

**ARTICLE****Neuroscience Study Abroad: Developing a Short-Term Summer Course****Michael G. Ruscio<sup>1</sup> and Christopher Korey<sup>2</sup>**<sup>1</sup>*Psychology Department and* <sup>2</sup>*Biology Department, College of Charleston, Charleston, SC 29401.*

Collaborative and international scientific efforts continue to be of increasing importance in the development of successful educational and research programs. The goal of our study abroad program, Neuroscience Seminar in Germany, is to bring this fact to light for undergraduates and make them aware of the global opportunities that exist in the neurosciences and related biological sciences. Here we discuss our experience of conducting a four-week summer study abroad course in collaboration with two universities associated with the German Graduate Schools of Neuroscience: Munich Center for Neurosciences – Ludwig-Maximilians-Universität (MCN-LMU) and Charité – Universitätsmedizin, Berlin (a joint institution of the Freie Universität and the Humboldt-Universität). This course combined the historical foundations of neuroscience in Germany with current research programs at these two prominent German research universities. Two weeks were

spent at each location and faculty members from the participating universities provided seminars, laboratory exercises, demonstrations and tours. Students were presented with background reading and lecture material prior to the seminars and activities. Additionally, they were responsible for leading seminar-style class discussions through brief presentations and submitting written critical analyses of primary research papers associated with the laboratory exercises. These assignments provided a means to assess learning outcomes, coupled with course evaluations. Overall, this experience may serve as a template for those interested in study abroad course development and research opportunities in the neurosciences.

*Key words: study abroad; history of neuroscience; international neuroscience research; research techniques*

Study abroad programs continue to be desirable elements of the undergraduate experience. With increasing globalization, there is an increased focus on international studies often incorporated into strategic plans or mission statements of many colleges and universities (Donnelly-Smith, 2009; Hovland, 2009). Undergraduate study abroad programs take many forms in their duration, logistical design and content. (A larger analysis of study abroad programs has been performed in detail by other sources, e.g., see Lewin, 2009). They have continued to grow steadily over the past several years in their popularity, particularly in the sciences (Wainwright et al., 2009). For example, at the College of Charleston student enrollment in summer study abroad courses has risen nearly 25 percent in the past three years (data from Center for International Education, College of Charleston). Study abroad in the neurosciences holds the promise of creating connections and collaborations among students and faculty in a field that is becoming increasingly interconnected and global. At the same time, neuroscience study abroad programs face unique challenges. For example, biology study abroad courses often identify a field site for studying a unique aspect of local ecology, therefore providing apparent justification for travel. Conversely, for neuroscience, as a more lab-based science, the value of a site visit may not be as immediately apparent. Another major challenge is that rigorous or restrictive curricular demands on neuroscience students can discourage or preclude them from pursuing a study abroad experience. There are fewer study abroad opportunities in neuroscience compared to other disciplines, and a full

semester abroad is often at the expense of undergraduate research opportunities at home. Here we detail our experience in creating and running a short-term summer study abroad course during the summer of 2011 with reference to course design, content and practical travel logistics.

Through existing collaborations between the Faculty for Undergraduate Neuroscience and the German Schools of Neuroscience (a consortium of graduate programs in Germany) we developed a four-week summer study abroad program: Neuroscience Seminar in Germany. We spent two weeks at the Munich Center for Neurosciences – Ludwig-Maximilians-Universität (MCN-LMU) and two weeks at Charité - Universitätsmedizin in Berlin. The program was designed to showcase the cutting-edge research at these universities and provide a view into the rich history of medical and behavioral neuroscience in Germany. Through laboratory exercises, site visits and interactions with German graduate students and post-doctoral research associates, the program aimed to expand the students' understanding of collaborative science and scientific opportunities in research that may exist abroad.

**METHODS: Course Content and Program Planning**

*Content: Seminar Presentations, Research Talks and Laboratory Exercises.*

The course structure was designed to give students a window into the full spectrum of a research program from design and data collection to publication. Course directors

(Ruscio and Korey – College of Charleston) served as instructors and coordinators for the program. Four to five faculty members at each institution (LMU and Charité) volunteered to contribute a seminar presentation/research talk, coupled with a laboratory exercise using techniques currently employed in their labs. The content of the course was designed in part to focus on the expertise of the faculty at each location. Therefore, at LMU we focused on comparative and systems level neuroscience. At Charité, the focus was on neurophysiology and medical neuroscience. The content was linked with a historical perspective at both locations.

