

ARTICLE

Collaborative Research in Teaching: Collaboration between Laboratory Courses at Neighboring Institutions

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The concept of collaboration is central to many scientific endeavors. Here we present a model for collaborative research between laboratory courses in behavioral neuroscience at different institutions (or for that matter, multiple classrooms at a single institution). This course design engages undergraduate students in novel scientific research inside the classroom, and in discussion of that research between classrooms. In addition to exposing students to scientific collaboration, teaching these courses in tandem allows for the sharing of a number of resources while allowing collection of potentially publishable data and training students to conduct continuing independent research.

For the 2003 and 2004 school years, we have run in collaboration the Laboratory in Brain and Behavior course at Colby College and the Laboratory in Behavioral Neuroscience: Learning and Memory course at Bowdoin College. The students enrolled in these courses have

conducted primary, novel research projects designed by the instructors using animal subjects. Students learn experimental design, and surgery, behavioral testing, and histological techniques. Enrollments are limited in these courses, so having both groups of students perform the same protocols increases the number of subjects in these studies, and therefore, the statistical power of the experiment. The physical distance between the schools requires that technology be used to bring students in the two courses together. We have used threaded discussion groups accessible to students at both schools for everyday exchange of methodological information and have used videoconferencing for "lab meetings" addressing methodological issues and data analysis.

Keywords: collaborative research, student laboratories, videoconferencing, scientific communication

Laboratory courses are often a compromise between the ease of "canned" exercises and the resources and time it takes to introduce students to the excitement of a novel research project. Ideally, we would like all students to do real research, and to do it as early in their academic careers as possible. This is especially true for STEM students (National Research Council, 2003), and recent reports have emphasized the importance of close research collaboration with faculty to the success of underrepresented minority students (e.g., Gandara and Maxwell-Jolly, 1999). This approach may be more challenging, but it may also be a better way to meet many of the desired curriculum outcomes such as those laid out by Wiertelak (2003). These outcomes include 1) introducing students to experimental methodology, design, and data analysis, 2) advanced awareness of a particular field within neuroscience, 3) critical and independent thought, 4) effective communication skills, and not least, 5) ethics.

Clearly, involving students in real research takes a considerable amount of time and resources. One way to reduce the load is to share experimental design, preparation and data between multiple classrooms or institutions. Here we present a model laboratory experience within the collaboration of two behavioral neuroscience courses at different institutions. The Laboratory in Brain and Behavior course at Colby College (PS235) and the Laboratory in Behavioral Neuroscience:

Learning and Memory course at Bowdoin College (Psyc276) are designed such that students participate in a real scientific experiment using rat subjects.

This model brings with it several advantages over individual laboratory courses. In our experience, we have been able to alternate summer piloting of the upcoming year's project, we have been able to pool data sets to increase n 's above what either lab could generate alone (especially important when classes are small), and we have fostered ongoing scientific collaboration between students and faculty at the two institutions.

MODEL COURSES

In these courses, students work together to investigate the neural basis of declarative memory in rats. In past projects, students have tested hypotheses such as whether the hippocampus is critical for nonspatial memory (2003) or "what, where, when" episodic memory (2004). For fall 2006, we will be exploring spatial and nonspatial retrograde memory. As a part of the courses, students learn hypothesis testing, a circumscribed literature germane to the hypothesis, basic skills in stereotaxic surgery (electrolytic lesions of the fornix), behavioral testing, histology, data analysis, and finally the ability to parlay the literature and their own results into formal scientific communication of their findings (e.g., preparation of a journal article as if for publication; see example syllabi in the Appendices).

Laboratory courses at our institutions are relatively small; enrollments have varied between six and 20 students each. Bowdoin College has a shared laboratory instructor who aids the professor in the teaching of student-run procedures. At Colby, the professor is aided by a student teaching assistant.

Typically, we have made a decision about the research question before the classes begin for two reasons (see Preparation below). First, this allows us to pilot the experiment during the summer before the course starts, thus increasing the likelihood that the novel research project will work. In order to reduce resources and faculty time expended, this pilot work is done at only one institution. Second, determining the focus early allows us to choose a research question consistent with the research programs of the instructors. This is not essential, but has the benefit of supporting an ongoing research program. In other words, the integration of teaching with a *successful* research project helps faculty meet their own research expectations.

