The Spirit of Science

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Members and guests. It is for me a very great honor and privilege to deliver this year's Presidential Address to the American Society for Clinical Investigation. As I pondered over what approach I would take, my mind drifted back to previous such addresses that I had heard. In fact, this is the 20th consecutive such oration at which I have been present. What, I have repeatedly asked myself, could I possibly add to the sage comments of my predecessors? As I thought about this I came to realize the highly personal nature of these commentaries in terms of both style and content. Each has been informed by the unique perspective of the President and shaped, of course, by the nature of his academic activities at the time. For example, several who have chaired departments have discussed the future of the physician scientist, while another focused on the key role of the department chair in promoting clinical investigation. Others who had been particularly active in the public sector have concentrated on the interfaces between the biomedical research community and governmental agencies and funding sources. Two recent presidents who had also served as Editors of the *Journal of Clinical Investigation* discussed peer review and fraud in science, respectively. But I have not chaired a department, led a division, organized a formal training program, or edited the *Journal of Clinical Investigation.* Rather, for the past twenty years I have largely devoted my professional activities to the scientific life and the associated activity of trying to nurture various young scientists who have come to work with me.

Given that this is my perspective, what should be my subject? I found my inspiration while reviewing the stated objectives of our Society, as set forth in its constitution written eighty years ago in 1908. Five objectives were listed: (*a*) the advancement of medical science; (*b*) the cultivation of clinical research by the methods of the natural sciences; (*c*) the correlation of science with the art of medical practice; (*d*) the encouragement of scientific investigation by the medical practitioner; and (*e*) the diffusion of a scientific spirit among its [the Society's] members.

This last I believe to be the most important. So apparently did our Founders, since they listed only two obligations of membership: to attend the annual meeting at least every other year and to "further the objectives of the society in the diffusion of the scientific spirit, particularly among his or her students and professional associates."

I would like therefore to discuss some of the highest ideals of the scientific spirit to which we all aspire by considering these questions: what is the scientific spirit? How do we get it? How do we foster it and keep it alive? And how do we diffuse it to our students and colleagues?

Although this address is ostensibly directed to the membership of the ASCI, I know that this room contains hundreds of young trainees and investigators early in their careers. I must confide that much of what I have to say is directed squarely at you.

Many of us seem to sense, in the aspiring young scientists who come to work with us, a confusion about the nature and importance of what constitutes the scientific method and what constitutes the true spirit of science. The scientific method concerns the practical aspects of how to pursue valid scientific questions according to a relatively well-defined set of rules of investigation using the latest scientific methods. It is the desire to learn these rules of investigation and state-of-the-art scientific techniques that brings these novice scientists to our laboratories. And unless we badly botch the situation, learn them they will. But if all we had to impart to them concerned such matters as how to design a controlled experiment, how to frame a testable hypothesis, how to do statistical analyses, purify a protein, or clone a gene, I think that most of us would long ago have lost the consuming enthusiasm for science that characterizes our work.

There is a much broader, all-encompassing approach to science that constitutes the true scientific spirit. And it is in fact the instilling and nurturing of this spirit in our students and fellows that constitutes perhaps the most important opportunity that we will have to have an impact on their careers.

The true spirit of science concerns an attitude or approach to scientific investigations that inspires, pervades, and permeates the entire enterprise. I would like to focus for a few moments on three elements of this scientific spirit: enthusiasm, creativity, and integrity. Let me begin with enthusiasm.

Of the various misconceptions people have about scientists, one popular one is that we are a rather dull lot: dry, pedantic, aloof, and largely devoid of temperament or emotion. Quite a contrast with popular stereotypes of, for example, artists of various kinds who may be perceived as much livelier, more colorful, and certainly more high spirited. However, the genesis of what we do derives from much the same wellspring as that of the artist (1). Simply stated, it is a keenly felt sense of wonder and curiosity that translates into a genuine enthusiasm for even the faintest glimpses of new understanding. The word enthusiasm is derived from the Greek and literally means "a god within." And so it is, since true enthusiasm for what we

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do, a real passion for new knowledge, is an empowering trait. It confers the ability, or rather the willingness, to tackle difficult and challenging problems. Moreover, it is extremely infectious and likely to be contracted by most people around you, many of whom then become focused on the same problems with which you are engaged.

