ARTICLE Using Case Studies from *Neurocase* to Promote an Understanding of and Appreciation for Behavioral and Forensic Neuroscience

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Understanding both the content and the relevance of neuroscientific material is often challenging for undergraduate students. To increase student interest in, engagement with, and understanding of neuroscientific material, Forensic Psychology and Psychology majors completed group presentations of case studies selected from the journal Neurocase. Cases were selected to emphasize issues relevant to psychology and forensic psychology. Presentation groups consisted of students with the same major, and students were reassigned to different groups for each presentation, ensuring an opportunity to work with different classmates. Presentations included a summary of the case study, explanation of the connections to neuroscience (i.e., neuroscience content), and a description of the different careers that might be associated with that case. Each group also generated a question used to stimulate discussion of the case study with the class. In

The field of neuroscience continues to expand and our understanding of how the nervous system works extends into many different areas and involves many different professionals. Access to neuroscientific material has greatly expanded because of social media platforms, blogs, podcasts, and TED talks. Undergraduate students majoring in Psychology and Forensic Psychology often struggle with neuroscientific content, anecdotally reporting difficulty with the material and challenges with understanding how the material connects to their individual career path. Such claims are often surprising to those of us working in neuroscience, but they do provide an opportunity for faculty to help their students better understand neuroscientific factors that have become increasingly more influential within forensic settings. For example, Cara Altimus (2016) reported an almost complete absence of neuroscience from the criminal justice system while working for the Department of Justice, despite the critical potential to contribute to our understanding of the mental state of perpetrators at the time of an offense (Egbenya & Adjorlolo, 2021). The importance of facilitating a solid understanding of and appreciation for neuroscience is important. One method of potentially achieving this in educational settings is with published case study research, broadly defined in this context as singlecase or small sample qualitative or quantitative designs.

Scientific case studies may be valuable pedagogical resources, but they are not without their flaws (Crowe et al., 2011). Many have criticized such reports based on a

addition to the instructor's assessment, students engaged in self- and peer-grading for each presentation. Demographic and group project questionnaires were administered after the last group project was completed. The project questionnaire consisted of 22 questions, using a Likert scale, and 3 free response questions. Non-parametric onesample Wilcoxon Signed Ranks tests revealed statistically significant effects for all 22 questions. Students found the work interesting and valuable, reported an increased understanding of the field, its applications, and career relevance, and a facilitation of critical thinking about the material. Students also found the grading rubric and the peer grading process to be an effective means of assessing student involvement and performance.

Key words: case studies; forensic neuroscience; neuroscience; biopsychology; group presentation

potential lack of generalization (Yin, 2009), although there may be several approaches to address this limitation including respondent validation and theoretical sampling (Crowe et al., 2011). Despite the debates around the scientific value and generalizability of case studies, this subset of scientific literature may be of value in the education of undergraduate students. Case studies are frequently associated with rare, unique, and/or otherwise undocumented cases elevating the level of intrigue and interest undergraduate students may have for the material. Such studies are often, but certainly not always, shorter than other empirical research reports, requiring less time to be read by undergraduate students. Case studies also frequently contain substantial details and history on the case(s) being reported, making them more tangible and relatable to the reader.

The use of case studies in education is not novel, and we expect that many faculty utilize case studies in the classroom at both the undergraduate and graduate level. For example, Whipple (2001) and Gelman and Mirabito (2005) reported the use of case studies to educate students pursuing a master's degree in social work, and Sudzina (1997) indicated the effective use of case studies for teaching educational psychology. Both Meil (2007) and Kennedy (2013) utilized case studies to help students better understand biopsychology and neuroanatomy, respectively. These studies make valuable pedagogical contributions and provide faculty with useful models for incorporating case

