

Syllabus

NEUR 592 | BIOL 691 | BINF 739

Neurobiology of Decision-Making

Spring Semester 2025

Weekly schedule: Starting on **January 21, 2025**, each week runs from Monday (12:01 am) to Sunday (11:59 pm).

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

Department: [School of Systems Biology](#)

Phone: 703-993-4358

Email: FKrueger@gmu.edu (preferred)

Office Hours: By appointment via Zoom

Course Description

Neurobiology of Decision-Making (also called Neuroeconomics or Decision Neuroscience) is an **asynchronous online course** that explores the fundamental questions about how our brain makes perceptual, value-based, and even more complex decisions in non-social and social contexts. Combined with hormonal and genetic approaches, students will learn neuroimaging, electrophysiological, lesional, and neurocomputational models to better 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:

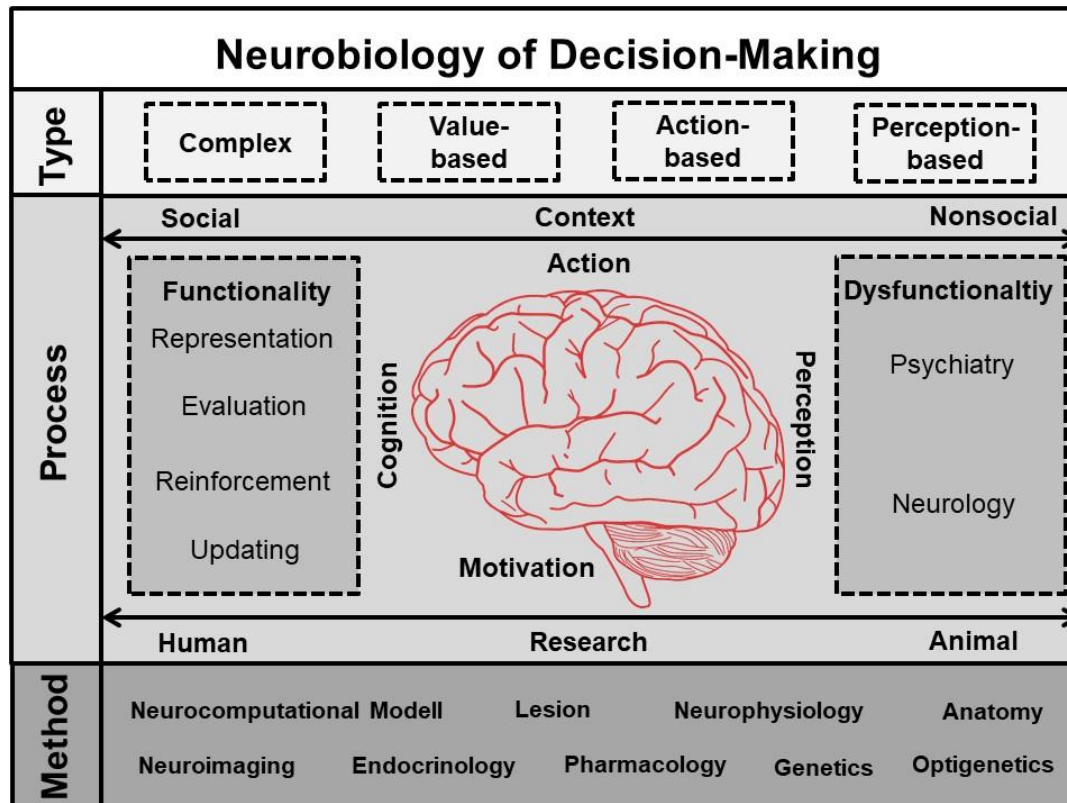
- **Part 1** provides an overview of the fundamental neurobiological tools used to study human and non-human decision-making, including basic computational models, anatomical brain structures, and neurobiological methodologies.
- **Part 2** looks at topics of the neural and psychological foundations 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 and 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 both animals and humans.

Concept map



Prerequisite

Prerequisites are the completion or concurrent enrollment in all other required general education courses or permission of 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.) (2014, 2nd edition). 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 available in Canvas (See Learning Modules).

Course Logistics

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

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

Although the delivery method is different, it should take the same time as a typical full-semester course. You should **expect to spend approximately 9 hours on coursework each week** (this includes the time you would have spent in a classroom). It is critical to keep up with weekly requirements. Each week, I will provide an announcement via email and a learning module in our Canvas course to specify required activities and assignments.

Blackboard (Available on January 21, 2025)

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

Access Canvas 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 (Spring 2025 Special Topics in Neuroscience: NEUR-592-DL1, BINF-739-DL2, BIOL-691-DL1)' under the 'Course List' heading.

