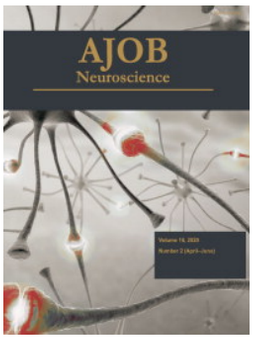

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Mentoring for Neuroscience and Society Careers: Lessons Learned from the Dana Foundation Career Network in Neuroscience & Society

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ABSTRACT

With the growth of neuroscience research, new neuroscience and society (NeuroX) fields like neuroethics, neurolaw, neuroarchitecture, neuroeconomics, and many more have emerged. In this article we report on lessons learned about mentoring students in the interdisciplinary space of neuroscience and society. We draw on our experiences with the recently launched Dana Foundation Career Network in Neuroscience & Society. This resource supports educators and practitioners mentoring students aiming to apply neuroscience in diverse fields beyond medicine and biomedical science. Through our programming, we identified three key lessons: (1) students are interested in exploring a wide range of neuroscience and society intersections; (2) outreach to underserved institutions generates avenues for students to join NeuroX conversations; and (3) by offering free access to online NeuroX resources and a network of subject-matter experts, the Career Network joins many partners helping to bridge the gap between neuroscience and society.

KEYWORDS

Career guidance; diversity; mentoring; neuroethics; neurolaw; neuroscience education; neuroscience & society; outreach

INTRODUCTION

Neuroscience is being applied in many ways outside the lab. As a result, an undergraduate neuroscience major might ask: "How can I pursue a career in neuroarchitecture?" or a graduate student in neuroscience might wonder: "How can I use my neuroscience training for a career in neuroeconomics?". Fields like neuroarchitecture and neuroeconomics are emerging, along with many other neuroscience and society endeavors, as viable career paths for the next generation of brain scientists. To help mentors whose students may be asking such questions, we discuss in this article new resources available for addressing the challenge of advising students interested in neuroscience and society careers.

Multiple indicators demonstrate that interest in neuroscience is expanding. The number of attendees at the Society for Neuroscience Annual Meeting, for example, has grown from 1,395 in 1969 to over 30,000 in recent years (Fields 2018; "About SfN" 2024). The number of neuroscience graduate students has grown significantly (Akil et al. 2016), and the number of undergraduate neuroscience programs increased 41% from 2013 to 2017 (Rochon et al. 2019). There has also been a rise in the development of neurotechnology (Gaudry et al. 2021). This growth has generated interest in applying neuroscience in other fields, and in applying lessons from other fields to neuroscience (Phillips and Sontheimer 2023). For example, the School of Neuroscience at Virginia Tech was founded on the idea that neuroscience is "a dynamic and far-reaching degree" and "a discipline well suited to reach far beyond the realm of bench research" (Phillips and Sontheimer 2023). The versatility of a neuroscience degree is evident in the range of careers students seek to pursue (Ramos et al. 2016a, 2016b).

Scholars and practitioners have explored neuroethics (Illes and Sahakian 2011), neuroeducation (Fischer, Goswami, and Geake 2010), neurolaw (Jones, Schall, and Shen 2020), neuroarchitecture (Eberhard 2009), and many more. We have identified 20+ neuroscience and society fields (Table 1). We refer to these neuroscience and society fields collectively as NeuroX to

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*All are co-lead authors of the article, as each has made unique and important contributions to the work described in the article.

Table 1. Illustrative list of NeuroX fields, in alphabetical order.

Neuroaesthetics	Neurocinema	Neuroethics	Neuroliterature	Neuroscience & Public Health
Neuroanthropology	Neurocriminology	Neuroforensics	Neuromarketing	Neuroscience & Public Policy
Neuroarchitecture	Neurodesign	Neurohistory	Neuromusic	Neurosociology
Neuroart	Neuroeconomics	Neurohumanities	Neurophilosophy	Neurospirituality
Neurobusiness	Educational Neuroscience	Neurolaw	Neuropolitics	Neurosports

capture the two-way intersections (the "X") between neuroscience and these societal sectors. We have found that trainees, both at the undergraduate and graduate level, are increasingly interested in NeuroX careers.

Previous research has identified a need for more support and career advice for neuroscience trainees who wish to pursue careers beyond medicine, academia, and the biomedical industry (Flaisher-Grinberg 2022; Shah and Juavinett 2022; Ullrich, Ogawa, and Jones-London 2024). Mentoring is difficult because it is not clear what types of careers are available in neuroscience and society, and what paths to those careers would be most beneficial to pursue. For example, there are not (yet) dedicated graduate programs in neuroarchitecture or neurosociology. Additionally, interdisciplinary work often requires proficiency in neuroscience *and* other intersecting fields, which can be a steep learning and training curve.