During the first several weeks of the courses (see sample syllabi in the Appendices), students are oriented to the theoretical background of the project and to the major procedures, and are divided into laboratory pairs. Critically, we also discuss the process by which we arrived at the hypothesis and design of the experiment. Because students will be expected to test their animals five days per week and to schedule outside procedures such as surgeries and perfusions with their partner, selection of an appropriate lab partner is essential. As we run the courses, and because we are training rats, students are expected to contribute significant outside of class time to the project. While this extra time could potentially be problematic, students are generally enthusiastic because the prospect of participating in a real research project outweighs the time commitment. In fact, we have had only a single student leave the course because of time conflicts and that person took the course the following year.

Once the students are divided into lab pairs, the pairs are randomly assigned two rats – one that will serve as a sham control, and one that will receive a surgical manipulation. Pairs select a daily testing time and major procedure times (e.g., surgery). Both students of each pair are required to attend every testing session and procedure. This requirement is intended to teach the students the importance of ethical, humane, consistent treatment of and respect for the animal subjects, as well as the commitment one makes to the experimental process.

The course meetings are divided into “labs” and “journal clubs.” Lab time is devoted to training the proper handling of animals, the techniques used in major procedures and behavioral testing, discussion of the ethics and regulations around the use of animals in research, and discrete procedures that can be completed within the allotted time (e.g., histological staining). During journal clubs, students are expected to discuss two or three primary research papers on topics germane to the study being conducted. There are three primary goals of the journal clubs. First, students are oriented to how to read and interpret primary research, and how to present scientific content to their

peers. Second, students are given good and bad examples of science writing to help demonstrate appropriate style for scientific writing. And third, the material covered in the journal clubs will ultimately become a part of the literature review in their final project – writing a scientific journal article (we have found that the *Journal of Neuroscience* Brief Communication or *Behavioral Neuroscience* formats are ideal for teaching students the rules of publishing in the field; see http://www.jneurosci.org/misc/ifa_bc.shtml).

In addition to journal club and lab work, each class session begins with a lab meeting to discuss daily progress of the experiment. During these times, we discuss how to deal with behavioral problems (e.g., response biases) encountered during daily testing. Toward the end of the course, these discussions turn to analysis of data and the findings. Because the course meets infrequently relative to daily testing and because data will ultimately be pooled across classrooms, students are additionally asked to post comments, questions, and data to a Threaded Email Stream (see below). Special lab meetings are also scheduled at critical junctures to allow all of the students to interact (see Videoconferencing below).

This course design provides many benefits for both students and professors. The students learn the design and methods of a novel research study and experience the ups and downs of primary research. In addition, they experience the collaborative nature of research and learn the benefits and challenges of conducting research with others. They also learn to communicate their ideas and questions in forms appropriate to scientific inquiry.

The professors are allowed the opportunity to conduct novel, potentially publishable research in the context of teaching, allowing the overlap of pedagogy and research that is beneficial when there is an expectation of both good teaching and good research from faculty at their home institution. The collaboration we are advocating in this article 1) allows faculty to share some resources (e.g., piloting the experiment), 2) allows faculty to share the development of experimental design and research ideas, and 3) helps to improve the likelihood of publishable data by increasing the number of available subjects included in data analysis, thereby counteracting the variability that arises from multiple investigators/surgeons/histologists working on a single project. In other words, increasing sample size decreases the standard error of the sampling distribution of means, thereby increasing statistical power.

PREPARATION

Several steps are involved in the development of these courses. First, the professors meet to discuss possible projects. Each year of this arrangement the class experiment has been piloted at either Bowdoin (2003) or Colby (2004) in the summer prior to the semester that the courses occurred. Bowdoin will pilot the experiment in summer 2006. Also necessary is coordination of class schedules such that experimental procedures occur as close in time proximity as possible and that appropriate times can be arranged for videoconferencing (The schedules used in 2004 can be found in the sample syllabi

in Appendices I and II). In addition, it is necessary to coordinate with the ITS/Media services departments to allow sufficient lead time to establish the email stream and to set up the videoconferencing equipment in each lab.

Bowdoin

Location: [Main Index](#) / Public Discussion Board

Rat Recall

[Back](#) | [Search](#)

Message Index

Welcome, your last visit was on Thu, Oct 21, 2004, 8:51 AM and there have been 0 posts added since then.

