Evolving the Culture of Science and Training in Neuroscience to Meet a Changing World: Proceedings of a Workshop in Brief (2021)

DETAILS

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Proceedings of a Workshop

IN BRIEF

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Proceedings of a Workshop—in Brief

Recent events, including the COVID-19 pandemic and the collective awakening around issues related to racial justice, diversity, and inclusion, have underscored the challenges facing neuroscience and neuroscience training, said M. Morgan Taylor, field engineer for the Data Sciences Platform at the Broad Institute of the Massachusetts Institute of Technology (MIT) and Harvard. To address these challenges, the Forum on Neuroscience and Nervous System Disorders of the National Academies of Sciences, Engineering, and Medicine convened a series of virtual workshops on neuroscience training. These workshops originated from the forum's Action Collaborative on Neuroscience Training: Developing a Nimble and Versatile Workforce. "The overarching goal of this series has been to catalyze reconsideration of how we think about neuroscience training in a rapidly changing world," said Taylor.

On February 22, 2021, the fifth and final workshop in this series, titled Evolving the Culture of Science and Training in Neuroscience to Meet a Changing World, brought together stakeholders from across the neuroscience ecosystem to discuss how the culture of science and scientific training can become more inclusive, balanced, and adaptive to changing times.

The culture of training has been at the root of discussions in all of the workshops, said Taylor. This final workshop expands on many issues raised in previous workshops, including the importance of mental health and well-being in academic research; how to resist the legacy of white supremacy and support diversity in academia; and how to redefine what success means for neuroscientists in both academic and non-academic settings. "Today at the capstone workshop in the series, we hope to boldly imagine what an evolved culture of science and neuroscience could look like and discuss concrete steps toward that necessary change," said Taylor.

Cultural evolution does not come easily to institutions, Taylor noted. Moreover, there can be a tendency to place too much burden on trainees to solve problems they were not responsible for creating, she said. "In any process of institutional change, there is an inherent dichotomy between bottom-up and top-down efforts and responsibilities," she said. "I hope and trust that we—trainees, early career scientists, faculty, and institutional leaders—all agree that we all need to contribute to this change." Effective communication is essential to these efforts, she added. "We hope these workshops can foster both communication and collaboration."

PERSONAL PERSPECTIVES ON THE EVOLVING CULTURE OF NEUROSCIENCE AND NEUROSCIENCE TRAINING

One way to frame changes in the culture of neuroscience is to connect it to the shared values of people in the field, said Taylor. With that in mind, she asked participants in the first panel to reflect on these shared values—inclusivity, equity, flexibility, and mental wellness—and to consider how creating a healthier, more inclusive, and more diverse community

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would improve not only the culture, but also the quality of science. Neuroscientists at different career stages, working in different types of environments and institutions, offered their perspectives.

Changing the Current Culture of Science and Training in Neuroscience: A Human-Centered Perspective

"We often take for granted that our enterprise, both in science and discovery, is one about communicating ideas from one human being to another," said Kafui Dzirasa, the K. Ranga Rama Krishnan Endowed Associate Professor at Duke University, with appointments in the Departments of Psychiatry and Behavioral Sciences, Neurobiology, Biomedical Engineering, and Neurosurgery. Changing the culture of science begins with people being good human beings, he said. Without that fundamental principle at its core, attempts to transform the culture will fall apart, he said.

Moreover, said Dzirasa, all science, inquiry, and discovery originate in the brain. "If we don't take care of the organs in our head and create environments where the organs in the heads of trainees are functioning optimally, the entire enterprise suffers." He noted that across all graduate training programs, there is an incredibly large incidence of mental health challenges, including depression, anxiety, and substance abuse (NASEM, 2021). These challenges underscore the need to support trainees and not burden them with unnecessary mental challenges.

A third important point Dzirasa made is that creating the best neuroscience enterprise requires recruiting the best talent. "If we can all agree that intellect is universally distributed, then we have to ask why our population of trainees doesn't look more like the talent pool we should be drawing on," he said. For example, he said, if an enterprise employs no women, it cannot be drawing from all of the talent available.

