

# Syllabus

NEUR 592 | BIOL 691 | BINF 739

## Neurobiology of Decision-Making

*Fall Semester 2022*

**Weekly schedule:** Each week runs from Monday (12:01 am) to Sunday (11:59 pm) starting Aug. 22, 2022.

**Instructor:** [Frank Krueger, Ph.D.](#)

**Department:** [School of Systems Biology](#)

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**E-mail:** fkrueger@gmu.edu (preferred)

**Office Hours:** By appointment (via Blackboard Collaborate Ultra or Zoom)

### Course Description

Neurobiology of Decision-Making (also known as Neuroeconomics or Decision Neuroscience) is an **asynchronous online course** exploring the fundamental questions about how our brain makes perceptual, value-based, and even more complex decisions in non-social and social contexts. In combination with hormonal and genetic approaches, this course discusses neuroimaging, electrophysiological, lesion, and neurocomputational models to understand the neurobiological mechanisms behind decision-making. The course is based on five parts that serve as introductions to major subareas of the neurobiology of decision-making:

- **Part 1** provides an overview of the fundamental neurobiological tools used in studying both human and non-human decision-making, including basic computational models, anatomical brain structures, and neurobiological methodologies.
- **Part 2** looks at topics of the neural and psychological foundations of preferences driving decision-making, including preferences for risk and uncertainty, interpersonal choices and self-control, and the emotion's impact on decision-making.
- **Part 3** examines learning and valuation through reinforcement learning (prediction and prediction errors) from error-driven learning to choice as well as from experienced utility to decision utility.
- **Part 4** deals with the neurobiological mechanisms of perceptual and value-based human decision-making, context-dependent decision-making, and benefit-cost integration in decision-making.
- **Part 5** covers the neurobiology of social decision-making, including social valuation, social strategic choice, theory of mind, and empathy.

## Learning outcomes

By the end of this course, students will be able to:

1. Understand the neuropsychological processes and neurobiological mechanisms of motivation, perceptual decision-making, and value-based human decision-making under the non-social and social context in both animals and humans; and
2. Evaluate the advantages and disadvantages of anatomical, genetic, neurophysiological, pharmacological, endocrinological, and neurocomputational methods in studying decision-making in animals and humans.

## Prerequisite

Prerequisites are the completion or concurrent enrollment in all other required general education courses or permission of the instructor. This course is essential for anyone interested in the rapidly developing field of neurobiology of decision-making. Reading, research and construction projects, and collaboration with the class are major components of the course.

## Textbook & Course Materials

### Required Text

- Glimcher, PW. & Fehr, E. (eds.). Neuroeconomics. Decision Making and the Brain. Elsevier Science Publishing.

### Recommended Texts & Other Readings

- Dreher, JC. & Trembla, L. (eds.) (2017). Decision Neuroscience. An Integrative Perspective. Elsevier Science Publishing.
- Other readings will be made available in Blackboard (See Learning Modules).

## Course Logistics

This course will use a distance learning format; the primary meeting space will be on Blackboard 9.1; and we will use other means of keeping in touch such as e-mail, telephone, and Blackboard Collaborate Ultra/ Zoom. This is a rigorous course: you will accomplish the following activities in a typical week:

- reading about 35-50 pages, reflecting the content, and discussing the material with your classmates;
- completing online activities and responding to weekly requirements; and
- working on assignments completing in Blackboard according to the assignment schedule.

Though the delivery method is different, it should take you the same amount of time as a typical full-semester course. You should **expect to spend approximately 9 hours on coursework each week** (including the time you would have spent in a classroom). It is critical to keep up with weekly requirements. Each week, I will provide announcements via e-mail and a module in our Blackboard course to specify required activities and assignments (available by clicking on 'Weekly Modules' on the course menu in Blackboard).

## Blackboard (Available on Aug. 22, 2022)

We will use Blackboard 9.1 for the course. Additional guidance on individual assignments and discussion questions will be posted there. All assignments will be submitted through Blackboard for grading. Please visit our Blackboard site regularly.