Existing initiatives to support NeuroX careers, especially neuroethics, have emerged. These include the IBRO-MENA International Conference on Neuroethics supported by the International Brain Research Organization, Early Career Policy Ambassadors sponsored by the Society for Neuroscience, and Affinity Groups supported by the International Neuroethics Society.

To further contribute to these efforts and promote resources, jobs, and opportunities in neuroscience and society fields, the Dana Foundation Career Network in Neuroscience & Society (Career Network) was launched in 2023. The goals of the Career Network are: (1) to recruit new people to neuroscience and society work, especially those from institutions and geographies that have not previously been exposed to this intersection; (2) to create and communicate new opportunities for fostering and sustaining work in neuroscience and society; and (3) to provide networking opportunities for trainees to form relationships that will contribute to career development. This effort is the first we know of that is singularly dedicated to NeuroX career mentoring and that provides resources across a wide range of NeuroX fields.

We maintain a website (www.neuroXcareers.org), distribute a newsletter to over 6,000 subscribers, and have hosted 41 regional, national, and international events across six continents—many of which are available on the website for viewing. In 2023, we launched the inaugural Virtual Career Fair in Neuroscience & Society (Career Fair). We designed the Career Fair to facilitate pathways into and improve understanding of 20+ neuroscience and society disciplines. The first Career Fair was held on Zoom for four consecutive nights in September 2023. The second Career Fair was held in September 2024, again over four consecutive nights. The first hour each night consisted of a four-person panel, and the second hour allowed students an opportunity to join breakout rooms for networking, mentorship, and individualized questions with subject-matter experts.

Speakers at the Career Fair educated students on how to effectively navigate these growing NeuroX disciplines by showcasing diverse career paths and offering advice based on challenges the speakers overcame. A key component of the Career Fair was engagement with neuroethics. In addition to a dedicated speaker and multiple breakout rooms on the topic, panelists across the different NeuroX fields spoke about ethical and societal implications. To take just one example, the discussion around neuroarchitecture considered the ethics of designing solitary confinement units in light of a growing understanding of what such isolation does to human brain function.

Building on the success of the first two Career Fairs, this article offers a roadmap for other organizations to develop similar programs tailored to local context. We discuss (I) Content Development, (II) Outreach and Recruitment, (III) Neuroethics as a Case Study of the Importance of NeuroX Initiatives, and (III) Guidance for Planning NeuroX Events.

Content Development

Breadth of NeuroX

A panel on neuroscience and society could feature panelists all working in different areas within a particular NeuroX field, e.g., four neuroethicists. Alternatively, a panel could feature one panelist each from four different fields, e.g., neuromarketing, neurohumanities, neuroethics, and educational neuroscience. Our planning team, consisting of one faculty member and the student leaders in the Career Network, discussed extensively the tradeoff between breadth (i.e., trying to cover as many of the NeuroX fields as possible), and depth (i.e., allowing enough

time to discuss the details of particular fields). Ultimately, we attempted to offer both, by expanding the Career Fair to four nights (allowing for 16 panelists) and by offering a second hour for breakout rooms (allowing for deeper dives on particular topics).

In addition, we discussed our organizing principle: Should we organize panels based on similar subject matters (e.g., grouping neuromarketing and neuroeconomics together), or should we instead organize panels based on *types* of careers (e.g., grouping panelists in industry together)? After debating, we decided to organize around the subject matter because we felt it would lead to a more cohesive discussion.

Acknowledging Uncertainty

In many career fairs, there are many potential employers and defined pathways. Students who aspire to be K-12 teachers, physicians, lawyers, architects, marketers and so on can be provided with clear advice about the types of jobs available and the steps needed to get them. Our Career Fair was markedly different. We had to confront a central challenge: What do we tell students about careers in fields that have few viable or defined career paths?

We decided to explicitly acknowledge this uncertainty and encourage our panelists to be candid about the challenges students would face in navigating these nascent interdisciplinary fields. One speaker shared this anecdote about the environment at the Salk Institute when neuroeconomics began to emerge: "One day during a lab meeting, a trainee asked the PI: What about jobs? The PI burst out laughing and said, 'Jobs? I haven't promised anybody jobs. There are no jobs in this.'" The principal investigator (PI) explained that students would have to *generate* these types of interdisciplinary jobs.