A second aspect of the scientific spirit relates to some of the deepest sources of our creativity: sources that must be encouraged in our students. I am referring here to such items as the cultivation of the intuitive side of our natures and of a receptivity or openness to the occasional gifts of discovery that go under the heading of serendipity or luck. By intuition, I am referring to those spontaneously occurring flashes of insight or knowledge, independent of any obvious reasoning or learning process that we all experience from time to time (2). Again in this regard, we are often unfairly stereotyped as polar opposites of those in the creative arts. Whereas they are thought to highly prize intuition, we scientists presumably have little use for it and rely only on the rigorous application of the scientific method and cool, clear-headed logic. Please do not misunderstand my point. I am not suggesting we retreat from rationality and a reasoned approach to our investigations. I can't imagine a successful pursuit of our goals if we did. Rather, I am suggesting that one of the unexpected and wonderful realizations of the novice investigator should be the extent to which our intuitions can importantly contribute to our science. When it comes to making creative scientific discoveries, imagination is perhaps more important than knowledge.

Most of our institutions, granting agencies, educational processes, and the like are highly skewed toward the rational ideal and the role of intuition is rarely even acknowledged. But an easy and comfortable relationship with those irrational or creative intuitions that we all occasionally have can greatly expand our scientific horizons. We need to acknowledge them as they occur and shape our daily practice of science. We need to encourage their expression, especially in our youngest colleagues. It is, in fact, from the fresh minds of our least experienced students and fellows, who are unencumbered by the dogmas and paradigms of our particular fields, that the most innovative and intuitive ideas are likely to spring, for it is they who are most likely to question assumptions that we have long ago accepted.

And what about serendipity or luck? Interesting, isn't it, that the most talented and successful investigators are often referred to by their colleagues as the luckiest. What an intriguing misconception. Luck in science is little more than the cumulative effects of intuition, creativity, and serendipity.

Serendipity is the gift of finding valuable things that are not specifically sought. But of course, the key is in recognizing them for what they are. Serendipitous events occur to all of us and presumably with a fairly constant frequency. What varies is the frequency with which we recognize such gifts. The "failed" experiment or the completely unexpected finding, viewed in the right light, often provides the key clue to an important discovery. But how often is it just cast aside because it doesn't agree with our expectations, or isn't what we think we wanted?

How do we acquire a taste for recognizing or appreciating these wonderful gifts? How do we develop such a sense in our students? As with so many other aspects of the scientific spirit, it's all a matter of attitude. If we get up most days with the optimistic expectation that something good is going to happen, we're much more likely to recognize it when it does, since we were basically waiting for it anyway. Better to anticipate miracles than disasters.

There are other attitudes and behaviors that encourage the recognition of serendipity and the flow of intuition. Humor and playfulness are two examples. A frequently exercised sense of humor favors the kind of wild, occasionally illogical or offbeat leaps that are part and parcel of the creative process. Seeing a joke often requires shifting one's frame of reference, which is also an important aspect of intuition. Playfulness and a sense of not taking ourselves too seriously also favor a certain freedom of the imagination that encourages conceptual innovation. Many of us tend to be quite informal in the laboratory and such informality may also encourage the expression of intuitive ideas. Obviously, the aggregate of these various elements constitutes an attitude or approach to science. It can be developed and nurtured, but only by day-to-day example.

I would like to turn now to another essential element of the scientific spirit, integrity. If intuition and serendipity are the sparks that ignite the fire of scientific discovery, and enthusiam fans the blaze, then it is integrity that provides the bricks that keep the fire from burning out of control and focus the resultant energy in a productive manner. By integrity, most of us mean an unswerving commitment to what we perceive as true and right, and to a set of consistent, personally realized principles of action.

On several occasions in recent years our senses have been assaulted by reports of fabricated data and fraud. In 1982, Phil Majerus directed his Presidential Address to the issue of fraud in science (3). Thankfully, examples of such behavior appear to be rare indeed. However, it is not over the issue of truth vs. blatant falsehood that our integrity is most likely to be compromised. It is rather in the realm of a whole series of more subtle corruptions that integrity may be tested. Let me provide a few examples.

