

ARTICLE

Pleasure and Pain: Teaching Neuroscientific Principles of Hedonism in a Large General Education Undergraduate Course

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In a large (250 registrants) general education lecture course, neuroscience principles were taught by two professors as co-instructors, starting with simple brain anatomy, chemistry, and function, proceeding to basic brain circuits of pleasure and pain, and progressing with fellow expert professors covering relevant philosophical, artistic, marketing, and anthropological issues. With this as a base, the course wove between fields of high relevance to psychology and neuroscience, such as food addiction and preferences, drug seeking and craving, analgesic pain-inhibitory systems activated by opiates and stress, neuroeconomics, unconscious decision-making, empathy, and modern neuroscientific techniques (functional magnetic resonance imaging and event-related potentials) presented by the co-instructors and other Psychology professors. With no formal assigned textbook, all lectures were PowerPoint-based, containing links to supplemental public-domain material. PowerPoints were available on Blackboard several days before the lecture. All lectures were also video-recorded and posted that evening. The course had a Facebook page for after-class conversation and one of the co-instructors communicated directly with students on Twitter in real time during lecture to provide momentary clarification and comment. In addition to graduate student Teaching Assistants (TAs), to allow for small group discussion, ten undergraduate students who performed well in a previous class were selected to serve

as discussion leaders. The Discussion Leaders met four times at strategic points over the semester with groups of 20-25 current students, and received one credit of Independent Study, thus creating a course within a course. The course grade was based on weighted scores from two multiple-choice exams and a five-page writing assignment in which each student reviewed three unique, but brief original peer-review research articles (one page each) combined with expository writing on the first and last pages. A draft of the first page, collected early in the term, was returned to each student by graduate TAs to provide individual feedback on scientific writing. Overall the course has run three times at full or near enrollment capacity despite being held at an 8:00 AM time slot. Student-generated teaching evaluations place it well within the normal range, while this format importantly contributes to budget efficiency permitting the teaching of more required small-format courses (e.g., freshman writing). The demographics of the course have changed to one in which the vast majority of the students are now outside the disciplines of neuroscience or psychology and are taking the course to fulfill a General Education requirement. This pattern allows the wide dissemination of basic neuroscientific knowledge to a general college audience.

Key Words: Reward; addiction; relapse; craving; body weight regulation; analgesia; empathy; behavioral economics; fMRI

INTRODUCTION

The integration of the field of Neuroscience into the broad undergraduate college curriculum has been an ongoing area of interest, particularly following the decade of the brain in the 1990s. Indeed within the Journal of Undergraduate Neuroscience Education, recent articles have identified novel approaches. Flint and Dorr (2010) described how the emerging field of Social Neuroscience was used to encourage a team teaching approach to merge psychological and neuroscientific principles. Mead (2009) described a non-majors course linking Neuroscience with Womens' Studies through a thorough analysis of sex, gender and the brain. Kronemer and Yates (2012) described a more advanced undergraduate course linking neuroscientific principles of consciousness and the mind. In each of these cases, an underlying motivation was not only to examine basic neuroscientific principles, but to employ interdisciplinary perspectives such as recently described by Crisp and Muir (2012). These

ideas are in keeping with the roles of Neuroscience in the Liberal Arts curriculum (Ramirez, 2007), how literature can inform us about the history of Neuroscience (Harrington, 2006), and how the philosophy and history of science, including neuroscience can be beneficial for life science students (Hockberger and Miller, 2005). In addition, it has been demonstrated that active learning, such as in an internship, service-learning, or some other hands-on experience can deepen academic classroom-based learning (Qualters, 2010). This latter concept relates directly to a particular feature of this course that will be described later in which we utilize ten undergraduates to lead discussion sections to create another level of feedback for the current students and to better inform the instructors and graduate teaching assistants as to how the course material is received by students. For these undergraduate Discussion Leaders, this course is active experiential education.