Generally, both inside and outside of the classroom language was not a barrier. All graduate level courses at both universities are taught in English, and all parts of our course were in English. In both Munich and Berlin many people speak some English, so an inability to speak German on the part of most of the students did not impede their ability to maneuver and explore the respective cities. However, the course did attract some students with background in German course work or who had chosen German to fulfill their foreign language requirement. In these cases, they did have some opportunity to exercise their language skills.

Students in the course were required to read a selection of articles from each faculty member or related research group. Prior to each seminar, two students were selected to present the articles to the class. This was done in a journal club style format with significant discussion regarding the article. These discussions helped raise the collective knowledge of the group, making them more prepared to engage in a discussion with the faculty member. Course organizers provided background lecture material and handouts to the class. Overall, our aim was to create a structure resembling graduate seminars.

Following each faculty seminar there were associated laboratory exercises. There are a small number of excellent summer programs that are designed to provide a more detailed laboratory experience and focus on learning the intricacies of techniques within a particular domain of neuroscience. However, this was not our goal. Rather, we aimed to provide students with an overview of several research programs and associated techniques to convey the wealth of tools and approaches a neuroscientist might utilize. A practical constraint that fostered this design is the nature of a study abroad course in neuroscience. All of the faculty at LMU and Charité generously volunteered their time for a day or afternoon. The program organizers were only on-site days before the course began (also preceded by a trip the previous year). The logistics of obtaining full-time teaching laboratory space and prepping a laboratory component from across the globe is a significant obstacle to offering a typical laboratory component with the course. Given this constraint, we decided that developing an intricate series of experiments spanning two weeks would not have been feasible (particularly on the course's first offering) and would have limited the scope of topics. Therefore, our goals focused on exposure to a variety of

techniques, rather than enhancing proficiency or mastery of a particular one.

Table 1 provides a general outline of most of the laboratory excises we conducted. This laboratory experience, paired with a seminar presentation and background reading, provided a brief glimpse of the spectrum of an entire research program. Among the examples listed in Table 1 the students were not necessarily engaged in every aspect of the techniques from tissue collection to data analysis. It was a combination of prepared materials to get students to a point where they could see a technique in action during an afternoon and gather data from a sample or subject. For example, in the comparative vertebrate neuroanatomy laboratory, the slides were already prepared and stained, so the focus was on identification of prominent neuroanatomical structures. When students were engaged in the patch clamping exercise the sections were already mounted and prepared, but each student had his or her turn at inserting the electrode into the cell and beginning the recording.

*Content: History of German Neuroethology and Medical Neuroscience.*

A historical perspective of German science was provided through site visits and lectures. From LMU in Munich, students and faculty took a day trip out to the Max Planck Institute for Ornithology in Seewiesen. In addition to getting a full day tour and series of lectures from current researchers working at the Institute, we were able to view the site where Konrad Lorenz performed his famous imprinting studies on greylag geese and fostered his collaborations with other famous ethologists like Niko Tinbergen. This historical perspective tied in well with the current research at the Institute and the systems level neuroscience programs at LMU.

In Berlin, students were immersed in the early years of the development of neuroscience, particularly in anatomy, microscopy, and neurophysiology. Many well-known scientists who made major contributions to biology and neuroscience worked in and around Berlin during the early years of the field (Bielka and Kettenman, 2005). Students were able to see original buildings and instrumentation from the founding of electrophysiology and hear about the impact of scientists such as Alexander von Humboldt, Johannes Müller, Emil du Bois-Reymond, and Julius Bernstein from Uwe Heinemann. At the Berlin-Buch campus students learned about the history of microscopy from Helmut Kettenman and were able to see his collection of original Berlin-built microscopes including the style that was used by Camillo Golgi for much of his ground-breaking anatomical work. In both places, students experienced “Ah ha” moments where they connected an abstract name from their textbooks to the concrete history of the field.

