

Science AMA Series: We're Neuroscientists coming from academia, government, and the non-profit sector here to discuss Neuroscience training in the 21st century. Ask us anything!

NeuroscienceTraining¹ and r/Science AMAs¹

¹Affiliation not available

April 17, 2023

Abstract

Hi Reddit! We are Drs. Huda Akil, Edda (Floh) Thiels, S. Murray Sherman, Todd Sherer, David Cardozo, and Walter Koroshetz – Neuroscientists who are passionate about rethinking neuroscience graduate and post-graduate training. We recently published a Perspective in Neuron that discuss the training and workforce needs for the neuroscience field in light of the changing scientific and career development landscape. With the launch of the US BRAIN initiative and similar large-scale neuroscience research programs being developed, globally important questions are being raised about whether we're training and developing students and postdocs in the right way to meet the ambitious aims of Neuroscience in the 21st century. We see a need for deeper quantitative, analytical skills and interdisciplinary skills amongst neuroscientists, as well as a more integrative training that better prepares students for careers both inside and outside of the academic system. Neuroscience as a discipline has been changing and growing, with an increasing emphasis on new technologies, more extensive collaborations, and big data increasingly requiring different kinds of experimental and analysis approaches. There are also more interactions at the edges of the field with other disciplines like translational medicine, engineering, and computer science. Students and postdocs, this is about you and your future, and we want to hear from you. What do you see as the key challenges for training and career development for neuroscientists? How do you feel about the vision proposed in the Perspective? Read the full text of the Perspective at Neuron

Huda Akil, Ph.D.: Gardner Quarton Distinguished University Professor of Neuroscience & Psychiatry and Co-Director & Research Professor The Molecular and Behavioral Neuroscience Institute, University of Michigan
Edda (Floh) Thiels, Ph.D.: I am a member of the faculty in Neurobiology at the University of Pittsburgh and a Program Director of the National Science Foundation. I can discuss neuroscience research and training from the perspective of a principal investigator and mentor, as well as training in neuroscience and related disciplines from the perspective of a funding agency.
S. Murray Sherman, Ph.D.: Professor and Chair of the Department of Neurobiology at the University of Chicago. My research involves very basic questions using animal models to investigate the functional organization of the thalamus and cerebral cortex.
Todd Sherer, Ph.D.: Chief Executive Officer, The Michael J Fox Foundation for Parkinson's Research
David Cardozo, Ph.D.: Assistant Professor of Neurobiology, Harvard Medical School. I am attempting to isolate neural stem cells from rat and human tissue.
Walter Koroshetz, M.D.: Director of National Institute of Neurological Disorders and Stroke
We're here from 1:00 pm to 3:00 pm ET (10 am PST, 6 pm UTC) to answer your questions about developing the expertise needed to advance neuroscience in the 21st century! Ask Us Anything!

[REDDIT](#)

Science AMA Series: We're Neuroscientists coming from academia, government, and the non-profit sector here to discuss Neuroscience training in the 21st century. Ask us anything!

NEUROSCIENCETRAINING [R/SCIENCE](#)

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CORRESPONDENCE:

DATE RECEIVED:

Hello, and thanks for doing this AMA! As a neuroscience post-doc, I thought that you made a lot of great points in your Neuron article. In graduate school, I, and many of my fellow grad students, were frustrated by the lack of career guidance from our mentors, particularly with regard to employment opportunities outside of academic research.

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I have two questions:

1. In your opinion, why haven't many advisors/departments (specifically in the life sciences, but I'm sure that this pertains to other disciplines as well) implemented some sort of training to prepare graduate students for careers outside of academia? Mentors know about the prospects of attaining a tenure-track position at a research university - and yet, they train their graduate students for this position, and this position only. Is it hubris? Are they forced to do this because their own success relies on producing other academic researchers? Do they just not care? Do they not have time? Any combination thereof?
2. Related to the first question, what do you think is the best plan moving forward to try and implement some of the solutions that you laid out in your article? Again, I think that you made some really great points, but how do you get advisors to listen? Where's the incentive?

Thanks!

[hhlhhlhl](#)

This is Floh Thiels, one of the authors of the Perspective. You raise important questions. There is growing recognition among training programs that training for careers outside of academia would be very valuable to include in their curricula. A common hurdle faced by programs wishing to implement broader training is that their faculty are not familiar with careers outside of academia and thus do not have the appropriate expertise in-house. Part of the solution will be greater communication among professional sectors, so that the appropriate knowledge can be incorporated into the curricula. It is worth pointing out that several efforts to address the issue of broader training are already underway, such as the Society for Neuroscience's creation of the Neuroscience Training Committee and its initiatives, training opportunities offered by the private sector, and NIH's BEST and NSF's NRT training programs. It takes time, and voices such as yours help move forward the process of expansion.

Hello, and thanks for doing this AMA! As a neuroscience post-doc, I thought that you made a lot of great points in your Neuron article. In graduate school, I, and many of my fellow grad students, were frustrated by the lack of career guidance from our mentors, particularly with regard to employment opportunities outside of academic research.

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Thanks!

[hhlhhlhl](#)

Murray Sherman from the University of Chicago again...My answer to your first question would largely be a repeat of an answer I gave above. Simply put, I believe the basis of PhD training is essential even for jobs outside of academia. In my view we (or at least most of us) train students to be genuine

scientists, and genuine scientists are needed in the many diverse fields beyond academia, even if these students end up in careers that do not involve active research. Regarding your second question... My understanding from talking to many heads of neuroscience programs nationwide is that virtually all of these programs recognize the desire of many students to prepare for careers beyond academia, and many have already undertaken changes to their training to introduce students to these "alternative" careers. This is an ongoing process and we are all waiting to see what will turn out to be best practices for this change. But the great challenge is to do this without seriously diluting the basic scientific training that a PhD represents..

My question is about teaching neuroscience to laypeople.

I'm inspired by TV shows such as Nova and Cosmos and believe they're extremely effective at educating the public about advanced scientific concepts that they otherwise would not understand/take the time to learn about. How can neuroscientists be more effective at translating our complicated research into easily-understood, engaging, and educational fodder for the public?

[loveandrave](#)

Floh Thiels, one of the authors of the Perspective. You are raising an important point. The ability to communicate effectively about your science with the public (including lawmakers) is incredibly valuable. One place where you can learn more about neuroscience outreach and advocacy is at the Society for Neuroscience website (<http://www.sfn.org/>). You could consider honing your skills by engaging in outreach through a SfN chapter or by making it one of the goals of your local neuroscience club. The long-term benefits of communicating about (neuro)science with the public are difficult to overstate. Something to consider for training programs when updating their curricula.

