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Editorial

The Temin Effect

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Many years ago, one of us (M.G.) interviewed the biologist Howard Temin. Temin had just won the Nobel Prize for his work on the discovery of reverse transcriptase—the class of enzymes capable of creating DNA from a RNA template—and he was an unforgettable figure. He had a wiry shock of hair and a wry smile. He was raised by activist parents in Philadelphia. His bar mitzvah money was donated to a refugee camp. His valedictory address in high school was about the hydrogen bomb. He had read deeply about philosophy and literature, and during the interview he spent as much time, brilliantly, in the larger world of ideas as he did talking about his own work in molecular biology.

We observe, of people like Temin, that they know a great many things beyond their field. But in the use of that word "beyond" is an assumption—that knowledge of literature and philosophy lies outside the domain of the scientist. Why do we assume that? The discovery of reverse transcriptase was a challenge to a tenet of modern biology so hallowed it was actually called "the central dogma": genetic information flows from DNA to RNA and from there is encoded in proteins. Temin argued it could also flow in the opposite direction—a claim that was treated with derision. To imagine a possibility so heretical required imagination. It required a paradoxical turn of mind. It was, in a way, an observation born as much of a literary sensibility as a scientific one. Temin's wide interests were not extraneous to his scientific pursuits. A case can be made that they were in the *service* of his scientific pursuits.

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In this issue, Gurwin et al[1] (see page 8) attempt to verify what we might (whimsically) call the "Temin effect." A group of medical students at the University of Pennsylvania were given six 90-minute training sessions at the Philadelphia Museum of Art. There they were taught, as art history students have been taught for centuries, how to *look* at art: how to observe and describe and discuss works of imagination. The question was, would lessons in a field far from their own make them better at the observational and diagnostic skills that lie at the core of ophthalmology? And the answer is that it did, substantially. Taking would-be physicians out of the hospital and into a museum—taking them out of their own world and into a different one—made them better physicians.

The scope of the study by Gurwin et al[1] is quite narrow: 36 medical students randomized in a treatment and control group. But the implications of the study are not. The prevailing trend in medicine—and in many other complex domains—has been toward greater and greater specialization in training. Cardiologists were once experts in all of the heart. Today, the field has been sliced into small pieces: Some cardiologists focus only on cardiac valves, with the rest of the organ—the coronary arteries, cardiac muscle, and the heart's electricity—left to others. Similarly, the IMG tennis academy in Bradenton, Florida, perhaps the most famous breeding ground for elite players in the world, begins its residential training program at the pre-kindergarten level. The tennis-playing adolescent has become the tennis-playing toddler. Tennis and cardiology and any number of other disciplines have responded to the increasing technical and informational demands of the modern age with *focus*: To be a great tennis player, the belief is, you have to play lots and lots of tennis.

But Gurwin et al[1] remind us that that position may conflate 2 very different principles. To be a great tennis player, clearly, requires lots and lots of preparation. But where is it written that that preparation needs to take place exclusively on the court?

Consider that scientists in the United States have about the same number of hobbies as members of the general public. But scientists inducted into national academies tend to have more. Nobel laureates have more still. Nobelists are at least 22 times more likely to partake in serious hobbies apparently unrelated to their work,[2] and those hobbies are particularly likely to involve serious aesthetic interests. More accomplished researchers have what a creativity researcher called "networks of enterprises," and when they approach difficult problems, they draw on analogies from one enterprise to inform another. As Santiago Ramon y Cajal,[3] the father of modern neuroscience, explained it, "To him who observes them from afar, it appears as though they are scattering and dissipating their energies, while in reality they are challenging and strengthening them." If, as Ramon y Cajal[3] suggested, it is not merely despite this time and energy apparently off task that they are able to hone their skills, but because of it, there may be a vast unexplored world of potential cross-training opportunities, of the sort described in the current issue by Gurwin et al.[1]

Temin's intellectual forebears, the actual, heretical Renaissance men, provide proof of concept. Where his contemporaries looked at the moon and saw a perfectly smooth, divine sphere, Galileo recognized shades of dark and light for what they were: mountains and craters. Why?

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He was trained as an artist and was well practiced at depicting 3-dimensional figures in various light conditions. As the science historian Mark Peterson wrote in his book *Galileo's Muse*,[4] Galileo's genius was built, in part, on his grounding in the arts: "It seems plausible, and perhaps almost obvious, that someone who is trained to see, and who thinks about the process of seeing, sees more and sees better."

That sort of preparation, Gurwin et al[1] argue, is what is missing in ophthalmology. "Observation and description are critical to the practice of medicine," they write. But they point out that physical examination courses in medical school generally focus on memorization of clinical signs, without regard to developing the underlying skill of observation. Cognitive psychologists have repeatedly shown that this variety of teaching will not lead students to develop broadly applicable skills that will serve them for a lifetime.[5] It will, instead, lead to a reliance on algorithmic rules for familiar situations. And algorithms, of course, are *algorithmic:* wonderful so long as they are facing a problem they have seen exactly before, and terrible when confronted with a novel situation. "Interestingly, we noted a decline in the overall score of the control group," the authors write, in one of the most intriguing (and troubling) moments in the article. Without a foundation in the basic skills of observation, further medical training may have the effect of *eroding* the skills of the would-be ophthalmologists.

Is this evidence of pedagogical negligence on the part of medical education? That is much too harsh. What we are witnessing here is in all likelihood a structural issue: There are simply practical limits to what or how much any one discipline can teach its students. Temin's love of paradox could *only* have come from literature. Similarly, the point made by Gurwin et al[1] is that sometimes medical students just need to leave the hospital and walk down the street to the museum.

This idea is not entirely new. The world of elite sports embraced the concept of cross-training many years ago. But one of the (many) thoughts prompted by the study in question is whether we have been too tentative in exploring the potential benefits of cross-disciplinary preparation. Tennis players at the IMG academy will occasionally, for example, repair to the gym, where they will squat and stretch and lift. But this is training that is different in degree from the athlete's primary activity—not in kind. Continuous improvement requires the ability to introspect about performance. It requires the capacity for self-analysis, a willingness to accept and respond to criticism. These are skills of character, psychology, and cognition. "He never learned how to play within the system," the National Basketball Association coach will sometimes say, wearily, of a player who never lived up to his potential. But maybe that is because the best place to learn to play within the system of professional basketball is away from the basketball court. Do those students at the IMG academy, tethered to their rackets from the age of 5 and 6 years, need to spend more time debating the classics in literature class?

We are back, admittedly, to being whimsical. But there are plenty more concrete questions raised by this line of inquiry. How long will the improved observational skills demonstrated by Gurwin et al[1] persist beyond the training period? Could additional or different kinds of training lead to larger improvements? Are there other nonmedical institutions a medical student might profitably visit in the course of his or her training? "After just the first session, I found myself listening to a radiologist discuss the same principles we used to look at art in analyzing a CT scan," one of the subjects in the study by Gurwin et al[1] is quoted as saying. It is a good thing to see "art" in the same sentence as "radiology." A medical expert is rightfully concerned with the particular and narrow aspects of their specialty. But as Temin and Gurwin et al[1] remind us, the best expert is the one who also belongs to the wider world.

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