

Readers Respond About Arrogance, Confidence, Brilliance, Humility, and Stupidity

Hats off to J. Murray Gibson for his Opinion piece, "Arrogance—A Dangerous Weapon of the Physics Trade?" (*PHYSICS TODAY*, February 2003, page 54). Arrogance is indeed a virus that infects the physics community, and I've seen its insidious effects on the career choices of generations of students, particularly women and other underrepresented groups.

But one thing about the piece puzzles me. Although Gibson's main point is that arrogance creates problems, his article repeatedly makes positive claims about arrogance: It is "a prized commodity," "something to be nurtured," or even "a tool . . . [for] cutting through the misconceptions that surround the natural world." To what effects of arrogance do these quotes refer? The only potentially useful ones I can imagine involve Machiavellian schemes to promote one's own agenda by simply being nasty. I hope we're not a profession that promotes that kind of behavior.

On the other hand, perhaps Gibson confuses arrogance with self-confidence. If you want to cut through those misconceptions, a high degree of self-confidence can be very important. But self-confidence need not entail arrogance. The greatest physicists I've known have been able to combine strong self-confidence with a concern for others that is the very opposite of arrogance.

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In his Opinion piece, J. Murray Gibson persuasively argues for moderating scientific competence with modesty. Physics is not just about pursuing one's curiosity with enthusiasm and asserting the superiority of its method over others. Physics also has a role that is best

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achieved through pursuing thoughtful conduct. And Gibson's perspectives can be expanded to look at "arrogance" of the physical sciences in general, rather than just physics.

Physical scientists have come to believe that their scientific method will help them understand and quantify everything they need to know about the material world. They believe that, with that knowledge, they could control and subdue that world. Such confidence is double-edged. On the positive side, it nurtures curiosity, traditionally the main inspiration for scientific inquiry. On the negative side, it fosters an attitude of conquest that is true arrogance. Especially troublesome at present is that the attitude of conquest is nurtured more by commercialism than by inspiration. The universality of Isaac Newton's and Albert Einstein's findings is truly impressive. Yet, those findings are limited; they are not applicable to the remarkable natural phenomenon, the life-to-death cycle. Living things possess remarkable abilities to sense their surroundings, to determine what parts of their environment are acceptable for sustenance, and to adapt their bodies and chemical behavior to changes in the world around them. Higher-order living things simultaneously possess opposites such as love and hate, compassion and violence, rationality and irrationality. Unlike the behavior of inanimate objects, that of living things cannot be predicted with equations; the elements of any such equation are capable of making judgments, whether conscious or unconscious.

Most people in our modern technological society, led on by the cockiness of the physical sciences, think that they can subdue Earth as they please. But nature's biosphere, the nutritional cycle, and the hydrological cycle are all intertwined in a way that cannot be predicted or controlled. Although practitioners of biotechnology and genetic engineering succeed in manipulating chemical molecules, they have no way of rationalizing how species and genera as a whole will respond to human manipulations. Viruses and microbes that quickly develop resistance to

new drugs or vaccines and pests that develop resistance to pesticides demonstrate the lack of knowledge. Physical scientists cannot predict and control at will because living things possess abstract attributes that lie beyond their science's foundational concepts. True, a connection exists between the physical body and those abstract attributes, but no framework yet exists to make sense of the connection between the palpable and the abstract.

Just as profound as the knowledge of the physical world is the knowledge related to the functioning of Earth—the environment, ecosystems, and the behavioral patterns of living things. Those areas of inquiry require descriptive, qualitative, and intuitive thinking. Such qualitative knowledge is as deep and valuable as the quantitative knowledge of physical properties and laws.

Gibson's seemingly simple statement that "we easily forget that we are all too human" is, in fact, profound. Humans are as capable of great leaps of imagination, creativity, beauty, and compassion as they are of indescribable violence and destruction. Concerns about global warming, destruction of habitats, and pollution of air and water, as well as the desire of world commerce to control natural resources for profit, indicate that the world of the living transcends the scope of the physical sciences. Many in the natural sciences think that we are at a threshold of either adapting our living to the constraints of nature or wreaking incredible damage to Earth as we destroy ourselves.