Our college has recently implemented the inclusion of a

neuroscience-based psychology course, Pleasure and Pain, as a non-major, non-prerequisite undergraduate offering that introduces a wide array and large number (250 enrollment per term) of students to neuroscientifically-grounded topics while also providing interactions with relevance to larger areas of inquiry (philosophy, psychology, anthropology, media studies, literature and behavioral economics). In addition to graduate student Teaching Assistants, this course also employs a novel technique that uses undergraduate student Discussion Leaders who were in the course previously to interact with the two faculty members and three graduate teaching assistants to provide an interface with the large population of current students. The following sections provide: a) a genesis and rationale, b) the organization of the curriculum, c) the grading rubric including exams and a unique paper using primary-source material, d) physical and technological aspects of the course, and e) use of graduate Teaching Assistants and undergraduate Discussion Leaders. We believe that this course strategy will be of interest to undergraduate neuroscience faculty readers, particularly those at large universities and/or those struggling with burgeoning enrollments.

Genesis and Rationale for the course

In 2009, Queens College revamped its General Education curriculum, creating and revising a series of courses under the rubric of Perspectives in Liberal Arts and Sciences (PLAS). This positioned Queens College well when the City University of New York (CUNY) initiated a university-wide initiative in General Education called Pathways which became effective in Fall, 2013. Within both PLAS and Pathways, one ambitious emphasis was to teach science-based lecture courses that would stress content, scientific method as well as thinking, and writing in the sciences, thereby creating an interdisciplinary approach that would be of meaning and relevance to all undergraduates.

It was within this context that two of us, James Stellar and Richard Bodnar, began imagining this Pleasure and Pain course. Dr. James Stellar, the former Dean of Arts and Sciences at Northeastern University from 1998-2008, and former Chair of the Department of Psychology at Northeastern University from 1995-1998, served as Provost of Queens College from 2009-2013, and is currently the Vice-President for Innovative Programs and Experiential Education. Jim's research since the 1970's focused on the underlying neurochemical and neuroanatomical substrates of drug addiction, particularly the mechanisms of cocaine intake, craving, and relapse. Dr. Richard Bodnar, a member of the Queens College Psychology faculty since 1979, was Head of the CUNY Neuropsychology Doctoral Sub-Program from 1992-1998, Chair of the Psychology Department from 1998-2008, and Dean of Research and Graduate Studies from 2008 to the present. Rich's research since the 1970's focused on the underlying neurochemical and neuroanatomical substrates of endogenous pain-inhibitory systems, of sex differences in pain and analgesia, of food intake circuits, and of the underlying neural substrates of conditioned flavor preferences. Although knowledgeable of each other's work

over the decades, we two never collaborated with each other, but believed that our common interests in brain mechanisms related to pleasure and pain could be reflected in an interdisciplinary, introductory and non-majors course. It should be noted that, unlike many other sister institutions in which Psychology resides in a Social Science Division, the Psychology Department at Queens College has always resided in the Mathematics and Natural Science Division. Further, in 2005, the Psychology and Biology Departments offered the only free-standing undergraduate Neuroscience Major at CUNY. This highly-competitive program by invitation only requires a thesis-driven research project, and has recently graduated its 100th undergraduate student. The Psychology Department created a Master's Program in Behavioral Neuroscience in 2008, which has a required research-derived Master's thesis. Finally, the Queens College Psychology Department is home to the campus-based CUNY Neuropsychology Doctoral Sub-Program since 1967 in which over 300 PhD students have graduated into the fields of basic Neuroscience and clinical Neuropsychology. Thus, Queens College and the Psychology Department were well-positioned to support a non-majors general education Pleasure and Pain neuroscience course.

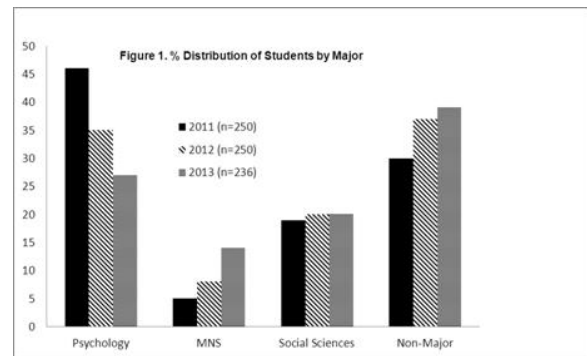


Figure 1. Shifts in the demographics of students enrolled in Pleasure and Pain over the three-year 2011-2013 period for the following groups: Psychology majors, MNS (Mathematics and Natural Science majors), Social Science (Social Science and Arts and Humanities) majors and Non-Majors (undeclared).