"Certainly, as we seek to transform our enterprises and bring in more people with more experiences and perspectives, we want to create an environment where they can thrive and not suffer from the stressful impacts that come along with the challenges of that transformation," said Dzirasa.

Another issue that challenges the ability to transform the field of neuroscience is the fact that the field has been optimized around individual inquiry and discovery, said Dzirasa. Yet, the Brain Research through Advancing Innovative Neurotechnologies (BRAIN) Initiative[1] and other transformative team science projects have demonstrated the power of bringing together teams of scientists across different backgrounds and perspectives to solve large problems. He said to expand such collaborative approaches across the field will require wrestling with incentive structures and organizing principles of neuroscience. For example, chemistry, biochemistry, physics, and computer science are all critical disciplines in neuroscience, yet each has its own set of incentive structures, said Dzirasa. He asked how people in those fields can be encouraged to conduct the type of science necessary to understand the functioning of the human brain and translate that into treatments and cures for devastating diseases.

Supporting Both the Well-Being of Neuroscientists and Excellent Science

Stories of graduate students experiencing depression and mental illness are common, yet often hidden from view, said Taylor. She struggled with depression and anxiety as she pursued her Ph.D., eventually learning that her skills were better suited for a career in software engineering. Within her academic circle, she felt stigma and shame about choosing a path outside of academia, but was fortunate to land at the Broad Institute of MIT and Harvard, which promotes team science and prioritizes the well-being of its employees. "This has driven home for me that supporting scientists not just as workers, but as humans, does not come at the expense of excellent science," said Taylor.

Sharon Milgram, director of the trans-National Institutes of Health (NIH) Office of Intramural Training & Education, agreed that the human needs of scientists at all levels—students, postdoctoral researchers, and faculty—have largely been ignored. "If we want to change the culture of science, we need to go back to that first principle that you are not hands with a keyboard or hands with a pipette, you are not somebody who writes papers; you are a whole human being with a family and identity and contextual factors and joys," said Milgram. Effective training to address these human needs requires both top-down and bottom-up approaches, she said.

For example, training in resilience and wellness is needed to help trainees and early career scientists achieve work–life balance by understanding how to "put an intense, high-knowledge career on top of a life that is full, rather than saying 'leave your life at the gate when you come in every day,'" said Milgram. She added that when trainees become demoralized, she often encourages them to find a way to harness their disappointment and anger to make changes to the part of the system that is at the root of their distress, whether it is in the sphere of the academic culture, social change, or other areas.

[1] To learn more about the BRAIN Initiative, see https://braininitiative.nih.gov (accessed March 15, 2021).

Milgram added that wellness can only thrive in an environment where bullying, harassment, and discrimination in the workplace have also been addressed. "No one will do well in an environment where bullying and harassment thrive, where people are told, 'well, this is terrible ... but you need that paper so put up with it,'" she said.

Institutional incentives and practices play a major role in creating a culture that prioritizes work–life balance, added Anne Urai, assistant professor in the Cognitive Psychology Unit at Leiden University, Netherlands. During her postdoctoral training in the United States, she said, it was not uncommon to find scientists conducting experiments at all hours, day or night. By contrast, the building where she works now is closed on nights and weekends, allowing access only on request if needed to collect data or perform other time-sensitive tasks. Urai acknowledged that having the lab open 24/7 provides flexibility, but noted that it also gives individual labs the power to determine their own lab culture. She suggested that institutions could take the lead in encouraging people to take time off for family leave, holidays, and vacations, for example, rather than leaving it to the principal investigators (PIs) to set expectations.

Alternatively, bottom-up approaches to support both a better work–life balance and better science are also emerging, said Urai. She noted that unions for postdoctoral researchers have sprung up at institutions such as Columbia University.[2] "The golden age of American capitalistic productivity was the age of a very strong labor movement working in conjunction with management so that everybody was happy and taken care of," said Alik Widge, assistant professor of psychiatry and director of the Translational NeuroEngineering Lab at the University of Minnesota. "We don't have to exploit people to get them to work better because they actually might be more productive if they were less stressed, adequately paid, knew their kids were taken care of, [and] knew that their house was not going to collapse on them," he said. "Stressed people just don't do good work." In fact, research has shown that productivity declines as the number of hours worked per week increases, Urai added.

