ARTICLE
Designing and Teaching Courses on Sex, Gender, and the Brain: Two Implementations in the Undergraduate Classroom

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Courses on the neuroscience of sex and gender can support inclusive and integrative neuroscience curricula. Developing and teaching such courses, however, can be intimidating for educators due to the subject's complexities and nuances, the increasingly politicized nature of the subject material, and the difficult conversations that the material invites. In this article we discuss how we approached the development of two undergraduate courses on sex, gender and the brain. In describing our thought process we discuss the institutional contexts for our courses and the rationale for the selected course structures, learning objectives, and content. We also describe how we fostered inclusive learning environments – particularly within the context of the COVID-19 pandemic – and implemented course activities and diverse assessments aligned to the course learning objectives. We hope that readers of this article can apply our insights into developing courses on sex/gender in neuroscience at their home institutions.

Key words: sex; gender; sex difference; course design; inclusive teaching; LGBTQ; COVID-19

Undergraduate courses focused on sex, gender, and the brain offer a unique opportunity to teach neuroscience topics and core scientific competencies such as critical reading of scientific literature and responsible scientific communication in an interdisciplinary and societally relevant way. The topic can easily engage non-science majors (Mead, 2009) and can also act as a vehicle to promote inclusion and equitable student outcomes among neuroscience/STEM students by demonstrating the relevance of neuroscience research to social/societal issues and to students' own lives (Artze-Vega et al., 2023).

Educating STEM and non-science majors alike in topics related to sex/gender is particularly urgent against the current political backdrop in the United States, which has been marked by legislation targeting gender-affirming care and the LGBTQIA+ community and legislation to prohibit the teaching of related scholarly fields such as gender studies. For example, the New College of Florida Board of Trustees recently voted to begin the process of shutting down the college's decades-old gender studies program. Providing opportunities for students to develop a critical consciousness of social/societal inequities is a core tenet of many of the inclusion- and equity-promoting pedagogies that we neuroscience educators strive to incorporate into neuroscience coursework and curricula (Freire, 1970; hooks, 1994; Ladson-Billings, 1995; Dewsbury, 2019). Courses on the neuroscience of sex and gender can provide "brave spaces" (Arao and Clemens, 2013) to encourage such development.

As a resource for faculty currently teaching or considering developing courses related to sex, gender and the brain, we previously published a review article on teaching sex/gender in neuroscience (Casto et al., 2022). In that article we focused on describing major content areas related to sex/gender in neuroscience through contrasting outdated/historical versus current understandings; we also provided readings and resources for instructors wishing to read up on these topics.

The present article moves from an abstract overview of content to specifics on courses designed for advanced students, including neuroscience majors. Here we document our design and revision of undergraduate courses at our own institutions: Harvard University, St. Mary's College of Maryland, and New College of Florida. We also describe and reflect on equity-minded pivots we made to our course design and delivery within the context of the COVID-19 pandemic. The key components of both courses - including target student audience and course format, guiding questions, learning objectives, assessments, and types of course materials used - are summarized in Table 1. Additionally, a repository of course materials, such as syllabi and rubrics, can be found on our open science page, https://osf.io/ec7sz/. We hope that this article will further empower faculty to develop and teach their own courses (or units within existing courses) on the important topic of sex/gender and the brain.

COURSE 1: SEX, GENDER, AND THE BRAIN (DR. TAN)

Course Context

Sex, Gender, and the Brain was offered from 2017-2022 as one of several advanced "neurotutorial" elective courses offered at Harvard College. The neurotutorial courses primarily enroll juniors concentrating in neuroscience. They meet once weekly for the entire academic year, providing students a longitudinal learning experience with their instructor in a small course setting. Course enrollment is capped at 12-15 students per year, depending on the overall

	Sex, Gender and the Brain (Harvard College)	**Sex, Gender, Mind and Brain (New College Florida and St. Mary's College of Maryland)**
Course Audience and Format	• Upper division Neuroscience concentrators (primarily juniors) • Pre-requisites: introduction to neuroscience course or permission of the instructor • Discussion-based seminar course (12-15 students), met once weekly over the entire academic year	• Biopsychology, Neuroscience, Gender Studies Majors • Pre-requisites: An intermediate course in Biology, Biopsychology, Neuroscience, Gender Studies, or permission of the instructor • Discussion-based seminar course (8-16 students), met twice weekly over the course of a semester
Guiding Questions (Learning Outcomes)	*We'll answer the questions:* • What types of sex (and gender) differences exist in the nervous system and how do these differences lead to sexually dimorphic behaviors in different animals? • What does the study of sex differences and sexually dimorphic behaviors in model organisms like worms, flies, and mice teach neuroscientists about general brain function? • How does the study of sex/gender differences in the brain relate to human health? • How is scientific information communicated to other scientists and to the general public, how does it go wrong, and how can we avoid common communication pitfalls?	*We'll answer the questions:* • Why and how have sex/gender differences in the brain and behavior been studied in the past, and today? • Does gender identity and sexual orientation have a neurobiological basis? • What are the biological bases of sex determination and its diversity within and across species? • How has the field of gender studies shaped the fields of biology and neuroscience?
Learning Objectives	*At the end of the year you should be able to:* • Debate the benefits, complications, and pitfalls of studying and reporting sex/gender differences (especially related to neuroscience) • Critically evaluate the scientific claims and interpretations made in research and popular press articles on the neuroscience of sex/gender differences • Identify attributes of "good" and "bad" science communication and accurately communicate scientific results via written, oral, and graphical means • Describe ways in which hormones and genes mediate sex differences in the nervous system and give examples of how biology is altered by environmental influences and experiences	*By the end of this course, you should be able to:* • Summarize core concepts of how sex and gender relate to the nervous system • Develop research questions on the intersections between sex/gender and the nervous system • Evaluate discrepancies between scientific and popular understanding of how sex and gender relate to the nervous system • Critique scientific claims related to neuroscience and sex/gender • Use gender studies frameworks to analyze the discipline of neuroscience
Assessments	• Weekly homework assignments: reflections, *eLife* "digests", graphical abstracts, chalk talks • Midterm assignment: *eLife* "digest" and graphical abstract for research article of student's choice • Final assignment: new science communication product to explain research article of student's choice	• Reading quizzes • Major assignment: research proposal with weekly scaffolded tasks
Course Materials	• Academic articles including primary research articles, commentaries, and perspectives pieces • Occasional news articles	• General audience texts: *Evolution's Rainbow* (Roughgarden, 2013); *The Gendered Brain* (also published under the title *Gender and Our Brains*) (Rippon, 2019); *The Design of Experiments in Neuroscience 2nd edition* (Harrington, 2020) • Academic articles: reviews, primary research articles, commentaries, and perspective pieces

