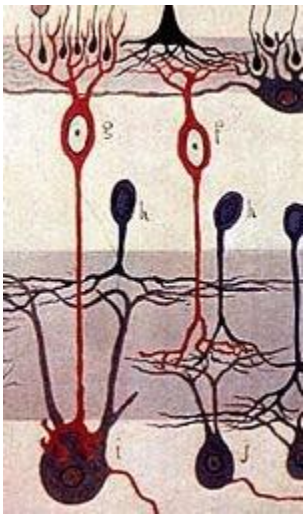
Identifying and Training Creative Scientists

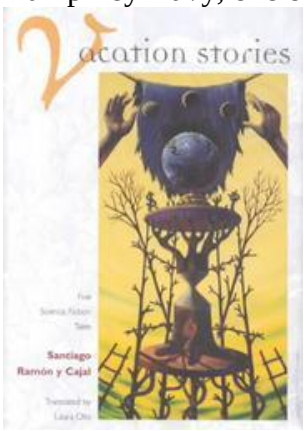
Nurturing creativity in science takes breadth of training.
Published on March 23, 2009 by Michele and Robert Root-Bernstein in Imagine That!



How do you search for scientific talent? What criteria should you use? IQ scores? High scores on math and science tests? Precocity in a scientific field? Some of the best scientists recommend looking for breadth of skills and talents in a variety of endeavors beyond the sciences.

In two previous posts, we argue that training in the arts benefits scientists in a variety of different ways. The best scientists are much more likely to be artists, musicians, actors, craftsmen, and writers than are typical scientists, or even the general public. Scientists draw skills, knowledge, processes, concepts, and even inspiration from their non-scientific avocations. Many are well aware of these advantages.

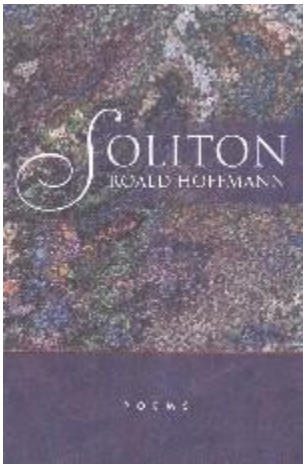
Perhaps the first scientist to recognize a correlation between scientific talent and non-scientific pursuits was Jacobus Henricus van't Hoff, a Dutch scientist who won the first Nobel Prize in Chemistry. Van't Hoff invented the field of stereochemistry (the study of atomic shapes); co-invented the field of physical chemistry; founded geochemistry; and helped to create the new field of history of science. In addition, he was a talented flautist, wrote poetry in four languages, and was a reasonable amateur artist. In 1878, twenty-one years before he received his Nobel Prize, he gave a lecture on "Imagination in Science" in which he argued (after having read some 200 scientific biographies) that the greatest scientists almost invariably display their imagination in non-scientific fields as well. Examples he cited included Galileo, also an artist, craftsman, musician, and writer; the astronomer Kepler, also a musician who described planetary motion as the "music of the spheres;"and Sir Humphrey Davy, one of the founders of modern chemistry, and also a poet praised by the likes of Coleridge.(1)



Santiago Ramón y Cajal, another early Nobel laureate (1906), also believed that the most creative scientists are broadly trained. One of the founders of neuroanatomy, Ramón y Cajal took time to practice gymnastics, to paint, to produce the first color photographs taken in Spain and start up a photographic supply company, and to write science fiction. (That's his drawing of nerves of the eye, above, and his *Vacation Stories*, right.) When it came to recruiting students, he rejected those focused solely on their science. "The far-sighted teacher," he argued, "will prefer those students who are somewhat headstrong, contemptuous of first place, insensible to the inducements of vanity, and who being endowed with an abundance of restless imagination, spend their energy in the pursuit of literature, art, philosophy, and all the recreations of mind and body. To him who observes them from afar, it appears as though they are scattering and dissipating their energies, while in reality, they are channeling and strengthening them..."(2)