- [1st testing h2 h5 h8 h11 - dont open binder during testing](#) - Sean and Justin - Wed, Oct 20, 2004, 5:15 PM
- [NOTES ON TESTING](#) - Seth - Wed, Oct 20, 2004, 12:23 PM
- [Shaping Day 5](#) - Rachel and Kelly - Fri, Oct 15, 2004, 4:11 PM
- [Shaping runs](#) - Andrew and Suen - Fri, Oct 15, 2004, 2:20 PM
- [10/13 H5 and H8 reports](#) - Sean and Justin - Wed, Oct 13, 2004, 5:41 PM
- [10/8 H5, H8 reports](#) - Justin and Sean - Fri, Oct 8, 2004, 6:21 PM
- [shaping #3](#) - Juila - Fri, Oct 8, 2004, 3:04 PM
- [shaping run #3](#) - Katie & Nancy - Fri, Oct 8, 2004, 9:51 AM
- [10/6 and 10/7 H5, H8 reports](#) - Justin and Sean - Thu, Oct 7, 2004, 9:56 PM
- [second shaping of H4 and H7](#) - Julia and Becca - Thu, Oct 7, 2004, 3:32 PM
- [Shaping runs H2 and H11](#) - Andrew Clark & Suen Wong - Thu, Oct 7, 2004, 12:12 PM
- [first shaping](#) - Julia Shaver and Rebecca Bartlett - Wed, Oct 6, 2004, 3:35 PM
- [first shaping](#) - Vanessa Lind - Wed, Oct 6, 2004, 12:25 PM
- [1st shaping run](#) - Nancy Curtis - Wed, Oct 6, 2004, 10:20 AM
- [Shaping Protocol](#) - Seth - Tue, Oct 5, 2004, 10:06 PM

Post a New Message

Name

Subject

Email (optional)

Message

Link (optional)

Figure 1. The Rat Recall Discussion board shown at a mid-way point through the Fall 2004 semester. Posts are descriptions of protocols and behavioral runs. Students are required to post results in real time (each day) and are asked to discuss problems and successes in the behavioral protocol.

VIDEOCONFERENCING

In order to have the members of each class meet and discuss matters important to the course without requiring the students to travel, we take advantage of the mobile videoconferencing capabilities of both schools. Members of the ITS/Media Services departments are able to set up the mobile units in the teaching laboratories at each school. The videoconferencing connection is established

through a standard TCP/IP network using network protocol H.323 language (this is a standard language for video transmission over the network). The hardware used to establish the videoconferencing link is two Model FX portable Polycom units (Polycom Inc., Pleasanton, CA; www.polycom.com), one unit located at each institution. A direct IP to IP connection between the Polycom units joins the participating institutions and visual and auditory information is displayed on a television by connecting the S Video output from the Polycom to a TV. For the first "lab meeting" we plan a general itinerary that involves introductions of faculty, instructors, teaching assistants, and students, discussion of the progress of each class, and the protocol for upcoming behavioral procedures. The format and set up are quite successful and allow the students to see and interact with those students that will be posting on the threaded discussion. The later videoconference is used for discussion of successes and failures in the methods and for data analysis. This time is also used to brainstorm changes to the protocol for future studies which are often conducted by independent study and honors students gathered from the courses.

THREADED EMAIL STREAM

For fall 2004, Nancy Grant and Adam Lord of the CIS department of Bowdoin College were charged with developing a platform by which students and faculty from both schools could read and contribute to a running discussion of course concepts and procedure. They integrated XMLBoard software licensed through the Free Software Foundation with the Psych276 course webpage to provide a multiforum message board. Posts were stored in XML format on the web server and rendered as HTML to users via a Perl module running an XML parser. More information about the software can be found at <http://freshmeat.net/projects/xmlboard>. The resulting page, named "Rat Recall Discussion," is shown in Figure 1 at a mid-way point in the experiment. The posts for the entire Fall 2004 semester can be viewed at <http://academic.bowdoin.edu/cgi-bin/xmlboard.cgi?board=PSYC%20276&action=index>. Students from both institutions were required to post descriptions of each day's behavioral run to the site so that others in the courses may track the progress of all animals in the study.

