

# College Students' Religious Beliefs, Knowledge of Evolution, and Science Literacy: Comparisons by Sex, Discipline, and Point of College Career

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## Background

In scientific circles, evolutionary theory ranks alongside gravity and electricity in its caliber as a theoretical notion verging on fact (Dawkins, 2009). However, in international comparisons, the USA ranks essentially at the bottom in acceptance of evolutionary theory. In fact, U.S. citizens score lower on knowledge and acceptance of evolution than do citizens in 32 European countries and Japan (Miller, Scott, & Okamoto, 2006).

Rates of science literacy in America are also relatively low by absolute standards, hovering between 25-30%. However, Americans score *higher* in science literacy than do citizens in many other countries (Hobson, 2008), including the same countries that outperform them in knowledge and acceptance of evolution. Scientists have suggested that required exposure to science courses in American colleges is responsible for the relative U.S. advantage in science literacy (Hobson, 2008). At the same time, other scientists have argued that strong religious belief in America is responsible for the U.S. deficit in understanding evolution (e.g., Dawkins, 2006).

Poor understanding of evolutionary principles and hostile attitudes toward evolution are tied to dangerous educational movements (Miller, 1999). And, deficits in scientific literacy (despite any relative cross-country advantage) are disconcerting because knowledge in the fields of genetics and biology is expanding rapidly. A basic level of understanding of genetics and biological processes is increasingly relevant for understanding current technologies, making informed medical decisions, and ensuring appropriate use of genetic information (Haga, 2006). Scientific literacy is also important for understanding probabilistic information and distinguishing between correlation and causation (for instance, in the case of the purported link between thimerosal in vaccines and ASD).

If being in college promotes science literacy and critical, evidence-based thinking, then college seniors should demonstrate higher levels of scientific knowledge and lower levels of religious belief than should freshmen. Among seniors, those in Math & Natural Sciences should score higher in science literacy than should those in other disciplines. The current study was designed to test these predictions.

## Method

### Overview

With help from faculty and staff across campus (see Acknowledgements), we collected responses from a representative sample of undergraduate students (499 female, 271 male) representing more than 35 unique majors on campus. Of these, 265 were in their freshman year, 142 were sophomores and juniors, and 354 were approaching graduation (seniors and beyond). All participants completed measures of scientific reasoning and scientific knowledge, as well as measures of religiosity, subscription to religious fallacies, and both moral objections to and distrust of science. Our items were taken from various sources, primarily from Hawley et al. (2010) and Miller (1998).

### Belief in God

Our measure of religiosity included a single question on an 11-point response scale (e.g., *"To what extent do you believe in God or a supreme being?"*) that ranged from *not at all* to *completely*. For purposes of analysis we created a categorical variable to highlight the differences between strong (8-10), moderate (3-7), and weak or no belief (0-2).

### Religious fallacies and objections

Three subscales evaluated religious fallacies and objections. One subscale assessed participants' moral objections to evolution (2 items,  $\alpha = .62$ ; e.g., *"People who accept evolution as fact are immoral"*), another assessed young earth creationist beliefs (4 items,  $\alpha = .90$ ; e.g., *"Adam and Eve from Genesis are the universal ancestors of the entire human race"*), and a third subscale assessed subscription to intelligent design fallacies (6 items,  $\alpha = .80$ ; e.g., *"There is scientific evidence that humans were created by a supreme being or intelligent designer"*). All attitude items were completed with an 11-point response scale that ranged from *disagree strongly* to *agree strongly*.

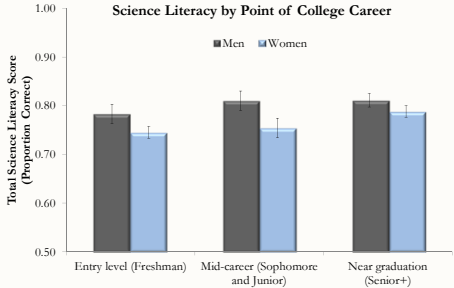
### Distrust of Science

Six items assessed participants' distrust of science ( $\alpha = .73$ ; e.g., *"Science and technology have created a world that is full of risks for people"* and *"Science and technology make our way of life change too fast"*). Items on this scale were also completed with an 11-point response scale ranging from *disagree strongly* to *agree strongly*.

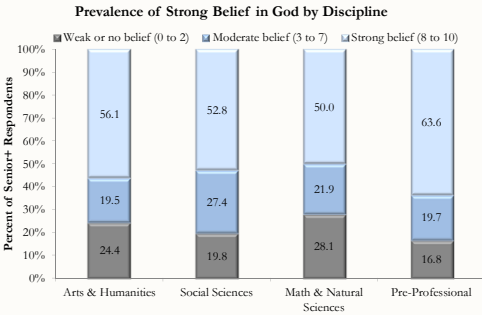
### Science Literacy

Participants completed a total of 55 closed-ended items to assess their knowledge and understanding of science. Questions spanned topics including genetics, *"The genetic information encoded in DNA molecules provides instruction for assembling fats and lipids"*, biology, *"The oxygen we breathe comes from plants"*, evolutionary theory, *"Increased genetic variability makes a population more resistant to extinction"*, life sciences, *Two experimental scenarios presented. There: "Which method will give you a valid answer?"*, earth sciences, *"The continents on which we live have been moving their locations for millions of years and will continue to move in the future"*, philosophy of science, *"Good theories give rise to testable predictions"*. We report subscale performance as well total science literacy.

