

# NEURAL SCIENCE (NEUR-SHU)

## NEUR-SHU 10 Free Will and the Brain (4 Credits)

*Typically offered occasionally*

The concept of free will plays a central role in society, in particular in the criminal justice system. In this course, we will explore the concept of free will and related topics in neuroscience such as intention and self-control. We will cover the evidence from neuroscience that argues that behavior is, under normal conditions, not deterministic, thus providing a material basis for the concept of individual agency. We will then address the neuroscience evidence for cases where individual agency is reduced through external influence via learning and the reward and punishment systems. Finally, we will examine the most extreme cases of this, psychiatric disorders that reduce agency: addiction, compulsive disorders, and anxiety disorders. Prerequisite: Not open to freshman. Fulfillment: CORE STS; Neural Science elective.

**Grading:** Ugrd Shanghai Graded

**Repeatable for additional credit:** No

- SB Crse Attr: NYU Shanghai: Neural Science Elective
- SB Crse Attr: NYU Shanghai: Science, Technology and Society

## NEUR-SHU 100 Math Tools for Life Sciences (4 Credits)

*Typically offered Spring*

This course will provide a broad introduction to basic mathematical and statistical tools for a quantitative analysis in the life sciences. It will cover a broad range of topics, including introduction to linear algebra, probability, linear regression, and statistical tests. We will use the mathematical programming language MATLAB for in-class demonstrations, computer lab during recitations and homework assignments. Prerequisite: Foundations of Biology I or Foundations of Biology II Fulfillment: Biology required; Neural Science required.

**Grading:** Ugrd Shanghai Graded

**Repeatable for additional credit:** No

- SB Crse Attr: NYU Shanghai: Biology Required
- SB Crse Attr: NYU Shanghai: Neural Science Required

## NEUR-SHU 120 Brain and Behavior (4 Credits)

*Typically offered Fall*

Brain and Behavior explores the relationship between the brain's structure and function and how it shapes both normal and abnormal behavior. This course provides a comprehensive introduction to the biological foundations of behavior, starting with the basics of brain development, neural communication, and sensory processing. Students will learn how electrical and chemical signals in the brain give rise to perception, movement, memory, and cognition. Later modules delve into emotions, mental disorders, the effects of drugs on the brain, and the intersection of neuroscience and artificial intelligence. By integrating fundamental scientific principles with real-world applications, Brain and Behavior equips students with a basic understanding of how the brain governs who we are—and how disruptions lead to neurological and psychological conditions. Prerequisite: None. Anti-requisite: Behavioral and integrative neuroscience (NEUR-SHU 251) Fulfillment: Neural Science elective; Social Science Focus Psychology track 200 level course.

**Grading:** Ugrd Shanghai Graded

**Repeatable for additional credit:** No

- SB Crse Attr: NYU Shanghai: Neural Science Elective
- SB Crse Attr: NYU Shanghai: Social Science Focus Psychology

## NEUR-SHU 130 Introduction to Linguistics: The Science of Human Language (4 Credits)

*Typically offered every year*

This is an introductory survey course to linguistics – the science of language. During this semester, we will address humans' language competence (e.g. is our language ability a learned behavior or rather an instinct? What do native speakers of a specific language implicitly know about word structure, sentence structure, sentence meaning, pronunciation? Etc.) and humans language performance in social context (e.g. why and how does language evolve in a society? How does language reflect our identity? Etc.). This course will approach these issues by incorporating theoretical and experimental works from (neuro)psychological, philosophical, mathematical/computational, and sociological/cultural perspectives. The course aims to help students understand multiple facets of language ability (a crucial cognitive function that defines who we are as humans – both in terms of intelligent individuals and a social species) and appreciate linguistic diversity. It will also show how linguists work towards a better scientific understanding of our language ability. Prerequisite: None. Fulfillment: CORE STS; Neural Science Electives.

**Grading:** Ugrd Shanghai Graded

**Repeatable for additional credit:** No

- SB Crse Attr: NYU Shanghai: Neural Science Elective
- SB Crse Attr: NYU Shanghai: Science, Technology and Society

**NEUR-SHU 131 Neural Bases of Speech and Language (4 Credits)***Typically offered occasionally*

How does our brain work to enable us to speak and understand language? Are there special parts of the brain dedicated to speech and language? What is it like to be abnormal at speech or lose language? This course provides an introduction of the neuroscience research of speech and language, and interdisciplinary field at the heart of human cognitive neuroscience. Lectures cover basic aspects of language processing in the healthy brain, ranging from early sensory perception to higher level semantic interpretation, as well as a range of neurological and developmental language disorders, including aphasias, dyslexia, and other speech and language impairment. Functional neuroimaging and electrophysiological techniques will be introduced. The goal of this course is to let students acquire basic knowledge of neurolinguistics, as well as familiarise the ideas of interdisciplinary research in the intersection of cognitive science and neuroscience. Prereqs: None. Fulfillment: CORE STS; Neural Science Approved upper-level Psychology courses; Neural Science Electives; Social Science Focus Courses Psychology - 200 level.