Table 1. Summary of key course components for the *Sex, Gender, and the Brain* and *Sex, Gender, Mind, and Brain* courses.

demand and course offerings. The overarching goals of the neurotutorial courses are to provide students the opportunity to explore research topics that are not covered in-depth in other parts of the curriculum and to build students' skills reading and analyzing primary scientific literature. Most students who enrolled in the course had previously completed a foundational neurobiology course. There is no expectation that students have prior experience reading primary scientific research articles.

Course Learning Objectives

Within the context of the general goals of the neurotutorial courses, I initially defined course goals and related course-level learning objectives within three domains: scientific content, scientific literacy, and communicating science. As the course evolved over the five years that I taught it, I altered the way I presented course learning objectives to students but maintained the prioritization of skill development over content knowledge. My rationale for doing so was that students' ability to comprehend scientific articles, evaluate evidence, and effectively communicate scientific findings are important both for students' training and futures in a wide variety of careers and for their ability to engage with current events as informed members of society and consumers of information. In communicating the learning objectives to students, I used an "infographic syllabus" (a syllabus that incorporates both visual imagery and text) to emphasize the scientific communication skills that students would learn, and elaborated on the full breadth of learning objectives that students should achieve by the end of the course in a supplemental "introduction to the course" slide deck. The most recent learning objectives for the course are given below:

- Debate the benefits, complications, and pitfalls of studying and reporting sex/gender differences (especially related to neuroscience)
- Critically evaluate the scientific claims and interpretations made in research and popular press articles on the neuroscience of sex/gender differences
- Identify attributes of "good" and "bad" science communication and accurately communicate scientific results via written, oral, and graphical means
- Describe ways in which hormones and genes mediate sex differences in the nervous system and give examples of how biology is altered by environmental influences and experiences

Student Assessments

In support of the course learning goals and objectives, assessments in the course required students to practice summarizing scientific articles via a variety of communication mediums. These included written summaries in the form of an *eLife* "digest" article, graphical abstracts, "chalk talks", and short-format social media posts. Each of these formats was selected for its real-world applicability - scientists do all these things now - and to provide students the opportunity to develop flexible science communication skills. Students were provided, and evaluated by, rubrics for each of these major assignment types. Weekly homework assignments, which rotated among these formats and related to the research article assigned for that week's class, served as formative assessments: students were evaluated using the rubric but received full credit for completion of the assignment.

For the summative mid-term assignment, students completed an *eLife* digest and a graphical abstract for a primary research article of their choosing and received the score that they earned based on the rubric. In earlier versions of the course, the spring semester similarly included a summative final chalk talk presentation on a research article of the student's choosing, with students presenting their talks in a class symposium that was open to the public and advertised among the Harvard undergraduate campus. When the switch to remote learning necessitated a change away from chalk talks, I created a new final assignment that gave students the opportunity to creatively apply their newly developed skills by summarizing a research article of their choosing using a *different* science communication medium not previously encountered in class. After the success of this assignment (discussed in more detail in the *Creating an Inclusive Learning Environment* section below) I decided to keep this new assignment even after the class had returned to in-person instruction.

During the first few years of the course I posted some of the students' homework assignments – including another assignment type, freeform blog posts – to a public-facing website that I created for the course (https://sexandthebrain.wordpress.com/). With the course blog, I wanted our students to actively participate in scientific communication activities beyond our classroom community. Students completed waivers at the beginning of the class to indicate the extent to which they wanted to publicly share their assignments: with their names attached, anonymously, or not at all. We further used a class Twitter account @sexandthebrain (on the platform now known as "X") to amplify the reach of our blog posts and to share other scientific information related to course content. After a few years of implementation I eliminated the blog and Twitter components of the course due to both logistical challenges and in response to platform analytics data. Logistically, since we read many of the same articles each year, I could not ask students to complete assignments on articles or topics for which there were already published posts. Additionally, in reviewing the Wordpress and Twitter analytics to assess engagement with our publicly shared materials, it was clear that our materials were reaching very few people.

Instructional Approach and Course Materials

Class sessions were entirely discussion-based. They included a combination of structured full class and small group discussion activities designed to maximize student engagement. For example, a typical class period might open with a full-class discussion of some questions to "set the

stage" for the paper discussion (e.g., What was the motivation for the study? What was the main research question?), followed by small group discussion in which each group is asked to answer a few questions related to a different figure in the paper. Groups are then asked to either select a reporter to share out their group's consensus talking points, or reporters are randomly assigned (e.g., the person with the next upcoming birthday will report out). As reporters share out, I facilitate further full class discussion via follow-up questions and provide an opportunity for students to ask questions themselves. Students appreciated the discussion format, as reflected in comments on course evaluations. For example, one student commented, "*She [Dr. Tan] allows discussions to happen freely without imposing restrictions on where they can flow, but she also comes ready with coherent class structure, so students aren't lost.*" The "coherent class structure" created through approaches such as those described above was a deliberate instructional design choice, as increased course structure has been shown to promote equity in the classroom (Tanner, 2013; Hogan and Sathy, 2022) and has particular benefits for students belonging to populations underrepresented in STEM (Eddy and Hogan, 2014).