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[loveandrave](#)

Walter from NINDS here. This is a very good point. Neuroscientists have interesting stories and are passionate about their science. Telling those stories in a manner that non-scientists can appreciate just takes practice and feedback. To start --always have an "elevator speech" ready that describes why you are excited about your work.

Hi everyone, thanks for being here! Really interesting perspective (I've only had the chance to briefly skim it) and in some ways it hits fairly close to home for me!

Reading through this, I am curious on your thoughts of what sets Neuroscience training apart from other areas of biomedical sciences? It seems that a lot of these concerns are generally applicable to a broader audience, especially those currently working in biomedical research. Beyond that, they are likely shared by graduate students in almost any field! With more and more students entering graduate education, on [/r/science](#) we see graduate students from every discipline worried about finding academic jobs, if they should post-doc or not, the lengthening time to get degrees, etc.

Personally, I feel that career development is still a huge issue for graduate students, many of which are

considering the private sector due to lack of jobs in academics. Requirements for moving out of academia are largely unknown to a majority of graduate students, and many have no experience working or interacting with the private sector. I see that industry post-docs are mentioned as a possible segue for interested students, but these opportunities seem incredibly limited. Very few positions are available, they are highly selective and often in fairly limited areas of the country.

Ultimately, most graduate students feel a bit of "doom and gloom" about their future career prospects. The positions in academia are obviously in high demand with low supply, and alternative options are not readily available or even presented to many graduate students. How do you see the best way to fix this problem?

Thanks!

[glr123](#)

This is Huda Akil, one of the authors and a neuroscience professor at the U. of Michigan. Great comment! You are correct that many of the issues discussed apply to most areas of the biosciences. In part, we wrote about the field we are most familiar with, but it has the additional feature of attracting a very large number of undergraduate and graduate students. This highlights the need for all of us to think about how to align the various opportunities for them, ensure that this interest is not lost, that it pays off both for them and for the field. Neuroscience also touches more directly on various other areas, such as the social sciences. Finally, while areas such as genetics have long emphasized the usefulness of statistical and probabilistic thinking, neuroscience has not fully incorporated quantitative thinking in its training. Regarding the career development question: A recent paper in Science showed that the doom and gloom are exaggerated-

See: <http://www.sciencemag.org/careers/2016/05/employment-crisis-new-phds-illusion> Nevertheless, you are definitely correct that graduate programs should offer many more options for the students to find their paths outside academia, develop partnerships and experience different opportunities. This is specifically one of the goals of this paper--to encourage training programs to strengthen that aspect and bring more partners to the table.

Thank you for taking the time to do this AMA.

I am a recent PhD graduate in Biomedical Sciences: Medical Physics. I spent the last three years doing research in a Neurology Research laboratory for a major hospital.

Students and postdocs, this is about you and your future, and we want to hear from you. What do you see as the key challenges for training and career development for neuroscientists? How do you feel about the vision proposed in the Perspective?

Quite frankly, I feel like I have no future in the field and that my 11 years of college education were a waste.

- I can't afford to move for a Post-Doc salary, greatly limiting my options for such a position.
- In the private sector, my PhD seems to have made me overqualified for all entry level positions while still lacking the practical experience needed for higher level positions.

I do like some of your suggestions, especially a greater emphasis on programming. I actually did some programming in my degree program, but I was expected to pick it up as I went and it was not part of the curriculum. This should change.

The challenge before us is how to train and retain a talented work force to ensure a bright future both for neuroscience in general and for the individual young scientists entering the field.

I disagree. The challenge isn't in training: it's in the (lack of) value society gives science and scientists.

- There seems to be virtually no demand for scientists in the private sector.
- Public sector scientists are expected to spend a decade in college amassing a huge amount of student loan debt, only to be paid a meager salary as a post-doc (which they could realistically be making as a store manager for McDonald's had they spent the past decade working there instead).
- Once scientists finally have "made it" and become professors or researchers, their job is just as much securing funding from an ever-shrinking pool of grant money as it is doing science.

[therealdoctornick](#)

Hi, this is David Cardozo, one of the authors. In response to your worry about jobs for scientists in the private sector, we've found that there is an ever-growing number of opportunities in fields like intellectual property, biotechnology, policy & regulation (both in the public and private sectors), investment and analysis, consulting, publishing & editing and so on. These opportunities are only going to increase in the coming years.

Thank you for taking the time to do this AMA.

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[therealdoctornick](#)

Walter here from NINDS. Your points are well taken. You may know that NIH funding has come

through some tough times as the budget had been essentially flat between 2003 and 2015. Hopefully that will change as Congress increased NIH funding this year for the first time in a long time. Maybe a good sign that the Senate Appropriation committee recommended another increase in NIH budget for next year. Fingers' crossed that things will improve!!!

While improved training for neuroscientists in data analysis, signal processing, feature extraction, machine learning, programming, etc. would obviously be invaluable, how much focus do you think there should be on collaboration with people from varying fields?

Rather than trying to push neuroscientists all the way over into electrical/computer engineering, it might be more efficient to pull the engineers toward neuroscience, and meet in the middle.

Most of the engineers from my PhD lab don't know much about neuroscience, but can very effectively apply signal processing/machine learning to any appropriate problem if you can lay out the application and communicate with them effectively.

[Pizzadude](#)

Huda Akil-- I think collaboration across fields is absolutely essential. It is in fact one of our recommendations. It is best if each member of the team understands enough about the neighboring field to not only communicate effectively, but exercise critical judgment, suggest other directions, reframe questions. But there is no way we can have both breadth and depth with out working collaboratively.

Do you foresee changes in how training is achieved? From all I hear it seems that a PhD has lost its luster, where you essentially just complete your mentor's work for 5 years on a specific funded project before you get to think for yourself, then you have to do 5 more years of a post-doc, most of which are filled by foreigners who are willing to work the long hours, some of whom get professor positions and some of whom stay as postdocs for a decade or more. Then you finish that and you still probably won't get a professor position unless you can get published in a big journal (which typically involves being on a paper with dozens of authors who each do a tiny part but who all get credit) or unless you get government grant funding (but most of those just go to big established labs and if you have innovative ideas they will just get shot down or stolen by the scientific reviewers with more abundant funding, resources, and experience). It all seems so different from an era of a PhD involving innovative thinking and where you weren't used as free (gov-funded) labor for a decade to help advance a professor's career. Do you think so many foreigners fill these training spots now simply because U.S. students don't want them, or is it because there is an emphasis on giving foreigners a chance with U.S. funded positions?