We must admit, since Cajal made this assessment of scientific talent knowledge has grown exponentially. Specialization, is it argued, is required for mastery of ever more deeply plowed fields. Nevertheless, recent Nobel laureates continue to repeat the mantra that scientific creativity *within* those fields draws sustenance from breadth *beyond* those fields. Donald Cram, a Nobel prizewinning chemist, craftsman, artist, poet and musician, said that "I have a tendency to use my hands and I also have a tendency to use my intellect. Well the sciences are a great way of combining these operations.... My concept of the ideal [scientist] is that you do one thing real well... and then you do a lot of other things, but not too many, maybe 4 or 6 or 10 different other things, which you do well enough to give yourself and possibly others pleasure. This should be distributed quite widely among sports and artistic things and carpentry and things that involve using your hands and a little music perhaps and things of that sort."(3) Peter Mitchell, another recent laureate in Chemistry (1978), agreed. "Most [scientists] who try to be creative..." he wrote, "have found that they've got to become craftspeople as well as art people."(4) Mitchell attributed his most important discovery to a third profound interest: the study of philosophy caused him to rethink the fundamental assumptions of modern biology, leading directly to his revolutionary experiments on the way energy is utilized by cells.

What's going on here? Why do so many leading scientists insist on paradoxically "scattering" and "channeling" their energies? The fact is that novel ideas, in science as well as in every other discipline, come from combining diverse and often disparate sources of problems, skills, knowledge, and methods. The most creative scientists recognize this fact and exploit it by integrating a wide range of interests. But some other purpose is also in play. The best scientists are also the best communicators, for novel and original ideas must be articulated and "sold" to a skeptical scientific community.



In this venture, skills learned beyond the sciences become invaluable. Nobel Prizewinning chemist Roald Hoffmann, for example, is also a professional poet: "I write poetry to penetrate the world around me, and to comprehend my reactions to it...." Likewise in his chemistry. "By being a natural language under tension," he says, "the language of science is inherently poetic."(5) Similarly, William D. Phillips, who won the Nobel Prize in Physics in 1997, writes that, "In high school, I enjoyed and profited from well-taught science and math

classes, but in retrospect, I can see that the classes that emphasized language and writing skills were just as important for the development of my scientific career as were science and math. I certainly feel that my high school involvement in debating competitions helped me later to give better scientific talks, that the classes in writing style helped me to write better papers, and the study of French greatly enhanced the tremendously fruitful collaboration I was to have with [a French] research group."(6)

In return to our original question, how should we go about identifying and fostering scientific talent, especially creative scientific talent, in our students? If van't Hoff, Ramón y Cajal, Cram, Mitchell, Hoffmann and Phillips are right, the standard approaches aren't going to work. Nobel prizewinners are rarely the best academic students. They do not have IQs that are any higher than those of scientists overall. They don't test higher on other standardized tests. They DO bring a much wider range of skills, knowledge, talents, and methods to their work.

So instead of looking for scientific and mathematical prodigies (however we choose to define these) and funneling them into early scientific specialization, we should be doing the opposite. As Cajal put it, we should be looking for and nurturing a "happy combination of attributes: an artistic temperament which impels [the student] to search for and [admire...] the number, beauty, and harmony of things."(2) We should give our science students the broadest possible education in arts, crafts, writing, philosophy, and everything else that makes us fully human.

This is not a new conclusion. In a report commissioned by the U. K. Royal Society in 1942, Nobel Prizewinning physicist William Lawrence Bragg concluded that "[t]he training of our physicists is literally too academic."(7) Bragg recommended a good dose of crafts in school and a wide range of hobbies at home. So do so many of our most successful scientists. Why, then, does our education system persist in earlier and earlier specialization when it is clear that increasing breadth fosters scientific creativity?

References

1. Van't Hoff, J.H. (1967). Imagination in science. (Springer, G.F. transl.). Molecular Biology, Biochemistry and Biophysics, 1, 1-18.

2. Ramon y Cajal, S. (1951). Precepts and counsels on scientific investigation: Stimulants of the spirit. (Sanchez-Perez, J.M., trans.). Mountain View, CA: Pacific Press Publishing Association, pp. 170-171).

3. Cited in Root-Bernstein RS, Bernstein M, Garnier H. (1998) Correlations between avocations, scientific style, work habits, and professional impact of scientists. Creativity Research Journal, 8 (2): 115-137, p. 126.

4. Wolpert, L. & Richards, A. (Eds). (1997). Passionate minds. Oxford, England: Oxford University Press.

5. Hoffmann, Roald. (1988, March). How I work as poet and scientist. The Scientist, 21, p. 10.

6. William D. Phillips. Autobiography. Retrieved March 23. 2009 from http://nobelprize.org/nobel_prizes/physics/laureates/1997/phillip...

7. Bragg, W. L. (1942) Physicists after the war. Nature 150, 75-79.