How to Be a Graduate Advisee

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Successful graduate training benefits from committed mentors and motivated students. Because scientific research involves investigating unexplored territory, however, each student's experience will necessarily be unique, making it rarely possible to conform to an idealized training sequence. To approach this inherently uncontrolled situation constructively, students are encouraged, first, to become aware of their own learning patterns and to apply this knowledge to selecting a thesis laboratory, and second, to cultivate an educational philosophy that helps them adapt to many circumstances.

Graduate school is an intellectual adventure. Like all adventures, it turns out more satisfactorily for some people than for others. A key determinant of the doctoral experience is the research laboratory in which each student conducts his or her thesis research. On this topic, sensible and thoughtful advice on the selection of a graduate advisor can be found in a recent essay by Ben Barres (2013), which enumerates many traits typical of good graduate mentors.

A complementary idea is the explicit acknowledgment that the same kind of mentoring does not work for everyone. My own impression is that the most effective action that beginning graduate students—or any other trainees—can take, before evaluating individual mentors according to any external criteria, is to engage in *self*-examination about how they learn best. Do they work well in an environment with resources available for the plucking, but that does not require weekly reporting of accomplishments to a supervisor? If so, perhaps a larger or more established laboratory, with a P.I. who checks in only occasionally, would suit. Or do they prefer daily one-on-one interactions with a boss who is intimately involved in the project and who personally teaches them how to execute techniques and design experiments? If so, perhaps a smaller or younger lab would be ideal, in which it is important to the P.I. that experiments succeed according to a plan in a grant proposal. An accurate self-assessment by the trainee can resolve the paradox that one person's neglect can be another's freedom and that one person's micromanagement can be another's nurturing. Barring the extremes, most problems arise not because specific P.I.s are intrinsically poor mentors, but because the training style of lab head and student do not match.

Today's overt discussions of ideal mentoring techniques are invaluable to combat the real abuses that can occur. Nevertheless, they run the risk of pushing both faculty and trainees into formulaic approaches to the apprenticeship of scientific training, whose diversity is precisely what drives the engines of creativity and discovery. Great science is done by a startling variety of personalities. Many fine researchers amuse each other with the unorthodox and often bizarre stories of their own training, which they somehow endured and learned from, even as several of their fellow trainees fled the field. The useful question to ask is not so much whether the trainers were at fault, but what it was in the survivors' character that permitted them to succeed in those instances where others failed. Were they aggressive? Submissive? Did they have a sense of humor about difficult situations? Did strong criticism roll off their backs? Did they connect particularly well with prickly personality types? Did they put their heads down and produce results that the P.I. could not resist? Did they seek personal mentorship from others and use the P.I. for a scientific relationship of convenience? Or did they have the sense and courage to walk away from an environment to which adaptation was impossible, and begin again? The answers will likely be different for different P.I.s and for different trainees. Those of us who care about scientific training should encourage students and postdocs to turn the microscope on themselves and study their own strengths, their own weaknesses, their own aspirations. By doing so, they can transform their "instincts"—the wordless recognition of a reality—into articulated judgments that they can trust, thereby steering themselves into environments in which they will thrive. If they do so, the scientific enterprise will thrive, too.

Achieving an awareness of one's own learning style and preference is only a single component of an effective education. Once one has found a laboratory, an equally valuable component is refining techniques to observe, approach, and interpret the transformations that one is undergoing as a trainee—in other words, to articulate what is happening to oneself. Over several years of watching scientists develop (including myself), I have assembled a list of ideas that may help those of you who are graduate students perceive yourselves less as passive recipients of education, and more as active individuals proceeding with a sense of self-determinism as you find your place in the scientific community.

On Doing Science

The science you are doing is the real thing. Although many students do not immediately realize it, graduate study is not a lab course, not a summer experience, not an exercise for personal enrichment. You are a real, practicing scientist, albeit a trainee, from day one. Just as an apprentice to a tradesperson contributes to making real products, the work you are doing *is* the science that goes into the journals, forms the fabric of discovery, and drives scientific advance. Take pride and pleasure in the fact that the impact of your thesis project can extend around the world.

Do not *let yourself get accustomed to failure.* Many experiments do not give meaningful or interpretable results the first, second, or even third time, and you may be required to wrestle with a technique for a long time before you get it to work. Nevertheless, every day you should be able to account for what you did: practice articulating for yourself what worked, and what you will do differently tomorrow. The worst thing that can happen to you scientifically is to get used to going into the lab, doing a procedure in a fixed way, getting no useful result, and going home, with the sense that that is all that science is. You *must* see movement on your research, not necessarily as daily data, but as a sense that what you did today gets you closer to an outcome. Stasis is your enemy; movement is your friend.