A primary instructional strategy that I used to scaffold these in-class discussions was the free, collaborative paper annotation software Perusall (https://perusall.com/). I uploaded the articles to be discussed in class to this platform and asked students to annotate the article as they read it - e.g., by asking questions of their classmates, highlighting important findings, and initiating discussions related to points of interest from the article. While Perusall provides algorithms to grade students' contributions, I did not grade any of the students' annotations. Rather, I prefaced the benefits of collaborative paper reading with the class at the beginning of the year and explained that it was my expectation that students would engage with their peers on the platform in service of their own learning and the learning of their classmates. Overall, students were quite engaged with Perusall (Figure 1). Their annotations gave me the opportunity to resolve some points of confusion in Perusall prior to our in-class discussion and also guided my lesson-planning for class.

As a second scaffold for the classroom discussions, I provided short slide decks that included background information on the topic and methodologies for each week's discussion article during the fall semester of the course. The decision to post slides as an asynchronous resource rather than an in-class mini-lecture was made after surveying students in the initial offering of the course on what would be most useful. From that survey, students noted that they

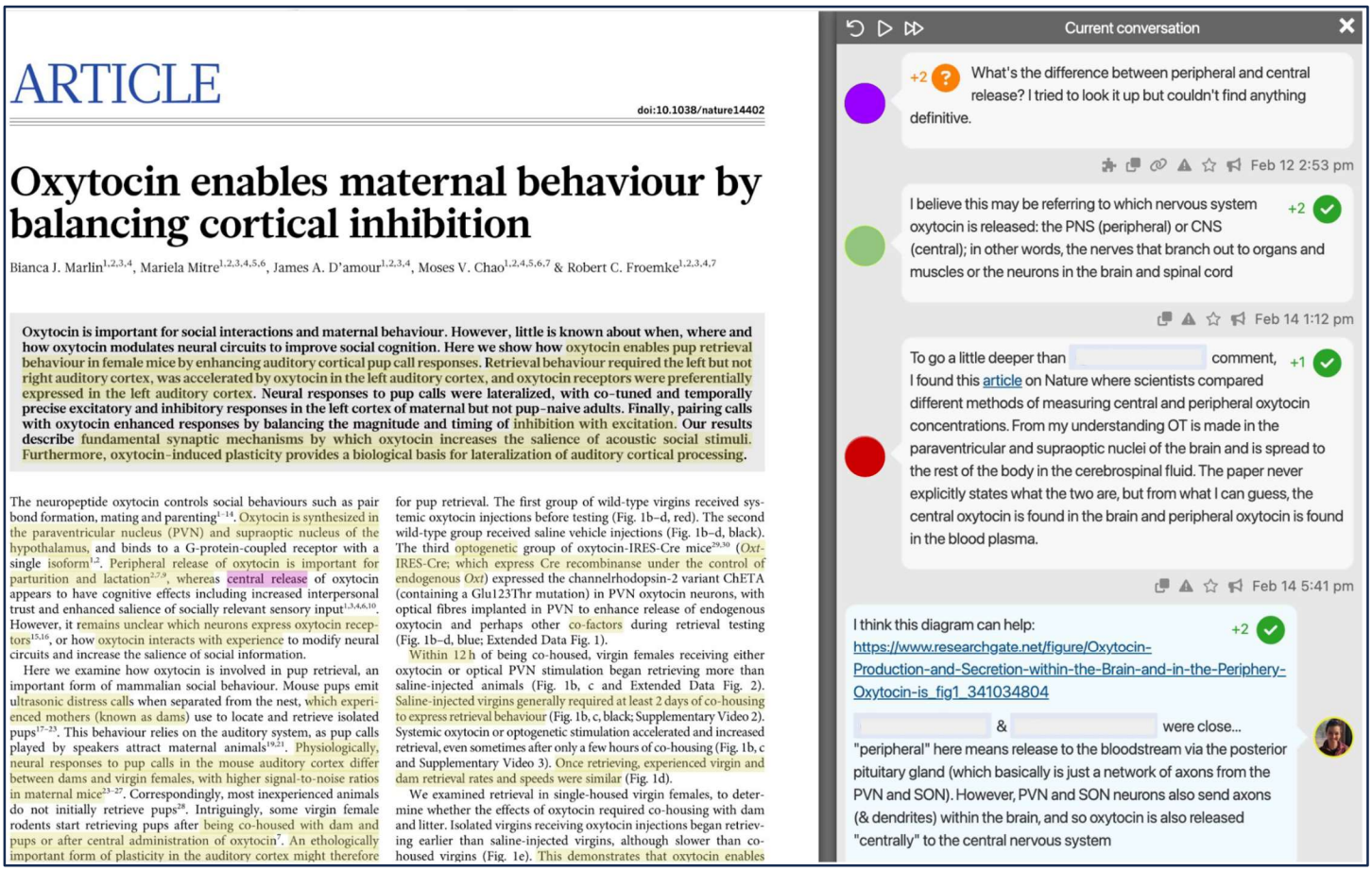

Figure 1. Screenshot of anonymized student annotations in the Perusall reading environment. The conversation thread corresponds to the purple highlight in the text. Each yellow highlight in the article indicates additional student annotations or comment threads. The platform facilitates interactions among students and between students and instructor. Students are also able to "upvote" specific comments or questions.

can review slides on their own but they cannot reproduce in-class discussion outside of class. (Notably, the inclusion of Perusall in subsequent years did offer a path for robust asynchronous discussion.) During the spring semester of the course, prepared slide decks were largely replaced by the chalk talk assignment, for which I asked students to explain key methods or background topics pertinent to the discussion articles.