CHALLENGES AND DIFFICULTIES

There are a number of challenges in coordinating this sort of collaboration. We have been lucky that the scheduling of our courses has allowed us to employ the videoconferencing without having to do so outside of class times. The course at Bowdoin was scheduled for Tuesday and Thursday afternoons, while the course at Colby was taught on Tuesday afternoons.

In addition to the scheduling differences, there are credit/workload differences between the two courses. The Bowdoin course is a four credit hour course that involves both lecture and lab time. The Colby course is a one credit laboratory course. This generally means that the students in the Bowdoin course get more extensive background for

the study and that it is supported closely by the material they are covering in the lecture portion of the course. In order to adjust for this discrepancy, we have focused primarily on the data and materials from the experiment in the discussions and have had the Bowdoin students explain some of the background information to the Colby students. Additionally, the overall academic schedules differ slightly between the two schools. Bowdoin begins before Colby and so usually has a head start on the experiment and their experience allows necessary modifications of the protocols before the Colby group begins.

There have also been several challenges associated with the course discussion board. Initially, because the discussion was set up at Bowdoin, Colby students needed special permissions to access the board. The first solution was to keep the stream open (not password protected). However, this opened the stream to spam entries. For the 2006 year, we will be developing a dedicated, password-protected website for the collaboration. This website will further allow the consolidation of resources. This secure website will house a) links to the threaded email stream, b) links to common resources for course materials (e.g., protocols), c) digital video of example procedures including surgery, behavioral testing, and histology demonstrations, and d) raw data (e.g., digitized video clips of all behavioral testing sessions so that students could score other students sessions to ensure that behavioral scoring is more uniform). For future years' collaborations, this website will require only minor modification and updating.

OUTCOMES

We have found that the student response to the courses is extremely favorable. In particular, students are enthusiastic about the opportunity to participate in real research, and express a better understanding of the scientific process at the end of the course. These responses are reflected in several selected student comments below:

"This course was awesome! It was so great to do *real* science and perform actual brain surgery ourselves."

"The class kind of took over my time, but in return, I learned so much."

"It was awesome to be exposed to "real" science this semester. It taught me a lot about the pitfalls and problems associated with science, and gave me a long-lasting appreciation of the scientific process."

"It was a great research and lab experience. We were involved in all aspects, including the process of improvising when things didn't go according to plan."

"I thought that this lab was by far one of the more valuable experiences I've had here at Colby. Very unique and hands-on."

Perhaps the best indication of the success of this model is that invariably students enrolled in these courses have become invested in the projects, and two or three students (at each institution each semester) have continued working on the studies as independent or honors research projects.

It is noteworthy that these independent research students have already been trained in the techniques they will need to complete the work on their project, reducing the time faculty spend training students. To this point, one project has ultimately resulted in a presentation at the Society for Neuroscience meeting (Herrick et al., 2004), and these data have recently been submitted to a peer-reviewed journal. Several other projects begun in the courses are continuing as ongoing honors and independent research projects.

Furthermore, while the collaboration has not cut the resources necessary to teach such courses in half, it has reduced the cost in materials and time for the two institutions and faculty. First of all, combining data between classes increases statistical power by increasing the number of subjects in the experiment. Pooling subjects also allows the courses to be taught even when enrollments are low. For example, enrollments have been as low as six students in an individual class. In this case, in order to test enough animals for a successful experiment, students would have to spend more time than is justified by the credit load of the courses. This would mean that faculty or laboratory instructors would need to pick up the extra work in order to get meaningful (potentially publishable) results.

Second, we have alternated the piloting of the experiments, so that only one faculty needs to dedicate substantial time to the experiment during the summer. In addition, the cost of pilot animals and supplies is halved for the two courses since only one pilot study is necessary. Third, designing a study that is novel, theoretically interesting, and amenable to the constraints of the classroom is both challenging and time-consuming. By collaborating on the project, the faculty are able to share ideas and planning for a single project. Finally, other resources can also be shared. For example, in 2006 we intend to invite several outside speakers to make research presentations germane to the experiment. Using our video-conferencing abilities, we will be able to share those speakers between institutions.

