ARTICLE
Integrating Community Outreach into the Undergraduate Neuroscience Classroom

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While both federal agencies and professional associations emphasize the importance of neuroscience outreach, this goal seldom reaches the undergraduate neuroscience classroom. However, incorporating outreach into undergraduate neuroscience classes is an efficient means to reach not only future scientists, but also the future practitioners (K-12 teachers, social service workers, etc.) with whom neuroscientists hope to communicate. It also provides a vehicle for faculty members to engage in outreach activities that are typically un- or under-rewarded in faculty reviews.

In this article, a Neuroscience Community Outreach Project (NCOP) is described. The project has been used in three offerings of a Cognitive Neuroscience course at a small liberal arts college, shared and applied at a large state university, and presented at a regional Society for Neuroscience meeting as an example of outreach opportunities for faculty. The NCOP assignment is a student-driven, modular activity that can be easily incorporated into existing neuroscience course frameworks. The assignment builds on student interests and connections in the community, providing a way for faculty at institutions without formal outreach programs to incorporate neuroscience outreach into the classroom and connect students to online resources. Several sample student projects are described across three broad domains (K-12 outreach, presentations to social service organizations, and media / popular press presentations). The article ends with a set of suggestions addressing common faculty concerns about incorporating community outreach into the undergraduate neuroscience classroom.

Key words: service learning; outreach; community-based learning; neuroscience; neuroscience education; pedagogy; teaching methods.

The importance of neuroscience outreach is widely recognized by both federal agencies (Friedman, 2008; NSF, 2007) and professional associations (Cameron & McNerney, 2006). For example, the Society for Neuroscience (SfN) recently adopted public education as one of its strategic goals (Cameron and McNerney, 2006; Spitzer, 2010). Outreach initiatives emerging from these efforts include the weeklong Brain Awareness Week campaign, collaborations with national K-12 teachers' associations, and the development of online and print resources for neuroscience education (Spitzer, 2010). Considerable effort has also been dedicated to providing resources that teach scientists how to communicate effectively with media and policy-makers (Cameron and McNerney, 2006; Spitzer, 2010). Such communication is known to be challenging and often involves learning to leave scientific jargon behind (Friedman, 2008; Shonkoff, 2000).

Community outreach has recently been described as a "scientific imperative" for the neuroscience research community (Friedman, 2008). Indeed, the pace of neuroscience research has led to rapid advances in neuroscience findings relevant to public health issues, including mental illness, drug addiction, and child neglect. At the most surface level, community outreach is a means for bringing basic neuroscience education both to K-12 students and to the general public. Community outreach also provides a backdrop for engaging the public in discussions about ethical issues relevant to neuroscience, including animal and stem-cell research (Iles et al., 2010). But perhaps more subtly, K-12 outreach is a key step in filling the science pipeline by exposing students to the content and excitement of an academic discipline often not covered in K-12 science courses (Cameron and Chudler, 2003; Dommett et al., 2007).

Despite the increasing role of outreach activities in the neuroscience research community, such outreach goals seldom make it into the undergraduate neuroscience classroom. Instead, undergraduate neuroscience classes typically emphasize technical understanding and laboratory exercises. While such content and laboratory training is clearly critical to a neuroscience education, exclusive focus on this type of training can leave students without a sense for the broader impacts and relevance of neuroscience information. However, meaningful integration of community outreach into undergraduate neuroscience classes can serve two complementary goals.

First, incorporating outreach into undergraduate neuroscience classes is an efficient means to reach future scientists and practitioners. Most obviously, this is important to those students who will go on to graduate education in pursuit of research careers. Early experience with science outreach may help prepare these future researchers to move beyond the "silent majority" of scientists who fail to engage in any outreach activities (Jensen, 2005). Perhaps less obvious, however, is the impact on those students who will go on to become the very practitioners with whom neuroscientists hope to communicate: K-12 teachers, social service workers, media personnel, and policy-makers (not to mention informed citizens). Somewhat paradoxically, this may represent the larger impact of incorporating outreach into

undergraduate courses. By introducing students to the materials they can access in the future (see Box 1 below), these students will leave the undergraduate neuroscience classroom having practiced applying neuroscience findings to an area of personal interest, and likely more receptive to neuroscience outreach efforts in the future.