Teaching Scientists to Be Excellent Mentors and Leaders

Becoming a good leader requires a range of skills not commonly taught during the postdoctoral training period, said Widge. These skills prepare leaders to work with and learn from people who are different from them by teaching them to be self-aware and recognize when their interaction with a trainee is being driven by their own personal experiences, said Widge. "We also don't teach people or give them examples about how to be wrong and how to be apologetic without falling to pieces," he said.

One area being addressed in Widge's department through an initiative led by the department chair involves teaching people how to have crucial, but often difficult, conversations about issues such as systemic racism and microaggressions. We spend a lot of time telling mentors what not to do, he said, but fail to train them on how to speak with trainees openly and honestly about the trainees' background or potential problems in the lab without negatively impacting their productivity.

Widge added that not only faculty, but also trainees themselves, need help in understanding how to work effectively in their lab environments. For example, trainees who cannot admit to being wrong create major problems, he said. "In my career, my biggest mistakes have been not finding a way to either coach that person to stop doing it or ask them to leave the team. Those folks turn into faculty members who do the same thing."

Early career scientists can also benefit from hearing the stories of more established researchers and undergo specific training on how to self-manage their careers, said Widge. For example, he mentioned the book *Making the Right Moves: A Practical Guide to Scientific Management for Postdocs and New Faculty* (HHMI and Burroughs Wellcome Fund, 2006). The book provides guidance and scenarios on topics such as how to negotiate a job offer, said Widge. Users' manuals for scientific careers could also provide templates for "how to politely walk something up the chain of command without taking no for an answer," he said.

Taylor suggested that learning how to be wrong gracefully is an opportunity for top-down modeling. "When the leader of a team can demonstrate the skill of being graceful and admit they are wrong and don't know everything, it impacts everyone on the team," she said. "It has to start from the top."

Milgram added that to make lasting change, training on management, leadership, emotional intelligence, and mental health needs to be conducted on a regular basis. "It's a lot harder to manage people than to develop technical expertise," she said.

Incentivizing good mentorship and deincentivizing bad behavior is also needed, Milgram said. When a trainee reports an unwelcoming environment characterized by microaggressions, for example, there should be procedures in place to move that trainee to another lab. She suggested that when mentors behave poorly and lose trainees or staff,

[2] To learn more about Columbia University's Postdoctoral Workers Union, see https://columbiapostdocunion.org (accessed March 12, 2021).

they should be deincentivized to continue that behavior. Training grants could also provide mechanisms to protect trainees from toxic environments, she said. Meanwhile, incentivizing good mentorship through “mentors of the year” awards that provide resources to great mentors, or incorporating mentorship metrics into the tenure process, could help promote better mentorship, she said.

Although it may not be possible to create a system free of people who lack what Widge called a “basic level of goodness,” he added that if it can be clearly shown that it “pays good to do good,” those people will realize they have to change their behavior to keep their jobs, get grants, and retain graduate students and postdoctoral fellows.

Shifting the Culture of Neuroscience Training Through Team Science

As more and more collaborative “team science” initiatives emerge, they provide opportunities for postdoctoral researchers and other scientists to experience a different way of doing science, said Urai. She had a postdoctoral fellowship at Cold Spring Harbor Laboratory, where she worked as a core member of the International Brain Laboratory (IBL) collaboration.[3] “It felt like a big risk at the time to do this kind of non-traditional postdoc, but I found it a really rewarding experience,” she said.

One of the main advantages to working as part of a team, said Urai, is that postdoctoral researchers have the opportunity to develop themselves as either specialists or generalists, depending on their interests, skills, and goals. A traditional postdoctoral fellowship requires trainees to develop specific expertise while also becoming familiar with the broader neuroscience literature and learning to manage technicians, communicate with experts in other domains, and write grants and research publications, she said. Allowing some people to be generalists, who translate between these technical specialists, opens up opportunities for those who want to manage and coordinate research programs and provide a good research environment for others with expertise in specific domains, said Urai. Moreover, this can lighten the load of all of the things a traditional postdoctoral researcher is expected to learn, she said. “I think that is just better for everyone in the long run,” she said.

