

ESSAY

Evolution and the Neuroscience Curriculum: A Call to Action

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The evolution-creation debate continues to evoke passionate arguments as the competing epistemological systems of theology and science clash. Recent legal challenges in Dover, PA and renewed attempts to insert some form of creationism into the Kansas curriculum are representative of current events. In Dover, the school board voted to add an Intelligent Design (ID) component to the curriculum and was taken to court by concerned parents. Prior to the court decision, Dover citizens spoke by voting out of office all those school board members who voted to include ID in the classroom. The court concurred with the citizens, and concluded that the school board had attempted to violate the Establishment Clause of the First Amendment of the Constitution by inserting a religious position into the classroom. The judge went a step further and expressed his disapproval of the disingenuous behavior by the school board members: *"The citizens of the Dover area were poorly served by the members of the Board who voted for the ID Policy. It is ironic that several of these individuals, who so staunchly and proudly touted their religious convictions in public, would time and again lie to cover their tracks and disguise the real purpose behind ID Policy"* (Judge John E. Jones III, 2005).

In 1999 the Kansas school board moved to insert a creationist component into the curriculum, and like Dover, they were voted out of office in the next election. New adherents to a creationist view have now been elected, and are trying once more to insert creationism into the Kansas biology curriculum. While this paper was being written, an election took place in which the majority antievolution forces on the Kansas School Board lost seats, leaving the current board with a six to four majority in favor of excluding creation science from the science curriculum. Counting Dover, the creationist proponents have lost nine major court cases (see Matsumura, NCSEweb.org), so why do they keep coming back for another bite of this sour apple? The answer may be that just one win in the courts will severely damage evolution education for years to come.

Many of us working in or studying neuroscience might be unaware of the extent to which evolution is a main target of attack by Christian fundamentalists. A Harris poll in June, 2005 sampled 1,000 U.S. adults regarding their belief about evolution. The survey found that 64% agreed with the statement that, "Human beings were created directly by God." The majority of U.S. adults polled (54%) did not think human beings developed from earlier species. This figure is up 8% from a 1994 poll, and suggests the "culture war" may be having a significant antievolutionary effect.

In the narrative that follows I will present a number of

findings from survey data that I gathered from students in various university courses. It needs to be clear that these are data of opportunity and do not constitute a formal scientific survey. The reader should view them as snapshots of particular students in defined situations. While I believe they are useful for the conclusions drawn in this article, they should not be generalized without care.

The majority of respondents came from a Midwestern, large city (Chicago), state university of approximately 12,000 students. The university is categorized as comprehensive (offering degrees through the masters in most disciplines) and largely attended by first generation college-bound students. The student body is approximately 63% female and 37% male, and has an average age of 28.5 years. The ethnic and religious composition is highly diverse, and it would not be uncommon to hear at least three different languages being spoken in any half hour of touring the university. The vast majority of respondents were students enrolled in a general education Survey of Psychology course (exclusively non-majors in psychology), upper-level courses in Physiological Psychology (required of majors), or a Seminar in Drug Abuse (a psychology elective). It should be clear that most psychology majors in the upper level courses view psychology as a social science, and come to these courses with a minimal background in the sciences. A second group of respondents was recruited from a PhD granting, public university, again located in the Midwest. This university has an enrollment of more than 25,000 students, and is largely populated by students from the Chicago suburbs. All the respondents in this group were in the College of Education, were 99% female, and far more homogeneous than the larger population described above.

The questionnaire was composed of two pages. Page one was mainly demographic in composition, but asked the straight forward question as to whether they believed in the theory of evolution. They were offered three choices: Yes, No, No Opinion. The second page consisted of a number of statements that essentially defines the spectrum of beliefs regarding evolution, from a standard scientific position to that of the young earth creationist position. Respondents were asked to carefully read all the statements and then circle the one that most closely described their belief (see Box 1 for position statements). They were all told that there were no "right or wrong answers" to this questionnaire.

Table 1A shows the percentage responses to each of the three belief choices (Yes, No, No Opinion) by the religious affiliation professed. There were 401 respondents to the questionnaire with 28% of these claiming to have no opinion. These individuals clearly had an opinion as they

overwhelmingly picked one of the four position statements on the second page of the questionnaire; however, for the rest of the analysis I will drop them from the descriptive statistics.

BOX 1.

QUESTIONNAIRE ITEMS

Please read the following statements concerning people's belief in evolution. Circle the number before the statement that is closest to your own current belief concerning the theory of evolution.

1. Scientific questions should be decided independently of religious assumptions: religion has been of no help in deciding either patterns (e.g., shape of orbits of planets or their causes. Similarly, arguments either for or against God that use natural patterns or processes as evidence are logically flawed.

2. Evolution is God's way of making diverse organisms (just as gravitation is God's way of controlling planetary motion).

Creation (as depicted in the Bible) is the ultimate origin of the universe and continues at each moment in its maintenance.