Access Blackboard 9.1 by following these steps:

1. Go to <http://mymason.gmu.edu>.
2. Login using your NETID and password.
3. Click on the 'Courses' tab.
4. Click on 'Neurobiology of Decision-Making (NEUR 592| BIOL 691| BINF 739 (Fall 2022))' under the 'Course List' heading.

## Instructor-Student Communication

I will respond to your e-mails from Monday (9 am) through Friday (6 pm) within 24 hours. If I am away from e-mail for more than two days, I will send an announcement to the class.

Before sending an e-mail with questions, please check the following (available on your Blackboard course menu) **unless the e-mail is of a personal nature**:

1. Syllabus.
2. Ask the Professor (Feel free to respond to other students in the Help forum if you know the answer.).
3. Blackboard Tutorials on how to use Blackboard features.
4. Blackboard Q&A (resources specific to Mason).
5. Technology Requirements.

## Mason E-MAIL

- Mason requires that Mason e-mail be used for all courses. I will be sending messages to your Mason e-mail, and you are responsible for ensuring you have access to these messages.
- You may forward your Mason e-mail to other accounts but always use your Mason e-mail when communicating with me to verify your identity.
- You must check your Mason e-mail account regularly and keep your mailbox maintained so that messages are not rejected for being over quota.
- When you e-mail me, you can expect a response within 24 hours (*Monday through Friday*). If I am going to be away from e-mail for more than two days, I will send an announcement to the class.
- When you e-mail me, be sure to include '**Neurobiology DM Course**' at the beginning of the subject heading to alert me that I have received a message from one of my online students.

## Participation

### Netiquette For Online Discussions

Our discussion should be collaborative, not combative; you are creating a learning environment, sharing information, and learning from one another. Respectful communication is essential to your success in this course and as a professional. Please re-read your responses carefully before you post them so others will not take them out of context or as personal attacks. Be positive to others and diplomatic with your words,

and I will try my best to do the same. Be careful when using sarcasm and humor. Without face-to-face communication, your joke may be viewed as criticism. Experience shows that even an innocent remark in the online environment can be easily misconstrued.

*Netiquette prepared by Charlene Douglas, Associate Professor, College of Health & Human Services, GMU.*

## **Technology Requirements**

Technology requirements for the course are:

- Internet connection (DSL, LAN, or cable connection desirable).
- Supported Web browser (e.g., Internet Explorer, Chrome, Safari) to use Adobe Connect for Live Class Sessions.
- MS Office 365 ProPlus is provided at no cost via the [Microsoft Student Advantage Program](#) (Access is tied to your @gmu.edu e-mail address).

## **Student Responsibilities**

### ***Mason E-mail***

Students are responsible for the content of university communications sent to their George Mason University e-mail account and are required to activate their account and check it regularly. For accessibility and privacy, the university, school, and program will send communications to students solely through their Mason e-mail account —students should respond accordingly.

### ***Patriot Pass***

Once you sign up for your Patriot Pass, your passwords will be synchronized, and you will use your Patriot Pass username and password to log in to the following systems: Blackboard, University Libraries, Mason E-Mail, myMason, Patriot Web, Virtual Computing Lab, and WEMS. [See <https://password.gmu.edu/index.jsp>].

### ***Students with Disabilities***

Students with disabilities who seek accommodations in a course must be registered with the George Mason University Office of Disability Services (ODS) and inform their instructor, in writing, at the beginning of the semester (See [Office of Disability Services](#)).

### ***Academic Integrity***

Students must be responsible for their work, and students and faculty must take on the responsibility of dealing explicitly with violations. The tenet must be the foundation of our university culture. [See <https://oai.gmu.edu/>].

### ***Honor Code and Virtual Classroom Conduct***

Students must adhere to the guidelines of the George Mason University Honor Code ([See Honor Code](#)).