The reading materials used for the course were almost entirely primary research articles. This aligned with one of the main goals of the neurotutorial courses: to teach students how to critically read scientific articles. Given the dual emphasis on how science is communicated and consumed, I occasionally supplemented the primary research articles with accompanying commentaries, letters to the editor, and general news articles. Students were often surprised that back-and-forth exchanges between scientists challenging the results of a published article (as appears in letters and responses from the authors) are actually published by the journal. These additional materials therefore expanded students' understanding of the ways in which scientific research is disseminated and debated among the scientific community. In selecting research articles (which changed slightly from year-to-year) I was cognizant to select articles that collectively showcased many dimensions of diversity, including model organisms, the backgrounds and institutions of the researchers, and the journals in which they were published. This is one way in which paper discussion activities using primary research literature can further equity, diversity, inclusion, and belonging in the classroom (Tan and Venkatesh, 2023).

Given the wealth of articles related to sex, gender, and the brain, I could have included any number of topics in the course to achieve the course learning objectives. In selecting topics and specific research articles, I chose to organize the course into five thematic units, briefly described here. The most recent reading list for the course is included with the syllabus posted on our OSF page (https://osf.io/ec7sz/).

The "Welcome to the Quagmire" unit opened the course as a unit designed to expose students to the various tricky aspects and nuances of the field. Specifically, we discussed the nuanced definitions of sex vs. gender, common pitfalls when reporting and interpreting sex differences (Maney, 2016; Garcia-Sifuentes and Maney, 2021), and a case study of science communication gone wrong (Ingalhalikar et al., 2014a, 2014b; Joel and Tarrasch, 2014). The next two units focused on the hormonal and genetic influences, respectively, on the sexual differentiation of the brain. I selected research articles that highlighted diverse model organisms spanning *C. elegans*, *Drosophila*, zebra finch, guinea pig, and mouse. They included both classical articles (e.g., Phoenix et al., 1959) and modern studies (e.g., Lawson et al., 2020) to showcase the evolving format of research articles and to expose students to foundational work in the field. I also deliberately selected articles that continually challenged the mental model we were building throughout the course through surprising or unexpected results. For example, we talked about the masculinizing effect of testosterone injections on the rodent brain, only to then read an article demonstrating that the masculinizing effect is due to the local conversion of testosterone into an estrogen (Wu et al., 2009). We followed a discussion of classical nuclear hormone receptors with an article about atypical receptors (Acharya and Veney, 2012). We also read an article demonstrating that glial cells, not neurons, underlie many aspects of sexual differentiation of the brain (Lenz et al., 2013).

The spring semester continued with the fourth unit, "The Inescapable Influences of Environment and Experience." After having spent a semester discussing biological mechanisms of sexual differentiation, I wanted to dispel any misconceptions about biological determinism and ensure that students appreciated the roles that the environment and experience play in sculpting these processes. In this unit we discussed research on a variety of environmental/experiential contexts, including the importance of sensory information in eliciting behaviors, the regulation of sensory processing by internal (hormonal) states, and the impact of the prenatal environment and early-life experiences on brain development. Additionally we discussed how *gender* (not sex) may influence the brain through, for example, epigenetic changes induced by gendered experiences (Cortes et al., 2019).

That discussion led nicely into the final unit of the course, "Quagmire Revisited: What about Humans?" In this unit we discussed a suite of articles related to controversial or complex aspects of sex/gender in humans, including the neural correlates (and ethics) of human sexual orientation and gender (LeVay, 1991; Wolpe, 2004; Ganna et al., 2019). During the final class session students read "dual perspectives" articles published in the *Journal of Neuroscience* (Eliot and Richardson, 2016; Shansky and Woolley, 2016) that debated the value of the National Institutes of Health (NIH) requirement to consider sex as a biological variable. With this final discussion we reinforced the complex nature of the topics we had discussed throughout the year and the reality that even neuroscience as a field hasn't reached consensus on these issues. We closed with a note of optimism, though, as I reassured students that they were now equipped to critically evaluate research in the field and to navigate the field's complexities.

Throughout the course, I aimed to relate scientific research topics to broader societal issues and themes. Although the course was taken by neuroscience concentrators, I wanted to emphasize the interdisciplinary nature of the field and to have students recognize science as being related, and relevant to, their other courses, interests, and experiences. Rewardingly, student comments across years, such as those given below, indicated that the course successfully altered students' perceptions about what science is:

"*The structure of your course did not just open the door to learning but open [sic] the door to build community. Together, we explored science from away [sic] that wasn't just strictly academic, but let us explore various social themes and issues from an understandable and relatable*

place. Most importantly, this class made me embrace science in a new way."

"I used to think of neuroscience research as a compilation of separate findings, generally independent from society and other fields of science. Now, I think it's better understood as an ongoing conversation, where researchers build on the past work of their peers and, perhaps more importantly, draw on societal norms to frame their thinking. This means a lot of possibilities for new research, but also for biases and harm. These are things that I intend to reflect on for the remainder of my academic and (if I'm lucky) occupational career."

"I appreciated the chance to reflect often on my learning experience and how we kept real–world issues in mind throughout the course. It wasn't just a science class to me; I felt like I learned a lot about society."

Creating an Inclusive Learning Environment and Adapting the Course to COVID-19 Teaching

Fostering an inclusive learning environment in which all students felt empowered and safe to contribute to conversations on challenging topics was of the utmost importance to me in designing this course. I included a statement in my syllabus explicitly discussing the importance of an inclusive environment and also (in later offerings of the course) began the first day of class with a discussion to collaboratively define community guidelines for our conduct in the class.