One strategy we have employed is to encourage students to focus on the substance of work, rather than job titles. For example, a search for "neurolawyer" positions will return no results. But in some key areas of law such as juvenile defense and brain injury litigation, lawyers are regularly employing brain science. They are neurolawyers even though that is not listed on their business card. Similarly, educators who deploy lessons from neuroscience in their classrooms are practicing educational neuroscience.

Emphasis on Inclusivity in Speakers

We hoped to present a program of speakers whose racial, ethnic, gender, geographic, and disciplinary diversity would create an inclusive virtual environment for attendees. We utilized an iterative process involving input from students in the Career Network on potential invitees. For each field, we initially examined the published scholarly literature, as well as recorded talks searchable online and web-based resources to identify potential speakers in each NeuroX field. Because our focus was on career development, we looked at many sectors of industry and in the nonprofit sector. Our final panelist lineup reflected this emphasis on balancing academic perspectives with nonacademic experts. In some fields, such as neuroethics and educational neuroscience, there were many potential speakers. But for smaller fields, such as neurosociology, there were only a handful of viable panelists.

Having established an initial roster of potential participants, we identified the best candidates for inclusivity and balance (by race, ethnicity, gender, career stage, geography). With no honoraria to offer, many of our invitations were declined. But through persistence and the generosity of experts across many fields, we successfully developed a diverse lineup of experts.

STUDENT OUTREACH AND RECRUITMENT

We aimed for a diverse Career Fair audience, with an emphasis on inviting students traditionally underrepresented in neuroscience, as well as educational institutions beyond R1 Universities (Grillo et al. 2022; Harrington 2022; Hill-Jarrett et al. 2023). In order to promote racial, ethnic, and regional diversity, and address the historical underrepresentation and exclusion of certain groups in neuroscience, we reached out to relevant departments, administrators, and student organizations at 860 schools designated as Minority Serving Institutions (MSI) by the Higher Education Act (Centers for MSI, Rutgers School of Graduate Education 2020); neuroscience programs at over 410 schools; all higher education institutions in South Dakota, Montana, Wyoming, North Dakota, Utah, Alaska, Idaho, Colorado, Nebraska, Nevada, Hawaii, Oregon, Kansas, Michigan, Wisconsin, and Missouri; professional associations; neuroscience industry firms; nonprofit organizations in relevant fields; and individual academic and industry leaders in relevant fields. We primarily focused our outreach on neuroscience, cognitive science, and psychology but also reached out to social science fields, including political science, sociology, criminology, business, and economics. In total, we sent approximately 5,000 individualized emails in each of the two years. These individualized emails described the Career Network, invited participation, and asked faculty and

professionals to share information about the Career Fair with their students and networks. Our email response rate was approximately 1%, in part attributable to summer staffing transitions, vacations, spam-filtering, and lack of existing relationships with the schools. Future Career Fair recruitment can prioritize more relational outreach.

This outreach succeeded, as the Career Fairs in both 2023 and 2024 proved a tremendous success in attendance and engagement. The 2023 event consisted of 39 panelists, 1,795 registrants, and 658 attendees across 27 countries. The 2024 event consisted of 37 panelists, 2866 registrants, and 776 attendees across 24 countries. Engagement within the program was extensive, with students asking questions during panels and breakout rooms, and guest speakers and breakout room leaders staying beyond the scheduled end time. We hosted the Career Fair as a Zoom "Meeting" rather than a Zoom "Webinar" so as to allow participants to unmute their microphones and turn their cameras on. This facilitated greater dialogue and genuine interactions between panelists, attendees, and breakout room leaders each evening. Event recordings with transcripts were made available online with the consent of participants, providing access for students who could not attend live.

NEUROETHICS AS A CASE STUDY OF THE IMPORTANCE OF NEUROX CAREER MENTORING INITIATIVES

Student engagement at the Career Fair around careers in neuroethics serves as a prime example of why initiatives like the Career Fair are meaningful in connecting students to emerging career opportunities. At both the 2023 and 2024 Career Fairs, leading experts in neuroethics, including professors, lawyers, and current neuroethics trainees provided a wide range of views on career opportunities within the field, ranging from academic research and healthcare policy to industry roles focused on ethical decision-making for technologies such as brain-computer interfaces and neuroenhancement.

During the event, many students voiced concerns about pursuing careers in neuroethics, citing unclear professional pathways and doubts about having the necessary interdisciplinary background. Several students wondered whether they could thrive in or even enter neuroethics without formal ethics training and wanted to know how to gain the skills needed. Panelists responded with specific, actionable advice, including pursuing specific degree programs, institutions, and labs, enrolling in specialized bioethics programs, taking advantage of interdisciplinary research opportunities that integrate neuroscience with ethical and policy frameworks, and engaging with organizations such as the International Neuroethics Society and the American Society for Bioethics and Humanities.