studies into their neuroscience courses. In the study reported here, we expand on those important contributions in several ways. First, many of these prior studies relied heavily on books consisting of published compilations of case studies. There are several such compilations of qualitative and/or quantitative reports including numerous books by Oliver Sacks (e.g., 1985, 1995, 2010, 2012), DSM-5TR Clinical Cases (Barnhill, 2023), Further Case Studies in Forensic Psychology (Tully & Bamford, 2022), Fractured Minds (Ogden, 2005), and books by Harold Klawans (e.g., 1988, 1990, 1996, 2000). These texts are extremely useful, particularly in the undergraduate classroom, and they are also often very well-received by students. However, those advantages are sometimes offset by a lack of rigorous scientific peer-review, the absence of important details that would otherwise be included in a published journal article, and the fact that many such examples are quite old. For example, it is not uncommon to have students raise concern regarding the use of outdated and offensive terms such as "moron," "booby," "retarded," and "idiots" as found in some of the early works by Oliver Sacks (e.g., Sacks, 1985). Second, reading, understanding, analyzing, and thinking critically about peer-reviewed empirical research are important skills for undergraduate students to gain and are things we hoped to help students with in the current study. Third, the rapidly evolving field of forensic neuroscience has been largely left out of the previously published case study compilations. Faculty developing courses in this area, or those who find increasing numbers of students with interests in forensic neuroscience, might benefit from the use of case studies with forensic neuroscience content. Fourth, many reports on the use of case studies for teaching purposes have highlighted opportunities to incorporate both group work and oral presentations. Both Meil (2007) and Kennedy (2013) indicated the importance of developing these skills at the undergraduate level. Here we have tried to expand upon the group work and peer evaluation process reported by Kennedy (2013) to facilitate group interaction and collaboration. Lastly, we were particularly interested in challenging students to consider the range of professions involved in the development of each case study as well as reflect on those who might be interested in reading and learning about the results of each specific case study. This was done to help students better understand the potential applications and relevance of the material.

Several of the five objectives described above have been identified as core competencies of undergraduate neuroscience programs (Kerchner, Hardwick & Thornton, 2012). These authors identified the development of basic knowledge in neuroscience, critical thinking and integration, and communication as three of the six core competencies. Survey respondents in the Kerchner et al. study indicated that the 'ability to read and analyze a primary research paper' was considered the most important aspect of critical thinking and the 'ability to present information orally in an organized and understandable manner' was the most essential component of communication. The activity we report here provides an opportunity for faculty to incorporate many of these core competencies in a single activity.

Here we present a successful and formalized approach to using case studies from the journal *Neurocase* in two sections of an undergraduate biopsychology course in which both Psychology and Forensic Psychology majors were enrolled.

MATERIALS AND METHODS

Participants

Thirty-five students, from two sections of a 300-level undergraduate Biopsychology course, at a small institution in upstate New York, participated in this activity. The mean age was 21.46 years (SD = 2.80) and responses for sex/gender indicated participation of 7 men, 25 women, 2 non-binary, and 1 transgender. Responses for race/ethnicity revealed 23 white, 1 Hispanic or Latino, 6 black or African American, 2 Asian, and 3 who indicated "two or more races." Nineteen of the students were enrolled in either the B.S. or B.A. Psychology degree program while 16 were enrolled in the B.S. Forensic Psychology program. Fourteen participants were seniors, 18 were juniors, and 3 were sophomores.

Students were expected to complete the case study assignment and group presentations as part of the course requirements. Completion of the demographic and project questionnaires was completely voluntary. The protocol for this study was approved by the Institutional Review Board for research with human participants prior to any data collection.

Materials

A standard demographic questionnaire was used to acquire information that would adequately describe the general characteristics of the sample, and provide the information reported in the participants section above. The project questionnaire consisted of 22 statements (see Figures 1-5) for which students reported their extent of agreement using a 5-point Likert scale (Disagree Strongly, Disagree, Neither Agree nor Disagree, Agree, and Agree Strongly). In addition to these items, participants were also asked to answer 3 open-response questions (What did you find most engaging, helpful, or interesting? What techniques did you find most helpful with engaging with the material? Do you have any suggestions or recommendations for improving this project?).

Articles were divided into two categories from which articles were selected and assigned to groups, those with relevance to students majoring in Forensic Psychology and those with more relevance to students majoring in Psychology. The full list from which articles were selected for each assignment is provided in Table 1 (interested faculty are encouraged to review *Neurocase* for other interesting case studies).