I incorporated several additional evidence-based practices into the course to create an inclusive learning environment in which all students could thrive. For example, I incorporated flexibility into the course to acknowledge that everyone is balancing many things in their lives and sought to build community among the students and myself (Hogan and Sathy, 2022; Artze-Vega et al., 2023). Students were given a "free pass" each semester that allowed them to skip an assignment, no questions asked. Each week students were invited to join me in "student hours" (not "office hours"), the purpose of which I clearly described in the syllabus (Jack, 2019). I asked students to submit short videos introducing themselves via Course Intros (https://courseintros.com) - a platform to help instructors learn their students' names through a flashcard feature - and I greeted students on the first day of class by name. This practice was particularly impactful, as noted by one student in their final course reflection: *"I still remember coming into the room and being so shocked that you knew who I was (even through the mask). For me, that was the first taste of how this course would end up progressing—a space where I would be recognized, encouraged, and validated."*

When we were required to abruptly pivot to remote teaching in the middle of the spring 2020 semester, I began our first Zoom class session with a check-in and a collaborative discussion to chart the remainder of the discussion. We discussed, for example, how to modify the chalk talk assignments for the virtual platform and how to adjust course materials and assignments to reflect current events and students' interests beyond the original scope of the course. As a group we replaced chalk talks with short powerpoint presentations on topics of students' choosing and we decided to replace some of the previously planned discussion articles with new articles such as a study investigating sex-based differences in coronavirus infection. We also discussed ways to foster community in the remote learning environment, which led us to begin each class with an icebreaker activity. Additionally, I opened the Zoom room early each week to host a "hallway hangout," an informal time for students to drop by and chat. Students appreciated the changes to the course, noting in course evaluations, "*I really like that we were able to choose how we wanted the rest of the semester to play out and plan our own assignments*." Another student elaborated, "*The instructor made it very clear that she was understanding of everyone's situations and the challenges that come with remote learning. At the same time, she made a huge effort to keep the class very engaging through presentations and ice breakers, while also keeping the in–class discussions similar to when we were on campus*."

As described in the *Student Assessments* section above, I replaced the final chalk talk assignment with an open-ended science communication assignment that asked students to present a research article of their choosing using a communication medium not previously encountered in the course. This assignment assessed students' ability to convey complex scientific information in an accessible way to a non-expert audience while offering students autonomy and flexibility. Students far exceeded my expectations in terms of their creativity and the ways in which they infused their assignments with personal meaning. For example, one student who spent his free time rapping and DJing wrote a rap to explain his article; another student created a video in Spanish in the style of the television show, *Despierta América*, so that her Spanish-speaking mother could learn about the research article. To present results from a research article reporting sex/gender differences in the perception of time passage during the exercise, one student created a functional baby mobile in honor of a family member. Impressively, the mobile was engineered to have different parts rotate at different speeds to represent the main finding from the research article. It was clear that this assignment provided a meaningful opportunity for students to "bring themselves" to the classroom and so I retained this assignment even after returning to in-person class. Over subsequent years student assignments included such varied mediums as Tik-Tok videos, memes, comic strips, and an illustrated children's book, to name a few.

Finally, another practice that I began during remote learning but retained throughout the duration of the course was to explicitly acknowledge the potential impact of world events on members of our learning community and to hold space during class time as needed to process these events (even at the expense of the planned academic topic for the day). This "Days After Pedagogy" - so named for the teaching that occurs on days after significant events impacting students' lives - has been shown to be deeply impactful for students (Dunn, 2022). That was also true for my own students. As described by one student in the final course reflection:

"*This class was a ray of light during the pandemic. It provided one of the few online spaces that were mostly free of stress, but more importantly hosted a real sense of community. During an especially challenging year, that sense of community and lack of stress from an academic source really made a big difference in my experience…Thank you…for giving us the safe space to have intellectual conversations and even just ~vibe~.*"

COURSE 2: SEX, GENDER, MIND, AND BRAIN (DR. LEININGER)

Course Context

Sex, Gender, Mind, and Brain ("SGMB") is an advanced elective course that I first developed (2016) and will teach again (2024) at St. Mary's College of Maryland as a neuroscience elective. I also redeveloped and taught the course at New College of Florida as an elective for biology, biopsychology, and neuroscience (2017, 2020, 2021). Both are public liberal arts honors colleges. The course takes an interdisciplinary approach towards the topic of sex/gender, both exploring how (neuro)science has studied the topic of sex/gender and how gender studies approaches can be used to analyze the scientific study of sex/gender. The course is a discussion-based seminar that enrolls 8-16 students, who usually have taken at least one intermediate course in biopsychology, neuroscience, or gender studies. Most, but not all, students had prior experience reading primary and secondary scientific sources.

That said, SGMB attracted a diverse audience of students due to the varied roles it played in the curriculum. At both institutions, SGMB carried both neuroscience and gender studies cross-listings. As a result, the course attracts students from several majors and minors, such as biology, biopsychology, psychology, neuroscience, and gender studies. At New College of Florida, SGMB also carried the Diverse Perspectives and Writing Enhanced designations. Diverse Perspectives courses engage deeply with issues of difference; students at New College are currently required to take a Diverse Perspectives course. The Writing Enhanced designation reflected additional training that I sought in writing pedagogy and the course's intentional teaching, scaffolding, and assessment of writing. Students developed their scientific writing by authoring a mock research proposal through scaffolded assignments and cycles of revision.