CONCLUSIONS

Here we have presented a model for the integration of teaching and research. We believe that introducing students to real research projects within the classroom 1) engages students more deeply in the projects and methodologies, 2) gives students a realistic view of the conduct of scientific enquiry, 3) trains students in techniques germane to the instructors' research programs, and 4) potentially produces publishable data. Furthermore, we argue that collaboration can be a useful tool with which instructors can decrease the resources necessary to conduct a "real" study and also, through pooling data, can increase the likelihood of publishable results by increasing sample sizes. In addition, this model could be used to integrate multiple lab sections of a larger course at a single institution instead of labs at different institutions.

While the scope and animal model (rats) used in the model courses may not work for every institution, there are many other research questions that can be scaled to the

capabilities of collaborating individuals or institutions. Thus, we believe that the model could be adapted to almost any institution and research program.

REFERENCES

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APPENDIX I: Psychology 235 Syllabus

Laboratory in Brain and Behavior

Professor Jennifer Yates

Class Meetings: T 1PM-4PM

Course Objectives

Our major task for the course is to conduct a novel experiment in the field of physiological psychology/behavioral neuroscience – from conception to publication. As the instructor, my aim is to immerse you in the process of scientific endeavor. To this end, all students will have the opportunity to conduct behavioral testing, neurosurgery, and histological analysis. Students will also be expected to participate in discussions of relevant topics and studies and to prepare a scientific manuscript ready for publication review.

Course Format

This course will include instructor-led lecture/discussion and laboratory procedures. Students will be required to conduct experiments using live laboratory rats, including behavioral testing, surgery, and histological analysis of brain tissues.

Laboratory Partners

Choose your partners well; you will work with them throughout the semester. You will operate on your animals, test your animals, and conduct histological analysis with your partner. Consult sign-up times before choosing a partner and make sure that you have schedules that allow you to work together. Both partners must be present at all procedures and while testing the animals – AT ALL TIMES. However, if you are not sure you want to conduct the surgery yourself, you may wish to find a partner that is sure they do. I will not do procedures for you (with the exception of perfusions).

Required Reading

Various papers (reviews and primary research) will be required for class discussions and to prepare your final paper. These papers will generally be provided at least one week before discussion, most likely as links on the course website.

Extra-class time

Because of the demands of behavioral testing, surgery, and histological analysis, students will be expected to make

commitments of extra-classroom time. If you are unable to meet the requirements below, you should not take this course.

Handling - week 3: Each group will sign up for two 1-hour time slots to handle animals during this week.

Surgery - week 4: Each laboratory pair will sign up for one 3-hour surgery block during this week.

Behavioral testing - weeks 5-10: Each laboratory pair will sign up for 2 1-hour time slots for the week. Some variability is permissible at the discretion of the instructor and will be worked out during sign-ups.

Perfusion - week 11: Each laboratory pair will sign up for one 3-hour perfusion block during this week. Students will be invited, NOT required, to perform perfusions, but will be expected to attend.

Histology - weeks 12 and 13: Students will be expected to cut, mount, and stain their brains, as well as analyze lesions. Histology processes will be conducted as much as possible during class time, but students should expect to spend a couple hours each week outside of class.

Grading

The primary responsibility in this laboratory class is to the rats. Any student that mistreats animals or does not fulfill the obligations of training and testing will not receive a passing grade. Further, any mistreatment of animals or failure to fulfill obligations to the animals will constitute a violation of the Honor Code. Grades will be computed from 200 points as follows.

Participation (50 Points)

I am giving you 50 points simply for showing up, being prepared for class, and taking care of your animals. Mistreatment of rats or failure to fulfill your obligations of training and testing will result in 0 points for your participation grade. Obligations of training and testing include being present at all testing and procedure sessions including surgeries and perfusions. Exceptions are made for emergencies with a dean's letter.

This course will rely heavily on discussion and interaction, so you are expected to contribute. Discussion and questions make for a lively and interesting class. Therefore, questions are heartily welcomed and encouraged. Although you will not be "graded" directly on discussion, class participation may affect your final grade. Borderline grades especially can be raised by class participation (active participants will receive as many as ten points added to their grade). If you are shy about speaking in class, come discuss the lectures with me during office hours.

There is another way that you could lose your participation points and that is by not returning the keys that you will be issued for the lab and animal facility. It is of the utmost importance that you return these to me. If you have not turned them in by the time you turn in your final paper, you will lose your participation points.

Laboratory Notebook (50 points)

You will be required to keep a laboratory notebook of all of the methods, observations, and results from our experiment. Further details about the specific requirements for this assignment follow the course schedule.