## Results



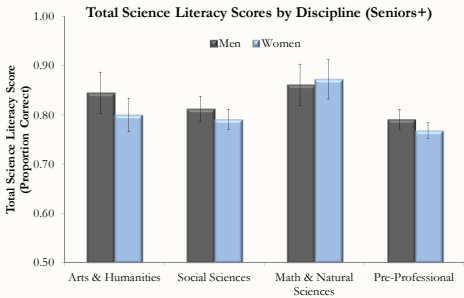
Men scored significantly higher than women on total science literacy,  $F(1, 677) = 31.99, p < .001$ , partial  $\eta^2 = .045$ . The sex difference was significant at each point in college (all  $ps < .015$ ). Across sex, college status was significantly associated with science literacy; however, for men the effect of college status was just marginally significant ( $F(2, 232) = 2.71, p = .068, \eta^2 = .023$ ), and no pairwise comparisons were significant. College status was a highly significant predictor of science literacy for women ( $F(2, 445) = 14.07, p < .001, \eta^2 = .06$ ); post hoc comparisons revealed that entry-level and mid-career females did not differ from one another ( $p = .70$ ), but female seniors scored higher than both entry level ( $p < .001$ ) and mid-career females ( $p = .009$ ).



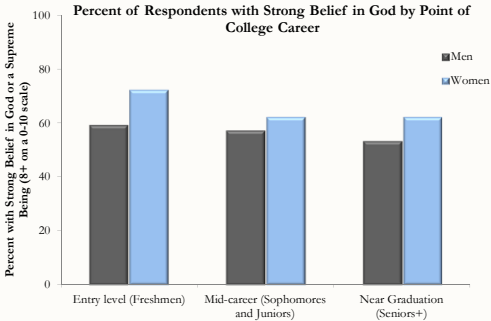
There were no significant differences between disciplines in percent of respondents reporting weak or strong belief in God,  $\chi^2(6, N = 352) = 6.08, p = .414, V = .09$ . In each of the four disciplines, 50% or more students reported a strong belief in God or supreme being. Taken with the figure to the right, our findings reveal that across sex, discipline, and point in college, over half of students carry a strong belief in a supreme being.

	Belief in God (0 to 10)	Religious Fallacies and Objections (0 to 10)	Distrust of Science (0 to 10)	Science Literacy (0 to 55)	Men Mean (SD)	Women Mean (SD)
Belief in God	-----	.61***	.19**	-.22**	6.61 (3.59)	7.40 (3.26)
Religious Fallacies and Objections	.63***	-----	.32***	-.47***	3.13 (2.24)	3.67 (2.08)
Distrust of Science	.30***	-.39***	-----	-.19**	3.48 (1.67)	4.03 (1.54)
Science Literacy	-.26***	-.43***	-.28***	-----	44.24 (4.31)	42.08 (4.54)
Freshmen Mean (SD)	7.83, (2.82)	4.04, (2.08)	4.08, (1.48)	41.47, (4.23)		
Sophomores & Juniors Mean (SD)	6.70, (3.67)	3.30, (2.24)	3.89 <sub>a</sub> , (1.61)	42.91 <sub>a</sub> , (4.76)		
Seniors+ Mean (SD)	6.82, (3.58)	3.18, (2.10)	3.62 <sub>a</sub> , (1.68)	43.81 <sub>a</sub> , (4.46)		
Overall Mean (SD)	7.14 (3.39)	3.48 (2.16)	3.83 (1.61)	42.83 (4.57)		

Note. Correlation coefficients for males ( $n$  range from 236 to 270) are above the main diagonal; coefficients for females ( $n$  range from 453 to 490) are below the main diagonal. \*\*\*  $p < .001$ ; \*\*  $p < .01$ . Rows in gray show college level differences. Students at different points in their college career differ on all four variables of interest. Groups with differing subscripts differ at  $p < .05$ . Rows in blue show sex differences. Men and women differ on all four variables of interest,  $ps$  ranging from  $< .001$  to .003. Equivalency for science literacy scores: 41.47 = 75%; 42.91 = 78%; 43.81 = 80%.