We saw value in having an open and frank dialogue about career paths in neuroethics. Current neuroethics trainees played a crucial role in discussions, offering relatable insights into how they overcame challenges and built upon their preexisting educational and career backgrounds. Student attendees noted that these interactions were inspiring and encouraging, helping them feel confident that they could pursue neuroethics as a career path.

LOOKING AHEAD: LEVERAGING THE CAREER NETWORK FOR STUDENT MENTORING

The combination of expert guidance, practical advice, and personal stories from current trainees has made our first two Career Fairs successful in providing students with the knowledge, pathways, and connections to succeed in interdisciplinary careers like neuroethics.

But it has also taught us that there is a much greater demand for mentoring in this space than is currently available. We hope the successes of the Career Fair will spur interest in other organizations developing NeuroX career mentoring programming. This could take on many different formats, such as tailored approaches for specific regions or a focus on a particular subset of NeuroX fields.

As a starting point, we hope that educational institutions, career advisors, neuroscience professors, and organizational leads will use the many freely available resources from the Dana Foundation Career Network in Neuroscience & Society to help craft advice, share potential opportunities, and suggest resources for learning more. The website also provides events that address concrete questions, such as: what graduate degree(s) do I need for a particular NeuroX field? To take one example, we hosted a program specifically dedicated to the JD/PhD track for careers in neurolaw.

In addition to resources posted online, we employ a Senior Fellow whose role is to answer individual inquiries and facilitate connections. In less than an hour, neuroscience professors can become better equipped to mentor their students in these new pathways to careers by perusing the website and sharing newsletter information with their communities. With a single email to the Senior Fellow, professors can

obtain additional information tailored to the unique needs of the professor's institution, geography, and student body.

For those who have a desire and time to do even more, we hope that academic departments and organizations outside academia will host their own NeuroX events. Recognizing that there are limited resources, especially limited time to add additional events to busy student schedules, we stress that a NeuroX event could be as straightforward as a roundtable discussion on the topic of careers in a neuroscience and society field. An event could also be integrated into an existing departmental workshop series, e.g., devoting one workshop a year to a NeuroX topic. Whether there is student demand is an empirical question, which departments could address through a neuroscience and society needs assessment. This might include asking all incoming graduate students and undergraduate majors about their interest in pursuing careers where they can apply their neuroscience knowledge outside the lab. We are not aware of a unit that routinely does this, so it's also an opportunity for a school to distinguish itself from peers.

One of the lessons we have learned is that mentoring students who want to explore NeuroX careers requires reaching to colleagues, often those we have never met before, in other departments on campus and sometimes in other nearby institutions. Potential partnerships may exist locally but remain difficult to identify. For example, is someone in philosophy already working on issues related to neuroethics, or is the School of Education integrating neuroscience into their curriculum on the developing brain? Engaging with local stakeholders, including industry partners, campus units, and nearby institutions, is time consuming but can be highly productive—both for mentoring and for potential new research collaborations. An efficient mechanism to facilitate the development of new collaborations is to integrate new experts into the local events discussed above.

A complement to local resources is a number of national and international organizations that can be useful for NeuroX mentoring. Organizations that may be of interest to mentors and mentees include: Simply Neuroscience, the Neuromarketing Science and Business Association (NMSBA), the Center for Law, Brain & Behavior (CLBB), the International Neuroethics Society (INS), Society For Neuroeconomics, Academy of Neuroscience for Architecture (ANFA), and many others. We have compiled lists of leading organizations in NeuroX subfields on our website. These organizations can provide mentors with access to subject-matter experts and events.

Internationally, we have had the privilege of supporting the launch of the Red Iberoamericana de Neuroderecho y Neuroética (Iberoamerican Network of Neurorights and Neuroethics), co-hosting an event on Neuroscience in Africa and Contemporary Challenges, presenting bilingual (Spanish/English) events to schools, and speaking with many international students who have come to the Career Fair and our events. Looking ahead, there is a need for further internationalization of neuroscience and society career mentoring.

CONCLUSION

Neuroscience trainees are increasingly interested in exploring careers outside the lab. While opportunities in interdisciplinary fields connecting neuroscientific expertise with other domains are emerging rapidly, navigating these pathways remains challenging for students. The Dana Foundation Career Network in Neuroscience & Society is a new resource for mentors, students, community members, and administrators to navigate and expand the new world of NeuroX careers. By offering free access to programs, compilations of NeuroX resources, and a network of subject-matter experts, the Career Network joins many partners in helping to bridge the gap between neuroscience and society.

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