We value critical thinking, and therefore, students must read the assigned material (e.g., books, articles) before the class with a critical eye. Active thought, quality of inputs, and a conflict resolution attitude should be your guiding principles.

The principle of academic integrity is taken very seriously, and violations are treated gravely. What does academic integrity mean in this course? Essentially this: when you are responsible for a task, you will perform that task. When you rely on someone else's work in an aspect of the performance of that task, you will give full credit in the proper, accepted form.

Another aspect of academic integrity is the free play of ideas. Vigorous discussion and debate are encouraged in this course, with the firm expectation that all aspects of the class will be conducted with civility and respect for differing ideas, perspectives, and traditions. When in doubt (of any kind), please ask for guidance and clarification.

Plagiarism is the equivalent of intellectual robbery and cannot be tolerated in the academic setting. If you have any doubts about what constitutes plagiarism, please contact me.

### ***University Policies***

Students must follow university policies [See [University Policies](#)].

### ***Responsible Use of Computing***

Students must follow the university policy for Responsible Use of Computing [See <http://universitypolicy.gmu.edu/policies/responsible-use-of-computing>].

### ***University Calendar***

Details regarding the current Academic Calendar [See <https://registrar.gmu.edu/calendars/>].

### ***University Catalog***

The current university catalog [See [University Catalog](#)].

## **Student Services**

### ***Writing Center***

The George Mason University Writing Center staff provides various resources and services (e.g., tutoring, workshops, writing guides, handbooks) intended to support students as they work to construct and share knowledge through writing (See [Writing Center](#)). ESL Help: The program was designed specifically for students whose first language is not English who feel they might benefit from additional, targeted support throughout an entire semester (See [Writing Center](#)).

### ***University Libraries***

University Libraries provide resources for distance students. (See <http://library.gmu.edu/for/online>).

## Counseling and Psychological Services

The George Mason University Counseling and Psychological Services (CAPS) staff consists of professional counseling and clinical psychologists, social workers, and counselors who offer a wide range of services (e.g., individual and group counseling, workshops, and outreach programs) to enhance students' personal experience and academic performance [See <http://caps.gmu.edu>].

## Family Educational Rights and Privacy Act (FERPA)

The Family Educational Rights and Privacy Act of 1974 (FERPA), also known as the ‘Buckley Amendment,’ is a federal law that gives protection to student educational records and provides students with certain rights. [See <http://registrar.gmu.edu/privacy>].

## Weekly Schedule

Distance learning courses are dynamic—to ensure we achieve our learning outcomes—we may need to negotiate weekly schedule changes. We will focus on learning, fairness, and reason for any approved changes. Each week's activities—reading assignments about topics, watching videos, and reflecting on neuroscience methods (via a blog), defining key concepts (via a glossary), testing your knowledge about brain anatomy (via a quiz), and sharing and discussing your knowledge with classmates (via discussion forum)— **require approximately 9 hours.**

The table below lists the weekly schedule, significant activities, significant assignments, points, and due dates for this course. Final grades will be based on the total number of points earned in the class.

<u>Weeks</u>	<u>Major Topics and Method</u>	<u>Assignments (graded)</u>	<u>Points</u>	<u>Due Dates (11.59 pm, EST)</u>
<p><b>Week 1</b> Monday, Aug. 22 - Sunday, Aug. 28</p>	<p>I. THE FUNDAMENTAL TOOLS Topic: Introduction: A Brief History of Neuroeconomics Introduction to Neuroscience Method: Single-Unit Recording</p>	<p>Orientation Quiz Topic: Discussion (Part 1) Topic: Glossary Brain: Quiz Topic: Discussion (Part 2) Method: Reflection</p>	<p>5 5 5 5 5 10</p>	<p>Sunday, 8/28 Thursday, 8/25  Sunday, 8/28</p>
<p><b>Week 2</b> Monday, Aug. 29 - Sunday, Sept. 4</p>	<p>I. THE FUNDAMENTAL TOOLS Topic: Basic Method from Neoclassical Economics Experimental Economics and Experimental Game Theory Method: Electroencephalography (EEG)</p>	<p>Topic: Discussion (Part 1) Topic: Glossary Brain: Quiz Topic: Discussion (Part 2) Method: Reflection</p>	<p>5 5 5 5 10</p>	<p>Thursday, 9/2  Sunday, 9/4</p>