As neuroscience labs are expanding to include experts in the fields of engineering, chemistry, and math, among others, Widge thinks investigators will become more comfortable with a diversity of perspectives and career outcomes. Dzirasa agreed that an academic career is not optimal for everyone. For example, he has had experts in machine learning join his lab. They laugh when he suggests an academic career path, saying, “There are other places I can go that are substantially more incentivized.”

Team science provides other advantages as well, said Urai, by requiring participating labs to be explicit about their labs’ expectations and philosophy, such as how authorship is determined and how projects are assigned. “Putting together all of these PIs and forcing them to make their expectations explicit allows best practices to spread across the collaboration, reducing the impact of some bad habits,” said Urai.

Democratizing Science as a Means to Empower Trainees and Drive Creativity

The incentives that drive capitalism—financial rewards and increasing power—do not necessarily transition well into a more democratic scientific culture that aims to empower trainees and spark creativity, opined Dzirasa. With so many big science projects now sharing data openly and globally, the rate-limiting step in scientific discovery is no longer who has the best microscope or who has the best data, he said. Rather, transformative and disruptive innovation can be driven by individuals across the spectrum of academic achievement. This has already happened in other fields such as computer science, said Dzirasa. “It’s no surprise that those who ended up leading the PC revolution or social media enterprises left college, started their own businesses, hired folks who were experts in their scientific domains, and there’s a disruptive innovation in the field,” he said. He added that social media also has transformative potential to stem bad behavior on the part of PIs by enabling trainees to voice their criticisms of PI behavior and have their opinions amplified by colleagues. “It builds checks into the system that may not have been there 20 or 30 years ago when those stories were unheard,” said Dzirasa.

INSTITUTIONAL PERSPECTIVES ON NEUROSCIENCE TRAINING AND THE EVOLVING CULTURE OF SCIENCE

The second panel shifted the focus to institutional changes needed to transform neuroscience training to better fit the growing diversity of both the scientific workforce and the scientific opportunities available to them, and to address the wellness of neuroscientists across all career levels, said John Krystal, the Robert L. McNeil Jr. Professor of Translational Research; professor of psychiatry, neuroscience, and psychology; and chair of the Department of Psychiatry at Yale

[3] To learn more about IBL, see https://www.internationalbrainlab.com (accessed March 11, 2021).

University. Much of the discussion revolved around team science—specifically, why it is essential to advance neuroscience, what roadblocks need to be overcome, and how team science and related transformations can help institutions deal with problems raised by the first panel and in previous workshops related to diversity, equity, stress, burnout, and alienation, said Krystal.

Recognizing the Importance of and Challenges Related to Integrating Team Science into Academia

Team science recognizes that scientific progress is achieved most effectively through one of a range of collaborative frameworks that harness the talents of people from many different backgrounds with diverse training, career levels, and perspectives, said Amy Bernard, director of science and technology strategy at the Allen Institute. The challenge, she said, is that these frameworks may not fit into traditional university structures, which more typically reward and support the progress of individual PI-level scientists rather than the science itself. “The pyramid model presumes that there is a single scientist running the whole show, and that is just not where the state of productive science is anymore,” said Bernard. “It’s not just one person investigating, it’s a team.” Yet, the pyramid is currently the predominant structure in academia for research funding, career advancement, and publication of research findings, she said. “These are areas where we need to take a disruptive approach to recreate what it means to have a productive and accurately reflected scientific landscape where individual contributions to the team effort are recognized.”

Such models already exist in other areas such as physics and in the space program, most recently exemplified by the recent landing of the National Aeronautics and Space Administration’s Perseverance Rover on Mars, a feat that could not have been accomplished without team science, said Emery Brown, the Edward Hood Taplin Professor of Medical Engineering and professor of computational neuroscience at MIT, and the Warren Zapol Professor of Anesthesia at Harvard Medical School. “We should borrow liberally from those models in our area of neuroscience and try to bring those paradigms to play in our laboratories and institutions,” said Brown.