The arrogance that Gibson highlights, rather than being an irritation in the form of having to tolerate someone's attitude, has more profound implications. Much will depend on whether we as physical scientists opt for the path of arrogance, or moderate it with a recognition that physics is only one component of the totality of human knowledge.

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As an undergraduate who is just receiving his physics degree, I have never seen such naked arrogance as

that in my physics program. J. Murray Gibson's discussion of his undergraduate training was very enlightening: I now see that the trial I went through is the rule rather than an unjust aberration. I had a teacher who was tyrannical, and I found the totalitarian classroom nearly intolerable. I learned that, although physicists are very smart people, they just don't get the idea of "human being." Perhaps the mathematical models on this subject are still not adequate for physicists' understanding. Gibson writes, "For the real physicist, this trial by fire is not quite enough to extinguish interest in the field." Ah, yes, an analogy that conjures the tempering of steel—you see, just a hardening process. You need lots of heat, and no emotions. Who needs emotions? They're not objective! Those physicists may be "real," their interests having survived, but they will be emotional cripples, looking to cripple others.

A different analogy may serve as a better model for the physicists trying to acquire a feel for this "human" stuff. The forester will tend seedlings in the nursery and provide the right environment for growth. When they are ready, they will be transferred to the ground where they may thrive. The forester cultivates them and does not force the issue. You will not find the forester hitting the seedlings with a hammer when they first break through the soil.

Perhaps the physicist might try to see potential in the undergraduate who can be cultivated. Of course, that variety of teaching is an art. I have found that there are two jobs one can get without experience. One is parent; the other is college teacher. Most physics professors have never cracked a book on learning theory and don't understand different learning styles. Gibson recasts arrogance as a virtue, but I think it is an archaic and unproductive teaching posture in dire need of updating. It is probably psychologically damaging and apt to arouse American students' intrinsic questioning of authority. If physics professors regarded undergraduates as sentient humans who get blown out of the field when confronted by poor treatment, then physicists would see the danger of arrogance and educational facilities would not need hubris monitors stationed outside the classroom next to the fire extinguisher.

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I couldn't disagree more with J. Murray Gibson's Opinion piece on arrogance. First, I believe that we physicists can be arrogant because we believe we are smarter than people in other professions and not because we are objective. In fact, our belief in our supposed objectivity may be one of our major failings.

Second, the attitude at other laboratories can be far different from that at Bell Labs, as described by Gibson. We at the David Sarnoff RCA Laboratories were blessed by working with Albert Rose, who has been called the father of photocon-

ductivity. Far from being arrogant, he was a brilliant but humble person. His humility permeated the labs; we all looked up to Al as a model of how to behave.

My conclusion is that arrogance in our profession is a one-edged sword aimed at ourselves, not a two-edged sword as Gibson has proposed, and arrogance should always be avoided. Let's use Albert Einstein as our model of behavior, and not brilliant but arrogant physicists.

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Congratulations to J. Murray Gibson for his much needed comments on the arrogance of some physicists. Let me give a specific example of such arrogance, heard during a lunch conversation at Bell Labs in the good old days. A very senior administrator of research commented about the Nobel Prize-winning chemist Peter Debye: "He could not have been that good a scientist or he would have become a physicist."

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To have, in the same issue, articles about the joy of physics and the privilege of being a physicist, on the one hand, and even a hint of the glorification of arrogance in physicists, on the other hand, represents a cruel irony. Victor Weisskopf would not be happy with that juxtaposition! There is nothing positive about arrogance. For every putdown artist among the greats of physics, such as Wolfgang Pauli, there were warm and humane greats, such as Enrico Fermi and Albert Einstein.

Arrogance is not a sine qua non for great accomplishment. In my own career, I have had wonderful experiences with great scientists who were kind, mentoring, and supportive, as well as unpleasant, and even shattering experiences with others, ruthless prima donnas whose behaviors have been very destructive. There is a close connection between arrogant wunderkinder and the incidents of fraud that have recently plagued physics research.

Many physicists have bemoaned the reduction in funding and prestige in our field during the past decade or so. For a premier physics magazine to print an article extolling the value of arrogance does not constitute good public relations in the battle to maintain the health of our science.