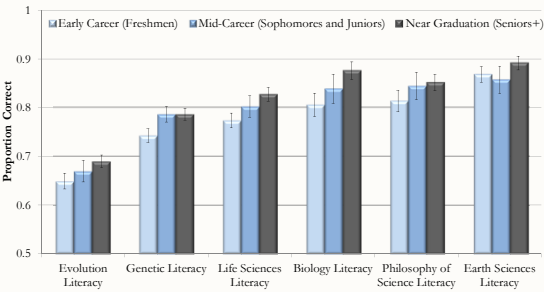
Scientific literacy scores differed significantly by discipline,  $F(3, 299) = 11.27, p < .001, \eta^2 = .10$ . Across sex, students in Math & Natural Sciences ( $n = 28$ ) scored significantly higher than those in all other disciplines (Arts & Humanities  $n = 33, p = .057$ ; Pre-Professional  $n = 146, p < .001$ ; Social Sciences  $n = 100, p < .001$ ). Arts & Humanities differed significantly from Pre-Professionals ( $p = .033$ ). However, Social Sciences did not differ from Arts & Humanities ( $p = .594$ ) or from Pre-Professionals ( $p = .147$ ). The effect of discipline held for both senior males ( $F(3, 114) = 4.497, p = .005, \eta^2 = .106$ ) and females ( $F(3, 185) = 7.732, p < .001, \eta^2 = .111$ ). For males, the only significant pairwise difference occurred between Math & Natural Sciences and Pre-Professionals ( $p = .011$ ). Females in Math & Natural Sciences scored higher than females in any of the other disciplines (all  $ps < .04$ ). Taken across disciplines, senior males ( $n = 118$ ) scored marginally higher than senior females ( $n = 189, F(1, 299) = 3.015, p = .084$ , partial  $\eta^2 = .01$ ). Men and women did not differ significantly within any of the four disciplines.



Among first-year students, females (72%) were more likely than males (59%) to report a strong (versus weak) belief in God,  $\chi^2(1, n = 264) = 4.03, p = .045, V = .124$ . However, the sexes did not differ significantly at midcareer ( $\chi^2(1, n = 140) = .351, p = .553, V = .05$ ) or as seniors ( $\chi^2(1, n = 352) = 2.661, p = .103$ ).

Across sex, point in college was associated with likelihood of holding a strong belief in God,  $\chi^2(4, n = 760) = 15.998, p = .003, V = .10$ . Whereas 69% of freshmen reported strong belief, 59% of mid-career students and 58% of senior level students did.

### Performance on Science Literacy Subscales by Point of College Career



Performance on each of the science literacy subscales was associated with point in college career (all  $F$ s  $> 3.63$ , all  $ps < .03$ ), with seniors generally surpassing freshmen and on some subscales the sophomores/juniors. Students scored low on evolution literacy relative to the other scales. Although students are performing well above chance, the differences in performance as a function of point in college are not extreme. For example, the effect size for life sciences literacy, which included questions about correlation-causation, experimental design, and the gambler's fallacy, was weak at .03: Point in college accounted for just 3% of the variance in life science literacy.

## Discussion

Overall, our findings suggest that science literacy levels in our college student sample, as a composite and in various domains, are well above the U.S. population average of 25-30%. That said, they showed room for improvement. A general trend in our data was for science literacy scores to be significantly higher among senior students than among the younger cohorts – particularly the freshman. The differences, however, were relatively small in effect size. Our data do not allow us to determine whether there really is something about taking college level science courses (or being in college more generally), or whether the effect is a function of general maturation, or whether the seniors showed an advantage merely because of differential attrition. That is, the seniors may just represent a fraction of students who have persisted through the intellectual and work ethic demands generally invoked by college life – they may be more able in general than the freshmen. Our follow-up data on the freshman sample, which we plan to acquire during the 2012-2013 academic year, will help us resolve these competing explanations.

Over half of all men and women in the sample reported a strong belief in God, across discipline and point of college career. Men scored lower than women in religious fallacies and objections, belief in God, and distrust of science and technology; at the same time, they scored higher in science literacy. In the senior sample, women in Math & Natural Sciences were a welcome exception, scoring higher than women in all other disciplines. However, we again encounter difficulties interpreting whether these higher scores result from a distinct curriculum or if these women already held an advantage as freshmen.

One limitation we faced in this study was differential participation by specific major. Although the sample was representative of the four disciplines across campus, the specific majors within these disciplines were not entirely representative. For example, a higher percentage of Pre-Professional participants were nursing majors than what is representative of our campus.

A second limitation centers on questions we could have asked differently. For example, we did not inquire about participants' specific religious affiliations. This would have allowed for further investigation of how particular religious views relate to overall scientific literacy, in particular evolutionary literacy.

Historically, America has been a very religious country; most polls suggest approximately 90% of the population believes in God. Students in our sample were also far more likely to believe than not. Given Dawkins' proposal that religious beliefs inhibit acquisition of knowledge of evolution, follow-up data on our freshman sample will help us determine whether strength of religious belief predicts subsequent avoidance of science (versus non-science) coursework, and whether religious belief predicts limited growth in knowledge of evolution and lack of confidence in the scientific enterprise.

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