[biopterin](#)

Huda Akil. I am sure the scenario you paint does happen. But there really are many others. Many of us see the process of granting a PhD as being about helping someone with talent hone their scientific skills, their thinking their taste in science. Our roles as mentors or thesis committee members is to make sure that this process is happening, that the student is maturing and developing his/her own intellectual style. And the goal of being a postdoc is to achieve even greater intellectual independence and scientific mastery. The postdoc period can be a great time in a young scientist's life because they don't have to worry about securing the funding or reaching a specific goal (completing a thesis), but exploring new ideas, developing new tools, seeing new connections. I feel that no great science gets done by turning trainees into automatons. The power of science is to have all the creativity, drive, differing points of views and different minds come together to address challenging questions. It's not always smooth, and some people are of course worrying about their future. But the whole field would

not survive and thrive without this kind of energy.

Hello, thanks for answering questions for us. I have a fairly straightforward question about the funding situation. One thing I hear a lot about as a graduate student is the funding squeeze. Many of my mentors remember the good times where funding was more plentiful in the 90s and seem dismayed at ever more competitive grant scores. Is the current state of funding in the neurosciences comparable to any other period in your careers? Is it likely that we will simply be training fewer neuroscientists in this era or do you think funding will swing back in our favor (perhaps from the private sector)?

[5-HT-3A](#)

This is Huda Akil, and I have been in the field long enough to have seen the various stages. The good old days have not always been that good. Over the years, the funding has gone in waves, up and down and up again. People forget. I am not trying to underestimate the challenges of getting federal research funding, but most people manage it with some perseverance, and even people who have gaps in funding most often get back on their feet. Being part of collaborations is very important to help buffer these oscillations.

Hello. Is the field of computational neuroscience accessible for someone who has a Bachelor's in Physics? Do you have any recommendations what should one read to get an overview of what's happening in the field of comp. neuroscience?

[Yajirobe404](#)

I'm back: Murray Sherman from the University of Chicago. As is the case at many universities, we at Chicago have a PhD specifically in computational neuroscience. Many of our best students arrive with undergraduate majors in mathematics or physics, so I would say you are pretty much in the mainstream for such a career. The challenge, of course, is to get the necessary biology and then neurobiology to move into neuroscience from physics, but most programs, including ours, offers students advice and mechanisms to do just that.

Hello. Is the field of computational neuroscience accessible for someone who has a Bachelor's in Physics? Do you have any recommendations what should one read to get an overview of what's happening in the field of comp. neuroscience?

[Yajirobe404](#)

Floh Thiels, one of the authors and faculty at the University of Pittsburgh. This message is to second Dr. Sherman's answer that PhD programs in Neural Computation or Computational Neuroscience exist throughout the nation (e.g., also at the University of Pittsburgh and Carnegie Mellon University). These programs bring together expertise from the mathematical and physical sciences with expertise in the biological sciences. Additionally, the larger neuroscience training programs typically welcome students with backgrounds in other but related fields. Being trained in multiple disciplines is an asset, for the trainee and the field to which s/he contributes.

Dr. Akil, I used to research in pain and analgesia in the late 80s and early 90s during graduate school and remember seeing your name on many papers I read back then.

Dr. Koroshetz, one of my dearest friends works for you, Paul Scott, and he is a great example of someone who took his academic training and put it to good use in a great job at NIH.

I got my training in experimental physiological psychology (now called "behavioral neuroscience"), and am now working for the IBM Watson Group doing training and research on our Watson AI products. I am also an adjunct at the University of Texas at San Antonio.

I tell my students that their skills in experimental psychology are very valuable in the job market of today and especially tomorrow. The ability to read and summarize information, analyze data, think formally about methods and operational definitions, and present complex topics to anyone, these are skills that have served me well since I transitioned from academia to business.

Students need to learn about the value of NETWORKING, getting to know people outside of their normal circles. That is something that can be taught, as there are very easy ways to go about networking without being annoying or self-defeating.

Another valuable personal trait is to not be afraid to take on new challenges. The best way to do this, I think, is to offer basic training in parallel areas. Teach grad students how to code. Teach them how to do basic consulting skills like doing a gap analysis, writing up user requirements, doing a social network analysis, etc, and teaching them the terms and language from industries or areas that are of interest to them (e.g, healthcare, oil and gas, manufacturing, IT). By doing this, you will give them the basic skills they would use to give them confidence to take on jobs and tasks outside of their comfort zones.

In my career working with Fortune 500 companies I have encountered neuroscience and psychology Ph.D.'s in different jobs all over the world. It has been proven to me that our skills are valuable, and that is a key message graduate students of today need to comprehend.

[ratthing](#)

This is Walter Koroshetz from NINDS here. Certainly from my position at NIH I am acutely aware of the value of scientific thinking in positions removed from the bench. We think about science policy, science communication, and make decisions on scientific priorities on a daily basis. Rigorous scientific training is a prerequisite for success in the programmatic aspects of NINDS. Probably lots of other institutions too, both public and private.

Thank you all so much for participating! How does funding for Neuroscience research compare to other fields? In your opinion, what do you view as effective steps to take to encourage a conversation between researchers, politicians, and funding agencies to make sure that more basic science research is funded?

[NeurosciJilly](#)

Walter from NINDS here. Many don't know that neuroscience commands more NIH funding than any other area of research. Lots of reasons why, primarily because neuroscientists submit the greatest number of great grants. Also important to know that brain disorders are the leading cause of disability in the US and this only grows as the population ages.

Thank you all so much for participating! How does funding for Neuroscience research compare to other fields? In your opinion, what do you view as effective steps to take to encourage a conversation between researchers, politicians, and funding agencies to make sure that more basic science research is funded?

[NeurosciJilly](#)

Floh Thiels, one of the authors. Funding levels are decided by lawmakers, and lawmakers listen to

their constituents, i.e., the public. Science advocacy and outreach are valuable instruments at the scientists' and their scientific societies' disposal for influencing the decision making process. One place where you can learn more about neuroscience outreach and advocacy is at the Society for Neuroscience website (<http://www.sfn.org/>). As mentioned elsewhere in this AMA, the long-term benefits of communicating about neuroscience with the public are difficult to overstate, and may be something to take into consideration by training programs when updating their curricula.

What moves can be made to increase pay for postdocs? In my experience, more PhDs are moving to industry (or more focused on moving to industry) than going the academia route, solely because the pay is terrible. It seems one is better off financially taking a job right out of college than going through the rigors of a PhD and then matriculating into a postdoc position. For all the time and training we put into our studies, postdocs are worth way more than the NIH mandated ~50k/year salary.