Course Learning Objectives

In developing the learning objectives for my course, I aimed to balance content knowledge, critical thinking and experimental design skills, and writing skills. Reflecting the more advanced nature of my course, several of my objectives focus on actions such as "critique", "evaluate", "develop", and "analyze". Because I wanted my course to take an interdisciplinary approach to studying sex, gender, and the nervous system, I included a learning objective related to using theories from gender studies (such as feminist theory) to analyze the discipline of neuroscience. I chose to include this objective because neuroscience (and science more broadly) exists within a historical, social, and political context, and that awareness of context facilitates critical thinking about the science.

- Summarize core concepts of how sex and gender relate to the nervous system
- Critique scientific claims related to neuroscience and sex/gender
- Evaluate discrepancies between scientific and popular understanding of how sex and gender relate to the nervous system
- Develop research questions on the intersections between sex/gender and the nervous system
- Use gender theories to analyze the discipline of neuroscience

Student Assessments

I designed SGMB with a mixture of low-stakes assignments and a highly scaffolded research proposal, which is the capstone project for the course. On a weekly basis, I gauge students' ability to grasp core concepts and think critically via their ability to author and respond to discussion prompts and complete low-stakes reading quizzes. Oftentimes, I organize the agenda for our class discussion around common themes raised in student discussion prompts.

The major assignment in the course is a research proposal relating to the intersection of sex/gender and neuroscience. In this assignment, students have the chance to explore an area of the literature that is interesting to them. They perform targeted literature searches and curate lists of relevant references through a shared group in the Zotero reference management software (www.zotero.org). Through completing a literature review, they practice putting literature in conversation and identify open areas of inquiry. Then, through a series of assignments they develop a research question and hypothesis, design an experiment, and discuss possible results and what those results would mean.

Past iterations of the course also included a student-proposed assignment. Students would choose a course outcome and topic of interest to them, design the assignment and get approval by me, and then complete the assignment. Example assignments that students completed included drafting general audience materials related to course topics (e.g., pamphlets, social media posts), a group presentation on the global presence of sex/gender in neuroscience research, and a teach-in on course topics that was open to the whole campus. After two iterations of the course and with the onset of COVID-19 and changes to the course structure, I decided to eliminate this assignment in favor of building out the research proposal assignment in more depth. That said, this sort of assignment is useful not only as a way for students to have agency in choosing the topic and format of their project, but also as a way to guide students through the idea of backward designing a project idea from an end goal and how to scaffold the project over time.

Based on instructional evaluations, students found that weekly assignments helped them complete the project in a manageable way. Example quotes on this theme include: "*I also found that breaking down the large research proposal assignment into parts was a useful strategy to get me to develop my thoughts throughout the semester instead of in one weekend*"; "*Weekly assignments towards a final project*

were a good way to put work in without it being overwhelming"; and, "*The course was pretty demanding in terms of reading and then weekly assignments due, but I feel it was spread out throughout the semester pretty well, which made it more manageable*."

While I have successfully taught SGMB at both colleges, I have had to adapt the course to different curriculum structures and approaches to assessment. As one example, New College evaluates students with a satisfactory/unsatisfactory designation with a detailed narrative evaluation in lieu of grades: an "ungrading" approach at a college-wide scale (Blum, 2020). Therefore, I evaluated student work using developmental written feedback on their logic, use of evidence, writing skills, and more, avoiding numerical or letter-grade feedback. Rather than reverting back to my original grading scheme from my very first iteration of the course, I will continue with alternative assessment practices within a graded context. Similarly to setting group norms around discussion and expectations, I aim to engage my students in discussion about grades and grading, using an essay by Kohn (2013) as a starting point, and co-create norms and expectations surrounding the un-graded nature of the course.

Instructional Approach and Course Materials

There are many core concepts related to sex/gender and the brain (Casto et al., 2022); I choose to explore a subset of these in my course, organized in units of 2-3 weeks, to span the broad topics of sex/gender, sex determination, the study of sex differences and sexual orientation in neuroscience, and gender representation in (neuro)science.

We begin the semester with an introductory 2-week unit when we set group expectations (which I describe further in the following section) and discuss ethical and epistemological issues in neuroscience, using Chapters 1-2 of Harrington (2020) and the first chapter of *Gender and Our Brains* (Rippon, 2019). We then move to three weeks of discussion on biological sex and sex determination across taxa and distinctions between sex and gender (and how these concepts can be entangled in humans). For this topic, chapters from *Evolution's Rainbow* (Roughgarden, 2013) and *Gender and Our Brains* (Rippon, 2019) are helpful to provide an overview, followed by a chapter on sexual differentiation in mammals from a neuroscience textbook (Bear et al., 2016). During this unit we also discuss intersex conditions / differences of sexual development (Ainsworth, 2015).

Over the next three weeks we discuss how neuroscience has framed the study of sex. We discuss the differences between sex differences and sexual dimorphisms, the framing of sex as a biological variable, and the entanglement of sex/gender (Maney, 2016; Rippon, 2019). We discuss a short essay by Fine et al. (2013) that uses feminist theory to interrogate why recent breakthroughs in neuroplasticity do not seem to have impacted traditional views and studies of "hardwired" sex differences, and the ensuing impacts on society. *Gender and Our Brains* (Rippon, 2019) defines key concepts in gender studies such as gender essentialism and complementarity, used as a lens through which to analyze the stated justification or interpretation of sex/gender differences in published articles. The article "Perils and Pitfalls of Reporting Sex Differences" (Maney, 2016) has been a fantastic source for the audience of this course in thinking about how and why the scientific community studies and reports sex differences, and how to improve this communication. Similar to Dr. Tan's course, we discuss Ingalhalikar et al. (2014a) and follow-up published correspondence (Joel and Tarrasch, 2014; Ingalhalikar et al., 2014b) as a case study of discourses of critique and disagreement in ways to measure and interpret sex differences in the brain. Finally, the "Dual Perspectives" articles on Sex as a Biological Variable (Eliot and Richardson, 2016; Shanksy and Woolley, 2016) provide useful background reading for a class discussion/debate on the NIH guidelines to require sex as a biological variable in biomedical research.

