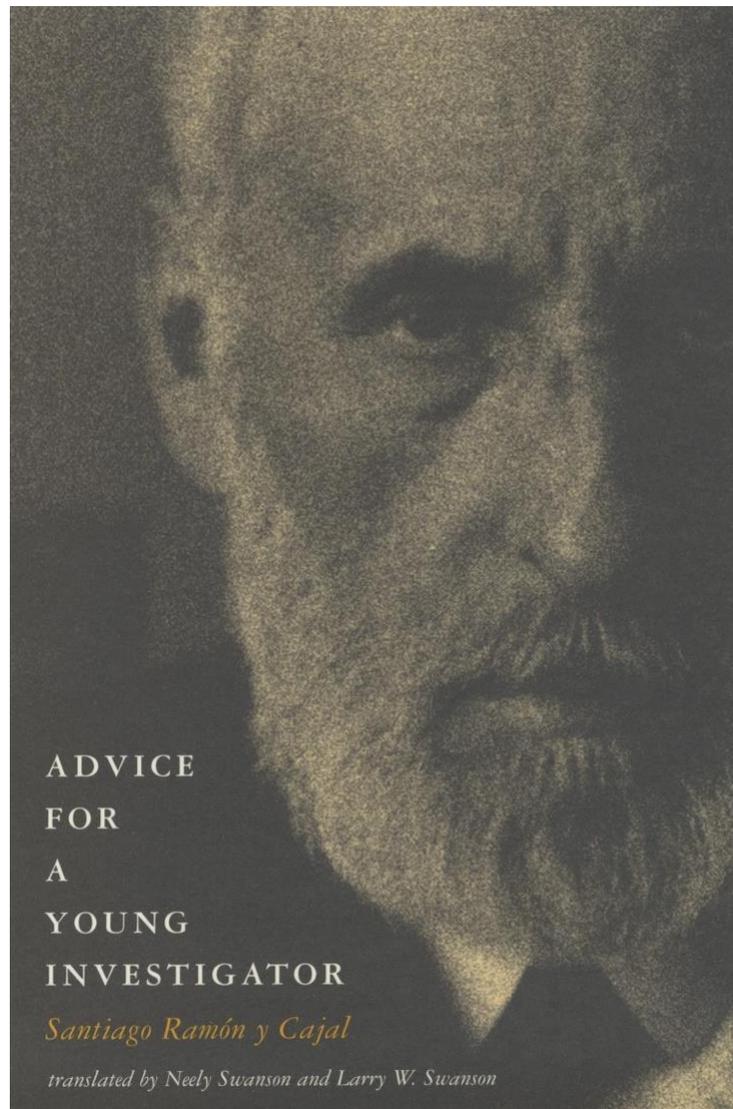


Santiago Ramón y Cajal's Advice for a Young Investigator

Review by Michael Anderson, Ph.D.



Editor's Note: Santiago Ramón y Cajal, a mythic figure in science and recognized as the father of modern anatomy and neurobiology, was largely responsible for the modern conception of the brain. The first to publish on the nervous system, he sought to educate the novice scientist about how he thought science should be done. We asked an accomplished young investigator to take a fresh look at this recently rediscovered classic, first published in 1897.

Santiago Ramón y Cajal's *Advice for a Young Investigator* might more accurately be titled *Advice for a Young Provincial Investigator*. Cajal, a renowned neuroanatomist who remains Spain's only Nobel Laureate in the sciences, wrote this and essentially all his works in turn of the century Madrid, and he acutely felt his distance from the capitals of European science. Paradoxically, however, this may well make the work *more* relevant to the young investigator in the globalized, interconnected world of today, for many obstacles to success are timeless struggles of the soul, and most of us are provincial in one sense or another. So, if you have just been elected a Junior Fellow of the Harvard Society of Fellows or have been anointed as brilliant, congratulations! There is little of use to you here. But if, like the vast majority, you hail from a rural university, a small liberal arts college, an underfunded hospital, or, yes, a struggling nation, then *Advice*, if not required reading, will at the very least repay the two afternoons it will take to absorb.

What is the advice of *Advice*? I distill seven themes, below, but I'll also note that one of his important instructions is to learn from, but never trust, the work of commentators. I endorse that caveat; what will resonate in this rich volume will necessarily differ for each of its readers.

1. The only thing in your power is your preparation

The role of chance in science is as undeniable as it is irreducible. You can do nothing to ensure success; there are no logical rules of discovery. But you can prepare yourself, and you *must*, so that when the unexpected finding, or odd phenomenon, or technological breakthrough occurs, it can be you who is best equipped to grasp its significance. Preparing means mastering bodies of knowledge and techniques known to be relevant, but also—and here I borrow not from *Advice* but from Cajal's remarkable biography—recognizing that sometimes knowledge and skills acquired from the necessity of circumstance will prove critical. So it was for Cajal, who, initially indifferent to medicine and needing a trade, was apprenticed to a barber. This granted such dexterity with a razor that when he finally came to the study of anatomy, his histological preparations were unusually skillful, enabling him able to see neural structures with exceptional clarity.