Instructor-Student Communication

I will respond to your emails within 24 hours from Monday (9 am) through Friday (6 pm). If I am away from email for over two days, I will post an announcement in the Blackboard course folder.

Before sending an email with questions, please check the following (available on your Blackboard course menu) **unless the email is personal**:

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

Mason EMAIL

- Mason requires that you use your Mason email for all courses. I will send messages to your Mason email, and you are responsible for making sure you have access to these messages.
- You may forward your Mason email to other accounts but always use your Mason email when communicating with me to allow verification of your identity.
- You must check your Mason email account regularly and maintain your mailbox so that messages are not rejected for being over quota.
- When you email me, you can expect a response within 24 hours (*Monday through Friday*). If I am away from email for more than two days, I will send an announcement to the class.
- When you email me, include **Neurobiology of Decision-Making** 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 create 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 use them 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 and

- MS Office 365 ProPlus is free via the [Microsoft Student Advantage Program](#) (Access is tied to your @masonlive.gmu.edu email address).

Student Responsibilities

Mason Email

Students are responsible for the content of university communications sent to their George Mason University email 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 email 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, MasonLive, 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 ([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 (<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, it is imperative that students read the assigned material (e.g., books and articles) before class with a critical eye. Active thought, quality input, 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, 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 ([University Policies](#)).

Responsible Use of Computing

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

University Calendar

Details regarding the current Academic Calendar (<https://registrar.gmu.edu/calendars/>).

University Catalog

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

Student Services

Writing Center

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

University Libraries

University Libraries provide resources for distance students (<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, work shops, and outreach programs) to enhance students' personal experience and academic performance (<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 protects student educational records and provides students with certain rights (<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)— **requires approximately 9 hours.**

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

<u>Weeks</u>	<u>Major Topics and Methods</u>	<u>Assignments (graded)</u>	<u>Points</u>	<u>Due Dates (11.59 pm, EST)</u>
Week 1 Tue., January 21 – Sun., January 26	<p style="text-align: center;">I. THE FUNDAMENTAL TOOLS</p> <p><i>Topic:</i> Introduction: A Brief History of Neuroeconomics Introduction to Neuroscience</p> <p><i>Method:</i> Single-Unit Recording</p>	Orientation Quiz Self-Introduction Topic: Discussion (Part 1) Topic: Glossary Brain: Quiz Topic: Discussion (Part 2) Method: Reflection	5 10 5 5 5 5 10	Sun., 1/26 Thu., 1/23 Sun., 1/6
Week 2 Monday, January 27 – Sun., February 2	<p style="text-align: center;">I. THE FUNDAMENTAL TOOLS</p> <p><i>Topic:</i> Basic Methods from Neoclassical Economics Experimental Economics and Experimental Game Theory</p> <p><i>Method:</i> Electroencephalography (EEG)</p>	Topic: Discussion (Part 1) Topic: Glossary Brain: Quiz Topic: Discussion (Part 2) Method: Reflection	5 5 5 5 10	Thu., 1/30 Sun., 2/2
Week 3 Mon., February 3 – Sun., February 9	<p style="text-align: center;">I. THE FUNDAMENTAL TOOLS</p> <p><i>Topic:</i> Computational and Process Models of Decision-Making Estimation and Testing of Computational Psychological Models</p> <p><i>Method:</i> Event-Related Potential (ERP)</p>	Topic: Discussion (Part 1) Topic: Glossary Brain: Quiz Topic: Discussion (Part 2) Method: Reflection	5 5 5 5 10	Thu., 2/6 Sun., 2/9

<p>Week 4 Mon., February 10 – Sun., February 16</p>	<p>II. NEUROPSYCHOLOGICAL FOUNDATIONS OF PREFERENCES <i>Topic:</i> Evolutionary Anthropological Insights into Decision-Making The Computation of Stimulus Values in Simple Choice <i>Method:</i> 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>Thu., 2/13 Sun., 2/16</p>
<p>Week 5 Mon., February 17 – Sun., February 23</p>	<p>II. NEUROPSYCHOLOGICAL FOUNDATIONS OF PREFERENCES <i>Topic:</i> Valuation for Risky and Uncertain Choices Valuation, Intertemporal Choice, and Self-Control <i>Method:</i> 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>Thu., 2/20 Sun., 2/23</p>
<p>Week 6 Mon., February 24 – Sun., March 2</p>	<p>II. NEURAL AND PSYCHOLOGICAL FOUNDATIONS OF PREFERENCES <i>Topic:</i> Social Preferences and the Brain Neuroeconomics of Emotion and Decision-Making <i>Method:</i> 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>Thu., 2/ 27 Sun., 3/2</p>
<p>Week 7 Mon., March 3 – Sun., March 9</p>	<p>II. NEURAL AND PSYCHOLOGICAL FOUNDATIONS OF PREFERENCES <i>Topic:</i> Multistage Valuation Signals and Common Neural Currencies Pharmacology of Economic and Social Decision-Making <i>Method:</i> 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>Thu., 3/6 Sun., 3/ 9</p>
<p>Spring Break Mon., March 10 – Sun., March 16</p>				
<p>Week 8 Mon., March 17 – Sun., March 23</p>	<p>III. LEARNING AND VALUATION <i>Topic:</i> Value Learning through Reinforcement Advanced Reinforcement Learning <i>Method:</i> 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>Thu., 3/ 20 Sun., 3/ 23</p>