[HottubDiarrhea](#)

Walter here from NINDS. Agree with your points. Not sure if it helps but the US government just increased the minimum wage under which people need to be paid for overtime. Believe the new limit is around \$47k. NIH will be increasing its salary for post docs to above this limit. Expect Universities will do so as well.

As science moves forward do you think there will be a shift towards diagnosing biochemically based mental disorders with improved technologies rather than by clusters of symptoms? Do you think this is reflected adequately in the current educational curriculum for those going into neuroscience?

[TheGrinningViking](#)

Huda Akil- This is indeed the hope--that we will know enough about the biology of psychiatric disorders that we can achieve much better diagnoses and tailor the treatments accordingly. We all know that each of the current diagnoses represents a constellations of disorders, that there are many genetic causes, that the interplay between biological and environmental factors is complex. The process of achieving a different classification needs to be iterative and self correcting. It has taken a long time for cancer treatment to approach this level of precision, and psychiatric problems are a great deal more challenging. Some graduate programs to offer course in translational neuroscience, but I am sure it varies a great deal across institutions. I see great value in being anchored in a better sense of these brain disorders as we strive to create better animal models, seek a better mechanistic understanding of their causes, and find better treatments.

Thanks for the AMA! My question is a bit broader, as it relates to Neuroscience's place in society in general. What do you feel Neuroscience's role will be in the upcoming technological advances? As we develop smarter AIs and things like cybernetic interfaces, where do you see Neurologists fitting in, as opposed to someone like an engineer or a physicist?

[robsquad](#)

I'm Todd Sherer, PhD, a trained neuroscientist and CEO of The Michael J. Fox Foundation for Parkinson's Research. Neuroscience is poised to be at a cutting edge for the implementation of technology into research and ultimately clinical care. In Parkinson's disease, a movement disorder, for example, there is significant work seeking to leverage wearable sensors and activity monitors (think fitbits) to more objectively monitor the disease symptoms. Big data analysis is also being applied to neuroscience in mapping the brain connections as well as assessing the molecular profiling of neurological and psychiatric diseases. Technology companies such as google, apple, intel, and others

are all working in neuroscience.

Hi, I'm specifically curious about the rise in focus towards quantitative methods in neuroscience. I currently do machine learning research on the electronic health record at the Yale School of Medicine. My first question is:

1) Is machine learning something the neuroscience community is interested in applying to the data they create? Is it already happening? How important do you think machine learning could be and how much impact do you think it could have in 21st century neuroscience?

In the paper, they mainly talked about quantitative skills from a statistical perspective. But how about modeling the brains or neural populations from the perspective of a dynamical system? I'm very interested in computational neuroscience. I take this to mean one of two things: performing quantitative analysis on data produced by real brains or constructing theoretical models that explain some aspect of brain dynamics, function, etc... My second question is:

2) Do you think the number of computational neuroscience PhD programs will grow in the coming future? They currently seem to be far and few or the computational aspect is something taught as one of many perspectives within a traditional neuroscience PhD. What do you think about the usefulness for getting a job and the future of the two approaches I mentioned: real data-based vs theoretical?

Considering that most neuroscientists aren't very rigorously quantitatively trained and the academic job market for neuroscience is very saturated, my third question is:

3) Do you think job prospects for someone with solid quantitative neuroscience skills are categorically different than someone with a traditional PhD in neuroscience? In terms of the quantitative people you work with, do they tend to have always had neuroscience backgrounds or are they coming from fields like physics, stats, computer science, etc...?

Thanks for doing this and thanks for your time!

[TheFlyingDrildo](#)

Floh Thiels, one of the authors. Quantitative skills, not just as applied in statistics, are of great value in the field of neuroscience. PhD programs in Neural Computation or Computational Neuroscience exist throughout the nation, and larger (as well as some smaller) neuroscience training programs recognize the value of students from different backgrounds. Clearly, there is room for rendering this practice more wide-spread. Machine learning is one of the topics covered in computationally-oriented programs, and may become more prevalent. It is of interest to multiple academic disciplines as well as certain industries. Thus, a neuroscience PhD with strong computational skills is likely to have a range of professional options. It is not (yet) very common for neuroscience departments in academia to have computational neuroscientists among their faculty, but the demand is likely to grow—we will not be able to understand the brain without bringing theoreticians and strong computational expertise to the enterprise.

Hi, I'm specifically curious about the rise in focus towards quantitative methods in neuroscience. I currently do machine learning research on the electronic health record at the Yale School of Medicine. My first question is:

1) Is machine learning something the neuroscience community is interested in applying to the data they create? Is it already happening? How important do you think machine learning could be and how much impact do you think it could have in 21st century neuroscience?

In the paper, they mainly talked about quantitative skills from a statistical perspective. But how about modeling the brains or neural populations from the perspective of a dynamical system? I'm very interested in computational neuroscience. I take this to mean one of two things: performing quantitative analysis on data produced by real brains or constructing theoretical models that explain some aspect of brain dynamics, function, etc... My second question is:

2) Do you think the number of computational neuroscience PhD programs will grow in the coming future? They currently seem to be far and few or the computational aspect is something taught as one of many perspectives within a traditional neuroscience PhD. What do you think about the usefulness for getting a job and the future of the two approaches I mentioned: real data-based vs theoretical?

Considering that most neuroscientists aren't very rigorously quantitatively trained and the academic job market for neuroscience is very saturated, my third question is:

3) Do you think job prospects for someone with solid quantitative neuroscience skills are categorically different than someone with a traditional PhD in neuroscience? In terms of the quantitative people you work with, do they tend to have always had neuroscience backgrounds or are they coming from fields like physics, stats, computer science, etc...?

Thanks for doing this and thanks for your time!

[TheFlyingDrildo](#)

Walter from NINDS here. Yes, I think applying machine learning techniques to the kind of "big data" being generated from brain imaging labs, physiology studies, or even clinical data will be fruitful. At NINDS we recently worked with Kaggle to offer a prize for the team best able to predict seizure onset from human electrical brain recordings. A 16 year old machine learning expert in Australia won!!

Is one lesson that could be drawn from the figures in the Neuron paper that we just need fewer neuroscientists? It's a very popular degree path, but are we doing students a disservice in allowing them to take that path with federal funding so restricted? With respect to figure 4, are the academic positions tenured, or does that include research associates, postdocs and contingent faculty? That would seem to matter in any analysis. Should we begin to emphasize academically-oriented PhD programs less, and put more resources into career-oriented MS programs? Thanks.