2. Be suspicious of "brilliance"

This theme is really a corollary of the first, but leads to a different moral. Brilliance is mastery of skills and knowledge known to be important. It of course often leads to opportunity and success.

But undue focus on this quality can engender worship of yesterday's abilities and insights, and this can hold individuals—indeed, entire fields—back. Never let perceived lack of ability limit you—*especially* when it's a self-perception. "Lack of ability" may simply be a set of skills waiting for its moment. Science needs a variety of minds. Besides, as Cajal writes, "work substitutes for talent, or better...it *creates talent*." The scientist's single most important virtue is perseverance.

3. Be appropriately respectful of authority, but no more

No theory, no method, and no experimental paradigm is perfect. Do not defend or dismiss the errors of your teachers; use them to identify new problems to solve.

4. Balance concentration and relaxation

Finding the time and space for extended and total concentration on a problem is vital. On these occasions shut out everything inessential: email, Facebook, politics. But when progress stalls after sustained and serious concentration, take a vacation. Plant a garden! The intellect thrives on a balanced combination of work and refreshment.

5. Don't worry about what it's good for

All scientific findings are useful, eventually. The call to specify in advance the use of an investigation represents a lack of faith in the scientific enterprise, and of necessity limits creativity. Cajal lists a dozen phenomena that, had we waited to know what they might be good for before investigating further, would never have been good for anything at all, and we would now lack such tools as batteries, photography, and x-rays. Good science makes for good application, not the other way around. Are you listening, National Science Foundation?

6. Favor independence over resources

When access to money, tools, or space would come at the cost of your autonomy, choose autonomy. Successful science can be pursued on any scale, but freedom of thought is non-negotiable. This may seem naïve in the age of Big Science, but it reflects my own experience. My most important work was begun as an unfunded side-project, and came to fruition in the lightly-subsidized lab of a small liberal arts college. My investigations were tailored to what undergraduate assistants could manage and, when I couldn't afford to generate my own data, I borrowed the data of others. You may object that such advice is hardly the basis for a universal principle: those data

took money to produce, just not my own. True enough. But this is advice to the *young* investigator. As the young mature, some will be successful enough to direct the large, well-funded projects that will produce the data, and miss the problems that will allow the next young investigators to move decisively beyond them.

7. Embrace scientific panglossianism

This is the very best time to be a scientist. So was last century. And so will be the next. For there are no small problems in science, only phenomena so incompletely understood as to seem so. In science, notes Cajal (quoting Geoffroy Saint-Hilaire), “the infinite is always before us.”

There is much more to this book than this sampling captures, including advice to the teacher, and even for choosing a life partner. That Cajal would think to include this latter is endearing, and, although his discussion is choked with objectionable stereotypes, the attempt reflects the positive and affirming thought that science is part of life, and should ideally be made seamless with it.

One of the strengths of *Advice* is its refusal to accept obstacles as excuses. This pull-yourself-up-by-your-bootstraps attitude will not please everyone—this is decidedly *not* a work of activism. (No bootstraps? Guess you’ll need to make some first. No leather? How about twine?) But it is what gives the book its utility to the young investigator needing to make his or her way in their particular time, place, and situation. And the attitude is inspiring, in its way. Cajal was acutely aware not just of Spain’s physical, but also *cultural* distance from the great scientific centers of the world, and his call for Spain to acknowledge and repay its accruing “debt to civilization” has a Kennedy-esque ring. His book is intended in part, I think, as a reminder that those in a position to contribute to the advance of scientific knowledge, in whatever way and to whatever degree their situations and abilities allow, have a sacred obligation to do so.

And Cajal does mean sacred. It may be that the spiritual attitude that suffuses the book embodies the most important advice in *Advice*. Science is not just a collection of techniques or strategies for producing knowledge, it is an ethical stance of commitment to the truth. The good scientist knows that honestly following the evidence is a form of respect for nature, and honestly communicating one’s findings is a form of respect for others. Recognizing the fallibility of both experiment and reason brings humility, and also charity. Knowing that ultimately science only progresses in collaboration builds community. Acknowledging the ways that science and scientists serially fail to

embody these virtues does nothing to lessen their importance or authority. His advice in the face of failure is simple: keep trying.

Bio

Michael L. Anderson, Ph.D., is associate professor of psychology at Franklin and Marshall College. His latest book, *After Phrenology: Neural Reuse and the Interactive Brain* (MIT Press), outlines a novel framework for understanding the evolution and functional organization of the brain. Anderson earned a B.S. in premedical studies from the University of Notre Dame, a Ph.D. in philosophy from Yale University, and did his post-doctoral training in computer science at the University of Maryland, College Park. He was a 2012-13 Fellow at the Center for Advanced Study in the Behavioral Sciences, at Stanford University.