The power of team science has also been demonstrated in the context of the COVID-19 pandemic, added K. Ranga Rama Krishnan, chief executive officer of the Rush University System for Health. “With COVID, there was an unprecedented level of cooperation and collaboration,” he said. “And we’re not even talking about a university; we’re talking about an entire community crossing national boundaries, coming together because we needed to as a society and as a human race.” A major mindset change was needed to achieve this, said Krishnan, because universities view problems through a discipline-based rather than a solution-based mindset.

Recognizing and Rewarding the Contributions Made in Collaborative Science Projects

One roadblock to integrating such systems in academia involves defining units of success, which in academia is typically publication of a major discovery, said Andrew Welchman, head of neuroscience and mental health at the Wellcome Trust and professor of neural intelligence at the University of Cambridge. When Perseverance landed on Mars, the celebration was immediate. By contrast, “When everything hinges on producing a big academic paper, I think that actually makes the whole workforce and the whole enterprise less agile,” said Welchman. He suggested that recognizing small units of achievement and the individual contributions made by the scientists who manage, extract, and analyze data would better highlight the value of those contributors.

Compensation and long-term career models also need to be revised, said Bernard. Funding projects from the bottom up rather than by PI-based, top-down approaches requires a change in mindset, she said. This change could also improve the financial security of people at many career levels, and the sustainability of their careers beyond the promise of faculty tenure.

Krishnan agreed that current reward systems do not encourage team science, in part because the metrics for team science progress are inadequate. He noted that reward structures have changed in other areas of cross-disciplinary work, but less so in the medical field. Yet, his experience in trying to change those structures encountered incredible systemic resistance, he said. “It’s not going to happen by itself; there has to be intentionality for it to change,” said Krishnan, adding that two kinds of intentionality are essential—first, being intentional in figuring out how to promote team science and reward team members; and second, intentionally breaking down barriers to team science, such as the systems for awarding grants, publishing research papers, and evaluating candidates for promotion.

Brown added that although leaders in institutions often speak about the advantages of team science and encourage their scientists to join these efforts, when the time comes to look at tenure accomplishments, their discussions become very siloed. “It requires extra effort on the part of leadership in those moments to go the extra mile and not look at the classic model for interpreting contribution,” he said.

One relatively new metric that enables grant review and promotion committees to recognize contributions beyond publications is the use of the digital object identifier (DOI) system.[4] DOIs can be assigned to any entity such as computer code or a data figure in a paper that is eligible as a form of evidence to be used in judging a candidate in terms of suitability for a project, said Welchman.

Bernard echoed Welchman's point that new models are needed to recognize contributions beyond publications and said this is especially true in terms of the way peer evaluations are used to determine what research is funded. The predominant funder in the United States, NIH, essentially invests in projects based on previous work, reasoning that additional promising work will be conducted in the future, she said. While Bernard acknowledged that there are advantages to that system, as pointed out in the previous session, it is not a model that encourages innovation. It functions as a pyramid model, advancing the person at the top (the PI), rather than the individuals who contribute to the work. "I think this kind of cutthroat system is unsustainable when you think about the type of science that we need to do that is more collaborative. This reward mechanism for funding is fundamentally not enabling that model," said Bernard. She imagined a system where individuals are compensated based on their contributions to projects, as demonstrated through DOIs or other metrics.

Walter Koroshetz, director of the National Institute of Neurological Disorders and Stroke, stated that in goal-directed projects, NIH is most concerned about the work being done, and not who is doing the work. He said that team science has been successfully implemented in clinical neuroscience research for decades. Groups of clinical scientists devoted to understanding specific diseases organize themselves into teams that become dominant drivers in patient-oriented disease research. These self-assembled groups include hundreds of people and they have learned to equitably distribute credit and leadership roles over time. They become sustainable and successful in competing for grants from both NIH and non-NIH sources because they champion important scientific questions and routinely deliver in their field, said Koroshetz. As a precedent for team science in the basic neuroscience field, he pointed to the BRAIN Initiative Cell Census Network (BICCN)[5] and the role of the Allen Institute as a good example. "I don't think the scores of labs working on the BICCN could have achieved their goals unless the Allen Institute had organized itself as a team science institution," he said. Scientists should view this as a wake-up call, he continued. "If you want to answer really important questions that can't be answered in an individual lab, then the community has to form a team and come in with the grants," he said.

