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The Influence of "Junk Science" and the Role of Science Education

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On September 10-14, 2000, the Hillsdale College Center for Constructive Alternatives held a seminar on "Junk Science: The Political Abuse of Research." Participants discussed the unfounded scientific claims and theories that are employed today for political purposes, and in particular for justifying more intrusive regulation of private and economic life. From persistent doomsday scenarios like global warming to the latest ergonomic arguments for near-total regulation of the American workplace, this abuse of science represents not only an economic threat, but a threat to freedom as well.

This threat can succeed only if Americans become gullible to the point of failing to distinguish solid science from "junk science." In the following presentation, Dr. Baron discussed the increase of such gullibility in our nation today and one of its root causes: declining standards in science education.

Science is exciting partly because single discoveries can change the course of history. Think of the effects on human health and longevity of the discovery of antibiotics, the multi-faceted impact on our lives of the discovery of polymers, or the far-reaching importance of the Human Genome Project. Unfortunately, however, most of the "revolutionary discoveries" made throughout history have turned out to be wrong.

Error is a regular part of science. That is why reports of new findings or discoveries, no matter where or how widely they are reported, should be regarded with healthy skepticism. The proper scientific approach to such claims involves a set of procedures called the scientific method. This method requires the design of tests or experiments that can be repeated with

the same results by anyone. These tests must also contain controls to ensure that the results are statistically significant.

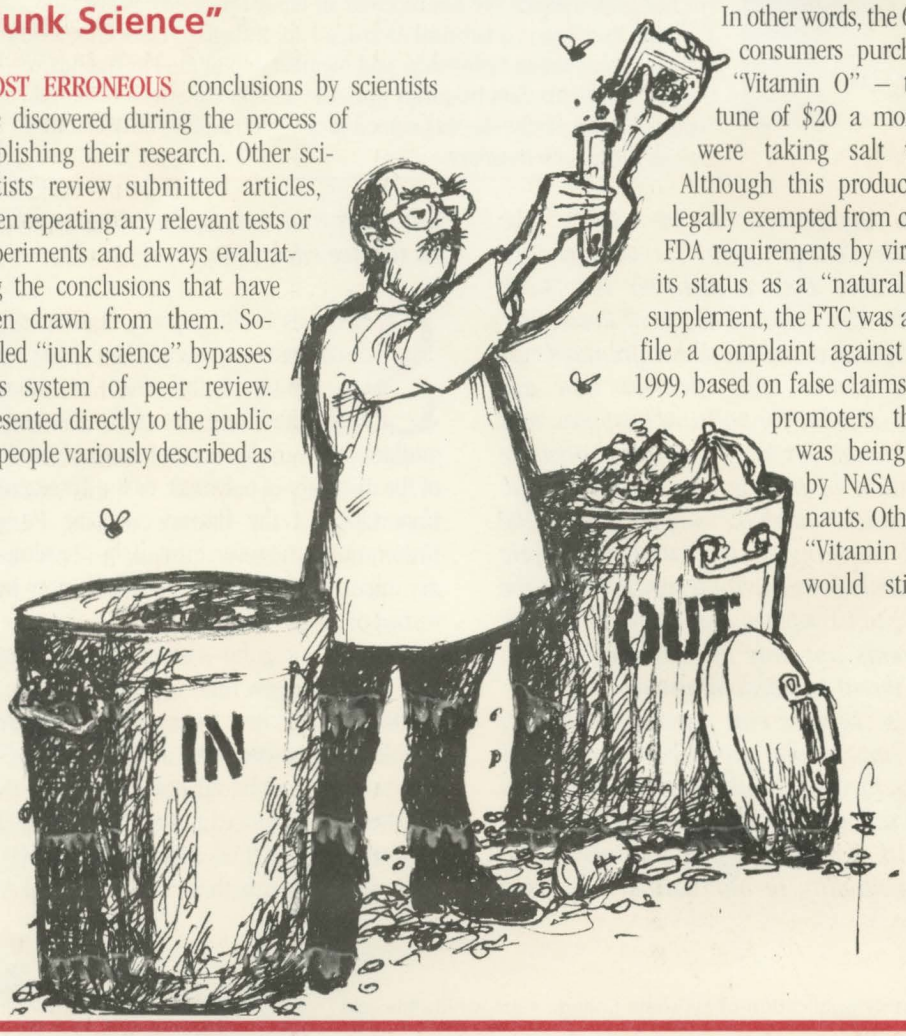
Let me illustrate the importance of controls by describing briefly an experiment in which my daughter participated as a subject some years ago at the University of Michigan Medical School. Its purpose was to determine whether the vaccine for tuberculosis could lengthen the interval during which newly-diagnosed type 1 diabetics do not experience severe high or low blood sugar. The subjects were divided into a group of those who received the vaccine and a control group of those who received a placebo. The subjects did not know who got the vaccine and, just as importantly, neither did the researchers – a type of control referred to as a "double-blind." By using two groups, the researchers were able to measure the "placebo effect" – a phenomenon in which patients improve because they falsely believe that they are receiving medicine. And by keeping themselves ignorant of the breakdown of the groups, the researchers were prevented from reading their hypotheses into the results.

"Junk Science"

MOST ERRONEOUS conclusions by scientists are discovered during the process of publishing their research. Other scientists review submitted articles, often repeating any relevant tests or experiments and always evaluating the conclusions that have been drawn from them. So-called "junk science" bypasses this system of peer review. Presented directly to the public by people variously described as "experts" or "activists," often with little or no supporting evidence, this "junk science" undermines the ability of elected representatives, jurists, and others – including everyday consumers – to make rational decisions.