Having defined and explored sex and gender differences, the course then explores why and how neuroscience has asked questions about neural bases of sexual orientation and gender identity (LeVay, 1991; Ganna et al., 2019). Here we focus on historical progression in scientific inquiry in this field, the strengths and weaknesses of the literature, and ethical implications of studying this topic (Wolpe, 2004). We end the course with a short 2-week unit on gender representation in (neuro)sciences. This unit includes both quantitative studies on gender representation across disciplines (Leslie, 2015) as well as qualitative reflections by Ben Barres, a transgender neuroscientist who wrote about his lived experiences in the sciences before and after transitioning genders (e.g., Barres, 2006). The last week of the course is used for a synthesis reflective discussion of the whole semester and final project work.

Instructional evaluation comments speaking to the course organization, noted scaffolded and in-depth exploration of topics as helpful to them. For example, students wrote: "*I felt the course was organized in a way that was helpful for my learning. Starting with general information on sex/gender before advancing into how it impacts the field of neuroscience was particularly useful for me*." and "*I was able to think critically about and understand sex on a deeper biological level and grasp how many variables go into developing a person and the ways in which things can misalign with typical development"*. Another student wrote "*I enjoyed the class and the associated readings [...] after taking the class I don't think gender or sex studies are so much my vibe, but it was a good experience*", suggesting that although they might not gravitate towards this field in the future, they appreciated exposure to the topic and/or instructional environment.

SGMB is a discussion-based course with minimal lectures. Students and I jointly explore topics through discussions of the texts as described above. Periodically throughout the course, I invited students to give input on topics or papers to read together. Themes from instructional evaluations suggest that students appreciated the discussion focus of the course. Example quotes speaking to this theme include:

"*A big part of this course was student-led, which is something that I liked.*" "*A lot of the in-class discussion was*

driven by students which was nice." "*This course was very different from any other course I have taken as it was discussion based. I found the amount of work very reasonable and also enjoyable and educational in many ways,*" and, "*I enjoyed how purely discussion-based this course was, with very little lecture. The material was strong enough to sustain a discussion on its own, [...] no doubt also due to the efforts of my classmates, all of whom I appreciate greatly*". Students also appreciated the ability to have input into topics: "*I like that throughout the course there have been surveys asking us about our interests relating to the course and what types of things we would like to learn more about*".

We also read and discuss the book *Design of Experiments in Neuroscience* (Harrington, 2020), assigned to help students increase their critical reading of the literature and support their development of their research proposal. For example, I pair chapters on particular study designs with scientific articles that use similar designs. As another example, students read the chapter on science vs. pseudoscience with a paired activity on analyzing a neuroscience social media post. Student comments on instructional evaluations spoke to the role of article discussions in developing critical thinking, such as the following comment: "*The papers given were very relevant and interconnected which allowed for great opportunities to discuss connections and compare and contrast studies. These studies really helped us to learn how to read scientific papers with a very scrutinous eye and catch any confounding variables we may never have previously thought about*".

Creating an Inclusive Learning Environment and Adapting the Course to COVID-19 Teaching

A high-trust, positive classroom rapport enables students to feel comfortable taking risks and stretching themselves in an intellectual setting (Frisby and Martin, 2010). In SGMB, I use many principles to help create a high-rapport classroom in all of my classes, including using name/pronoun name tents and allowing multiple modes of discussion (mixtures of small group and large group discussions). Owing to the primarily discussion-based nature of the course and students' varying levels of comfort or prior experience with the material, I have used some time in the first week of class to co-construct a set of shared class principles with my students; in this way I invite students into the conversation surrounding respectful dialogue and shared trust in the classroom. Briefly, students individually brainstorm their expectations of themselves, their peers, and their instructor, and then work in groups to draft and revise a shared understanding of expectations. During this process, I encourage students to be transparent about the motivations behind their expectations. For example, the expectation of being on time and present for class relates to the shared responsibility of students in the class to engage in knowledge-building through discussion.

The COVID-19 pandemic required me to adapt my course due to changing circumstances. In Spring 2020, when many universities moved to emergency remote instruction, I pivoted the course to a remote synchronous delivery through Google Meet. In this context, I made a few changes to try to maintain an inclusive environment. First, we spent a few minutes at the start of class before discussion for general check-ins, as a place for students to share worries, concerns, and lighthearted content from their surroundings such as pets. I decided to stop giving reading quizzes, which had been given on paper. Instead, students sent me a question from the reading ahead of each class and we used those questions to structure discussion. As we adjusted to spotty internet connections and the possibility of needing to miss class, students took turns taking notes on our class conversation in a Google Doc. This was useful not only for students who needed to miss class, but also as a memory aid for those who felt overwhelmed during quarantine.

In Spring 2021, I offered the course again in a hybrid format, meeting one day in person and one day online. While video conferencing was necessary to achieve less contact time during the most vulnerable early periods of the pandemic, I was also mindful of equity aspects of video calls on Zoom, including internet bandwidth, home privacy, and the phenomenon of Zoom Fatigue (Castelli and Sarvary, 2021). Blog posts by sarah madoka currie (https://disabilitynewswire.net/designing-accessible-classroom-communities-on-discord/) and Ashley Lear (https://www.scholarlyteacher.com/post/discord-in-the-classroom) describe how Discord can be used to achieve an inclusive classroom meeting space, and for many of the reasons described in these posts, I decided to use Discord for my virtual class meetings. Unlike an ephemeral Zoom meeting, Discord servers are a stable location with archives of chats, links shared, etc. In a hybrid environment, I hoped that the interface would give a stronger sense of "place" for our classroom. Additionally, the user interface of Discord prioritizes humanization and interaction while deprioritizing video. Although video calls in Discord are possible they are not necessarily the dominant mode of communication. Discord's user interface can be used to prioritize text channels or screen sharing over participant videos, and promote community through voice, chat, and emoji reactions.