*Content: Graduate Programs in Germany.*

Another important aspect of our program was to allow students from the US to interact with graduate students

<i>Laboratory Topics and Exercises – LMU -Munich</i>	
Comparative Vertebrate Neuroanatomy <ul style="list-style-type: none"> <li>• View slides of fish, amphibians, reptiles and birds.</li> <li>• Identification of gross brain structures and 'mystery brain'.</li> </ul>	Wullimann Lab Hosted by: Dr. Mario Wulliman
Auditory Physiology <ul style="list-style-type: none"> <li>• Patch-clamp and voltage clamp techniques recording from brainstem nuclei involved with sound localization.</li> <li>• Sound proof chambers for providing discrete auditory stimuli and measuring neurophysiological response.</li> </ul>	Grothe Lab Hosted by: Dr. Alexander Kaiser, graduate students and post-docs
Development <ul style="list-style-type: none"> <li>• Invertebrate models: <i>Drosophila</i> and grasshoppers.</li> <li>• Identification and mapping of stem cells and their lineage.</li> <li>• Confocal fluorescence and laser ablation.</li> </ul>	Boyan Lab Hosted by: Dr. George Boyan, graduate students and post-docs
Behavioral Neuroscience <ul style="list-style-type: none"> <li>• History of ethology and neuroethology.</li> <li>• Neurophysiology of bird song perception and production recorded using acoustically isolated chambers .</li> <li>• Zebra finch outdoor and indoor aviaries.</li> <li>• Wind tunnel: physiology of flight.</li> </ul>	Max Planck Institute for Ornithology Hosted by: Dr. Moritz Hertel, senior researchers, graduate students and post-docs
<i>Laboratory Topics and Exercises – Charité - Berlin</i>	
Mammalian Electrophysiology <ul style="list-style-type: none"> <li>• Over view of hippocampal neuroanatomy and function.</li> <li>• Field recordings from mouse hippocampal slices.</li> </ul>	Schmitz Lab Hosted by Dr. Benedikt Salmen
Advanced Confocal Microscopy <ul style="list-style-type: none"> <li>• <i>Drosophila</i> model of synaptic development and plasticity.</li> <li>• Discussion of microscopy and use of fluorescent proteins.</li> <li>• Stimulated Emission Depletion (STED) super-resolution microscopy.</li> </ul>	Sigrist Lab Hosted by Dr. David Oswald and Omid Khorramshahi

Table 1. Laboratory Exercises and Techniques Included in the Four Week Course by Location.

and post-doctoral students. The course was designed to attract advanced science students from the US, many of whom have plans for graduate school, yet their actual knowledge of graduate school is often fairly limited. Graduate students and post docs from LMU presented an afternoon of brief talks, followed by dinner at a local Bavarian restaurant hosted by the program. In Berlin there were a similar series of presentations and an on campus barbeque where students met graduate students, post-docs, and faculty in a more casual setting. In addition to these events, representatives from each graduate program had an afternoon to talk with the students about graduate opportunities and how a student might pursue their post-graduate studies outside of the US.

#### *Logistical Details and Planning.*

As with any study abroad program, substantial planning occurs prior to the initiation of the course. The summer before the course began, both course directors traveled to the German host institutions to determine the feasibility of the course, faculty interest and available classroom and laboratory facilities. The faculty and staff at both LMU and Charité were incredible partners in this whole endeavor. The necessity for laboratory facilities makes having an enthusiastic partner university (or universities) essential when developing a course in the neurosciences. The alignment of reciprocal goals between program organizers and the respective universities and colleges formed the cornerstone of this program. In addition to outlining our

common interests on our preliminary trip, we also needed to identify locations for housing and dining options. At both locations dining was available on campus for breakfast or lunch, but housing was not. Housing was found at nearby hostels or hotels. This was due in part to the timing of our course relative to the German academic calendar, as both institutions were still in session and, therefore, did not have any available dorm-style housing. Nearby hostels and hotels had affordable rates, but housing became a significant cost for the program.