Fraud takes several forms. The first and most obvious is the substitution of falsehood for truth. But another is simply selective withholding of truth. In science, this may take the form of selection of some data for presentation or analysis and elimination of others. Surely we have all examined results of individual experiments so technically flawed that their results cannot be used. But the temptation to exclude experiments that do not conform to expected results for inappropriate reasons is an example of one of the many subtle tests of integrity to which all investigators are regularly subjected. As in other aspects of our lives, withholding or rejecting information is occasionally justified. But the criteria for such decisions must be carefully examined and rigorously applied.

There are numerous other abuses of integrity. A common one is the purveying of bullshit. Notwithstanding the contrary opinion of some in this room, I claim no special expertise in this area. However, Harry Frankfurt, Chairman of the Department of Philosophy at Yale, has recently considered the subject in an essay entitled "On Bullshit" (4). He points out that, whereas lying involves falsity, bullshit involves fakery: it is essentially phony rather than false. Bullshit may or may not be false as well. What marks it as bullshit is that it has been constructed with absolutely no regard for its truth or falseness. Examples unfortunately abound. A scientist may claim credit for work and ideas he has appropriated from others. The data he then reports may still be true, but they are essentially counterfeit. Some mislead without specifically lying by obfuscating

the truth or by hyperbole. We can all think of examples we have encountered. In a sense, these bullshitters are even greater enemies of the truth than liars. At least the liar is guided by the truth, for to lie he must first define what he takes to be the truth. Not so the bullshitter. He pays no attention at all to the truth. Overindulgence in bullshit thus ultimately tends to corrupt the most fundamental aspect of the scientific process, the founding of conclusions on accurate and appropriate data. Despite my earlier comments about some of the overlaps between science and art, the nature of bullshit is so antithetical to both the spirit and method of science that those who regularly and skillfully engage in its production are generally referred to, even within scientific circles, as bullshit artists.

Our integrity is also tested every time we participate in decisions regarding authorship of scientific papers. Again, we need to have a clearly articulated set of principles that we conscientiously apply. Even then, there are often difficult choices to be made. It's hard to understand why one would wish to coauthor a paper when one's intellectual and/or technical input have been trivial or when one's role has been "an administrative one." How sad that scientists who would never dream of falsifying their own data are more than happy to falsify the record of scientific discovery by demanding that their names adorn papers inappropriately.

There are other ways in which integrity shapes our careers. A very important one concerns our global approach to the central issue of what scientific questions we ask and what areas or topics we choose to work on. Most of us apparently share a common goal in this regard. We aspire to develop, over time, a significant, perhaps even important, body of research that approaches an interrelated set of scientific questions relevant to human physiology or disease. We realize that this takes time and that in the book of investigations we are each painstakingly putting together, there will be many chapters. Nonetheless, we anticipate that when the last chapter is done it will be possible to discern, without much difficulty, a consistent and coherent set of themes and motifs throughout the work and to understand how and why we got from here to there.

But occasionally, these intentions go awry. I have realized this as I have sifted through many hundreds of dossiers of candidates for election to this society over the five years that I have served on its Council. From time to time I have read bibliographies that, to be charitable, can only be referred to as miscellaneous. There is no consistent set of questions or themes: each paper relates to a different subject. Questions are never pursued in any depth. Every year or two the investigator has shifted his allegiance to the latest and trendiest subject in a very opportunistic fashion. The questions pursued are invariably those suggested by the work of others. Such scientists seem like leaves blowing in the wind generated by the ever advancing storm of scientific progress.

But what is truly sad is that these investigators will never know the satisfaction that comes from a period of sustained inquiry into a significant and complex set of scientific problems; or that which derives from having had the courage to pursue a course of inquiry into new terrain requiring new types of technologies; or that which comes from seeking to answer questions uniquely posed by one's own work. In this regard, we are all ultimately forced to come to grips with the realization that we are destined to never come up with the ultimate answers but rather to only be able to progressively refine the questions. In this sense, a mark of our maturity as scientists is our ability to deal with being less and less satisfied with our answers to better and better questions.