Don't worry about worrying. One often hears students preparing for exams or presentations say, "I know I shouldn't get nervous," but there is no harm in a little well-placed nervous tension. Anxiety is a liability only if it paralyzes you: if it gets to that point, you certainly must combat it. But a moderate amount of nervousness can be a fuel that prompts you to work hard, solve problems, and get things done. Learn to use the momentum generated by the sense of pressure to propel you into a rigorous preparation for your performance, and remember that the world's best work is done not by complacent, self-satisfied people. It is done by people who feel the challenge (usually in the pits of their stomachs), who recognize the risks and complications that the challenge entails, and who use that awareness to get the job done.

Use your resources. Surprising as it may seem, your advisor doesn't know the answer to your research question. Nor is he or she likely to be withholding information from you about how to advance your project. It is obvious but worth articulating: scientific questions are unlike exam questions; there is no answer key. The nature of research science is that it is uncharted territory, despite what you hear of road maps, so take advantage of everything at your disposal to find the way. Your advisor or other people in your lab may help you get started, but don't expect them to teach you everything explicitly. Accustom yourself to learning by example (or counterexample). Read the literature; attend seminars; participate in journal clubs; check out core facilities and the services they provide. Most importantly, talk about your science with a variety of people—classmates, teachers, committee members, postdocs. You will likely be amazed at how useful information emerges from unexpected sources.

Pay attention to the unusual. If something in your work seems weird, it probably is. If something looks wrong, sounds wrong, smells wrong, something needs attention! The best way to deal with a scientific problem is to anticipate it; the next best is to recognize it and solve it once it exists; the worst is to avoid it. All scientists can tell you the story of something they ignored and later regretted, or something that they paid attention to and then thanked their lucky stars for. My own such story involves examining a peculiar capacitative transient that turned out not to be capacitance at all, and instead was the observation that began my career.

On Advisors and Mentorship

Think of us as your coaches. The premise of graduate school is that you have approached a group of scientists because we have something to teach that you actively want to learn. A natural consequence is that we occasionally must correct you—whether we set you straight on a fact, point out that you did a calculation wrong, or explain that your conceptualization of a phenomenon is awry. Accept a language of correction. Remember that those of us who take the time to teach you are on your side, trying to coax you into a deeper understanding of your chosen field. If we were athletics coaches telling you to modify your swing, or music teachers suggesting less vibrato or more bass support, you would likely accept the criticism. You would know that we were trying to help you improve your own performance, so that when you went out in the world, you would show yourself to your best advantage. The same principle applies in graduate school.

Remember that you are interviewing all the time. Other scientists form their opinions of you through your daily interactions with them. Present your best face to them. The way you respond to an unexpected result (a good or bad one), how you ask or answer a question in class, how you present data at a journal club, what you say or do in social situations—all of these create other people's sense of your identity. Small but illustrative interactions are often reported in letters of recommendation, and minor incidents may directly influence other scientists who are evaluating you. For instance, I accepted a student into my lab specifically because of her response to an exam question I had accidentally miswritten so that the arithmetic became rather too lengthy for a timed test. She was the only one in the first-year class to keep her head and work through the whole problem correctly. I found this behavior recommendation enough. She graduated with four published papers, an individual NIH grant, and a baby.)

Cultivate the ability to get inspired. When you see other people excel scientifically—your peers or seniors—you can have several reactions. One is to dismiss those people as extraordinary, perhaps contrasting them with yourself so that you feel dejected or inadequate. A second response is to put those people down by criticizing an unappealing attribute that they have. A third, and perhaps the most constructive, reaction is to look at those people's abilities as something to aspire to. What can you learn from them? What would it take for you to achieve something equivalent? How can you gather clues from their approach to science to make yourself into what you want to be? Inspiration is exceedingly valuable in providing the motivation to keep going when things are tough and in giving you guidance on how to get things done.

A related point is that others' success—those in your program, and especially in your lab—is often contagious. Since research is associated with a lab almost as much as with the individuals who conducted it, you get a modicum of credit for the high-quality work of your lab-mates, and your own achievements likewise reflect well on them. Also, students tend to succeed in packs or clusters, so rejoicing in others' success and helping buoy up your colleagues is both generous and adaptive.