Following this preliminary trip, we began to work more closely with the Center for International Education at the College of Charleston to work out the logistics for the course. Working with the existing infrastructure for study abroad programs greatly facilitated the planning for our program. This was particularly true regarding the course budget. The course budget comes entirely from program fees (billed to students in addition to a tuition cost). Program fees include flight, housing, most meals, faculty travel and faculty per diem charges. Advertising for the course begins in September of the previous year. Application deadline is late February to early March, with the course beginning in late May. Flight costs and USD/Euro ratios can change significantly within that time period introducing several moving variables within the budget equation relative to the time line for course organization. In addition to currency fluctuations, the number of students also influences the overall budget (as it relates to covering faculty travel and per diem), so this

budgetary factor needs to be balanced with the optimal course size for the type of program being developed.

For our first offering we aimed for 10 students. We generally envision the enrollment at this size or similar in future years. The course is designed for advanced undergraduate neuroscience (and related fields) students and open to all colleges and universities in the United States. Therefore, we developed an application process requiring the applicant to submit a letter of intent, letter of reference and transcript. Advertising for the course as well as application instructions were made available through a course website: [blogs.cofc.edu/germanneuro/](http://blogs.cofc.edu/germanneuro/). Students who were accepted from outside of the College of Charleston registered for the course through the College as if they were taking a summer course. For these students credits are intended to transfer back to the home university and should count as an elective towards a biology, psychology or neuroscience major or minor degree. (This is at the discretion of the college or university to which the credits transfer).

After notifying students of their acceptance, we met with the College of Charleston students as a group briefly, and had Skype conferences with the students from other universities. We also set up a password protected web site to allow students access to course materials and information regarding travel. This same web-site was also used for students to submit their written work (see following section).

## RESULTS AND DISCUSSION

### *Assignments and Grading*

The students' grades were based upon four written assignments and class participation/ laboratory technique. For each faculty seminar two students were assigned to lead the class discussion and were required to write a 3-5 page critical analysis of the research. Each student did this once for the Munich portion and once for the Berlin portion. These papers were due before the respective portions of the program began. Students were also required to respond to two essay style take-home exam questions (one from Munich and one from Berlin). These questions asked students to address what would be the 'next step' in one of the research programs associated with the course (students could not choose the same topic/faculty seminar for which they led the discussion/ wrote their critical analysis). Their responses were due approximately one week after the course finished. Allowing time to write while abroad is difficult. Having the deadlines for the assignment prior to, and following the course, allowed students to spend their time at the destination universities focusing on the laboratory work and engaging with students and faculty. Conversely, the difficulty in this approach is that with so much time devoted to laboratory exercises, site visits and some tourism, there is little time for detailed grading and feedback. Therefore, it is challenging to truly enhance scientific writing in this format. The feedback they receive during the presentation is substantial and there is also the value of critiquing the

presentation of others. The additional value of this approach is that for many of these students it may be the first time they are required to write critical analysis papers (as opposed to lab report or manuscript format), which combine background reading, a seminar and experimental observation. Ultimately, this will help cultivate their skills of synthesis and analysis.

Of course, in addition to all of the above assignments we wanted to ensure that students had sufficient time to enjoy both Munich and Berlin. As would be the case for any international destination, it would be a missed opportunity to spend time exclusively in the laboratory. Although most of the days were entirely full in the lab or classroom, evenings and weekends provided ample opportunity to explore. In both cities we scheduled tours and day trips on one weekend day, leaving the other open. With student discounts for most forms of public transportation and museum admission these tourist excursions were done at a very reasonable cost.

### *Evaluation, Challenges and Future Plans*

Based upon our experience offering this class during the summer of 2011 we hope to offer it on an annual basis. By most measures the course was mutually beneficial for the graduate programs at LMU and Charité and the students. Targeting a student demographic of advanced neuroscience students produces a class dynamic where the students make the most of the opportunities, while also enjoying the locale. Although the students took full advantage of the opportunities to explore both Munich and Berlin, the course did not seem to attract a demographic of those looking for a "vacation."