Although a large public college, Queens College rarely offered large-scale classes of 200 or greater. To reach a maximal number of students, we acquired use of our 250-seat Rosenthal Library Auditorium, and because of our administrative schedules, we taught the course in three successive spring semesters in 2011, 2012 and 2013 in twice a week classes (75 minutes) beginning at 8:00 AM. Despite the early hour and the "newness" of the course, we enrolled classes of 250, 250 and 236 registrants. Analysis of the over 700 enrolled undergraduates revealed an interesting pattern (Figure 1). In 2011, students were divided into the following majors: 46% (Psychology), 5% (other departments in the Mathematics and Natural Science (MNS) Division), 19% (Social Science, Arts and Humanities, Education Divisions), and 30% (undeclared). In 2012, the distribution of students shifted: 35% (Psychology), 8% (other MNS departments), 20% (Social

Science, Arts and Humanities, Education Divisions) and 37% (undeclared). Finally, in 2013, the distribution of students shifted yet again: 27% (Psychology), 14% (other MNS departments), 20% (Social Science, Arts and Humanities, Education Divisions), and 39% (undeclared). It is apparent that as the course matured, larger segments of students in a given class were taking it for its "general education" aspects as demonstrated by the increase (59% [2013] vs. 49% [2011]) of students who are using the course as a Science General Education course, and the corresponding decrease of Psychology majors (46% [2011] to 27% [2013]). Thus, a Neuroscience-related topic is being effectively delivered to a wide segment of students through this General Education format.

The Curriculum

The course introduces students to the psychological, philosophical, biological, neurochemical, sociological and evolutionary facts, principles, and theories underlying the concepts of Pleasure and Pain. These include an introduction to basic neuroscientific and anatomical principles, sensory characteristics of pleasure and pain, neurobiological systems controlling pleasure and pain, pharmacological substrates of pleasure, pain and pain inhibition, neurobiological theories and data of addiction, and translational implications of pleasure and pain examining the psychopathological and neurological disorders and their treatment. The wider examination of pleasure and pain was considered from the perspectives of Philosophy, Anthropology, Literature, Social Psychology, Neuroeconomics, Marketing, and Media Studies. Throughout the course, comparisons are made between classic and current theories and empirical data. The learning goals satisfied both the Natural Science requirement for the Queens College PLAS framework as well as the Scientific World requirement in the CUNY Pathways Initiative. Thus, it had 5 aims: 1) introduce students to multi-disciplinary approaches to important societal concepts (e.g., pleasure and pain), 2) introduce students to the use of primary- and secondary-source materials, 3) allow understanding of differentiations among theories and data, 4) demonstrate such understanding in a synthesized paper using primary-source articles by assigned single authors or research groups, and 5) introduce students to the use of neuroscientific methods to elucidate molar issues related to pleasure and pain.

Over a 15-week semester, the syllabus and lectures covered three major areas related to Pleasure and Pain and its neuroscientific substrates: a) basic mechanisms (~14 lectures), b) interdisciplinary concepts (~8 lectures) and c) translational implications (~8 lectures). Because this was a General Education course, there were no prerequisites, and therefore no pre-assumed knowledge. Thus, any material necessary for further understanding had to be included within the course framework. We also had the choice of presenting such material in a linear fashion with basic mechanisms taking the first 50% of the course, interdisciplinary concepts taking the third quarter, and translational issues covering the final quarter of the course. We deliberately did NOT take this linear path because we

wanted to emphasize to the students the importance of making connections among more global and not just reductionistic and segmented views of the subject matter. Table 1 provides the actual schedule of classes for the Spring, 2013 semester.