**Grading:** Ugrd Shanghai Graded**Repeatable for additional credit:** No

- SB Crse Attr: NYU Shanghai: Neural Science Approved upper-level Psychology Crs
- SB Crse Attr: NYU Shanghai: Neural Science Elective
- SB Crse Attr: NYU Shanghai: Science, Technology and Society
- SB Crse Attr: NYU Shanghai: Social Science Focus Psychology

**NEUR-SHU 132 Meaning (4 Credits)***Typically offered every year*

This course is about a supreme aspect of the human race: seeking and creating meaning. The central topic of this course is how humans use language to encode meaning, create meaning, interpret meaning, do with meaning, and reflect on meaning, and then how humans' meaning-related activities go beyond language. We will study how philosophers and linguists approach this topic, introducing influential ideas on language and meaning. We will also study how various kinds of media, from pictures and comics to computer programs, provide new ways of encoding and interpreting meaning as well as new perspectives on studying meaning. Prerequisite: None. Fulfillment: Core STS; Neural Science elective; Humanities Introductory course.

**Grading:** Ugrd Shanghai Graded**Repeatable for additional credit:** No

- SB Crse Attr: NYU Shanghai: Humanities Other Introductory Course
- SB Crse Attr: NYU Shanghai: Neural Science Elective
- SB Crse Attr: NYU Shanghai: Science, Technology and Society

**NEUR-SHU 133 Speech, from hearing to voicing (4 Credits)***Typically offered every year*

Speech, or spoken language, is one of the few basic abilities that set us apart from other animals including our closest primate cousins. Yet, the use of acoustic signals for communication is widespread across a variety of species, from songbirds to primates, orcas, dolphins, and more. Understanding the subject of speech requires knowledge across multiple disciplines including acoustics, anatomy, physiology, cognitive psychology, neuroscience, and linguistics. Moreover, exploring the evolution of vocal communication across animal species yields broader insights into every facet of human speech. This course is an introduction to these topics and explains how events within these domains interact to bring about communication by speech. Prerequisite: None Fulfillment: Neural Science elective.

**Grading:** Ugrd Shanghai Graded**Repeatable for additional credit:** No

- SB Crse Attr: NYU Shanghai: Neural Science Elective

**NEUR-SHU 201 Introduction to Neural Science (4 Credits)***Typically offered Fall*

Introductory lecture course covering the fundamental principles of neuroscience. Topics include principles of brain organization, structure and ultrastructure of neurons, neurophysiology and biophysics of excitable cells, synaptic transmission, neurotransmitter systems and neurochemistry, neuropharmacology, neuroendocrine relations, molecular biology of neurons, development and plasticity of the brain, aging and diseases of the nervous system, organization of sensory and motor systems, structure and function of the cerebral cortex, and modeling of neural systems. Prerequisite: BIOL-SHU 21 Foundations of Biology I and BIOL-SHU 22 Foundations of Biology II (could be co-req). Fulfillment: Biology Electives; Neural Science Required Courses.

**Grading:** Ugrd Shanghai Graded**Repeatable for additional credit:** No

- SB Crse Attr: NYU Shanghai: Biology Elective
- SB Crse Attr: NYU Shanghai: Neural Science Required

**NEUR-SHU 210 Cellular and Molecular Neuroscience (4 Credits)***Typically offered occasionally*

A lecture course that provides students with broad exposure to current questions and experimental approaches in cellular neuroscience. Lectures are organized into three areas: cell structure and organization of the vertebrate central nervous system, mechanisms underlying neural signaling and plasticity, and control of cell form and its developmental determinants. Prerequisites: NEUR-SHU 201 Introduction to Neural Science AND [PHYS-SHU 11 General Physics I or PHYS-SHU 91 Foundations of Physics I Honors]. Fulfillment: Neural Science Required Courses.