Setting up multiple voice channels in Discord (Figure 2) allowed for more flexibility in students joining and leaving breakout conversations, as it was not necessary for me to open and close breakout rooms each time we wanted to have breakout conversations. I used breakout voice channels for quick "think-pair-shares" as well as lengthier breakout discussions. Additionally, multiple breakout text channels allowed for synchronous written conversation threads on various topics. For example, I could pose different discussion questions in three different breakout channels and students could rotate through the channels, leaving thoughts, emojis, etc. on each others' comments. Then we would gather together to summarize each channel's threads and debrief further. This approach allowed for students to engage at different frequencies and processing speeds.

Students seemed to respond well to Discord based on how they engaged during the course and comments they wrote on instructional evaluations. For example, one student noted: "*Discussions were fun and easy to participate in [...] the use of discord made participation less daunting by being*

chat focused instead of voice/camera focused, while still allowing those functions if necessary" and another noted "*I think Discord is a great alternative to Zoom because you can DM people right then and there and look back on what we discussed*".

CONCLUSION

Here we have described two specific implementations of undergraduate courses on sex, gender, and the brain, highlighting our rationale for the specific decisions each of us made in designing and modifying our courses. We hope that faculty who are interested in designing similar courses find the examples helpful and we encourage such faculty to connect with colleagues with whom they can brainstorm ideas for their course. As Dr. Leininger developed and revised her course, she consulted with librarians on information literacy goals, the Director of the Writing Program on scaffolding the research proposal assignment, Women and Gender Studies Faculty on helpful readings related to gender studies analyses of neuroscience, and staff from the LGBTQ+ student services office to better understand students' general interests and needs. Although we (Drs. Tan and Leininger) initially developed the courses described here before we met one another, the evolution of our courses benefitted from our collaboration and conversations after we met at the 2020 FUN Virtual Summer Meeting. Specifically, we leveraged each other's prior experiences and successes in the classroom and incorporated elements of each other's courses into our own. For example, Dr. Tan's class section on human sexual orientation was modified to incorporate the articles by Ganna et al. (2019) and Wolpe (2004) based on Dr. Leininger's teaching of a similar class unit. Dr. Leininger has recently incorporated the *Perusall* collaborative annotation tool and some of Dr. Tan's science communication assignments into her course.

As highlighted here and in previous publications (Mead, 2009; Casto et al., 2022) the topic of sex/gender and the brain is inherently interdisciplinary and naturally lends itself to learning objectives, instructional activities, and materials that emphasize the broader social/societal context in which neuroscience research is embedded. We encourage readers to see Mead (2009) for a description of a third sex/gender and the brain course that, in helpful contrast to those described here, was designed for non-science majors.

Instructors can achieve a wide variety of learning objectives with their students in this type of course, including objectives related to critical thinking, responsible science communication, and experimental design. Taxonomies of learning including Bloom's Taxonomy (Bloom et al., 1956) and Fink's Taxonomy of Significant Learning (Fink, 2013) are useful resources to help define learning goals and objectives. Fink's Taxonomy is particularly helpful for articulating learning objectives that extend beyond the realm of foundational knowledge, as the taxonomy includes five additional, interconnected types of significant learning that are easily applied to this specific course topic and context: application, integration, human dimension, caring, and learning how to learn. Instructional design frameworks such as Backward Design (Wiggins and McTighe, 2005) can guide faculty in aligning their assessments and instructional activities to their specific desired learning objectives.

Figure 2. Setup of channels on the Sex, Gender, Mind, and Brain Discord channel. The "Class Time Voice" channels and "classtime-chat" channels were used for whole class discussion, whereas the "small group" voice and chat channels were used for breakouts. Additional channel categories included channels for QandA and a "Just for Fun" area for memes, news, and moral support. Not shown in this screenshot is the actual text channel interactions which are located to the right of the channel menu.

Our neuroscientific understanding of sex and gender is constantly evolving as more research is published, andmany excellent new works will inform future iterations of our course. For example, Proceedings from the Society of Integrative and Comparative Biology's 2023 Symposium "Sexual Diversity and Variation" provide new insights into sexual differentiation and classification across taxa (McLaughlin et al., 2023), how research into sexual diversity

and variation is situated in a historical and social context (Lewis and Sharpe, 2023), and educational and societal implications of research on sex determination within our present moment (Sharpe et al., 2023). Eliot et al. (2023) describes best practices for rigorously studying and accurately communicating neuroscience findings related to sex/gender. Massa et al. (2023) builds on recent Symposium conversations at the Society for Behavioral Neuroendocrinology about how to deconstruct the complex marker of "sex", which can help the neuroscience community better study underlying physiological processes of interest, producing more accurate science while combating potentials for misinformation or weaponization of this science. Casper et al. (2022) provides a qualitative study on how transgender, nonbinary, gender nonconforming, and questioning students perceive the diversity of sex/gender content in introductory courses, as well as recommendations for making biology instruction more inclusive for queer students. These and many other publications (including those highlighted in Casto et al., 2022) provide a rich array of possible course materials from which educators can draw. Combining such materials with thoughtfully designed learning objectives and equity-minded instructional practices can yield transformative learning experiences for our students that not only strengthen their understanding of neuroscience content and practice, but also prepare them to meaningfully engage with contemporary sociopolitical topics.

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