Manuscript (100 Points)

You will be required to write a scientific paper describing the experiment conducted in this course, that is (in principle) ready for submission to the journal Behavioral Neuroscience. This paper is due on the last day of final exams and we will discuss preparation of this manuscript throughout the course. Further details about this assignment are provided below.

Course Schedule:

Week	Lab Period Activities	Experiment Activities
1	Orientation: Introductions, Expectations, Responsibility, Lab Partners	Experiment Overview IACUC protocol
2	Human and sheep brains, Journal Club	
3	Surgery Demo	Meet your rats: Handling Techniques
4	VIDEOCONFERENCE	Surgery: Sign up for times
5	Behavior Demo	Recovery
6	FALL BREAK	Acclimation to maze, Transport, Handling, Food preference, Turn in lab notebooks
7	Journal Club, Discussion: Scientific Writing	Training
8	Journal Club, Progress Report	Training
9	Journal Club, Progress Report, Methods Draft Due	Training
10	Perfusion Demo	Training
11	Data Analysis, Introduction Draft Due	Perfusions: Sign up for times
12	Brain Slicing Demo	Slicing: Sign up for times
13	Staining Demo, Wrap-up, Questions on Papers	Staining
	Lab Notebooks Due, Final Paper Due, Keys Due	

Laboratory Notebook

In research, it is of the utmost importance to keep careful, detailed records of your methods and results. In order to ensure that you learn these practices, each of you will be keeping a lab notebook of our experiment. This will include all of your methods, your surgery records, and your data from behavioral testing.

For this assignment, you will need a notebook in which the numbered pages cannot be removed and a black pen. There are at least two different types of acceptable notebooks available in the Colby bookstore.

Lab notebooks will be collected on the days indicated in the syllabus and graded. I will be looking to see that there are complete descriptions of your methods and that your records are legible and organized (for instance, that you write your methods and results chronologically). As we perform the methods for this experiment, I will give you tips on how best to record them in your notebook. In your notebook there should be absolutely NO white out. Any mistakes you make will be crossed out with a single line and initialed.

Laboratory Report

Your lab report will be written as if you are submitting it for publication to the journal *Behavioral Neuroscience*. This is an APA journal and as such you will follow the guidelines found in the *Publication Manual of the American Psychological Association (5th edition)*. In addition, you will need to follow the "manuscript submission guidelines" for the journal. These instructions are available at the website of the journal at www.apa.org/journals/bne/submission.html. Feel free to ask questions about any instructions that are unclear. If you do not have access to the Publication Manual, there are copies in the computer cluster in the Psych Department and on the bookshelf outside of Colleen Burhnam's office. There is also a copy on reserve in Miller Library, as well as one in the writing center.

Drafts of various parts of the paper will be due throughout the semester. Make sure that you are checking the syllabus regularly

to keep up with drafts that you have to turn in. I will get your drafts back to you in as timely a manner as possible so that you have time to make corrections. You can always feel free to turn in drafts or the final paper earlier than the dates listed in the syllabus.

APPENDIX II: Psychology 276 Syllabus**Laboratory in Behavioral Neuroscience: Learning & Memory**

Professor Seth Ramus

Lab Instructor Nancy Curtis

Discussion: Tuesdays 1:00 – 2:25 PM

Lab: Thursdays 1 – 3:55 PM

This course will require significant extra-class time (see below)

Course Aims

To conduct a *novel* experiment in the field of behavioral neuroscience – from conception to publication. As instructor, my aim is to immerse you in the process of scientific endeavor. To this end, all students will have the opportunity to conduct behavioral testing, neurosurgery, and histological analysis of brains. Students will also be expected to lead, and participate in, weekly journal discussions, and to prepare a scientific manuscript ready for publication review.

Generally, the course will focus on a systems-level approach to the neurobiology of memory, and in particular on the role of the hippocampal memory system. Because of the emphasis on scientific process, we will focus on topics most germane to our experiment. Therefore, this course is not intended to be a comprehensive survey of systems-level neuroscience nor of the neurobiology of memory. For those who are interested, a comprehensive survey of the neurobiology of learning is taught in alternate spring semesters (Psyc 318: Memory and Brain).