[BrainBites](#)

Floh Thiels, one of the authors. It is not the authors' intention (or place) to prescribe a particular curriculum formula. There is great variety in the contexts in which the various programs in the US (and other nations) operate, and it would make sense for them to leverage the special opportunities around them. We are pointing out areas that deserve further attention and aim to stimulate discussion about the elements that training programs may wish to consider when reflecting on and revising their curricula with the goal of preparing their trainees for the workforce, including a strong and vibrant workforce that advances our understanding of the brain and can address diseases of the nervous system.

As a soon-to-be freshman in college looking towards a computer science degree but also interested in neuroscience, what types of opportunities and research would someone like me be getting into with that type of training? Artificial intelligence seems to be a key topic, but are there other areas besides that?

[dg4f](#)

This is David Cardozo, one of the authors. There is a growing synergy between computer science and neuroscience in several areas. This is especially true in the fields that are engaged in neural prosthetics (nervous system control of prosthetic devices) and in large scale electrophysiological data analysis. My suggestion would be to take an introductory neuroscience course to see whether there are any aspects of the field which grab your imagination. Good luck!

Thank you for thinking about us young scientists. I'm glad SOMEONE is finally thinking about this serious problem. My question is about bias in the field towards famed / established scientists. My understanding is that NIH evaluation of a grant takes into account the history of the PI quite significantly, and also that publishing seems easier for famous scientists (I have great respect for older scientists but I have also seen quite some papers that aren't quite Nature or Science quality that got in probably because of the name). This people-based approach instead of idea-based approach is adding positive feedback and negative feedback loops and making it even harder on young scientists. And I think we are losing a lot good ideas because of it. Are there efforts currently to push for double blinded grant and paper reviews?

[rustyneuron](#)

Floh Thiels, one of the authors. There are various funding opportunities, federal as well as private, aimed specifically at junior investigators. If you wish, these opportunities constitute explicit bias against established PIs. This is just to point out that there are mechanisms in place to help junior PIs on their path of becoming established PIs, a desire by funding agencies and foundations alike, for they recognize the importance of influx of new ideas. The PI's track-record is only one of the criteria taken into account during evaluation of a grant application. Ways to broaden access/opportunity are under discussion in various contexts; double-blinded reviews is one of the options discussed.

In teaching data analysis skills, would you rather focus on algorithms or methods? I've met postdocs and PIs who care really deeply about the algorithms but struggle to implement them in somewhat antiquated environments like matlab, and their workflow only really works for them individually, making it hard to scale/share their work. I've also met some more data hacker-type people who don't really care much for the academic side of the algorithms, but can work really well with open source tools like Python. They might end up reinventing the wheel in some way simply due to not knowing the literature as well as the academics do. Which of these do you think needs to be focused on more in neuro research?

[PascLeRasc](#)

Walter from NINDS here. I think your point underlines the need for teams to form. Worst case scenario is for the science to fail because the expertise is not matched up sufficiently well to ensure that the data is analyzed correctly- either because used the wrong analytic tool or because didn't understand the details behind the data elements.

Can you move into neuroscience research with relative ease if you went to medical school instead of a post-grad program?

[REMfulness](#)

This is David Cardozo, one of the authors. There are many examples of successful scientist who entered the field with a medical school vs. a PhD background. Notable among them is the great David Hubel.

What are the chances of successfully getting into neuroscience research for a psychiatrist?

[Malknar](#)

There is a huge need for psychiatrists/neuroscientists. But you would need to find a neuroscience lab willing to train you in rigorous neuroscience research, almost the equivalent of a PhD, before you can start to receive your own research funding or be a strong partner in translational research. I have seen it done very successfully.

Hi all, Thanks for taking the time to do this AMA. I am currently a postdoctoral fellow working in a quantitative cell biology lab.

My question concerns the first and second point of your recent Perspective in Neuron. In the two parts entitled "Developing the Expertise Needed to Advance Neuroscience in the 21st Century" and "Strengthening Experimental, Analytical, and Communication Skills" you make a number of statements regarding the skills that should be required of a Neuroscience trainee. These range from having a solid understanding of general biology, neuroscience, computer programming (python, MATLAB), experimental design, scientific writing (including grant proposals), laboratory management, communication skills (ranging from biology to mathematics) and so on...

My concern is we are asking too much of our trainees (who are going to take postdoctoral positions that are drastically underpaid) and not promoting collaboration between postdoctoral fellows due to the highly competitive nature of academic research.

You touch upon solutions to these problems further into the perspective which are universal to all fields of academic medical research, such as the need to restructure positions in academia. Although I believe one thing to add to this is promoting collaboration between graduate students and postdoctoral fellows without it negatively affecting career development.

Hope to hear your comments and thanks again

[ApplesAndCheese_22](#)

Walter from NINDS here. You ask whether we are asking too much of our trainees? I think you have a point and a more team science approach has appeal in which people with a variety of special expertise work together. Still need to be aware that writing skills essential to obtaining grants and publishing papers. Skillful data analysis and knowledge of the instruments used to collect data is essential to ensure your science is high quality.

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Hope to hear your comments and thanks again

[ApplesAndCheese_22](#)

Floh Thiels, one of the authors. You make an important point! Collaboration and teamwork are important skills to teach and enable trainees to hone, for our ability to continue to make significant advances in understanding the brain depends increasingly on our ability to bring together and leverage different kinds of expertise (such as, for example, biology, physics, math, engineering, psychology).

Hello! I am an undergraduate student studying Neuroscience as well as Biology, Anthropology and Philosophy (I decided on an interdisciplinary major to ensure a well-rounded foundation before grad school). I'm very interested in the interdisciplinary potential of neurological research. I am especially interested in finding ways to use biologically-based research techniques to better understand how different approaches to education affect students. I'm also very interested in studying the way scientific research in general manifests in broader society (i.e., how information is spread from academia to the masses, how that information is used or misconstrued, and the ethics thereof). Sorry if I'm rambling.

My question is do think there is a good case to be made for bringing neuroscience into other fields, thereby creating sub-disciplines within neuroscience (for instance, educational neuroscience or psychosomatic neuroscience), or would such endeavors be considered less rigorous and useful than neuroscience alone?

And if I might ask a second question, I am also curious about what sorts of skills and interdisciplinary knowledge you would consider most valuable to an aspiring neuroscientist.

Thank you kindly and thank you for your work in the field!