We requested the students fill out a detailed evaluation form ranking virtually every aspect of the program including accommodations, meals, the quality of each faculty presentation and the quality of each laboratory experience on a 7 point scale (7 being the highest). In sum the evaluations were all extremely positive (with no measure falling below a 5 and a modal value of 7 across measures). Student comments on the evaluations were enthusiastic as well. Any study abroad program promises the romantic allure of a novel destination, so in many respects students are primed for a positive experience. For our program we tried to balance this enthusiasm with scientific interest and manageable course work. Although most days in the lab or classroom were very full, students commented that they felt they had enough time to explore the cities and that there were generally enough group activities (one on the weekend, 2-3 during the week usually paired with a group dinner) and enjoyed the balance of structure and freedom.

Although not formally assessed, the course appeared to increase students' affinity for cross-cultural neuroscience. Among the students enrolled in our first class, one applied to both graduate programs (LMU and Charité) another enrolled in a semester study abroad at an affiliated German Schools of Neuroscience campus (Göttingen) and a third is seriously considering application to one of the programs this coming year and has been in contact with a

representative from their graduate school. Some students have remained in contact with the graduate students they met at LMU and Charité. Overall, the program appeared to make them aware, familiar and more comfortable with the prospect of pursuing career opportunities in Germany. Future offerings of this course will enable us to assess this more empirically.

One challenge the course will continue to face, however, is variability in student academic background. Although there is some time to provide background during the course, the assigned articles can be difficult reading for students with limited background within a specialization of neuroscience. Given the breadth of material the course covers, invariably there will be material that is completely novel to some students. To that end, we are developing online primers and short multiple choice tests that students can use prior to the course. It would seem overly prescriptive and cumbersome to require each student to have a particular set of prerequisites and weigh their equivalency across universities. Furthermore, although this diversity of academic backgrounds presents some issues, it also enhances the class dynamic as fresh perspectives are brought to each discussion.

Another major challenge for any study abroad program is cost. Often these programs can be cost prohibitive for the typical student. Offering the course in the summer has some advantages regarding timing (relative to curricular issues), but it requires a substantial cost above regular annual tuition. In contrast, for some semester study abroad programs, tuition is often comparable to a regular semester. There is no one formula to reduce cost. The College of Charleston provides competitive summer scholarships for these programs, which helps defray the cost (with the average summer program running about 4000.00 USD). Through informal conversations with several students who applied (or thought of applying), finances were noted as an issue. As they are currently run, summer study abroad programs are limited to only those students who have the financial means. Often times, these students have traveled abroad more than once with family or through a different study abroad course. Study abroad courses are advertised as life changing moments for students, but unfortunately this experience is out of reach for those students of limited means for which these courses may truly be a shift in perspective. Success in attracting this student population will require additional institutional support and/or grant support.

One challenge that all study abroad courses in the neurosciences will face (to some degree) is that it is often difficult for students majoring or minoring in neuroscience or related fields to have enough latitude in their undergraduate curricular requirements to allow for a semester study abroad. We have addressed this issue in the current course by offering it during the early part of the summer. This timing does not conflict with most academic calendars on semester schedules in the US. Furthermore, scheduling the course from late May to early June generally does not preclude students spending another two

and half summer months engaging in research back in their US home institutions as many advanced neuroscience students do in the summer.

The timing is similarly beneficial for the course instructors from the US, and provides us with sufficient time in the remaining summer to work back in our labs. Although the course is four weeks long, the duties are divided among the two instructors so each covers approximately two weeks, split by location. This arrangement has the further benefit of requiring the course budget to cover the expenses of only one faculty member at a time. Both course instructors are paid a salary at a scale similar to instructing a summer course on campus.

At present there are a few programs that address the issue of semester study abroad experiences in the sciences. Several US colleges and universities have partner institutions in Europe and help sponsor a semester abroad program in a particular discipline. These programs can be difficult to maintain on a regular/annual basis and are not targeted towards students outside the universities. Euroscholars (<http://www.euroscholars.eu/>) is one program that seeks to place students in a laboratory during a semester study abroad experience and also provides a curriculum that is developed around the student's interest. As a product of this course we have also explored options with the German Schools of Neuroscience and Network of European Neuroscience Schools to cultivate interests in this type of endeavor among US and European researchers and students.

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Address correspondence to: Dr. Michael G. Ruscio, Psychology Department, 57 Coming St. College of Charleston, Charleston, SC 29401. [rusciom@cofc.edu](mailto:rusciom@cofc.edu).