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Physics is not as arrogant a trade as J. Murray Gibson claims. My dictionary calls arrogance "unwarranted pride," and I warrant that our trade is somewhat justified in being proud of its accomplishments.

In Drexel University's course on science and religion, taught by a trinity of one campus minister, one physicist-philosopher, and one humble physicist, I emphasize what I call the principle of scientific humility—

that integral to science is our express lack of knowledge. That lack is clear in physical measurements, each one of which has an attached uncertainty, colloquially called an "error." In precision work, two errors are often given for a measurement: one covering experimental errors and one covering systematic errors. We ask students to find other areas of human endeavor in which uncertainties are similarly openly displayed.

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Although I am impressed with J. Murray Gibson's courage to abjure humility and lecture us on the evils of misplaced arrogance, I hold that there is a little more, and very much less, to be said on that topic. Even as we physicists must be arrogant to box with God as we do in our exploration of His creation, we have to be humble in considering possible errors in our conclusions. Our answers must be correct; our colleagues are—properly—unforgiving of error.

Contrary to Gibson, I don't find that the "me teacher, you student" arrangement that goes back at least 5000 years to Ur of the Chaldees is insufferably arrogant. Nor is it arrogant to hold that a particular formal mentoring program that Gibson espouses, one that extends beyond our present traditions, might do more harm than good.

Then Gibson confuses political correctness with humility and considers that our arrogance contributes to our "severe underrepresentation of women and minorities" and adds "Since I do not believe that white males have an intrinsically higher ability in physics than other groups have, I think we might have a problem in our profession." Years ago, at a small conference held to address the barriers women meet in science, a prominent astrophysicist suggested that we should regard those barriers as dismantled only when 50% of scientists were women. Ruth Bader Ginsburg then asked if, at that time, we should expect that only 3% of scientists be Jewish!

The varying representations of different races, genders, and ethnic groups in science, arts, sports, commerce, and other fields surely follow from causes outside of physics or any perceived arrogance of physicists.

Overall, one must not equate arrogance with disagreement with Gibson—or even with me.

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I use my own arrogance to criticize J. Murray Gibson's Opinion on arrogance. Gibson misses one important point: Never ascribe to arrogance what is more properly described as stupidity.

Gibson quotes otherwise "rational and intelligent scientists" as saying, "Just show me a well qualified XXX [woman or minority] and I will hire him or her on the spot—I have no bias." He calls such a statement classical arrogance. I use my arrogance to claim that anyone who says such a thing cannot be a good scientist. A good scientist does not dismiss a question by claiming to know the answer; he answers the question by asking another question. Science progresses when people find the right questions.

The right question with regard to groups underrepresented in physics is, Why are there no qualified XXXes available?

I started asking questions about women in physics after being annoyed by Steven Goldberg's article, "Numbers Don't Lie: Men Do Better Than Women," in the 5 July 1989 *New York Times*. The author noted that men do better than women on the mathematics portion of the Scholastic Aptitude Test and jumped to conclusions about a possible physiological basis.

I recalled an arrogant old saying, "Figures don't lie, but liars can figure," and I started asking relevant questions.

Why are so very many of the successful American women scientists and mathematicians born outside the US? Why is it hard to find American-born women in nuclear and particle physics of comparable stature to the enormous number of successful American women in those fields who were born outside the US?

I noted Maria Goeppert-Mayer, C. S. Wu, Gertrude Scharff-Goldhaber, Fay Ajzenberg-Selove, Noemie Koller, Sulamith Goldhaber, Juliet Lee-Franzini, Sau Lan Wu, Inga Karliner, and so on. There are exceptions: Nina Byers and Glennys Farrar are American-born. I may have missed some others, but the asymmetry is still striking. I thought that I had finally found a top American-

born woman particle theorist in Helen Quinn, until I learned that she was Australian.

Why is the ratio of women to men in physics much higher in France, Italy, and Poland than in the US? Do European women do better in primarily Roman Catholic countries than in Protestant ones? Is the greater success of European women because they had Marie Curie as a role model, or because the Virgin Mary is so important in Roman Catholic culture?

Why is there apparently such a large number of women mathematicians and engineers among the Soviet Jewish immigrants to Israel and the US? Why was one of those the only woman with a tenure position in a large leading American university mathematics department?