<p><b>Week 3</b> Monday, Sept. 5 - Sunday, Sept. 11</p>	<p>I. THE FUNDAMENTAL TOOLS Topic: Computational and Process Models of Decision Making Estimation and Testing of Computational Psychological Models Method: Event-Related Potential (ERP)</p>	<p>Topic: Discussion (Part 1) Topic: Glossary Brain: Quiz Topic: Discussion (Part 2) Method: Reflection</p>	<p>5 5 5 5 10</p>	<p>Thursday, 9/8  Sunday, 9/11</p>
<p><b>Week 4</b> Monday, Sept. 12 - Sunday, Sept. 18</p>	<p>II. NEUROPSYCHOLOGICAL FOUNDATIONS OF PREFERENCES Topic: Evolutionary Anthropological Insights into Decision Making The Computation of Stimulus Values in Simple Choice Method: Magnetoencephalography (MEG)</p>	<p>Topic: Discussion (Part 1) Topic: Glossary Brain: Quiz Topic: Discussion (Part 2) Method: Reflection</p>	<p>5 5 5 5 10</p>	<p>Thursday, 9/15  Sunday, 9/18</p>
<p><b>Week 5</b> Monday, Sept. 19 - Sunday, Sept. 25</p>	<p>II. NEUROPSYCHOLOGICAL FOUNDATIONS OF PREFERENCES Topic: Valuation for Risky and Uncertain Choices Valuation, Intertemporal Choice, and Self-Control Method: Positron Emission Tomography (PET)</p>	<p>Topic: Discussion (Part 1) Topic: Glossary Brain: Quiz Topic: Discussion (Part 2) Method: Reflection</p>	<p>5 5 5 5 10</p>	<p>Thursday, 9/22  Sunday, 9/25</p>
<p><b>Week 6</b> Monday, Sept. 26 - Sunday, Oct. 2</p>	<p>II. NEURAL AND PSYCHOLOGICAL FOUNDATIONS OF PREFERENCES Topic: Social Preferences and the Brain Neuroeconomics of Emotion and Decision Making Method: Magnetic Resonance Imaging (MRI)</p>	<p>Topic: Discussion (Part 1) Topic: Glossary Brain: Quiz Topic: Discussion (Part 2) Method: Reflection</p>	<p>5 5 5 5 10</p>	<p>Thursday, 9/29  Sunday, 10/2</p>
<p><b>Week 7</b> Monday, Oct. 3 - Sunday, Oct. 9</p>	<p>II. NEURAL AND PSYCHOLOGICAL FOUNDATIONS OF PREFERENCES Topic: Multistage Valuation Signals and Common Neural Currencies Pharmacology of Economic and Social Decision Making Method: Functional Magnetic Resonance Imaging (fMRI)</p>	<p>Topic: Discussion (Part 1) Topic: Glossary Brain: Quiz Topic: Discussion (Part 2) Method: Reflection</p>	<p>5 5 5 5 10</p>	<p>Thursday, 10/6  Sunday, 10/9</p>
<p><b>Week 8</b> Monday, Oct. 10 - Sunday, Oct. 16</p>	<p>III. LEARNING AND VALUATION Topic: Value Learning through Reinforcement Advanced Reinforcement Learning Method: Resting-State fMRI (RS-fMRI)</p>	<p>Topic: Discussion (Part 1) Topic: Glossary Brain: Quiz Topic: Discussion (Part 2) Method: Reflection</p>	<p>5 5 5 5 10</p>	<p>Thursday, 10/13  Sunday, 10/16</p>
<p><b>Week 9</b> Monday, Oct. 17 - Sunday, Oct. 23</p>	<p>III. LEARNING AND VALUATION Topic: The Basal Ganglia and Reinforcement Learning From Experienced Utility to Decision Utility Method: Functional Near-Infrared Spectroscopy (fNIRS)</p>	<p>Topic: Discussion (Part 1) Topic: Glossary Brain: Quiz Topic: Discussion (Part 2) Method: Reflection</p>	<p>5 5 5 5 10</p>	<p>Thursday, 10/20  Sunday, 10/23</p>