Second, engaging undergraduate students in neuroscience outreach allows faculty members to incorporate outreach into their teaching. At most academic institutions, outreach activities by faculty members are unfortunately as yet un- or under-recognized in faculty reviews (Cameron and McNerney, 2006; Iles et al., 2010). This lack of recognition presents a primary challenge for academic neuroscientists engaging in community outreach: there are few, if any, rewards to engaging in outreach. Nonetheless, incorporating outreach into classroom teaching allows neuroscience faculty members to engage in outreach by overseeing student-generated projects, rather than being responsible for all setup and coordination. This relieves some of the burden on faculty members and also takes advantage of students' connections and involvement in the community. Moreover, to the extent that students find community outreach valuable, it may lead to greater satisfaction with course content and higher perceived relevance of course material to students' long-term goals and overall education, which are dimensions of teaching often queried in faculty evaluations.

Box 1: Online neuroscience resources for students' outreach projects. Web sites represent K-12 educational materials, popular-press style presentations of brain science, and policy briefs.

- Neuroscience for Kids
  http://faculty.washington.edu/chudler/neurok.html
  A comprehensive website with child-friendly activities and resources for neuroscience education. Includes links to video footage from Brain Works, a 30-minute children's television program on the brain, hosted by Dr. Eric Chudler.

- DANA Foundation
  http://www.dana.org/
  This web site contains several educational resources on neuroscience, including lesson plans for student activities, links to webcasts and podcasts on neuroscience, and resources for journalists.

- Changing Brains Online Video: University of Oregon
  http://changingbrains.org/
  A 60-minute science program produced by the Brain Development Laboratory at the University of Oregon, available for free download. The DVD is made for non-scientists and provides information on brain development, as well as how experience shapes brain development. Separate 5-10 minute segments cover different aspects of brain development (e.g., vision, audition, attention).

- Brain & Mind: Electronic Magazine on Neuroscience
  http://www.cerebromente.org.br/
  An online magazine with articles related to neuroscience, using language accessible to laypersons of all ages. Articles include coverage of basic neuroscience information, the history of neuroscience, and links between neuroscience and public health issues.

- Neuroscience Art Gallery
  http://www.cerebromente.org.br/gallery/all.htm
  A rotating set of artistic works depicting topics related to neuroscience (e.g., Art & Psychosis, Optical Illusions, etc.)

- PBS "A Science Odyssey"
  http://www.pbs.org/wgbh/aso/
  Web page providing resources to accompany a PBS series on science. Resources are available for teachers, and science information is presented in diverse ways, including as comic strips and as interactive multimedia activities for students.

- National Institute of Drug Abuse (NIDA)
  http://nida.nih.gov
  This web page includes resources about drugs and their effects on the brain, written in accessible language. Specific tabs link to information for students and educators.

- National Scientific Council on the Developing Child
  http://developingchild.harvard.edu/index.php/activities/council/
  A web site with resources relating neuroscience to public policy issues, including research briefs summarizing individual high-impact research studies and compiling neuroscience information relevant to policy issues such as the effects of toxic stress levels on the developing brain.