Develop both respect and compassion for your advisor. This pairing may be so startling that it probably bears repeating a few times. Respect, one hopes, should come relatively naturally: it is highly inadvisable to work for someone whose intellect, at least, you do not respect. Of course, you may find, as you get to know your advisor well, that he or she has aspects that you admire, approve of, and understand, as well as character traits that fall into a different category. Such deviations from perfection are typical of most people. You do not have to revere your advisors or even mimic them exactly. You can focus on what they have to offer that you want to master.

As for compassion, think about what your advisors have experienced or overcome to get to the point at which they are, and what they are still grappling with, like any other human beings. Bear in mind that the lab that you are in is a fragile entity that can sink or float, often depending on your contribution. Your advisor, like you, may be subject to anxieties and uncertainties about the future. Is he or she pushing for tenure? Wondering whether the next grant application will be funded? Dealing with a personal crisis like a sick parent or a troubled child? Your advisor is depending on you, just as you are depending on him or her. Think of yourself not as going head to head with this person, but as working with him or her, shoulder to shoulder toward a common goal of getting science done. Ideally, your advisor will be doing the same with you.

On Perspective on the Scientific Life

Hold to your ideals. All institutions (including universities and the broader institution of Science), by their vast inertia, have a way of pushing down on and curbing your ideals. Keep sight of what *you* think science should be. Everyone beginning graduate school or any other new venture is hoping that something good is going to happen to him or her. What is that good thing? Why did *you* decide to become a scientist? It may have been because of the curiosity of learning how brains and bodies work, the desire of contributing to a cure for an illness, or simply the realization that you excelled in science classes and wanted to participate in the discipline. Keep reminding yourself of what good thing *you* hoped for and don't hesitate to work to make your environment into something that has the capacity to fulfill that good.

Maintain your humanity. Long hours and long years with a narrow focus are often stimulating and productive, but on occasion they can become demoralizing. To counteract the downside of long-term focus, set yourself up to use your out-of-lab time as a restorative by using your lab time efficiently. Whenever you are in the lab, make sure that you are making progress—on experiments, analysis, writing, and/or interaction that advances your thinking. Outside of the lab, try to do at least two of the following regularly: participate in the arts, play sports or do other exercise, cultivate friendships outside of lab time, and engage in service to others. These outside activities tend to open and clear your mind, renew your enthusiasm for your work, and help you keep perspective. Science is not—and never will be—a 9-to-5 job, but single-mindedness and humanity are not incompatible.

Become a scholar. Graduate school is about education: the immediate education of learning how to do and think about neuroscience, and the broader education of becoming an informed, logical, and rational thinker who applies a scientific approach to problem solving in all arenas of life. Read, think, and discuss widely. Being a scholar involves learning to reflect deeply before making decisions, evaluating facts and weighing evidence, considering other points of view with minimal bias, and not picking what is gratifying in the moment but selecting what is adaptive in the long run, both for yourself and for others.

Never be afraid to change your mind in the face of new evidence. The frontier of scientific research is dynamic and uncertain—and the sooner one accepts that fact, the better. If your pet hypothesis slides down the drain, it isn't the end of the world. You can be quite sure that nature has solved the riddle in a way that is more beautiful than anything that you or anyone else can invent. Listen to what the data are telling you, even if it is not what you expect. Sometimes your experiments may even reveal the kind of answer that tells you that you must reframe the question. The value of being willing to change your mind pertains to more general issues as well. If you discover that the lab you are in is not a good match for you, don't hesitate to make a change; you will likely thank yourself all your life. Or, if you find that something other than Ph.D. research is a better way for you to offer your skills to the world, do it. If you carry the ability to gather and evaluate evidence logically into other walks of life, you will still be a practicing scientist.

The final point on the list is not an instruction, but a reminder, which is worth reiterating to yourself every year: *Graduate school should be the most fun you ever have.* Understanding this idea requires recognizing that "fun" is not simply entertainment, but the long-term pleasure of learning things that you want to learn, of being paid a stipend to go to school, of making yourself into the educated, reasonable, capable person that you want to be. Working on a scientific project should feel like reading a good novel, so that each day you cannot wait to get back into the lab to find out what happens next. I encourage you to look back every year to see how you have grown from the previous year, and to reflect on the fun of discovery, both scientific and personal; the fun of *becoming* something, of shaping your own brain; and the fun of transforming from a student, full of hope and potential, into a full-fledged, independent scientist.

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REFERENCE

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