Some versions (of evolutionary theory) emphasize the independent creation of life or of souls. Others also suggest that evidence of intelligent design can be seen in particular features of life.

3. This position is the same as number 2, except that it accepts only evolution within groups (within man, within fishes, but not across groups as from fishes to man).

New groups (especially humans) were newly created at approximately the time when they first appear in the fossil record. The diversity and complexity of new forms when created increases progressively through time.

4. The earth is only a few thousand (5000—10,000) years old. The geological record was largely formed in a year-long global flood. Some adaptive variation has occurred, but only within "kind" (human to human, dog to dog, etc.).

This position rejects much of the findings/conclusions of the physical and biological sciences, such as the conclusion that the earth is billions of years old.

If we look at only those responding "Yes" or "No" to a belief in evolution, we see that 72% claim to believe, while 28% claim not to believe in evolution. Table 1 shows a breakdown by the religious belief of the students. It is interesting to note the large percentage of Catholic students in this sample from two state universities. Of particular interest in the overview figures is the response of those students identifying themselves as Christians who have the lowest belief in evolution (55%), while those with no religion have the highest belief in evolution (94%). Among Catholic students, 79% report a belief in evolution, which may represent the Catholic Church's current stance on the topic. We will see that this group has a particular view of the kind/extent of evolution that is acceptable. Islam is considered to have a fundamentalist view of evolution, but that is not evidenced in our respondents, although the sample is small (14), with 71% accepting evolution. Of particular interest to this author is the view of those students from the larger state university who were exclusively in the College of Education and overwhelmingly female with only 54% believing in evolution. This is far below the overall 72% belief rate (which was calculated

with this group included), and about the same as the group identifying itself as Christian in religious affiliation.

An analysis of student beliefs when they were allowed to choose a modified interpretation of the theory proposed by Charles Darwin shows some interesting interpretations. Table 1D shows that of those students who claim no religious affiliation only 8.9% choose a modified theory of evolution, while those who identify as Christian, Catholic, Islamic choose a modified version of evolution in 82.1%, 59.5%, 93.3%, respectively. When I use the term "modified version" of evolution, it should be clear that this would be unacceptable to a scientific interpretation of evolution.

Table 1: Questionnaire results concerning a belief in evolution
(All data expressed as %)

A. Response when given choices of:	Yes	No	No Opinion	
			28	
B. Response omitting NOP: (n= 388)	72	28	--	
C. Belief by religious affiliation:				
Christian	55	45		
Catholic	79	21		
No Religion	94	6		
Islam	71	29		
D. Position statement:	1.	2.	3.	4.
Christian	17.9	52.6	24.4	5.1
Catholic	40.5	37.9	20.7	0.8
No Religion	91.1	2.2	4.4	2.2
Islam	6.7	60.0	20.0	13.3

Needless to say, this gratuitous modification of a scientific theory is not acceptable. Once it is pointed out to the students that they cannot arbitrarily change the tenets of a theory to fit their personal belief system, other examples of inconsistencies can be pointed out. One example might be the scientific assertion that the earth is 4.5 billion years old, as opposed to the young earth creationist's assertion that the earth is approximately 6,000 years old. The student can be asked to consider what other scientific conclusions would be called into doubt by accepting an earth that is only 6,000 years old.

It is clear that the majority of students who express a religious belief either do not understand the basic tenets of Darwin's theory, or believe that they can modify the theory to accommodate their religious beliefs. Position 2 (see Box 1) consisted of three sentences that attributed evolution to God as his mechanism of running the universe, that the biblical version of creation was true, and that God gave man a soul and was the designer. Position 3 repeats the claims of position 2, and adds that there is no evolution between species (so fish can evolve but there is no continuity between fish and any other species). There is a clear statement that species such as man were newly created. Position four is a statement of the young earth creationist claiming the earth to be between 5000-10,000 year old and clearly stating that this position rejects the findings claimed by modern science. It also clearly states that there can be no evolution across species. The reader should consult Table 1D for the degree of belief in each of these categories. Perhaps the most important conclusion that can be drawn from these data is that the majority of

students claiming to accept evolution do not understand the concept and will readily modify it to conform to their religious beliefs. Eugenie Scott (2004) offers an excellent and detailed treatment of the various belief positions in this area.

My purpose for writing this essay is not to merely review the current culture war abroad in the land, but to sound an alarm and recommend a call to action. We should take to heart the admonition of Theodosius Dobzhansky that without evolution, nothing in biology makes sense, and we should consider modern evolutionary theory as the closest thing we have to a unifying concept in the life sciences. While such a statement may seem obvious to my biology colleagues, many psychologists (my own discipline) may find such an emphasis to require a significant restructuring of their curriculum.