Krishnan said that over the past 20 years, NIH has increasingly rewarded teams coming together to do science, but he argued that while these projects tend to be cooperative and collaborative, "more integrated work will take some time." One reason for this, said Krishnan, is that unlike the Wellcome Trust and other organizations that take a more interdisciplinary approach, universities and medical schools have been slow to change their policies, procedures, and reward mechanisms that focus on individual contributions and disciplinary-based work. Gaining acceptance for trans-disciplinary training has even been difficult, he added. Moreover, said Bernard, "we have to recognize, consider, and integrate the model of who is doing the work in science with a structure that doesn't just recognize it but rewards it." NIH is indeed that structure, she said, and they do factor in who is doing the work when they balance the attributes of individuals who will receive support. Other research organizations such as the Allen Institute as well as universities and other institutions are left on their own to manage this balancing act, said Bernard.

Using Team Science to Drive Transformation and Help Institutions Address Challenges Related to Diversity, Equity, and Well-Being

Welchman echoed Bernard's concerns about how a funder selects who will be on the team and what attributes will be used to select those individuals. "If we are really serious about changing the structure of science and moving it toward thinking about team-based contributions, maybe some of the attributes that we should be looking for at those early career stages relate to the ability to work on a team and the ability to contribute things other than just being the one hero," said Welchman.

Diversity also needs to be addressed, added Welchman. "If we carry on using exactly the same means of assessment and metrics, we are not going to change the composition of the workforce," he said. "We need to think a bit more imaginatively about how we might get people in at early points in their career, because investing in those people now is going to pay dividends in 10 or 20 years."

Brown pointed out that team science will not necessarily provide solutions to diversity and inclusion, and looking at those two issues will not provide solutions for team science. "The two have to run in parallel and cross-pollinate," he said. Krishnan agreed, and going back to his earlier comments about intentionality, suggested that cross-pollination will not happen by chance, but will require planning and intentionality.

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[4] To learn more about the DOI system, see https://www.doi.org/index.html (accessed March 14, 2021).

[5] To learn more about BICCN, see https://braininitiative.nih.gov/brain-programs/cell-census-network-biccn (accessed April 29, 2021).

Welchman noted that the neuroscience workforce is young and attuned to the idea of working collaboratively and recognizing individual contributions within the context of a team. But as was pointed out in the first panel, the pressure of working in the system as it exists now has affected many people's mental health. Welchman suggested replacing unrealistic expectations that each individual should be able to do everything—come up with the ideas, run the experiment, do the analysis, produce beautiful artwork, and write eloquently—with a model that tells trainees it is acceptable to be contributing to a project and working on a team. "I think this is a sure-fire way of increasing the sense of well-being that people have because you are recognizing the contributions that each individual person can make in a way that is open, fair, and constructive."

Supporting Scientists in Diverse Career Trajectories to Strengthen Team Science

Stronger support for a broad range of career trajectories is another essential component of team science, said Welchman. For example, he mentioned the Sainsbury Wellcome Centre in London, where scientists who have chosen not to pursue a tenure-track position are recognized, rewarded, and able to advance their careers as staff scientists. Welchman said these scientists may be world experts in particular sets of skills they bring to big projects. "Without them, those projects couldn't be working," he said. Other scientists in both industry and academia are following different routes to make contributions to science not only by doing day-to-day research, but also by facilitating research, said Welchman. "We need to be more open to the range of contributions."

Krishnan added that team science is difficult to maintain in practice. Someone who is good at creating teams may not be the best scientist, but the best organizer, he said. Moreover, he said, universities do not teach students how to learn or how to form and maintain teams.

Another structural hindrance to team science is the difficulty of moving among sectors, said Welchman. He said new models are needed that recognize the contributions a scientist makes in different sectors rather than relying so heavily on the number of papers published and a long record of attracting funding, Indeed, he suggested that moving among sectors should be viewed as a positive rather than a negative. "If your whole career has been spent in three or four labs, it is really difficult to get a range of experiences and to see different ways of working."