Neurocase Articles					
Biopsychology/Behavioral Neuroscience Articles		Forei	Forensic Neuroscience Articles		
Adluru et al., 2020	BrainAGE and regional volumetric analysis of a Buddhist monk: a longitudinal MRI case study	Bani-Fatemi et al., 2015	Epigenetic studies of suicidal behavior		
Assefa et al., 2012	Case report: anxiety and fear in a patient with meningioma compressing the left amygdala	de Castro Prado et al., 2021	A case of developmental pedophilia unmasked by frontotemporal dementia		
Bauer et al., 2020	Social cognition in an adult epilepsy patient with developmental amnesia	de Oliveira- Souza et al., 2001	Executive amnesia in a patient with pre- frontal damage due to a gunshot wound		
Benoilid et al., 2013	Heroin inhalation-induced unilateral complete hippocampal stroke	Degeilh et al., 2017	Functional brain alterations during self- reference processing in adolescents with sexual abuse-related post-traumatic stress disorder: a preliminary report		
Buchwald et al., 2020	Musical hallucinations with a right frontotemporal stroke	Devinsky et al., 2010	Kluver-Bucy syndrome, hypersexuality, and the law		
Dubarbie et al., 2020	Fatal consequences of decreased sensitivity to pain and temperature in a frontotemporal dementia patient	Durmaz et al., 2020	From psychosis to Wernicke encephalopathy: a case of hunger strike in prison		
Fornazzari et al., 2021	The painter who changed her brain at the flick of a switch	Habermeyer et al., 2012	LH-RH agonists modulate amygdala response to visual sexual stimulation: a single case fMRI study in pedophilia		
Herbet-Seropian et al., 2021	Uncommon case of complete loss of hunger following an isolated insular stroke	Kalbe et al., 2008	Neuropsychological and neural correlates of autobiographical deficits in a mother who killed her children		
Kashfi et al., 2017	Hyper-brain connectivity in binge drinking college students: a diffusion tensor imaging study	Kopelman et al., 2001	Amnesic syndrome and severe ataxia following the recreational use of 3,4- methylene-dioxymethamphetamine (MDMA, 'Ecstacy') and other substances		
LaPorta et al., 2021	The man behind the bed: a case of peduncular hallucinosis treated with quetiapine and melatonin	Mitchell et al., 2006	Divergent patterns of aggressive and neurocognitive characteristics in acquired versus developmental psychopathy		
Li et al., 2020	Radiographic and neurobehavioral profile of sports-related concussion associated with scholastic wrestling: a case report	Odegard et al., 2013	Memory impairment exhibited by veterans with Gulf War illness		
Maresca et al., 2021	Assessment and rehabilitation of cognitive deficit in a Niemann-Pick type C disease patient	Pignatti et al., 2012	Selective IGT decision-making impairment in a patient with juvenile Parkinson's disease and pathological gambling: a role for dopaminergic therapy?		
Reinders, 2008	Cross-examining dissociative identity disorder: neuroimaging and etiology on trial	Pontius, 2008	Kindled non-convulsive behavioral seizures, analogous to primates. A 24 th case of 'limbic psychotic trigger reaction': bizarre parental infanticide – might nonvoluntariness during LPTR become objectified by primate model?		
Ruis et al., 2015	Cognitive disorders after sporadic ecstasy use? A case report	Rodriguez et al., 2017	A neuropsychological study of older adult first-time sex offenders		
Sato et al., 2021	Visual texture agnosia caused by bilateral posterior cerebral artery stroke: a case study	Takahashi et al., 2018	DNA methylation of the NR3C1 promoter region in brains of pediatric victims of physical abuse		
Saunier et al., 2021	Cerebellar damage affects the inference of human motion	Yiannopoulou et al., 2009	Possible epileptic origin of symptoms in a case exemplifying the sleeper kind of 'limbic psychotic trigger reaction.'		

Table 1. List of identified case studies published in the journal Neurocase with relevance to biopsychology/behavioral neuroscience and forensic neuroscience.



Figure 1. Mean response to each question from the Project Questionnaire that addressed neuroscience knowledge.



Figure 2. Mean response to each question from the Project Questionnaire that addressed critical thinking/integration.



Figure 3. Mean response to each question from the Project Questionnaire that addressed group work.



Figure 4. Mean response to each question from the Project Questionnaire that addressed grading.



Figure 5. Mean response to each question from the Project Questionnaire that addressed the assignment satisfaction.

Question & Category of Response	Representative Examples of Qualitative Responses	Number of Responses
What did you find most engaging, helpful, or interesting?		·
Readings	"The articles in general are very interesting."	21
Groupwork	"I think the most engaging thing was being able to communicate and learn from others." "What I found the most beinful about these projects were	9
Presentation/Assignment	that they helped to apply the things we learned in class into ways that were easy to understand."	8
Careers What techniques did you find most helpful with engaging with the material?	"I found looking into the different jobs very interesting."	3
Groupwork	"Being able to talk with the members of your group to better understand any material."	8
PowerPoint for Presentations	"Making the PowerPoints was a good way to lay out information for someone like me who is a visual learner." "The techniques I found the most helpful with engaging with the material were the discussion questions at the	3
Discussion	end of the project. They helped me to think more about the topics and engage in discussions with my classmates."	4
Do you have any suggestions or recommendations for improving this project.		
Grading Process	"I would give everyone an individual grade for the content they did in the presentation otherwise I enjoyed doing these and hope you continue them."	7
No Changes	"No, not really? I think everything was great, especially in terms of getting people out of their social "bubbles" after the pandemic. Very helpful."	6

Table 2. Responses to the 3 open-response questions were divided into categories based on response type. A representative example of the type of response is provided for each category as well as the number of responses within each category.