Several posters recently presented at the Society for Neuroscience describe the efforts of different institutions to incorporate outreach into the undergraduate neuroscience curriculum. For example, some institutions have developed specific undergraduate courses devoted to neuroscience outreach, often with a focus on K-12 school presentations (e.g., Pyle et al., 2009; Attar et al., 2010; see also www.bri.ucla.edu/bri_education/scienceoutreach.asp). At other institutions, individual courses have incorporated optional outreach or service learning components, sometimes in place of traditional laboratory activities and/or in collaboration with formal service learning programs at the institution (Gittis, 2009; Butcher et al., 2010). In addition, some individual neuroscience classes offer creative activities that challenge undergraduates to communicate neuroscience findings to a K-12 audience (Brabb et al., 2008; McLaughlin et al., 2010). These efforts highlight the emerging interest at several institutions to incorporate outreach activities into the undergraduate neuroscience curriculum. However, it can remain a challenge for individual faculty members without institutional or external support to incorporate outreach into their existing neuroscience classes.

In sum, although the research community endorses the value of neuroscience outreach, it is not traditionally incorporated into the undergraduate neuroscience curriculum. Unfortunately, this means a lost opportunity – both for faculty, as a means to engage in outreach, and also for students, as a means to become immersed in the broader impacts of neuroscience content. Below, a community outreach project assignment is described that faculty can easily incorporate into undergraduate neuroscience courses. The project has been used in three offerings of a Cognitive Neuroscience course at a small liberal arts college, shared and applied at a large state university, and presented at a regional Society for Neuroscience meeting as an example of outreach opportunities for faculty (Stevens, 2010). The outreach project represents a modular activity that will allow any neuroscience faculty member to incorporate outreach into their undergraduate teaching.

DESCRIPTION OF COMMUNITY OUTREACH PROJECT

The Neuroscience Community Outreach Project (NCOP) was initially developed for use in a Cognitive Neuroscience course in the Department of Psychology at Willamette University during the fall of 2008. This course is one of several upper-division offerings in biological and psychophysical processes that Psychology majors can take in partial fulfillment of program requirements.

The NCOP assignment has been used in three annual offerings of Cognitive Neuroscience, with class size ranging from 15 – 21 students. Most students taking the course are Psychology majors (75%), with a smaller number of students majoring in Exercise Science (15%) or Biology (10%). The majority of Psychology majors later pursue graduate degrees in psychology or professional schools (e.g., education, law, medicine, social work), and many ultimately work in the fields of education or social services.

In addition to its use at Willamette University, the NCOP assignment has been shared and applied at the University of Oregon. At this large state school, the NCOP assignment was incorporated into a cross-listed undergraduate and graduate elective seminar course on cognitive neuroscience entitled “Neuroscience and Society.” This discussion-based seminar course focused on the application of neuroscience research to other disciplines and societal concerns (e.g., law, sports rehabilitation, and education). The class included approximately 25 students, mostly undergraduates majoring in Psychology. To facilitate the use of NCOP in this new setting, a template for the assignment description was provided that could be modified, as well as complete sample projects. (Both the assignment template and sample student projects are posted in the Supplementary Online Materials on the JUNE web site.)

The NCOP assignment provides a general structure for guiding students in developing and executing an outreach project on neuroscience. Students are asked to think creatively about the relationship between neuroscience and real-world issues. Although students have considerable latitude on the project, in all cases the project culminates in something tangible that can be evaluated, e.g., a video, web page, set of lesson plans, etc. Students can work alone or in small groups when completing the project.

One feature of the NCOP is a set of intermediate deadlines that allow tracking and feedback on outreach projects. Students are required to turn in a project proposal early in the semester that includes a clear description of their project plan, a timeline, and the tangible item(s) that will be submitted for evaluation. To facilitate this process, several general project ideas are described to students, e.g., preparing and delivering a class unit on the brain to a first grade classroom, designing an informational web page on the neurobiology of anxiety for a college health center, or producing a news segment on a recently published research article with public relevance. However, students are encouraged to think beyond the suggestions provided, as the goal is for students to relate the projects to an area of personal interest.

These proposals are then reviewed, with feedback provided to students to help guide project execution. While many projects are clearly defined at this stage, some projects need to be narrowed in scope. As well, potential problems can be identified early, e.g., for students hoping to make a presentation to an elementary classroom, this is a time to discuss ways to make contact with local schools if students have not already done so. This stage also provides an opportunity to identify those students making presentations to outside agencies or who may require more close supervision during the execution of their projects.