Brown noted that individuals with Ph.D.s have many opportunities to receive cross-disciplinary training in business, engineering, or medical aspects of different problems that can help investigators learn what is needed to turn their discoveries into new products. For example, the Harvard–MIT Health Sciences and Technology (HST) program[6] offers such courses, which Brown said are essential to help people meld their skills into a team and should be encouraged. Krishnan noted that he took a similar type of course at Stanford University when he was preparing to implement team-based learning at a medical school in Singapore. One of the first things he had to teach students in Singapore was how to form and work in teams, he said. "It is a teachable skill."

Fostering More Egalitarian Working Relationships Between Leaders and Trainees

Team science upends the concept of trainer–trainee as defined by the stratified model employed by most universities, said Bernard. Rather, a mixture of people with varying expertise and specializations work together to move science forward, eliminating the notion that there is a certain cohort of people who have all of the knowledge (trainers) and others who do not (trainees).

Krishnan added that moving from the "sage on the stage" to the "guide on the side" model is easier to build from scratch than to change an existing model. However, Krystal noted that under the right conditions, the more egalitarian model can emerge organically. For example, in the first panel, Urai discussed IBL, which was funded by the Wellcome Trust in part as "a kind of experiment in how we do science." The PI group was distinguished and full of ideas about how to structure the project in a different way, said Krystal, but it turned out that the implementation was driven by a group of postdoctoral researchers who invented new ways of working that the PIs had not envisaged. This included new ways of sharing data and managing attribution on pieces of work, he said. "It really changed the culture and some of the working practices across the whole of that network," said Krystal.

While in this case of IBL, leadership became somewhat of a joint responsibility, it is important that PIs articulate the sort of environment they want to cultivate, said Welchman. It can be a flat kind of team structure rather than a pyramid where it is easy to share ideas, brainstorm, and admit mistakes, he said.

"This kind of interaction between trainees and leaders on teams is an important part of the change," added Brown. "It has always been collaborative, but now we're talking about structures that are intended to protect and foster that kind of collaboration across the levels of hierarchy."

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[6] To learn more about the Harvard–MIT HST program, see https://meded.hms.harvard.edu/health-sciences-technology (accessed March 18, 2021).

For example, as Bernard noted earlier, the role of the postdoctoral researcher dramatically changed at the Allen Institute. To start with, they eliminated the term "postdoc" from their lexicon, replacing it with career positions such as scientist, engineer, or data analyst, she said. "These are people who have already undergone 5 to 7 years of postdoctoral or graduate training, so to continue to give them the title of trainee is a little demoralizing, and I would argue it is also patronizing," said Bernard. However, she also provided an example of an incentive structure having a negative effect on the goals of team science, noting that the term PI was needed to apply for grants from NIH and other organizations. "So we started semi-arbitrarily assigning people to list as the PI," she said, which unfortunately led to her institution moving away from true team science. Krystal added that some funding agencies now allow grants to be submitted with multiple PIs listed, which has enabled the sharing of credit and responsibility for the grant. Similarly, he said, there has been a growing use of multiple first and last authors.

About the question of mentoring, Bernard said that the approach taken at the Allen Institute is to say, "We are hiring you to work on problems with other people. You will need to be mentoring others as well as be mentored by the team." She noted that this approach is not unique. She and her colleagues are simply trying to modernize and implement strategies that create better environments for career development, added Bernard.

Envisioning Changes to Neuroscience Training Within a Broader Context

In addition to transforming the culture of postdoctoral training in neuroscience, Krishnan noted that there has been a move in society to train people for careers that do not require a Ph.D. For example, he and his colleagues started a program in the west side of Chicago to train high school students from underprivileged backgrounds to know enough about computer science to operate and maintain an electronic health record. "Then they can go to college or do whatever they want, but now they have experience," he said. "We are in the middle of change. If you look at how people learn and where they learn from, that has changed," he said. "You are going to see this in neuroscience; you're going to see it everywhere."

Krystal concurred. "We are in the midst of a change in the way we think about the structure of science and what our aspirations are for science, how we consider the impact of science, and how we prepare people for careers in this very changing world," he said. "It's an exciting and scary place to be, but I think in this discussion we heard a lot about the paths forward." ◆◆◆

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