Students were required to work in groups on these projects. To facilitate individual involvement and engagement with the group, part of each student's grade was associated with their assessment of themselves and each group member. A Peer Grading Rubric was developed and administered through the Canvas learning management system. Students were asked to rate themselves, as well as each individual group member on four measures using a 5-point Likert scale (Very Poor, Below Average, Average, Above Average, and Excellent). The four items were "Was open and flexible with respect to scheduling group meetings," "Attended scheduled group meetings," and "Came to group meetings prepared." Only the course instructor had access to students' self and peer ratings.

Each student's grade for each of the four projects was determined using the grading rubric displayed in Appendix 1. The teamwork portion of the grade was worth 5 points and was determined by calculating the mean of all the self/peer ratings from the Peer Grading Rubric. To encourage group work, students were told that the presentation "content" grade and the grade for the "PowerPoint slides" would be the same for all group members. In other words, students were all encouraged to work together to determine the content and to develop the PowerPoint Slides. Only the Presentation Quality portion of the grade was specific for each individual group member.

Procedure

For each of the four projects, groups were formed with 3-5 students sharing the same major, and each group was then assigned an article relevant to their major. New groups were formed for each project so that students would have an opportunity to work with different classmates.

It was recommended that group members share contact information so that they could easily arrange to work together on the project outside of class. Groups were required to thoroughly read and discuss their assigned article and then develop a 10–15-minute PowerPoint presentation including the following components: 1) a summary of the case study, 2) a description of the specific neuroscientific content, and 3) a detailed description of the different types of careers that might have been involved in this case study and careers of individuals who might be interested in a case study such as this. In addition to these items, each group was instructed to develop a discussion question to be shared with the class at the end of their presentation to facilitate further analysis of the case and class participation.

Within 24 hours of the classroom group presentations, each student was required to go into the Canvas learning management system and submit their self and group member evaluations using the Peer Grading Rubric. Students were told that if they assigned a grade below "Excellent" for themselves or for any of their groupmates on any of the four items that they must provide an indication as to why that rating was given. Unjustified ratings below "Excellent" would not be accepted. Average scores on each of the four items were calculated and incorporated as a small portion of each student's assignment grade.

Toward the end of the semester, after all group presentations had been completed, students were asked to complete the demographic questionnaire and the project questionnaires. No names were provided, demographic and project questionnaires were submitted separately and placed into separate envelopes, and completion of the questionnaires was entirely voluntary.

RESULTS & DISCUSSION

Non-parametric one-sample Wilcoxon Signed Rank tests were conducted for each of the 22 Likert-scale questions using "3" (Neither Agree nor Disagree) as the median comparison value. Questions were divided into groups based on content. Questions on neuroscience knowledge, displayed in Figure 1, revealed significant effects for all questions with z-scores ranging from 4.77 to 4.85 and all p values <.001. Figure 2 displays the results of the questions on critical thinking/integration. Z-scores for these questions ranged from 4.56 to 4.93 and were all significant with p values <.001. Groupwork questions were also significant, with z-scores ranging from 3.24 to 4.94 and p values <.001 (see Figure 3). Questions about grading are displayed in Figure 4. All questions were statistically significant. Five had p values <.001 with z-scores between 3.83 and 4.75 and one question (Assigning all group members the same "content" and "PowerPoint" grades for the assigned article was fair.) had a z-score of 2.64 and p value of .008. Lastly, the questions about assignment satisfaction (see Figure 5) revealed z-scores ranging from 4.61 to 5.09 with p values <.001.

Participants provided many written comments for the open-response questions, none of which were negative. These comments were examined and broken down into categories for each open-response question. Table 2 shows the primary categories of responses for each question, number of responses within each category, and provides a representative example of the type of comment within each category.

The case study projects used here appear to have been very well received by the students. Based on the questionnaire responses, students generally found the projects helpful in terms of understanding the broad relevance of neuroscientific material to the fields of Psychology and Forensic Psychology, and they found the readings interesting and unique. Responses to the questionnaire items on assignment satisfaction were also very positive.