The last aspect of integrity I wish to mention concerns our often tested ability to say no. Any modicum of success as an academician gains us immediate entry into such activities as committees, study sections, site visits, symposia, lectureships, and various administrative responsibilities. And of course, we all have a variety of responsibilities to fulfill to a variety of constituencies. But, for as long as we remain active scientists, directing the work of younger colleagues, and coauthoring papers, we must devote sufficient time to the task. And, as we all know, science is never easy and is always time consuming. The only way to preserve sufficient time for the enterprise of science is for us to learn how to say no. We can't do science a couple of afternoons a week, and we can't be there for our students and fellows if we are incessantly chasing around the globe. Granted, some of us can do more than others, and each of us is the best judge of just how much he or she can handle. But for as long as we wish to consider ourselves active scientists, integrity is required to prevent these various activities from so compromising the energies we devote to scientific investigation that they fall below critical level.

There are other reflections about the scientific spirit beyond these few thoughts on enthusiasm, creativity, and integrity that I would like to share. But time is short and I want to spend just a few moments considering how we get the scientific spirit in the first place, and how we keep it alive. The most important mechanism for developing the scientific spirit in fledgling investigators is the mentor. The various and sometimes subtle aspects of how to pursue science that we have been discussing are not learned in class or from studying texts or journals. They require close contact with a role model for a significant period of time. Ironically, these issues are hardly the things that our students or fellows think they have come to our laboratories to learn. But they are ultimately far more important than the more straightforward and mechanical aspects of the scientific method. In this regard, I am often struck by what I consider to be the inappropriate use of the term "training" in the context of laboratory investigation. To me, training is something I've always associated with dogs or monkeys, not scientists.

I don't think it's possible to "train" a scientist. Ultimately, all students or fellows have the responsibility for acquiring the necessary specific skills or techniques from those around them. But it is the special responsibility of the mentor to provide a model for the integrated functioning of the scientific method and spirit in the day-to-day practice of science. In this regard we need to let our guard down a little. We need to let our students share our enthusiasm, let them sense our feeling of expectancy and optimism in the lab or our exhilaration when we are playing out some intuitive or imaginative scientific fantasy. We need to let them in on our difficult scientific decisions, be they about authorship, inclusion of data, or whether to persist with a refractory problem. It is only by sharing such experiences that a mentor can really help to influence those most important aspects of a novice's entire approach to scientific investigation.

That at least some of these attributes, which may contribute to success in science, are transferable is supported by the existence of scientific lineages. I'm sure that many members of this society spent fellowships in laboratories of other members, who in turn were students or fellows with other members.

Evidence of such lineages, which can be found throughout our scientific program, highlights the role of traditions, and in particular of this society and its annual meeting in keeping the scientific spirit alive within us all. In recent years, progressive specialization in both clinical and research activities has threatened the survival of cross-disciplinary societies such as the ASCI. Nonetheless, we continue to flourish and the quality of science on this year's program is again outstanding. Especially in changing times, traditions provide an anchor of stability and a touchstone for important values. As we gather here each year, we share much more than just our latest scientific findings. What goes on in the meeting rooms defines just a part of what is meaningful at these gatherings. For it is in the innumerable encounters of old friends and colleagues that will go on here in the next few days, that perhaps something even more important transpires. It is a subtle process of reaffirmation and rededication to a shared commitment to the pursuit of lofty goals, in the true spirit of science to which this society was originally dedicated eighty years ago.

In discussing today some of the ideals of the scientific spirit to which we all aspire, I have focused on integrity, an openness to intuition and the gifts of serendipity, and the facilitating roles of humor, playfulness, and enthusiasm in the creative process. I'd like to share one last, perhaps obvious, thought. It is that these elements are not unique in their relevance to the scientific process in which we are all engaged. In this sense, the spirit of science is very much part of the spirit of life. If we allow it to pervade all aspects of our personal and professional activities we can reap rich rewards, not the least of which is sharing the experience and the approach with those around us.

Thank you.

References

1. Koestler, A. 1964. The Act of Creation. Dell Publishing Co., Inc., New York. 751 pp.

2. Goldberg, P. 1983. The Intuitive Edge. Jeremy P. Tarcher, Inc., Los Angeles. 241 pp.

3. Majerus, P. 1982. Fraud in medical research. *J. Clin. Invest.* 70:213–217.

4. Frankfurt, H. 1986 (Fall). On bullshit. *Raritan.* 6:81–100.