Lecture	Topic
1	Course Overview
2	Brains, Cells, and what every citizen needs to know about neuroscience
3	Basic neuroanatomical and neurotransmitter pathways related to pleasure
4	Brain anatomical pathways related to homeostasis and motivation for pleasure
5	Brain neuroanatomical pathways related to pain and pain inhibition
6	Cocaine, Heroin, Caffeine, chocolate, etc. - Drug addiction as a model of pleasure seeking
7	Special Lecture I: Philosophical issues related to pleasure and pain: Hedonistic Utilitarianism
8	Special Lecture II: Philosophical issues related to pleasure and pain: Critique of Utilitarianism
9	Brain chemical pathways related to pain, analgesia and related psychological states
10	Special Lecture: Cultural issues related to pleasure and pain: Anthropological studies in healing
11	Food addiction (obesity, anorexia) as models of pleasure and pain
12	Liking, wanting and needing, craving
13	Neuroeconomics - pleasure/pain and the "gut sense" goes to the market
14	FIRST EXAM
15	Certainty and Truth in Science
16	Special Lecture: Description of Pain in Literature
17	Special Lecture: Mind Genomics: Know what people want before they know it.
18	When is pleasure pain and pain pleasure?
19	Special Lecture: Pleasure and Pain in Moving-Image Media
20	Animal and clinical models of analgesic systems: Stress, Sex Differences and Psychopharmacology
21	Value in human interaction and empathy: Social Psychology meets Neuroscience
22	Animal and clinical models of pleasure: Self-stimulation and Drug Self-administration
23	Animal and clinical models of food palatability: Acceptance and Preferences
24	Mindfulness, confidence, pleasure in the clinic and in college education
25	Special Lecture: Human studies on pleasure and pain using Brain Event-Related Potentials
26	Special Lecture: Human studies on pleasure and pain using Brain Imaging
27	Decisions about Moral Dilemmas: Roundtable concerning Ethics, Neuroscience and Philosophy
28	Wrap-up, Reaction and Feedback
29	FINAL EXAM

Table 1. Psychology 103: Schedule of Classes for Pleasure and Pain

Five lectures devoted to basic mechanisms started the course with Drs. Stellar and Bodnar: a) basic neuroanatomical, neurophysiological and neurochemical concepts, b) brain systems related to "pleasure" and

“reward,” c) brain homeostatic systems, and d) brain systems related to pain and pain inhibition. Three guest lectures followed examining philosophical and anthropological issues related to Pleasure and Pain. Two philosophical lectures were presented by Dr. James Muyskens, a philosopher and current President of Queens College since 2002. Jeremy Bentham’s philosophy of hedonistic utilitarianism was contrasted with Immanuel Kant’s concepts of moral consequences in behavior. Anthropological views of Pleasure and Pain was presented by Dr. Murphy Halliburton who lectured on comparisons of ayurvedic and Western medical practices for pain treatment in India and attitude changes towards “pleasure” in food in Maoist and post-Maoist China.

Five further lectures were presented by Drs. Stellar and Bodnar devoted to specific neuroscientific and psychological issues: a) the role of dopamine and other neurotransmitters in the nucleus accumbens, amygdala, prefrontal cortex and other brain areas regulating intake of cocaine and other drugs of abuse in animal and human models, b) food addiction concepts related to obesity, diabetes, bulimia, compulsive overeating, and anorexia, c) psychological and physiological substrates of “needing,” “wanting,” “liking” and “craving” related to theories of Berridge, Robinson, Koob and Volkow, d) psychological and physiological substrates of opiates (tolerance, dependence and withdrawal) related to pain inhibition and addiction, and e) neuroeconomics of pleasure (e.g., Herrnstein’s Matching Law, “rational economics,” and Glimcher’s theories that the “brain predates rational choice”). This was followed by a 50-55 question multiple-choice mid-term examination.

The “second half” of the course commenced with five lectures devoted to larger interdisciplinary issues. One lecture covered concepts of “truth and certainty” relating them to pleasure and pain through statistical and ethical standards. A second lecture questioned Bentham’s consideration of hedonism as defining “good” as “maximally pleasurable” and “minimally painful” and defining “evil” as “maximally painful” and “minimally pleasurable” by asking “when is pleasure painful” and “when is pain pleasurable.” This lecture explored “negative” downward spiral of drug addiction, (initial positive reinforcement followed by subsequent avoidance of negative consequences), and interactions between psychopathological states and substance abuse. The remaining three guest lectures stressed interdisciplinary issues. Dr. Jason Tougaw (English) lectured on literary issues of pain, empathy, and the difficulties in writing about pain states to convey qualia. Dr. Amy Herzog (Media Studies) lectured on the roles of pleasure and pain (and their interdigitation) in classic and modern film. The third lecture presented by an alumnus, Dr. Howard Moskowitz (Moskowitz Jacobs & IdeaLab), used his groundbreaking taste psychophysical approaches towards identifying multiple segments of populations who differentiate the desirability of certain aspects of products. His studies, popularized in a TED lecture by Malcolm Gladwell, revolutionized the marketing of such household names like Grovestand Orange Juice and Prego spaghetti sauces.