As with most academic activities, it is important that they represent an effective use of class time and help students learn and understand the material. Responses to the questionnaire regarding neuroscience knowledge indicated that students felt strongly that the projects helped them understand the material better. This impression was corroborated by many open-response comments. Students also indicated that they were able to better understand how the neuroscience-related content was applied to other topics with comments such as, "Real world applications like these always help me connect content better," "The forensic psychology ones really drew me in and I was able to apply what I was learning to my future career," "It's good to see how biopsych is applied in the real world," and "This helped me make connections within the class so we could then study or help each other make sense of the material."

We believe that the structure of the required groupwork, along with the presentation, resulted in important collaborative work. While there were no specific negative comments regarding the use of these projects, some students did recommend changes to the overall grading rubric. In each group, students received the same grade for the 'content' of the presentation and for the 'PowerPoint slideshow,' for which there was substantial overlap on the rubric. Assigning the same grade to all students in the group for these portions of the assignment was done to encourage groupwork and broader understanding of the assigned article. While groups frequently assigned individual group members specific project responsibilities, the shared group grade approach helped to make sure that all group members were approximately equally familiar with all aspects of the project. This approach also emphasized each individual group member's responsibility for all the content and the development of the PowerPoint presentation. Despite these design benefits, some students felt as though the work done by each group member was disproportionate and thus recommended individual grades for these portions of the assignment (e.g. "I would give everyone an individual grade for the content they did in the presentation otherwise I enjoyed doing these and hope you continue them," "I would recommend individual grading. I feel that group projects always have that one person who doesn't do their part and not everyone should be affected," and "I think grading each person on their own slide they've added to or created. I'm not sure if that's effective, but overall grading is good."). There will probably always be a few students who do not put in the same amount of work as their groupmates, but we believe that this shared grade approach resulted in highly beneficial peer interaction, the development of new peer contacts, and while anecdotal, some students did report talking with group members about other aspects of the course content.

The pedagogical use of case studies in undergraduate neuroscience courses represents an invaluable means of educating students. Utilizing such activities may also provide a way of incorporating several of the neuroscience program core competencies identified by Kerchner et al. (2012) into a single course. Here we have expanded the use of case studies to include the developing field of Forensic Neuroscience, highlighted the importance of using primary articles from a peer-reviewed empirical journal, demonstrated beneficial effects on knowledge acquisition, and incorporated a strong connection to career-related aspects of each case study. We also reinforced the use of such activities to promote group work, collegiality, and oral communication. Faculty who regularly teach undergraduate courses in neuroscience are encouraged to add enriching case study activities such as these to their list of course assignments.

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APPENDIX 1-Project Grading Rubric

Teamwork: ____/5

Presentation Quality: /20

19-20 pts = presenter is 1) very knowledgeable, 2) very familiar and comfortable with the material, and 3) speaks very clearly and at an appropriate pace.

17-18 pts = presenter was average on one or two of the items above.

15-16 pts = presenter was average on all three of the items above.

10-14 pts = presenter was poor on one or two of the items above.

0-9 pts = presenter was absent, clearly unprepared, and/or poor on all three items above.

Content: _____/20 (all group members receive the same grade) 19-20 pts = content was excellent including, 1) summary of the article with emphasis on

biopsychological/neuroscientific content, 2) detailed explanation of how the article demonstrates important connections to biopsychology/neuroscience, 3) discussion of job/career relevance and why, and 4) development of a clear discussion question and leading a meaningful and insightful discussion in class.

17-18 pts = content was above average, where one of the 3 items above was average.

15-16 pts = content was average, where two of the 3 items above were average.

10-14 pts = content was below average, where one or two items above were poor.

0-9 pts = content was missing and/or all three items above were poor.

PowerPoint: _____/10 (all group members receive the same grade)

10 pts = slides were excellent, containing 1) names of each group member, 2) dates/times the group met outside of class and who attended, 3) clear designation of what part of the presentation each group member was responsible for, 4) a bullet point summary of the article, 5) a bullet point explanation of how the article demonstrates important connections to biopsychology/neuroscience, 6) a bullet point list of the

job/career relevance, 6) a discussion question developed by the group and explanation indicating its importance.

8-9 pts = One or two of the items above were average or only moderately well-developed.

6-7 pts = All three items were average or moderately well-developed or one or two of the items were poor.0-5 pts = All the items were poor or one or more were not included.

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