Course Format

The course will include instructor-led lecture/discussion, laboratory preparation and discussion, and student-led discussion (see syllabus). Each laboratory pair will be required to lead discussion at least once during the semester (schedule to be determined during the second week of classes). Students will be required to conduct experiments using live laboratory rats, including behavioral testing, surgery, and histological analysis of brain tissues.

Extra-Class Time

Because of the demands of behavioral testing, surgery, and histological analysis, students will be expected to make significant commitments of extra-classroom time. If you are unable to meet the requirements on page 2, you should not take this course.

Required Reading

Various supplemental papers (reviews and primary research) will be required for class discussions, and to prepare your final paper. These papers will generally be provided at least one week before discussion, either as a Xerox or as an e-reserve. Readings will be provided by instructor and presenting students.

Laboratory Partners

Choose your partners well, you will work with them throughout the semester. You will test your animals, operate on your animals, conduct histological analysis, and present at journal club with your partners. Consult sign-up times before choosing a partner, and make sure you have schedules that allow you to work together. Both partners must be present at all procedures, and testing the animals – AT ALL TIMES. However, if you are not sure you want to conduct the surgery (etc.) yourself, you may wish to find a partner that is sure they do (and vice-versa). Nancy

and I will not do procedures for you (with the exception of perfusions).

Extra Class Time

Surgery weeks 3 and 4: Each laboratory pair will sign up for two 3-hour surgery blocks during these two weeks.

Behavioral testing weeks 6, 7, 9, 10, 11: Each laboratory pair will sign up for a 1-hour slot. You must be able to attend that same slot M-F. Testing will often be less than 1 hour, but must be conducted 5 days per week. Some variability is permissible at the discretion of the instructor, and will be worked out during sign-ups. Because of the nature of the experiment, we will need both morning and afternoon slots.

Perfusion weeks 12,13: Each laboratory pair will sign up for one 3-hour perfusion block. Students will not be required to perform perfusions, but will be expected to attend.

Histology weeks 13, 14, 15: Students will be expected to cut and mount their brains, as well as analyze lesions. As much histology as possible will be conducted during class time but students should expect to spend about 4 hours each week outside of class.

Grading

The primary responsibility in this laboratory class is to the rats. Any student that mistreats animals or does not fulfill the obligations of training and testing will not receive a passing grade. Further, any mistreatment of animals or failure to fulfill obligations to the animals will constitute a violation of the Honor Code. Grades will be computed from 300 points as follows:

Participation: (100 pts)

I am giving you 100 points for free for showing up, preparing for class, and taking care of your animals. Mistreatment of rats or failure to fulfill the obligations of training and testing will result in a 0 participation grade. Obligations of training and testing include being present at all enrolled testing and procedure sessions. Exceptions are made for emergencies with a dean's letter. You MUST arrange for the care of your animals except under the most extenuating circumstances (i.e., you are in a coma).

This course will rely heavily on discussion, so you are expected to contribute. Discussion and questions make for a lively and interesting class. They are heartily welcomed and encouraged. Although you will not be "graded" directly on discussion, class participation may affect your final grade. Borderline grades especially can be raised by class participation (active participants will receive as much as 10 points added to their grade – you can earn more than 100 points!). If you are shy about speaking in class, come discuss the lectures with me during office hours. Students are also expected to prepare for the journal club presentation. This will not be graded, although presentations of superior quality may result in an extra 5 points.

To ensure preparation for discussions, students will need to turn in a Discussion Preparation for each journal club. The preparation will include 3 parts (I will give you an example before the first journal club) 1. questions, comments, thoughts. 2. a brief description of the methodology (if a primary paper) or a summary of a review 3. a description of the most important or interesting point/finding, and why you think it is important or interesting. You will get 1 free pass for not preparing for the journal club. Obviously, presenters will not be expected to turn in the Discussion Preparation.

Take-home exam (100 pts)

Essay exam, with three questions related to topics covered in the class, including materials presented in lectures, discussions, and labs, as well as methodological issues discussed in the course. The exam is open-book, but not open-neighbor. All answers must

be well-written and answers will be returned for rewriting if they are not clear.

Scientific journal paper (100 pts)

You will be required to write a scientific paper describing the experiment conducted in this course, that is (in principle) ready for submission to the *Journal of Neuroscience*. This paper is due on Dec 15 and we will discuss preparation of this manuscript throughout the course. Go to the website www.jneurosci.org and look at the instructions for authors. You will be expected to follow the guidelines, including word counts, formats, and citation.