**Grading:** Ugrd Shanghai Graded**Repeatable for additional credit:** No

- SB Crse Attr: NYU Shanghai: Neural Science Required

**NEUR-SHU 222 Perception (4 Credits)***Typically offered occasionally*

How do humans and other animals obtain knowledge about the world? It is easy to take perception for granted, but complex processes (only partly understood) underlie our ability to understand the world by seeing, hearing, feeling, tasting, and smelling it. Perception has fascinated philosophers, physicists, and physiologists for centuries. Currently, perception is a central topic not only in neuroscience, but also in psychology, cognitive science, and computer science. How do scientists approach perception? We seek to discover lawful relations between perceptual experiences and the physical world and to develop models of the processes and mechanisms that produce these connections. To accomplish this, we need accounts of the information, the computational processes, and the neural mechanisms involved in perception. In this course, we will discuss fundamental problems in perception (primarily vision), and learn about techniques that are applied in attempts to solve these problems. The learning outcomes of this course include a better understanding of human perception and critical thinking skills for the analysis and interpretation of the related research reports. Prerequisite: NEUR-SHU 201 Introduction to Neural Science OR PSYC-SHU 101 Introduction to Psychology or AP Psychology: Score of 5 or IB Psychology HL (Higher Level): Score of 7 or A Level Psychology: Score of A. Fulfillment: Biology Electives; Neural Science Approved upper-level Psychology courses; Neural Science Electives; Social Science Focus Courses Psychology - 200 level.

**Grading:** Ugrd Shanghai Graded**Repeatable for additional credit:** No

- SB Crse Attr: NYU Shanghai: Biology Elective
- SB Crse Attr: NYU Shanghai: Neural Science Approved upper-level Psychology Crs
- SB Crse Attr: NYU Shanghai: Neural Science Elective
- SB Crse Attr: NYU Shanghai: Social Science Focus Psychology

**NEUR-SHU 251 Behavioral and Integrative Neuroscience (4 Credits)***Typically offered Spring*

This lecture and laboratory course addresses the physiological and anatomical bases of behavior. Lectures and laboratory experiments will emphasize mammalian sensory, motor, regulatory, and motivational mechanisms involved in the control of behavior, and higher mental processes such as those involved in language and memory. Co-requisite/ Pre-requisite: NEUR-SHU 201. Fulfillment: Neural Science required.

**Grading:** Ugrd Shanghai Graded**Repeatable for additional credit:** No

- SB Crse Attr: NYU Shanghai: Neural Science Required

**NEUR-SHU 261 Neurobiology of Decision Making (4 Credits)***Typically offered occasionally*

This special topics course will review recent research that combines psychological, economic, and neurobiological approaches to study human and animal decision-making. The course will focus on our current understanding regarding the neural underpinnings of decision-making, and how evidence concerning the neural processes associated with choices might be used to advance economic and psychological theories of decision-making. Topics covered include valuation, value learning, perceptual and value-based decisions. Prerequisite or Co-requisite: NEUR-SHU 201 Introduction to Neural Science. Fulfillment: Neural Science elective.

**Grading:** Ugrd Shanghai Graded**Repeatable for additional credit:** No

- SB Crse Attr: NYU Shanghai: Neural Science Elective

**NEUR-SHU 270 Introduction to Theoretical Neuroscience (4 Credits)***Typically offered Fall*

This course introduces students in neuroscience and mathematics to theoretical studies of neural systems. The course material is models of the nervous system at many different levels, including the biophysical, the circuit and the systems levels for biological sensing, motor control, perception, and learning. We will follow the classic textbook, "Theoretical neuroscience" by Dayan and Abbott. This broad introduction of topics in computational neuroscience aims to provide initial guidance for students to choose the computational approach to describe and analyze the data. The students will be encouraged to read the references and utilize the online materials before the lectures so that the students can participate in the discussion during the class. Mathematical tools in probability and differential equations and programming in Matlab will be introduced as needed within the course. Prerequisite: Undergraduates: Mathematical Tools for Life Sciences (NEUR-SHU 100) or MATH-SHU 235 (Probability and Statistics), or MATH-SHU 238 (Honors Theory of Probability).

Graduates: Mathematical Tools for Neural and Cognitive Science (NEURL-GA.2201). Fulfillment: Neural Science Electives.

**Grading:** Ugrd Shanghai Graded**Repeatable for additional credit:** No

- SB Crse Attr: NYU Shanghai: Neural Science Elective

**NEUR-SHU 301 Action and Cognition (4 Credits)***Typically offered every year*

We need to interact with people and the environment efficiently to survive, evolve, and create a better future. Action is a crucial process in this fundamental interaction. Recent advances in cognitive science and cognitive neuroscience emphasize the functions of action and its relations to cognition. The aims of the course are to provide students with a broad understanding of the foundations as well as cutting-edge advances on the topic of the relation between action and cognition. We will focus on the research that has led to those theories, as well as experimental approaches that derive and support these hypotheses. In doing so, students will also learn about the goals as well as the scientific procedures of behavioral and cognitive neuroscience research and the methods that are being employed to reach these goals. Prerequisite: Introduction to Neuroscience AND Behavioral and Integrative Neuroscience Fulfillment: Neural Science Electives.