His presentations show the applicability of these approaches in “learning what people want before they know it.”

The final series of lectures focused on “how” discoveries about pleasure and pain are made. This is both intrinsically and practically important in aiding the students in completing the required paper. Four lectures by Bodnar and Stellar covered descriptions of their own research programs investigating neuroanatomical and neurochemical substrates of cocaine intake and relapse using pharmacological, microdialysis and c-fos activation approaches, supraspinal pain inhibitory circuitry and its relationships to sex differences and stress-induced effects, limbic and hypothalamic circuits involved in food intake mediating orosensory and post-ingestive mechanisms involved in acquisition and expression of conditioned flavor preferences, and insula, prefrontal and accumbal circuits regulating complex decision-making about positive and negative situations. Two guest lectures investigated human responsiveness to pleasure and pain using brain event-related potentials (Dr. Ray Johnson) and functional magnetic resonance imaging (fMRI: Dr. Jin Fan). The course closed with a roundtable discussion among Drs. Bodnar, Fan, Muyskens and Stellar evaluating moral and ethical dilemmas from philosophical and neuroscientific approaches. This basic pattern of course delivery and topic staging remained consistent over all three years.

Grading

Grades for the course were derived from three sources: two (mid-term, final) multiple choice exams, and a 5-page research paper. The two exams were comprised of 50-65 questions that equally represent all of the lectures. Indeed, to allow assessment, and capitalize on the repetitive nature of some of the material throughout the course, 10 questions appeared on both mid-term and final, allowing “test-retest” assessment of learning. Well prior to each of the exams, five “practice” questions were distributed for study by the current students and discussion by the Discussion Leaders.

To expeditiously handle the large number of students, four unique versions of the two exams were created with the order of the questions scrambled. Students were instructed to sit immediately adjacent to one another (no empty seats) with the four versions distributed in each row to form uniform “columns” of exams. The two instructors and the three TAs monitored each exam. The students returned both scantron and exam with their names noted on both. Grading rubrics have maintained a high degree of consistency across the three classes from 2011-2013, indicating stability in teaching. Grades of A-F (and their + and – counterparts) with similar distributions observed for both exams in all classes. Item analyses of each question allowed question rewriting (and in rare instances question discarding), and have indicated reliability in difficulty.

The Research Paper

The five-page paper is a mixture of expository and transactional writing styles, and is a synthesis of the assigned, but unique primary-source articles indicating the

overarching purpose of the research with hypotheses and theories, the techniques and results that researchers employed, and the degree to which the researchers addressed their hypotheses in light of the data. During Week 2 of the course, the students are allowed to choose from one of the following paper topic areas: neuroanatomy and neurochemistry of Pleasure and Motivation; neuroanatomy and neurochemistry of Pain and Analgesia; drug addiction and craving as a model of Pleasure seeking; food addiction and conditioned flavor preferences; needing, wanting, liking issues related to Pleasure; analgesic systems and how opiates act in the brain; analgesic systems and the roles of stress and sex differences; and neuroeconomics in relation to Pleasure and Pain. Virtually all students were given their first choice. They then wrote an expository one-page essay due in the fourth week of the course describing the rationale and interest about their choices. The paper was graded by the three Teaching Assistants (TA) on a “check-plus,” “check” and “check-minus” basis with the latter group encouraged to meet with the TAs to discuss writing strategies.

Primary-source articles (typically 4-8 printed pages each) by prominent researchers in each of the paper topic areas were organized into a library of pdf sources. From these articles, a unique trio of related primary-source articles was assigned to each student. The paper was organized in the following manner. The first page introduced in expository style the general principles of the selected topic as it related to Pleasure and Pain followed by specific issues raised by the three papers, including conceptual interconnections and statement of overall goals and hypotheses for each paper. The second, third and fourth pages of the paper were written in transactional style describing for each article principal methodologies (including operational definitions), major findings (results), and *interim* interpretations of results of each study as it related to the hypotheses. The fifth page of the paper synthesized principal findings and interpretations of the three papers together with the final sentences summarizing “where does the field go from here?”, and how these findings related to overall understanding of Pleasure or Pain. A reference section followed using the style of the American Psychological Association.