Both the biologist and psychologist will be faced with another conundrum and that is whether to teach the science of evolution or to engage the controversy. The question is, are we aiding the creationists if we teach the controversy, rather than only presenting the factual content of evolution. I think we will have to teach both factual content and at least some aspects of the evolution-creationism controversy. How much of the “controversy” we need to address may be more debatable. In my own situation, I use this controversy to distinguish between different epistemological systems. After reviewing the idea that epistemology is the philosophical study of how we validly come to know something, I make an effort to show the value and utility of various epistemologies and to point out that various epistemologies rely on different types of evidence and that you cannot go back and forth between the systems and consider your conclusions to be equally valid in all systems. Theology relies on both revelation and logic, but science has no place for revealed truths.

While there is no one curriculum or lesson plan for teaching evolution, the following lesson plan fits the needs of my student population. My Physiological Psychology course is composed of students who, at most, may have had an introductory biology or chemistry course, many have had neither. I allot three hours for this unit with a number of learning objectives for the lectures and demonstrations.

Hour One: There are two primary learning objectives for the first hour of instruction. Objective one is to give a short biographical sketch of Charles Darwin and his era, along with the time scale associated with evolutionary theory, starting with the earth’s age of 4.5 billion years. This is followed by introducing the concepts of natural selection, fitness, mutation and variance. The second objective is to present the concept of epistemology. Various epistemological approaches including theology, literature, law and science are briefly explained. The emphasis is placed on the need for evidence to draw conclusions. It is pointed out that each epistemological system has its form of evidence, along with its values and limitations. While all epistemological systems may have value they can conflict with each other. When the systems come into conflict, the nature of the question and the quality of the evidence become critical.

Hour Two: The second hour is devoted to tracing the evolution of hominids by presenting the students with a series of skulls including Ape, Australopithecus, *H. habilis*, *H. erectus*, *H. Neanderthal*, and *H. sapiens*. The students are given a handout on which they are asked to compare various anatomical features across the various skulls. The students are presented with some of the more fascinating but unsolved questions in evolutionary science, such as when language might have appeared, or whether *H. Neanderthal* and *H. sapiens* were always separate populations or whether they may have mated with each other. The students are given a list of readings that they consult on their own.

The city of Chicago has an excellent natural history museum which currently has an outstanding exhibit entitled, “The Evolving Planet.” I offer students extra credit for attending this exhibit. While this assignment is voluntary, over 95% of my students take advantage of this opportunity and many attest to its value in their written report.

Hour Three: The third hour is devoted to presenting examples from current genetic research supporting evolution. I favor examples from the areas of evolution and developmental biology, or what is often called Evo-Devo.

I wish to emphasize that this lesson plan is not being offered as a universal plan, but one specific to my course. Those in different disciplines or course levels should design their own curricula and learning objectives. One approach might be to assign one of the many popular science books available to the prepared reader.

I would be remiss if I didn’t list some of these excellent books. Sean Carroll, of the University of Wisconsin, has written two of the most stimulating books in this genre. His *Endless Forms Most Beautiful: The New Science of Evo Devo and the Making of the Animal Kingdom* (2005) is guaranteed to stimulate any serious student. His newest book, *The Making of the Fittest: DNA and the Ultimate Forensic Record of Evolution* (2006) presents genetic findings that make the veracity of evolution all but indisputable. Finally, for those interested in the culture war swirling around evolution my recommendation would include E. J. Larson’s *Summer for the Gods: The Scopes Trial and America’s Continuing Debate Over Science and Religion* (1997). This highly readable book won the Pulitzer Prize. If one is interested in an in depth, and readable, dissection of the creation-evolution debate, I highly recommend Massimo Pigliucci’s, *Denying Evolution: Creationism, Scientism, and the Nature of Science* (2002).

There are many benefits that accrue from this unit of instruction. First, it combats those who misrepresent the theory of evolution. Second, it gives the student an accurate factual base on which to make decisions following a critical analysis of the issues. Finally, it introduces them to what is arguably the most comprehensive and best supported theory in all of science.

It is my hope that the Faculty for Undergraduate Neuroscience will form a committee to explore this important curricular issue with the goal of generating a model approach to teaching the topic.

REFERENCES

- Carroll S (2005) *Endless forms most beautiful: The new science of evo devo and the making of the animal kingdom*. New York: WW Norton.
- Carroll S (2006) *The making of the fittest: DNA and the ultimate forensic record of evolution*. New York: WW Norton.
- Harris Poll #53, July 6, 2005.
- Kitzmiller v. Dover Area School District*, 400F. Supp. 2d 707 (M.D. Pa. 2005).
- Larson EJ (1997) *Summer for the gods: The Scopes trial and America's continuing debate over science and religion*. New York: Basic Books.
- Matsumura M (2001) Eight major court decisions against teaching creationism as science. National Center for Science Education. www.ncseweb.org/resources/articles.
- Pigliucci M (2002) *Denying evolution: Creationism, scientism, and the nature of science*. Sunderland, MA: Sinauer Associates.
- Scott EC (2004) *Evolution vs. creationism: An introduction*. Westport, CT: Greenwood Press.

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