**Grading:** Ugrd Shanghai Graded**Repeatable for additional credit:** No

- SB Crse Attr: NYU Shanghai: Neural Science Elective

**NEUR-SHU 305 Special Topics: The Meaning of Natural Language (4 Credits)***Typically offered Fall*

Perspectives from Linguistics, Cognitive Neuroscience, and Computer Science: Humans are animals of meaning. Among all kinds of interpretive activities – from recognizing bird songs and dog barks to appreciating impressionist artwork, the most human-specific is the use of language: with a limited number of symbols, humans can encode and convey an unlimited number of ideas with varying complexities, from concrete entities as simple as red boat to hypothesized models as intricate as artificial neural networks. How do we describe and analyze natural language meaning? How does our brain support the processing of natural language meaning? How can we make machines understand natural language meaning? This course seeks to provide a general introduction to current research on (the representation and/or processing of) natural language meaning, drawing on and bridging three different disciplines: formal linguistics, cognitive neuroscience, and computer science. Lectures cover (i) the modeling of natural language meaning in formal linguistics, (ii) hypothesized brain mechanisms underlying the processing of natural language meaning, (iii) main computational techniques that perform natural language understanding tasks, (iv) and cutting-edge research on bringing together interdisciplinary views. Pre-requisites: Students are expected to have taken core courses in the first two years of NYU Shanghai curriculum, including Introduction to Neuroscience. Otherwise, students should first ask for the instructor's permission. Fulfillment: Neural Science elective.

**Grading:** Ugrd Shanghai Graded**Repeatable for additional credit:** No

- SB Crse Attr: NYU Shanghai: Neural Science Elective

**NEUR-SHU 401 Neural Science Honors Seminar (4 Credits)***Typically offered Spring*

Open only to students qualified and having been recommended by the Director of Neural Science program. Fulfillment: General Elective.

**Grading:** Ugrd Shanghai Graded**Repeatable for additional credit:** No**NEUR-SHU 997 Independent Study I - Neural Science Capstone (4 Credits)***Typically offered Fall and Spring*

Prerequisite: All Neural Science Major Required Courses (Introduction to Neural Science, Cellular and Molecular Neuroscience, Behavioral and Integrative Neuroscience, Math Tools for Behavioral Science), permission of a neural science faculty member (at NYU-Shanghai, NYU-Abu Dhabi, or NYU-New York) who will act as a sponsor and mentor, and approval of the Director of Undergraduate Studies for Neural Science. The faculty mentor must be selected in consultation with the Director of Undergraduate Studies for Neural Science. Offered in Fall or Spring. Can be repeated once. 2 to 4 credits per term for a maximum of 8 credits. Minimum 4 credits are required to fulfill the capstone course requirement. This course aims at engaging students in research. Taking the course for 4 credits requires 10-12 hours spent on conducting research per week (2 credits require 5-6 hours per week). It is designed to offer students an opportunity to observe neuroscience research up close and gain hands-on research experience by working as a member in an active research team. Independent Study I and II can be done with the same supervisor or two different supervisors. No lectures will be given. Student researchers are expected to attend and actively participate in lab/supervision meetings. Prerequisite: None. Fulfillment: Neural Science Required Courses.

**Grading:** Ugrd Shanghai Graded**Repeatable for additional credit:** Yes

- SB Crse Attr: NYU Shanghai: Neural Science Required

**NEUR-SHU 998 Independent Study II - Neural Science (2-4 Credits)**

Prerequisite: All Neural Science Major Required Courses (Introduction to Neural Science, Cellular and Molecular Neuroscience, Behavioral and Integrative Neuroscience, Math Tools for Behavioral Science), permission of a neural science faculty member (at NYU-Shanghai, NYU-Abu Dhabi, or NYU-New York) who will act as a sponsor and mentor, and approval of the Director of Undergraduate Studies for Neural Science. The faculty mentor must be selected in consultation with the Director of Undergraduate Studies for Neural Science. Offered in Fall or Spring. Can be repeated once. 2 to 4 credits per term for a maximum of 8 credits. Minimum 4 credits are required to fulfill the capstone course requirement. This course aims at engaging students in research. Taking the course for 4 credits requires 10-12 hours spent on conducting research per week (2 credits require 5-6 hours per week). It is designed to offer students an opportunity to observe neuroscience research up close and gain hands-on research experience by working as a member in an active research team. Independent Study I and II can be done with the same supervisor or two different supervisors. No lectures will be given. Student researchers are expected to attend and actively participate in lab/supervision meetings. Prerequisite: None. Fulfillment: Neural Science Required Courses/ Electives.

**Grading:** Ugrd Shanghai Graded**Repeatable for additional credit:** No

- SB Crse Attr: NYU Shanghai: Neural Science Elective

- SB Crse Attr: NYU Shanghai: Neural Science Required