In grading, the TA’s divided the paper into the five sections, and assigning a 20% grade for each section. The grading rubric for the whole paper follows the following scheme: 100 (A+), 95 (A), 92 (A-), 89 (B+), 86 (B), 82 (B-), 79 (C+), 76 (C), 72 (C-), 69 (D+), 65 (D), 60 (D-), 50 (F), and 0 (Not handed in or plagiarized). Grading rubrics were discussed extensively in staff meetings between the TAs and instructors. Over three years, different TA’s have achieved over 0.9 reliability in assigning grades, and the 230-250 students in each class were assigned unique combinations of primary-source articles. This approach allowed us to engage a large class of students in strongly-demanding and unique writing assignments, provide all of them feedback in the initial assignment, have them demonstrate competence in both expository and transactional scientific writing styles, understand in their writing the differences among theories, hypotheses, data

and interpretations, and become exposed to the lifeblood of the scientific method, the peer-reviewed primary-source article within the domain of Pleasure and Pain.

Determination of the final grade was based entirely upon student performance. However, rather than relying a 33.33% portion for each of the exams and the research paper, a hierarchical assignment was made such that the Highest Grade score on the exams or paper counted towards 45% of the total grade, the Middle Grade score counted towards 35% of the total grade, and the Lowest Grade score counted towards 20% of the total grade. This grading scheme is the subject of some discussion with the students and offers a certain opportunity to exercise basic math skills. There is an opportunity for extra points (see Discussion Leader section). Of course, cheating or plagiarism is not tolerated, and if caught, the student will receive an F for the course, and be referred to the Vice-President of Student Affairs.

Physical and Technological Aspects of the course

The Rosenthal Library is well-suited for such a course, particularly at the early time. Attending largely a “commuter” school (there is a 500-person dormitory on campus with a college enrollment of over 20,000 students), students often take public transportation (multiple buses or a subway and bus ride) or drive to campus. Thus, transportation tie-ups can have students arrive late. The auditorium seating arrangement (each with a “writing arm”) allows for easy ingress and egress to seats without disturbing neighbors. The auditorium has a stage that is fully “miked” and a large projection screen for all of the course’s Powerpoint and multi-media presentations. An audio-visual technician is stationed in the back of the room, and videotapes all lectures. The room has excellent “wi-fi” access enabling all students to bring and use laptops, smart phones, and tablets as well as the traditional notebook.

The major interaction among the faculty, the TA’s and Discussion Leaders, and the students enrolled in the class occurs through Blackboard. All students are vetted in Blackboard, and all course materials are placed there for easy access. Given the uniqueness of the course, there is no assigned textbook, and students appreciate the cost savings to them. Rather, all of the lectures listed in Table 1 come with their own unique PowerPoint presentation that is made available to the students at least several days before each lecture, and is left there for the duration of the course. Lectures contain links to web pages of individual professors, public domain on-line articles in the popular and scientific press, TED talks, and other materials that reinforce and, in some cases, complement and explain further the points made in lecture. Also posted on the Blackboard site is any secondary-source or primary-source reading assignments. Blackboard also supports any accompanying video clips, and all of the video-recorded lectures. Therefore, students who miss the class can have access to that lecture within one day, and the students attending the lecture can use the videotape for review. The accessibility of the video-records does not appear to appreciably affect attendance as a typical lecture is

attended by well over 150 students. Students do report anecdotally that they use the recorded lectures to review portions of the PowerPoint presentations which they either did not understand or in which they got lost.

The Blackboard site has postings of review questions before examinations, and can safely provide scores within 24 hours after an exam without affecting privacy concerns. As for the paper, a full library of the three uniquely-assigned primary-source articles are coded and stored as downloadable pdf files. When students finish their paper assignment, they are uploaded onto Blackboard, and checked by plagiarism programs before grading.

In addition to the Blackboard site, our students have regular e-mail access to their undergraduate Discussion Leaders, and the graduate Teaching Assistants. E-mail queries are generally answered within 24 hours. They also have e-mail access to both faculty instructors, and in the case of one (JS), students can communicate with him on both Facebook and Twitter. JS maintains a course Facebook page called P&P Course at Queens College. The "twitter-verse" is very active during a class when JS is not actually lecturing! Topics discussed on twitter typically include immediate clarification of points made and how the presentation at the moment relates to larger issues such as topics discussed in previous lectures.