An example of "junk science" I like to use with my students is the myth of "fat-free foods" invented by the food industry with the help of federal regulators. By regulatory definition, these foods may contain monoglycerides and diglycerides, but not triglycerides. From the point of view of solid science this definition makes no practical sense, given that the body metabolizes mono-, di- and triglycerides in essentially the same way. Meanwhile unwary consumers take the "fat-free" label as a license to eat these foods to excess, and Americans are more obese now than ever before.

A more amusing example is "Vitamin O," a wonder supplement advertised to "maximize your nutrients, purify your blood stream, and eliminate toxins and poisons – in other words, [to supply] all the processes necessary to prevent disease and promote health." It was described on its label as "stabilized oxygen molecules in a solution of distilled water and sodium chloride." In other words, the 60,000 consumers purchasing "Vitamin O" – to the tune of $20 a month – were taking salt water! Although this product was legally exempted from certain FDA requirements by virtue of its status as a "natural" diet supplement, the FTC was able to file a complaint against it in 1999, based on false claims by its promoters that it was being used by NASA astronauts. Otherwise "Vitamin O" would still be



one of the world's best-selling placebos.

The potential lasting power of "junk science" is demonstrated by the story of German physician Samuel Hahnemann, who took quinine back in 1776 to investigate its use against malaria. After taking the quinine he experienced chills and fever, which are the symptoms of malaria. From this he concluded, wrongly, that "likes cure likes," i.e., that diseases should be treated with medicines that produce similar symptoms to the diseases. In the course of testing this theory with other herbal remedies, Hahnemann discovered that many "natural" herbs are toxic and made his patients worse. To reduce the toxic effects, he diluted the remedies until they seemed to be working. On that basis he formulated a "law of infinitesimals" stating that higher dilutions of herbal cures increase their medicinal benefits. To be fair, Hahnemann conducted these experiments more than 70 years before scientists understood that a dilution weaker than one part in 6.02×10^{23} may not contain even a single molecule of the dissolved substance. Thus he did not realize that upon administering to his patients 30x preparations – dilutions of one part herb to 10^{30} parts water – the placebo effect was all that was really left to measure.

Incredibly, homeopathic medicine today still relies on Hahnemann's theories. Not only does it often come in 30x preparations, it comes in 200c dilutions – solutions of one part herb to 100 parts of water 200 times, resulting in one molecule of the herb per 10^{400} molecules of water! Modern homeopathists obviously can't deny that such preparations are beyond the dilution limit, but they insist that the dilutions still work because their water or alcohol/water mixtures somehow "remember" the herbs. Despite this preposterous claim, the market for these remedies is enormous.

Just as many homeopathic preparations are diluted to the point that they are nothing but water, many "natural" herbs on the market contain drugs and chemicals which interact with the human body like prescription drugs. For example, Echinacea stimulates the immune system, which could prove harmful to people with type 1 diabetes, rheumatoid arthritis, or other autoimmune diseases. It is therefore unwise – to put it gently – to take herbal remedies or supplements of any kind without consulting a doctor and/or the *Physician's Desk Reference for Herbal Medicines*. But many Americans do so, equating "natural" with "harmless" and "good."

Cause and Solution

I HAVE addressed here the corrupting influence of "junk science" in the area of consumer foods, vitamins and diet supplements. The same dynamic increasingly affects other aspects of our individual and collective lives as well. But I believe the root cause is the same: Americans are losing the common-sense skepticism toward scientific claims that animates the scientific method itself. And one of the reasons for this is a slow but steady degradation of our educational system. In short, as Charles J. Sykes explains in *Dumbing Down Our Kids*, theories such as "outcome-based education," "cooperative learning," and "maximization of self-esteem" are fast replacing reading, writing, and arithmetic as the goals of education.

Anecdotal evidence of this trend is vast and compelling. For instance, when average SAT math scores fell from 500 to 424, the College Board responded by allowing the use of calculators. When that didn't work, they "recentered" the test by adding approximately 20 points to the math scores (while also adding 80 points on the verbal side, for a total of 100), regardless of achievement. At the state level, many high school competency exams are written at an eighth-grade level. And coloring for credit in elementary-level math classes is now fairly common. Is it any wonder that so many of the kids we now graduate from high school enter the workforce unable to add in their heads or make correct change, or arrive at college incapable of solving the simplest equations?

The situation is no better in the sciences. Students at a Seattle middle school spend two weeks studying the eating habits of birds by trying to pick up Cheerios with tongue depressors, toothpicks, spoons, and clothespins between their teeth. "Educationalists" call this creative and engaging. But it doesn't create useful or important knowledge. And surely it is not true that such activity is more engaging than learning about Newton's Laws or DNA.

A popular high school chemistry book moves from "Supplying Our Water Needs," which includes a discussion of acid rain, to "Chemistry and the Atmosphere," which addresses the ozone layer. This approach would not be all bad if the chemistry behind these issues was rigorously taught and if important topics unrelated to

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social controversies were also included. Unfortunately they are not. When I called the American Chemical Society – which, sadly, produced this textbook – one of those responsible justified its approach by pointing out that most high school graduates don't pursue science in college. Furthermore, he said, students introduced to chemistry in this way enjoy it more and find it easier to handle, resulting in higher self-esteem. I asked if it had occurred to him that perhaps students don't pursue college science because they don't obtain the requisite skills or knowledge in high school. Regardless, when the American Chemical Society endorses a high school science text that doesn't even list the scientific method in its index, we shouldn't be surprised that so many Americans gorge themselves on "fat-free foods," throw their money at "Vitamin O," or risk their health by taking "natural" herbs without investigating their effects.

The solution to the problem I have outlined is easy to see, and is by no means impossible to accomplish. Individually, we must be careful to take our bearings from the scientific method when confronted with scientific claims, employing healthy skepticism and asking questions before believing what we hear or read. Together, we must work diligently to revive real standards in primary and secondary science education. ♦