Because students have considerable latitude in project design, they are also asked to create an evaluation rubric for their project, describing what A-, B-, and C-level work would look like. (Failure to complete a project would result in an F (0 points) for the assignment.) Sample rubrics and

student projects representing A-level work are provided in the Supplementary Online Materials. The use of student-generated rubrics allows for discussion of expectations for project quality. However, most projects include grading components related to both content (e.g., accuracy of material, range of sources and information, depth of analysis) and presentation (e.g., professionalism, writing conventions, and artistic quality, as appropriate). For projects that involve presentations to outside classrooms or groups, students are asked to include some form of evaluation from the participants or supervising teacher, as well as a reflection on what aspects of the presentation worked well or might be changed in the future.

Depending upon the nature of students' projects, during the semester some level of project supervision may be needed. This supervision typically occurs for projects that involve presentations to outside agencies, or reviews of preliminary drafts of pamphlets or other materials that will be broadly distributed. The final project is typically due a few weeks before the end of the course to avoid conflicts with final papers and exams.

In previous course offerings at Willamette University, the NCOP assignment has been worth 8-10% of the students' final grades, with the remaining portions based on exams/quizzes (~65% of the final grade) and a major written paper in the form of a research proposal (~25% of the final grade).

SAMPLE STUDENT PROJECTS

One goal of the NCOP assignment was to allow students to link neuroscience content to their future career goals or individual interests. The most common outreach activities were represented in the following broad categories. Full sample projects completed by students are also available online as supplementary materials.

K-12 Education: Many students interested in pursuing teaching careers chose to make presentations to K-12 classrooms. This gave students a chance to connect their neuroscience and education training, and also brought students into contact with web sites and neuroscience teaching resources they could access in the future (e.g., Neuroscience for Kids, Chudler, 2010). Figure 1 shows students making a presentation to an elementary classroom. In preparing their classroom visits, students considered effective ways to engage younger students, including the use of hands-on demonstrations and relating neuroscience information to age-appropriate topics. Students already taking education courses often aligned their presentations with state content standards and/or included curriculum staging (e.g., presentation, independent student practice, review) and evaluation of students' learning. One group of students chose a more curricular-focused project and designed a weeklong curriculum with five daily lessons to be used by first grade teachers during Brain Awareness Week. The curriculum included background information for the teacher, activities and handouts for students, and links to multimedia resources. Materials were available as both a hard copy packet and as a self-contained CD. We are in the process of making these lessons available on the web for teachers.

Figure 1. Undergraduate students giving a lesson on the brain to an elementary school classroom as part of the Neuroscience Community Outreach Project.

Social Service Organizations: Many students enrolled in the course were also completing internships or volunteering at local social service organizations. These organizations targeted diverse groups, including families at-risk for child neglect, incarcerated youth, and individuals with drug or alcohol dependency. For these students, the outreach project was an opportunity to link neuroscience research to issues at their internship site. For example, two students made a presentation at a juvenile detention center where they worked as interns. Given the high percentage of youth with drug or alcohol dependency, the students prepared a powerpoint lecture on the effects of alcohol on the brain, the neural bases of dependency, and recent research on neuroplasticity. Students worked to provide information that would give the youth a sense of the biological bases of addiction, as well as long- versus short-term consequences of substance abuse. Another student had connections at a local agency working with at-risk families to prevent child abuse and neglect. This student prepared a presentation for staff at the center on the effects of extreme stress and neglect on brain development, drawing largely on policy briefs created by the National Scientific Council for the Developing Child (http://developingchild.harvard.edu/index.php/activities/council/). These students learned valuable information about the relationship between neuroscience research and social issues, and also were able to serve as ambassadors by bringing neuroscience content to their internship sites.