Perhaps one must look back much earlier than university or graduate school to understand the problem. Are subtle prejudices and sociological factors in American culture crucial at high-school and perhaps even at elementary school levels?

These are the questions to ask; they will lead us to serious thinking and perhaps to finding some answers. It is a copout and a deflection to say, "Just show me a well qualified

XXX and I will hire him or her on the spot." Bias is not the problem.

Some of my women physicist friends who were born outside the US confirm that the problem begins quite early. One who immigrated from Europe to America when she was in high school said that she was considered peculiar in the US, because "girls were not supposed to be smart." Another said that the best road to success for a woman physicist would be to start her education in Europe and move to the US at a later point in her career. Girls who wanted to be physicists had a much easier time in Europe until they hit a point on the academic ladder where there was real discrimination. At that point, they could do much better in the US.

The moral: Be arrogant. But ask the right questions. If you are sure you know the right answer, you are probably stupid, not arrogant.

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Gibson replies: I appreciate the healthy response to my Opinion piece. The writers added

many valuable insights, and several echo my sentiments. My original piece was intended as a condemnation of the behavior that most of us would identify as arrogant. Most of the disagreement is due to semantics concerning the meaning of the word *arrogance*. I came not to praise arrogance, but to bury it.

Admittedly, the word arrogance is technically inaccurate to describe the positive behavior that I defended. My poetic license may have confused some readers. The dictionary definition of arrogance suggests overbearing behavior based on inappropriate views. "High degree of self-confidence"—Richard Noer's phrase—or even *assertive* may well be more accurate to describe the positive side of arrogance. Because arrogance and self-confidence seem intimately related even though one is bad and the other is good, I chose to blur the distinction.

Physicists are, as Leonard Finegold observes, more open than other professions to admitting uncertainties. We physicists have much to be proud of, but for our own sake, we need to admit our weaknesses.

I disagree with Robert Adair's comment that the varying represen-

tation of different races and genders in physics follows entirely from causes outside the field. If that were true, wouldn't all professions experience the same degree of representation?

Harry Lipkin makes the valid argument that stupidity may be mistaken for arrogance. He correctly notes that gender representation is slightly better in some other countries and that we can learn from that. We Americans are known around the world for our hubris, and this may explain some of the differences.

The combination of brilliance and humility that Leonard Weisberg mentions is the ideal paradigm for a physicist; I intended in my piece not to argue against that combination of traits but instead to discuss why it is uncommon.

T. N. Narasimhan makes a profound point when he observes that man's arrogance toward nature is dangerous. I also like James Kellinger's apt metaphor for the misguided teacher as a forester waiting for seedlings to spring up from the soil so that he can then hit them with a hammer.

Fortunately, very few writers disagree with my concern about the

downside of arrogance, and most object only to my apology for it. I stand corrected on the technical usage of the word. However, knowing that the boundary between bad arrogance and good self-confidence is blurred helps us fulfill our aim to stamp out one and not the other. Frankly, I anticipated more radical disagreement than is reflected in this set of letters; instead, almost all the writers view arrogance as a real problem for the profession. I hope that view is representative of the community.

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Cloaks and Kudos for PHYSICS TODAY'S Portrayal of Women

In the delightful Harry Potter book and motion picture series, one of Harry's cherished possessions is an invisibility cloak, which enables him and his friends to carry out many explorations and pranks. Women in

physics achieve invisibility without such whimsy, and PHYSICS TODAY continues to be a prime contributor to that invisibility. Perhaps, like Harry and his friends, women's invisibility in the physical sciences contributes to their strength. However, Harry and friends are only occasionally invisible. In the pages of PHYSICS TODAY, women in the physical sciences are only occasionally visible.

The January 2003 issue is typical. In all of its articles and departments combined, the only woman appears on page 37, in a photo showing that "informal gatherings were a part of the charm of the 1954 Varenna Summer School." From the picture and caption, I see that the school was so informal that men could take off their shirts and have first names; the one woman has no first name and is completely covered (she even wears sunglasses—perhaps to maintain her relative invisibility). Maybe she is just there to contribute "charm."

The three invited articles are, as usual, all by men (five of them). The obituaries are all by men. The book reviews are all written by men about books by men. The "We Hear That"