[WhinnyMore](#)

This is David Cardozo, one of the authors. This is a thoughtful posting. Two points: sub-fields tend to emerge naturally as they grow and centers of gravity emerge. This was the case with neuroscience itself as it emerged from biology, pharmacology and physiology departments. As for skills, a deep understanding of biology, a good grounding in basic neuroscience courses and computational training will stand you in good stead.

First of all, thank you for holding this AMA! I will soon be starting my final year of my PhD in psychology/cognitive neuroscience (my specialization is with human EEG). In these final stages of my degree, I am uncertain as to what career I will ultimately follow. Academic jobs in our field have become increasingly difficult to attain, and I'm not sure if I'm willing to put all my eggs in one basket in the hopes that I will attain one. Alternatively, there seems to be an increasing demand for people with experience with experimental design/quantitative methods in data science.

I love the research endeavor itself, and my questions are thus: are there any opportunities to conduct research in settings outside of academia, or are all my best options within academia? Will a career in a data science related field actually utilize my skill set? Regardless of where I choose to do, would it hurt to a post-doc after my PhD?

Thanks again, I'm looking forward to your responses!

[starbelly](#)

I'm Todd Sherer, PhD, a trained neuroscientist and CEO of The Michael J. Fox Foundation for Parkinson's Research. Thanks for the great question. There lots of different opportunities in addition to an academic career to consider with your PhD. Many of these will continue to use your research and scientific skills. High quality, applied research is conducted in industry both biotech and pharma. Increasingly, research is being conducted and managed at funding agencies including the NIH and medical research foundations. Independent of the path you ultimately pursue, there is an advantage to completely a high quality postdoc where you can get more experience in managing research projects as well as expanding the areas where you would have expertise. As more high volume data collection technologies (omics, remote monitoring, imaging) become integrated into research, data science knowledge is a critical skill to bring to the table.

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Thanks again, I'm looking forward to your responses!

[starbelly](#)

Walter from NINDS here. My sense is that there will be growing demand for people with experience in quantitative methods in data science. One of the hardest troubles we have had is recruiting statisticians to work hand in hand with our scientists. Some of the "big data" companies are also interested in the complexity of neuroscience data and how the brain processes information.

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Thanks again, I'm looking forward to your responses!

[starbelly](#)

This is David Cardozo, one of the authors. It certainly will not hurt your options to do a postdoc.

Virtually all career opportunities that are available to newly minted PhD are also available to a postdoc. There are many research opportunities in biotech and pharm. outside of academics.

Hello! I'm currently enrolled at an undergraduate institution in Boston, (just wrapped up freshman year). My father has a neurodegenerative disease that has been with him for most of my childhood and has ultimately pushed me in a direction to pursue medicine, particularly neurology. Dr. Cardozo, you may know his neurologist, Dr. Schmahmann, as he is heavily involved at HMS. My question is this; as an undergraduate, how can I get involved in neuroscience research? I have a deep passion for the field, but find myself limited in opportunities to pursue it at an undergraduate level.

Thank you so much for this great AMA by the way!

[laneboyll](#)

This is David Cardozo, one of the authors. I certainly do know Jeremy Schmahmann who is great neurologist, teacher and researcher. If you identify institutions in your geographic area and write to either department chairs or neuroscience program directors, indicating your interest in working in a neuroscience laboratory, there is a more than reasonable chance that you will identify an opportunity.

Hello! I'm currently enrolled at an undergraduate institution in Boston, (just wrapped up freshman year). My father has a neurodegenerative disease that has been with him for most of my childhood and has ultimately pushed me in a direction to pursue medicine, particularly neurology. Dr. Cardozo, you may know his neurologist, Dr. Schmahmann, as he is heavily involved at HMS. My question is this; as an undergraduate, how can I get involved in neuroscience research? I have a deep passion for the field, but find myself limited in opportunities to pursue it at an undergraduate level.

Thank you so much for this great AMA by the way!

[laneboyll](#)

Walter from NINDS here. Prior to coming to NIH I was in Boston and know Dr. Schmahmann well. Hope your dad does well. To your question, we frequently had summer students in the laboratories, many colleges have some funding for summer students either at their own labs or outside labs.

I'm studying Computer Science and am interested in Computational Neuroscience. So here are a few questions:

1. Are there any introductory Neuroscience online courses you can recommend?
2. What is the role of computer models in fighting diseases like Alzheimer's and Parkinson's now and what do you think it will be in the future?
3. In machine learning we use some models loosely inspired by the brain. Do you think further discoveries in Neuroscience could lead to improvements of such systems. (also getting closer to artificial general intelligence)

[KarlKastor](#)

This is David Cardozo, one of the authors. I can answer question 1&3. I have an opinion about #2 but I will leave that to experts in those fields. 1. There are several excellent online Neuroscience courses. If you search for them, you'll find many of our universities offer them. 3. It is very likely that basic discoveries in neuroscience will impact AI.

What background do you need to get into neuroscience in general? (particularly if your local university does not offer an undergrad neuroscience course)

[penatbater](#)

Murray Sherman here...One of the virtues (and challenges) of neuroscience is that it is arguably the most interdisciplinary of sciences and therefore attracts students with the most diverse of educational backgrounds. I could turn your question around: What background would virtually disqualify one from a future neuroscience career? I can't think of one offhand. Having said that, my advice is to get as much math and other quantitative training as practical, because I believe that one of the future productive areas of neuroscience will require these skills, and you don't want to be left behind.

What role do you see physician-scientists playing in the advancement of neuroscience research?

[prynceszh](#)

This is Walter Koroshetz from NINDS. I think of physician-scientists as the glue between the army of neuroscientists who uncover secrets about how brain functions normally and how it dysfunctions in disease states and the army of physicians who are trying to do the best thing for their patients. Physicians-scientists help fill this important gap, which unfortunately is getting wider. Of note, the number of biomedical scientists has exploded in past 40 years but the number of physician scientists is basically flat. So their value has increased!

We see a need for deeper quantitative, analytical skills and interdisciplinary skills amongst neuroscientists

Dr. Koroshetz, as an engineer, I found myself nodding as I read this. Nevertheless, some years ago, the NINDS decided to stop participating in the K25 mentored quantitative training award, which was intended to give people like me the opportunity to add neuroscience training on top of my engineering background. What is the rationale behind that? Wouldn't it make more sense to encourage a push towards interdisciplinary training starting from both sides, neuroscientists and engineers/mathematicians/physicists? As it stands, I think the NINDS will lose a generation of engineers to industry, which tends to be a one way street.

[Im_Pedantic](#)

Walter here from NINDS. I totally agree with your points on the importance of brining folks with engineering background into neuroscience. We talk about that in the article. The K25 mechanisms just didn't get many applications so we hope that post docs will apply through the F32. We also will be putting out special post doc (F awards) for people from the quantitative and engineering science to work on BRAIN initiative projects.