Course Schedule:

Week	Topic	Outside Class Time
1	Orientation: Expectations, Responsibilities, Introductions, Choosing your lab partner, Overview of experiment. Lab Demonstration: Perfusion	
2	Lab: Surgical techniques. Lab partner choice/ journal club topics due. Lab Demonstration: Lesion surgery	
3	Lab: Meet your rats/ handling techniques. Lecture: The catastrophe of memory. Multiple memory systems. (Lab: Library Orientation). Sign up for testing times	Surgery
4	Discussion: The ethics and responsibilities of animal research. Discussion: Experimental Design. Lecture: Anatomy of the rat olfactory memory system. Discussion: Scientific Reading and Writing. Lab: Behavioral Shaping Techniques	Surgery
5	Journal Club 1: Dissociations within the temporal lobe memory system. Guest Lecture: Diane Lee, CSU Long Beach	Recovery
6	Journal Club 2: The role of the hippocampus in space; VIDEOCONFERENCE. Journal Club 3: The role of the hippocampus in episodic memory Lab: Behavioral Testing Techniques	Shaping
7	Fall Break. Journal Club 4: The role of the cortex in memory.	Shaping
8	Journal Club 5: Fornix vs. Hippocampal lesions. Lab: Writing Introduction and methods. Take-Home Exam distributed	Training
9	No Class – SfN Meeting. <i>Memento</i> . Take-Home Exam due at beginning of class	Training
10	Journal Club 6: Declarative vs. Nondeclarative memory – dissociations I. Journal Club 7: Declarative vs. Nondeclarative memory – dissoc. II. Methods section draft due	Training
11	Journal Club 8: Declarative vs. Nondeclarative memory – neuropsych. Lab: Another look at the Intro, Writing Results and Abstract. Discussion: behavioral results. Sign-ups due for perfusion and histology	Training
12	Lab: Histological Techniques and Perfusions. Guest Lecture: Howard Eichenbaum, Boston University. Intro draft due	Perfusion /Slicing
13	Discussion: Interpreting and presenting behavioral results. Thanksgiving Break	Perfusion /Slicing
14	Lab: Writing a conclusion. Lab: Staining. Lab: Interpreting what you see under the 'scope	Slicing & Staining
15	Lab: Analysis of brains. Abstract draft due. Discussion: Final Presentation and discussion of results	Histological Analysis
	Final day to submit paper	

Hints for Good Success

Come to class prepared. Read, and *think about* the assigned material before class, and be prepared to discuss the materials or

answer questions. Show up to procedures early, with a full stomach, empty bladder, and appropriate clothing.

If you miss a class, get the notes from a fellow classmate and come to office hours to clarify anything you do not understand.

If you are having trouble in class, come to office hours or make an appointment. But don't wait until the last minute, come in early, and come in often! If you are having trouble, participation in office hours can only help your grade. I am always happy to read drafts of written material before submission. The earlier I get a draft, the more attention it will receive.

If you want more extensive help with your writing, help is available through Writing Project Workshops. To reserve a conference, go to the Writing Project website http://academic.bowdoin.edu/writing_project.

Reproduction of Lectures

I do not give blanket permission to reproduce my lectures or discussions in any way. This includes (but is not limited to) verbatim recording of lectures and public posting of notes on the Internet. If you wish to record or post lectures or discussions, you must first obtain my permission. Sharing personal lecture notes and ideas with fellow students enrolled in the class is allowed (and highly encouraged).

Academic Integrity

Cheating and plagiarism will *not* be tolerated. Any work turned in that is not your own will not be counted toward your grade (in other words, you will get a zero). Please consult your student handbook on the Academic Honor Code. You will be expected to document the ideas and interpretation of others in any written communication. If you are unsure how to do this, or how to appropriately paraphrase, make an appointment with me as early as possible. Because we are using live vertebrate animals, failure to meet your obligations to the animals (including, but not limited to: mistreatment, neglect, or failure to train or test the animals, or fabrication or alteration of data) will be considered a violation of the honor code, and will be dealt with severely.

Note: this is a real experiment; therefore unforeseen circumstances may alter the timing of some activities. I will try to keep changes to a minimum and to anticipate changes as far in advance as possible.

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