Week 9 Mon., March 24 – Sun., March 30	<p style="text-align: center;">III. LEARNING AND VALUATION</p> <i>Topic:</i> The Basal Ganglia and Reinforcement Learning From Experienced Utility to Decision Utility <i>Method:</i> Functional Near-Infrared Spectroscopy (fNIRS)	Topic: Discussion (Part 1) 5 Topic: Glossary 5 Brain: Quiz 5 Topic: Discussion (Part 2) 5 Method: Reflection 10	Thu., 3/ 27 Sun., 3/ 30
Week 10 Mon., March 31 – Sun., April 6	<p style="text-align: center;">IV. THE NEURAL MECHANISMS FOR CHOICE</p> <i>Topic:</i> Neural Mechanisms for Perceptual Decision-Making Value-Based Decision-Making <i>Method:</i> Transcranial Magnetic Stimulation (TMS)	Topic: Discussion (Part 1) 5 Topic: Glossary 5 Brain: Quiz 5 Topic: Discussion (Part 2) 5 Method: Reflection 10	Thu., 4/ 3 Sun., 4/6
Week 11 Mon., April 7 – Sun., April 13	<p style="text-align: center;">IV. THE NEURAL MECHANISMS FOR CHOICE</p> <i>Topic:</i> Multiple Systems for Value Learning Integrating Benefits and Costs in Decision-Making <i>Method:</i> Transcranial Direct Current Stimulation (tDCS)	Topic: Discussion (Part 1) 5 Topic: Glossary 5 Brain: Quiz 5 Topic: Discussion (Part 2) 5 Method: Reflection 10	Thu., 4/10 Sun., 4/13
Week 12 Mon., April 14 – Sun., April 20	<p style="text-align: center;">IV. THE NEURAL MECHANISMS FOR CHOICE</p> <i>Topic:</i> Neuronal Circuit Computation of Choice The Neurobiology of Context-Dependent Valuation and Choice <i>Method:</i> Invasive Stimulation Methods in Animals (Microstimulation)	Topic: Discussion (Part 1) 5 Topic: Glossary 5 Brain: Quiz 5 Topic: Discussion (Part 2) 5 Method: Reflection 10	Thu., 4/17 Sun., 4/20
Week 13 Mon., April 21 – Sun., April 27	<p style="text-align: center;">V. BRAIN CIRCUITRY OF SOCIAL VALUATION AND CHOICE</p> <i>Topic:</i> The Neural Basis of Strategic Choice Brain Circuitry for Decision-Making in Non-Human Primates <i>Method:</i> Invasive Stimulation Methods in Animals (Optogenetics)	Topic: Discussion (Part 1) 5 Topic: Glossary 5 Brain: Quiz 5 Topic: Discussion (Part 2) 5 Method: Reflection 10	Thu., 4/24 Sun., 4/27
Week 14 Mon., April 28 – Sun., May 4	<p style="text-align: center;">V. BRAIN CIRCUITRY OF SOCIAL VALUATION AND CHOICE</p> <i>Topic:</i> Understanding Others: Brain Mechanisms Prospect Theory and the Brain <i>Method:</i> Lesion Studies (Humans)	Topic: Discussion (Part 1) 5 Topic: Glossary 5 Brain: Quiz 5 Topic: Discussion (Part 2) 5 Method: Reflection 10 Course Evaluation 15	Thu., 5/1 Sun., 5/4

Exam Week Mon., May 5 – Sun., May 11	Research Grant Proposal	Submission: Proposal	150	Sun., 5/11
			Total 600	

Grading Scale (points)

Final grades assigned for this course will be based on the percentage of total points earned and are assigned as shown in the table. Remember that I do not give grades; you earn them.

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