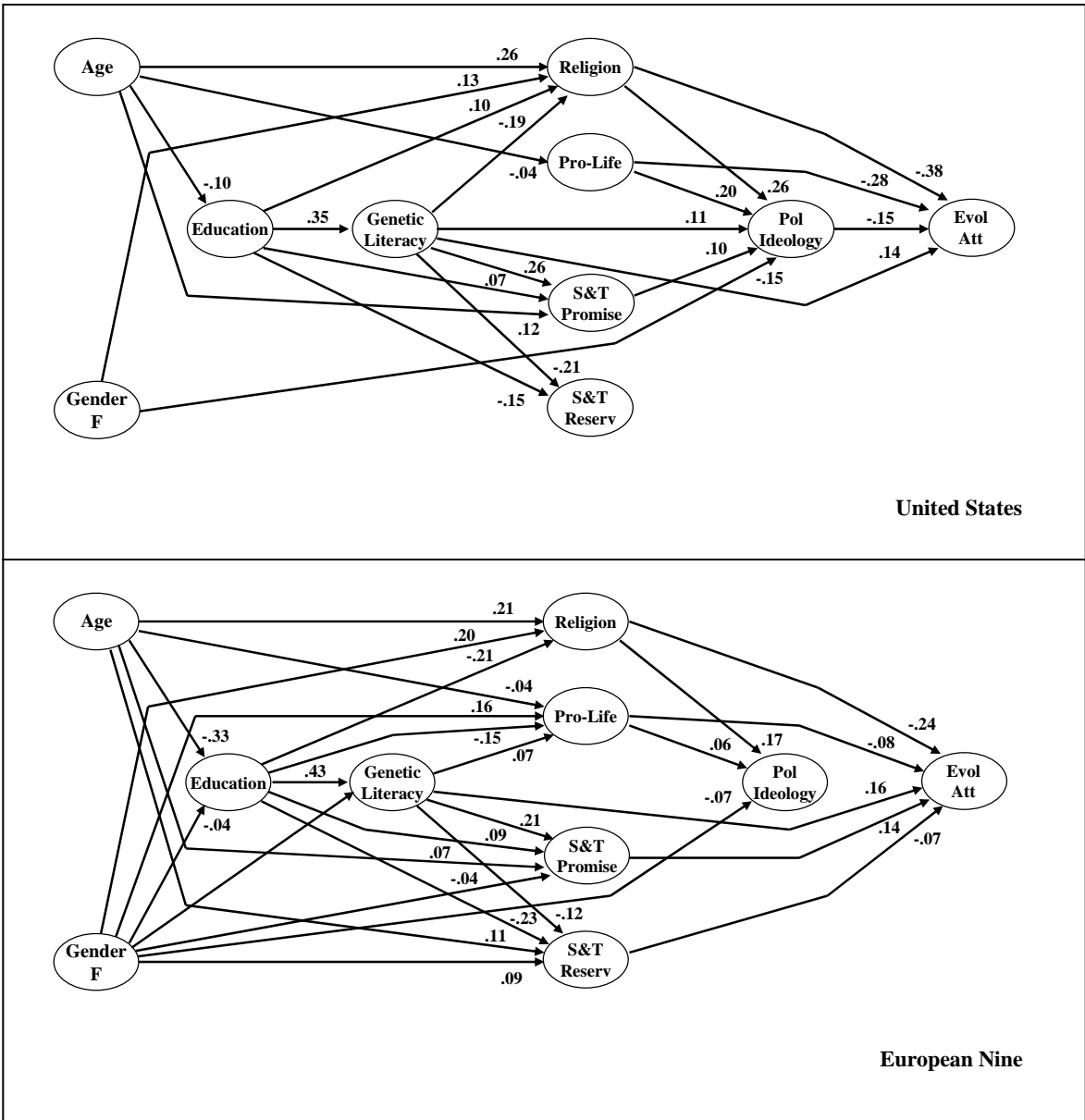
**Fit for two-group model:** minimum-fit  $\chi^2 = 60.9$ ; degrees of freedom = 29; root mean square error of approximation (RMSEA) = 0.015; 90% confidence intervals for RMSEA = 0.010, 0.021.

**Table S2.** Acceptance of selected scientific constructs, United States, 2005. *N* = 1484.

	True	Not sure	False
Over periods of millions of years, some species of plants and animals adjust and survive while other species die and become extinct. (T)	78%	16%	6%
More than half of human genes are identical to those of mice. (T)	32	47	21
Human beings have somewhat less than half of the DNA in common with chimpanzees. (F)	15	48	38
The earliest humans lived at the same time as the dinosaurs. (F)	28	22	51
Human beings were created by God as whole persons and did not evolve from earlier forms of life. (F)	62	2	36
Human beings, as we know them today, developed from earlier species of animals. (T)	40	21	39



**Fig. S1.** Public acceptance of evolution in 10 countries, 2002-03.



**Fig. S2.** Path models to predict attitude toward evolution, 2002, 2003.