<b>Week 10</b> Monday, Oct. 24 - Sunday, Oct. 30	IV. THE NEURAL MECHANISMS FOR CHOICE Topic: Neural Mechanisms for Perceptual Decision Making Value-Based Decision Making Method: Transcranial Magnetic Stimulation (TMS)	Topic: Discussion (Part 1) Topic: Glossary Brain: Quiz Topic: Discussion (Part 2) Method: Reflection	5 5 5 5 10	Thursday, 10/25  Sunday, 10/30
<b>Week 11</b> Monday, Oct. 31 - Sunday, Nov. 6	IV. THE NEURAL MECHANISMS FOR CHOICE Topic: Multiple Systems for Value Learning Integrating Benefits and Costs in Decision Making Method: Transcranial Direct Current Stimulation (tDCS)	Topic: Discussion (Part 1) Topic: Glossary Brain: Quiz Topic: Discussion (Part 2) Method: Reflection	5 5 5 5 10	Thursday, 11/3  Sunday, 11/6
<b>Week 12</b> Monday, Nov. 7 - Sunday, Nov. 13	IV. THE NEURAL MECHANISMS FOR CHOICE Topic: Neuronal Circuit Computation of Choice The Neurobiology of Context-Dependent Valuation and Choice Method: Invasive Stimulation Method in Animals (Microstimulation)	Topic: Discussion (Part 1) Topic: Glossary Brain: Quiz Topic: Discussion (Part 2) Method: Reflection	5 5 5 5 10	Thursday, 11/10  Sunday, 11/13
<b>Week 13</b> Monday, Nov. 14 - Sunday, Nov. 20	V. BRAIN CIRCUITRY OF SOCIAL VALUATION AND CHOICE Topic: The Neural Basis of Strategic Choice Brain Circuitry for Decision Making in Non-Human Primates Method: Invasive Stimulation Method in Animals (Optogenetics)	Topic: Discussion (Part 1) Topic: Glossary Brain: Quiz Topic: Discussion (Part 2) Method: Reflection	5 5 5 5 10	Thursday, 11/17  Sunday, 11/20
Monday, Nov. 21 - Sunday, Nov. 27	Thanksgiving Recess			
<b>Week 14</b> Monday, Nov. 28 - Sunday, Dec. 4	V. BRAIN CIRCUITRY OF SOCIAL VALUATION AND CHOICE Topic: Understanding Others: Brain Mechanisms Prospect Theory and the Brain Method: Lesion Studies (Humans)	Topic: Discussion (Part 1) Topic: Glossary Brain: Quiz Topic: Discussion (Part 2) Method: Reflection Course Evaluation	5 5 5 5 10 15	Thursday, 12/1  Sunday, 12/4
<b>Exam Week</b> Monday, Dec. 5 - Sunday, Dec. 11	Research Grant Proposal	Submission: Proposal	160	Sunday, 12/11
			<b>Total</b> <b>600</b>	



## Grading Scale (points)

Final grades assigned for this course will be based on the percentage of total points earned and are assigned as follows:

Letter Grade	Percentage	Points	Performance
A <sup>+</sup>	98-100%	583-600	Superb Work
A	93-97%	558-582	Excellent Work
A <sup>-</sup>	90-92%	540-557	Nearly Excellent Work
B <sup>+</sup>	87-89%	522-539	Very Good Work
B	83-86%	498-521	Good Work
B <sup>-</sup>	80-82%	480-497	Mostly Good Work
N/A	<80%	<480	Failing Work