Use of Graduate Teaching Assistants and undergraduate Discussion Leaders

In 2011 and 2012, the course had two graduate Teaching Assistants. However, in 2013, with the advent of including the initial 1-page expository essay as well as the full 5-page paper, we increased the number of graduate TAs to three. They are either Neuropsychology PhD students or Behavioral Neuroscience Masters students. TA major duties are in three broad areas: 1) Manage the course structure including the Blackboard site, the development of all versions of exam material, assignment of and grading of papers based on pdfs of original research articles, collection and analysis of exam grading data; 2) Interact with the students to answer questions after each class, in office hours, and by e-mail or otherwise on line (e.g., Facebook chat); 3) Oversight of the undergraduate Discussion Leaders (next paragraph) and interaction with the instructors about the content, style, and delivery of course material.

Following the Spring, 2011 class, Drs. Bodnar and Stellar felt that there was still a "distance" between themselves and the students and even between the "graduate TAs" and the students. Therefore, we recruited 10 students who did well in the 2011 course to serve as "Discussion Leaders" for the Spring, 2012 course. Discussion Leaders were selected on two criteria: a) a diversity of students from different fields (e.g., not a homogeneous bunch of undergraduate Neuroscience majors), and b) students who did well in the class. It should be noted that all of the students were not just "straight-A acers" of the exams and papers. Indeed, some of them expressed a difficult "learning curve" in adjusting to this course. We felt that such an experience was actually beneficial to future students! The Discussion Leaders were

enrolled in a 1-credit Special Topics course headed by Jim Stellar and so the basic Pleasure and Pain course developed a "second" course within it on how to present neuroscience material to students and provide strong student feedback to the instructors. To be a Discussion Leader, these students had to commit to 10 1-hour meetings: a) an initial organizational meeting, b) 4 pre-meetings with the faculty members and the TAs, c) 4 discussion sessions with the students strategically placed throughout the semester with their student group (see Table 1 for dates), and d) a final wrap-up session. We followed the same procedure for the spring, 2013 semester, recruiting students from the spring, 2012 class. Current students who attend and participate in these assigned Discussion sessions receive one additional point added to their final grade for each session for a maximum of four extra points. What we have observed is a "complete flowering" of this concept that is described by these Discussion Leaders. Discussion Leaders also worked with the TAs to develop written materials to help the student review for the two exams.

Specific Graduate TA Responsibilities and Observations

Graduate TAs serve as the mediator between the primary instructors and students. In addition to maintenance of the course, TAs are responsible for the Blackboard website containing PowerPoint and video lectures, supplemental materials and announcements. They also prepared the lecture room one-half hour prior to each lecture. This class preparation includes loading of lecture PowerPoint files onto the computer and setting up the associated projector screen and microphones. Any technical assistance needed is coordinated with the TAs and the Office of Converging Technologies as well as the Audio/Visual Department at Queens College. The TAs are also responsible for the maintenance of files containing pertinent material to be discussed in class that are provided in both pdf and PowerPoint formats on Blackboard. These are disseminated to all registered students one week before the lecture. During the lecture, TAs provide microphones to the students when questions are raised to the lecturer. This is necessary to ensure that all student questions and comments be made audible while the course is being videotaped. TAs hold office hours to facilitate student questions and answer student emails. In order to maintain the dynamic of the course and to address any pressing issues, TAs attend weekly Wednesday meetings with the course instructors. Examination preparation and policies are implemented during this meeting to allow preparation of the four versions. TA's grade examinations, and post results on Blackboard. The TAs assign paper articles, grade them and providing feedback to students.

The organization of Discussion Leader meeting times is coordinated by the TAs. Additionally, material to be presented is reviewed for accuracy by the TAs prior to the meeting. During the course of the semester, TAs hold informal meetings with the Discussion Leaders to discuss strategies for better addressing student concerns. As a

result of these meetings and in anticipation of the final examination, the TAs felt the need to create a “student-led” review sheet that would be addressed in person by the heads of the course. In order to create the review sheet, TAs instructed the Discussion Leaders to gather lecture questions from students who attended their meetings. These questions were used to create a “wrap-up” lecture to which the heads of the course addressed each question and provided additional comments with regard to the final examination.