I am currently a neuroscience undergrad. I've spent the past year as a research assistant in a phenomenal cognitive science lab. I plan to stay for a second year, but I also want to move into a neuroscience lab in the near future. Should I stay with that neuroscience lab for longer or try to gain experience in more than one neuroscience lab?

Also, what are some skills you would recommend an undergraduate looking for a career in neuroscience research develop?

[roadkill336](#)

This is David Cardozo, one of the authors. Follow your heart! Don't strategize but pursue the studies that most excite you. As for skills that will help you succeed in neuroscience, I believe that the keys are a strong background in biology and a solid computational grounding.

If a high schooler wanted to go into neuroscience, what advice would you give them? Colleges, college major, graduate studies, internships, etc.

[greyspatter](#)

Walter from NINDS here. Neuroscience is a great field. Lots to learn so advice is to dig in and read about the history of neuroscience, what is going on now and get involved in a neuroscience project as summer student in a lab. Don't worry about the details. Just follow the best opportunity as it becomes available.

What advice do you have for an undergraduate neuroscience student regarding what the most useful information would be to focus on?

[StillWeCarryOn](#)

Walter from NINDS here. My suggestion would be to get a broad sense of neuroscience-- say from one of the many great Neuroscience textbooks. Then look around for a project in which you develop some special expertise and have fun with it.

It seems to me we have a pipeline problem, in that there is a disconnect between the aims of T32 training programs, how they are evaluated, and the array of career outcomes that are available. Is it wise, or sustainable, to evaluate training programs solely on research outcomes and placement in tenure track faculty positions when the reality is that very few trainees will achieve that? It seems to me that all T32s should move toward more of a BEST model, or at least promote outcomes that are outside the tenure track since that's where most of the trainees are going to end up. As it stands, T32s fulfill the needs of research faculty mentors - not so much the needs of trainees in the face of disemployment. We need career services embedded in graduate programs to offset the lack of aptitude of research faculty to assist with these essential training elements. There's no need to water down training to do this, but there does need to be a mindset shift at the NIH level.

[BrainBites](#)

This is David Cardozo, one of the authors. Your comments are right on target. We anticipate that evaluation of T32 programs will shift towards acknowledging the value of careers outside of academia. NIH initiatives such as the BEST program which you site and the recent requirement for Individual Development Plans signals this change in direction. I heartily agree that we need institutionalize career training opportunities within neuroscience programs.

Thank you for doing this AMA! I just graduated with a BA in Biology and am now fascinated with studying the brain in graduate work. I am particularly interested in doing interdisciplinary work with how music can functionally alter the brain and even give us insights into how and why the brain functions the way it does. Obviously this will need to be more specific for graduate research however I wanted to hear y'all's opinions on the importance of interdisciplinary study in Neuroscience? Will a pure Neuroscience degree really get you anywhere anymore or does it really need to be paired with

something so that the student is more specialized?

I'll be reading the paper you posted later today but I've got work in a few minutes and just wanted to get a question in. Thank you again for this AMA!!

[USBport](#)

Walter here from NINDS. A number of scientists are trying to tackle how music is encoded in the brain and how it leads to the appreciation we have for music. It's a very interesting question and takes both knowledge of how the brain processes sound as well as the components that make up music.

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I'll be reading the paper you posted later today but I've got work in a few minutes and just wanted to get a question in. Thank you again for this AMA!!

[USBport](#)

This is David Cardozo, one of the authors. There is no doubt that a neuroscience degree will open many doors for you and give you the opportunity to pursue the area that you are passionate about.

Neuroscience is often regarded as a hopeless field where success is extremely difficult to have and you can spend years having accomplished nothing.

Why should a young scientist go into neuroscience today?

[JohnnyOnTheSpot](#)

Hi, everyone. I'm Todd Sherer, PhD, a trained neuroscientist and CEO of The Michael J. Fox Foundation for Parkinson's Research. Neuroscience is definitely a difficult field and encompasses study of some of the most complex diseases (such as Alzheimer's, Parkinson's and mental illness). These diseases have a dramatic impact on our society both from a human health and also financial perspective. We need the best and brightest to be working on these problems. New technologies like brain imaging and increased understanding of the genetic components of these diseases are opening up new research opportunities. The potential for research advances is very significant in these areas.

My friend had a stroke. She's walking a little but can't talk or swallow well, what part of the brain has she (hopefully temporarily) lost? How common is this and do many retain this ability? And, what causes the healing that is associated w/the recovery?

[4waystreet](#)

Walter from NINDS here. Sorry to hear about your friend's stroke. Stroke can affect the brain areas responsible for motor control of different parts of the body, either the brain cells themselves or the connections between the brain cells. Importantly most people recover function in the months after stroke as the brain learns to re-wire. Understanding how the brain does this and how to help it along is

a major area of investigation in neuroscience.

Thank you for doing an AMA! What do you think of MD/PhD programs with a more fundamental (e.g., molecular neuroscience) PhD part rather than clinical? I feel like these programs are meant to create stronger researchers that can bring their clinical experience to the lab and vice-versa. However, I can't see how, let's say, your experience with clinically depressed patient can meaningfully contribute to your research with mouse models of the regulation of the Dorsal raphe's activity by SSRIs. Am I wrong to say that for a neuroscientist that isn't directly involved in the development of treatments with the clinical population of interest, his clinical experience doesn't really matter? I know that MD/PhD programs are somewhat prestigious, and might look well when applying for grants, but do you think that for someone that's mainly interested in research at the molecular level, this would negatively impact his abilities as a researcher (investing 4 out of 7-8 years of program to the MD + subsequent years of specialization instead of full time dedication to research).

I've completed my master's degree, and the institution where I study offer the possibility to apply to MD/PhD programs. I've been considering for a while to apply to the program (even though the probability of acceptance would be rather slim). Part of me would like to practice, but if my main goal is to study synaptic plasticity on the molecular level and its impact on the development of neurological diseases (like schizophrenia or autism), would you recommend me to stick to a research based curriculum given that I'd strongly favor a research career over practice?

[viggarr](#)

Huda Akil. Obtaining both an MD and a PhD would clearly be a major commitment on your part. You are right that once you have both degrees, especially with a specialty such as neurology or psychiatry, you would have many opportunities for positions. Also, success rate for grant funding appears higher. There was a study conducted about MD-PhDs by the NIH last year and you may wish to look at it. It is also the case that some MD-PhDs wind up functioning primarily as basic scientists or only as clinicians, and the question is whether it's a good investment. Speaking for myself, I think that having the dual degree provides a perspective and a depth of knowledge that is unique and worthwhile, and I have wished over the years that I had done both. Whether it justifies the extra time and effort is obviously a personal decision.