Radio, Print, and Video Broadcast: Some students showed an interest in mass media and the communication of neuroscience findings to a public audience. One student was a DJ at the school's radio station and created a podcast about common misrepresentations of brain science in the popular press. Another student was the president of a student organization working with families affected by autism. She knew that many parents had difficulty wading through scientific articles. To address this need, she designed a creative, 14-page brochure that provided basic information on interpreting and critiquing

research studies, including a discussion of one popularly cited article that had since been retracted by the editors (see Figure 2 below). Other media-related projects included a video demonstration of the action potential acted out by a group of students on a football field and an edited version of an I Love Lucy episode that included MTV-style pop-up text with brain facts linked to the events on the screen. Many of these materials involved hands-on learning about the brain and were made available in future years to new students, providing supplemental learning materials in different styles.

Figure 2. Sample student project: a 14-page primer on interpreting research articles, focused on autism research.

POTENTIAL CHALLENGES

It can be daunting to add another required component to an undergraduate neuroscience course. Below, some of the concerns faculty might have about incorporating the NCOP assignment or other outreach activities into their classes are identified, along with practical suggestions for addressing those concerns.

- *Quality Control:* Some faculty may have concerns about the quality or accuracy of student presentations. Here, the proposal process provides an opportunity to build in quality control steps. It can also be useful to constrain a project such that it is easier to ensure that students are able to be accurate in their presentations. As well, the range of online resources available, some of which are described in Box 1, provide a rich source of material to help guide students.
- *Faculty Time Commitment:* Adding any new component to a class adds a new time burden for faculty members, in this case to review project proposals, provide feedback, and oversee projects. This is indeed a time commitment, but a relatively modest one compared to the effort students put into completing projects. Reviewing project proposals also is, in my experience, much more rewarding and interesting than reviewing exams or final papers. In addition, faculty teaching larger classes may be able to involve teaching assistants in this aspect of the project. Many campuses also have community outreach offices, and partnering with these organizations may help facilitate student contact with relevant outreach sites.
- *Grading Ambiguity:* Unlike exams, an outreach project has a much less clearly defined "correct answer." Requiring students to create grading rubrics provides one method for developing standards for each project but that puts the burden on students. However, many students exceed any expectations that would have been set for the assignment, as evidenced by some of the projects described earlier. The NCOP assignment has typically been worth ~10% of students' final course grades, which is enough to be meaningful but not enough to compensate for poor performance on exams or papers.
- *Student Feedback:* Faculty may worry that students will feel over-burdened by an outreach project. In my experience, students comment on the value of the assignment as providing a real opportunity to practice neuroscience outreach and link course content to other areas of their life. I have often been surprised at the amount of time students elect to invest in their projects, as well as the quality of the final products. However, based on student feedback, I have learned that it is important to structure intermediate project deadlines and also to "front-load" the outreach project early in the semester, so that it does not compete for time with final exams and term papers.
- *Targeting the Assignment:* Some faculty may feel a generic outreach project is too broad to align with the specific content focus of their course. In this case, the NCOP assignment can easily be modified to focus students' outreach on a topic most relevant to course content (e.g., drug processes in a psychopharmacology course, or the neuroscience of health in a psychoneuroimmunology course). By asking what long-range value is expected for the course content, the outreach project can be designed to facilitate that application, whether it is on a more broad or focused scale.

CONCLUSIONS

Teaching undergraduate neuroscience classes provides a unique opportunity for neuroscience outreach. Even at institutions without formal outreach programs, faculty can easily incorporate student outreach projects into the curriculum. These projects provide an opportunity for students to relate neuroscience findings to an area of personal interest and also capitalize on students' diverse interests and connections within the community. Outreach projects also introduce students to the array of neuroscience resources available on the web that they can continue to access long after leaving the classroom. For

faculty, community outreach projects are an effective way to incorporate outreach into faculty life and promote students' long-term engagement with neuroscience material.

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