Finally, many of the TAs are also adjunct instructors themselves with an interest in staying in academics following attainment of their masters or PhD. As a result, to be able to experience the creation, development and tweaking of a brand new course is a crucial learning experience for the TA's future career. By creating a symbiotic relationship among the TA's, primary instructors and Discussion Leaders; the course allows for various kinds of professional and experiential learning that aids all parties in the advancement of teaching and instructing strategies.

Specific Undergraduate Discussion Leader Responsibilities and Observations

An almost universal experience of the undergraduate Discussion Leaders was that leading discussion groups was an incredible experience, and in one description, “a first foray onto being on the other side of the teacher's desk.” The Discussion Leaders found that they had to balance working both collectively and independently, dividing the work amongst themselves, but working on their own lecture sections independently. They brainstormed to come up with ways to run effective discussion sections despite considerable variations in personality and dynamics.

Another important experience included the excitement of actually talking to other students about the various topics covered across the semester ranging from literary issues related to neuroscience to the dopamine system. A vital aspect of this experience was the ability to make connections between the class and the students' lives. One example of this was illustrating a study that connected pictures of cute baby faces to activation of the subjects' nucleus accumbens. This was accomplished by actually presenting a series of Tumblr blogs dedicated to pictures of cute babies. Very often, student struggles with complex course material may be mitigated if the student is asked to produce any illustrative personal experiences (e.g., through a brief essay assignment). Such a concept can be done in a large class in this Discussion format.

Because of the academic diversity of the Discussion Leaders, the undergraduate students found that the Discussion Leaders identified with many of their struggles. This identification became a teaching mechanism by which the Discussion Leaders could solidify the student's knowledge of basic neuroscience, neuroanatomy, statistics and concepts in psychopathology by using a language the students could more easily understand and give the students a realization that memorization was not enough, if something was learned—it would stay with you forever.

A frequent issue in this discussion group concept was the desire of the instructors to have “discussion” during the discussion groups, whereas the students wanted to review the mountainous backlog of material they had yet to comprehend. Although great diversity of styles were used by Discussion Leaders including lecturing, fill-in the blanks, quizzing, one-on-one, class outlines, and review questions, each of which can be effective and theoretically gives the students options, this can end up with most students missing out on a part of the discussion. The idea of handing out review sheets was a huge success. The PowerPoint presentations contained a variety of pieces of information, much of which would not be necessary to know for the examinations. By recounting their own past experiences managing this information as past students of this class, the Discussion Leaders reinforced how helpful it would be for students to have a guide to the important points that were more likely to appear on the exam. This helped avoid frustration and helped students score better on the tests. The Discussion Leaders found that they often became the first in line to answer questions for students, and give them an idea of how to approach the major requirements in the class.

A major challenge that the Discussion Leaders encountered was the assigned paper based on three primary source articles. Many students experienced frustration on having to begin reading papers with very heavy jargon, and confusing statistical graphs that took effort to decipher before they got the general idea of how the data was being organized. The Discussion Leaders created and employed strategies to help the students systematically go through the articles and organize their ideas around them. Major solutions included reading abstracts, identifying operational definitions, and returning to past lectures, which discussed material relevant to their papers.

Thus, the Leaders often gave pointers on how to study off the PowerPoints, how they approached reading and summarizing what was for many of them their first scientific papers and often asked questions to the TA's and Professors on the students' behalf.

SUMMARY

We served multiple masters in this course. We introduced science concepts, particularly neuroscience, to a large audience of students who might have had few such experiences in college. We provided these students experience to multiple points of view from two co-instructors and many guest instructors, some far outside the field. We taught a large course that was highly efficient and thus conserved institutional resources thereby allowing a public institution with modest tuition to run many other small courses in other needed areas (e.g., writing, language). We experimented with serious web enhancements providing students with all necessary learning materials without cost. We gave them a means to communicate with us and each other using available public domain software (e.g., Facebook and Twitter). We involved undergraduates on the teaching side, providing an experiential opportunity for them to learn as well as

providing the instructors and TAs with a much deeper connection to how undergraduates were receiving the course. Many of our staff meetings and much of the times we all met together were devoted to this feedback and how to handle it. We had fun as a large teaching staff and a large course. We let go a little of the control professors typically possess, and the course improved. To all of us on the teaching side, the course was a pleasure ... not a pain.

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