As a high school senior, give me a sales pitch as to why I should consider majoring in neuroscience

[Gage_Ward](#)

This is David Cardozo, one of the authors. You shouldn't look for or be influenced by a sales pitch. My best advice is to look into your heart and find out what you truly enjoy and pursue it.

How does interdisciplinary research in Neuroscience happen? How do people with undergraduate/graduate level training in physics, chemistry, mathematics, engineering disciplines etc., go on to specialise in Neurosciences, and what are the benefits due to this interdisciplinary approach?

[lukeskywalker1729](#)

Huda Akil-- Find a neuroscientist with an open mind, interested in those skills, who is tackling problems that could use that expertise. It's a great combination, everyone learns and the problems get solved in usual and creative ways.

Thank you so much for answering our questions. I am a PhD student in a biochemistry department with a developmental neurochemistry project. My questions cover a little bit of everything.

- 1) As a non-neuroscience PhD student with a neuroscience based project, do you have any tips on how to better understand the enormous amount of literature that is considered the "basics of neuroscience"? What do you guys think are the fundamentals of neuroscience that every student should know when doing research in this field? And from the opposite side, what other topics do you think students should have a handle on in order to become better neuroscientists?
- 2) After finishing my PhD, I will be starting medical school. I am pursuing both degrees because I would be unhappy just doing one or the other so what is the best way to get back into neuroscience research after I finish my residency?
- 3) How do you feel about over-expressing neural proteins in non-neural cell lines (COS-7, HEK293, CHO) to test protein-protein interactions?
- 4) Currently the outlook for students and postdocs is not encouraging. It seems that many departments are hiring but none of them are hiring young professors why is that? And what do you think is the most important quality (ex. published, funding, collaborations) to have when applying for your first tenure track professorship?
- 5) And finally, how do you think that the changing political climate will affect how neuroscience research as well as research in general is funded?

Thanks again!

[noci2015](#)

Walter from NINDS here. Good questions, I think best way to get essentials is to master a general neuroscience textbook. Textbooks include what a good educator considers significant in the field. Getting back to research after an MD PhD requires some planning and keeping your eye on what you really want to do with your life. NINDS has programs to fund residents to do neuroscience research during their residency and then fellowship funding for 1 1/2 to 2 years of research at the end of clinical training. Our signature career development award (k23 or K08) are 5 year grants after which an MDPhd should be all set to jump in to an independent investigator track. We also fund early stage investigators applying for our bread and butter award (R01) at a higher rate than established investigators. We truly are trying to invest in the future.

[deleted]

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This is David Cardozo, one of the authors. Thanks for your thoughtful posting. In the article, we discuss the ever increasing opportunities for PhDs in neuroscience. It really is a growth industry which includes research opportunities outside of academia.

Hello! Great article, and very timely for me. I am a trying to decide between two labs for my postdoc, and as you all point out, training should be a big part of this decision.

In lab 1) I'd have to opportunity to directly pursue a line of research that I am most passionate about, the kind of work that I would do if I had my own lab. I'd get training on all aspects of what is immediately applicable to that project, using state of the art techniques. Or 2) I could pursue a project that is similar in a few ways to my interest, but also have the opportunity to learn, help develop and apply cutting edge techniques under development in the lab. I'd receive great training in these technical skills, but

likely weaker training on most other aspects.

Both are new labs (with little training record) at highly regarded institutions, and have secure funding.

I suppose my question is - Would participating in the development of cutting edge techniques outweigh being able to hone my skills in what will likely be my future work?

Thanks for any and all advice, I appreciate what you all are doing!

[Morfojin](#)

Walter here from NINDS. Don't know that could offer advice here. Sounds like two good options. Would be great if you could get some time to train on the cutting edge techniques and incorporate them into your pursuit of what you are most passionate about.

After receiving my B.S. in Neuroscience and working in a behavioral Neuro lab for 2 years, I came out knowledgeable yet lacking any superb skills. Through discussion with other undergrads in Neuro labs throughout the university, we all felt a similar way- as if our undergrad status diminished any true potential we could offer the lab. Yes, undergrads may be the rookie of sorts; however, the bulk of grunt work seemed appalling. In addition, most of the PIs lacked interest in their undergraduate workforce. The attitude given towards undergraduates actually impaired the further growth of interest for a neuroscience graduate education. Personally, I'm looking into cognitive neuropsychology- but many of my peers strayed elsewhere.

My question is: how important do you see your own/past undergraduate students and how involved are you with them? I believe true lab immersion is needed for further advancement in the neuroscience academia, especially in the early years (undergraduate), do you agree?

[Rslabs](#)

Murray Sherman back...I can answer this in two ways. First, as an undergraduate, I spent two years working in a neuro lab, and it cemented my commitment to the field. It was a wonderful and valuable experience. Second, undergraduates at (my place) the University of Chicago are encouraged to spend time in research labs, and I usually have 3-4 at a time in mine. I believe they benefit from the experience as I did, and the more industrious have co-authored research papers. I would not go so far as to say undergrad experience in a lab is essential for a career in the field, but a good experience here can be helpful.

It sounds to me like you're talking about the importance of several important, but fundamentally different approaches; e.g. the importance of understanding big data genomic approaches versus the ability to harness genetic tools (e.g. ontogenetics, DREADDs, and CRISPR). That's just a few examples, there's so many important and specific approaches that are necessary to understand, let alone to be able to do yourself, that it's a challenge to design programs that include the right amount of general breadth AND depth in specific approaches. Would you view having a critical understanding of all these important approaches as being part of the core of a ~5 year graduate program, or should students specialize and broaden their scope post-degree?

(edited for clarity since I'm no longer on mobile)

[bovineblitz](#)

Walter from NINDS here. You hit on an important point- neuroscience is expanding in so many ways that a trainee can not hope to master of them all. One idea is to train yourself on enough different techniques so that you will feel confident in the future to take on new techniques that your scientific

question calls for.

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Murray Sherman here. I'm not sure where you got the idea that most neuroscience programs focus on human subjects rather than animals. I don't have numbers on this, but it seems to me just the other way around. The vast majority of PhD programs in neuroscience focus on animal research. Also, I suspect that if you manage to sample abstracts at any Society for Neuroscience meeting (sfn.org), you will find that the vast majority use animal models for their research.