Government of Russian Federation

Federal State Autonomous Educational Institution of High Professional Education

«National Research University Higher School of Economics»

Faculty of Psychology

Syllabus for the course
«Cognitive Neuroscience»

030300.68 «Cognitive sciences and technologies: from neuron to cognition», Master of Science

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Approved by:

Recommended by:

Moscow, 2015

This syllabus may not be used by other departments of the University and by any other institutions without permission of the Author.
1. Scope of Use

The present syllabus establishes minimum demands of students’ knowledge and skills, and determines the content and the forms of educational activities, reporting and grading. The present syllabus is designed for lectures, teaching assistants and students of Master Program 030300.68 "Cognitive sciences and technologies: from neuron to cognition". This syllabus meets the standards required by:

- Educational standards of National Research University Higher School of Economics;
- Educational program "Psychology" of Federal Master’s Degree Program 030300.68, 2011;
- University curriculum of the Master’s program in psychology (030300.68) for 2013.

2. Learning Objectives

Learning objectives of the course "Cognitive Neuroscience" are to introduce students to the neurobiological basis of cognition, its foundation and connections to other branches of knowledge:

- Fundamental theory about neural processes that underlay high order cognitive functions;
- Recent progress in the field;
- Research Methods in neuroscience applicable to the fields.

3. Learning outcomes

After completing the study of the course "Cognitive Neuroscience" the student should:

- Know basis of neural processes that support high order functions;
- Know methods used to study the neuronal basis of cognition;
- Be able to distinguish the capacities and restrictions applied by brain structure and functioning to psychological processes;
- Possess skills for choosing appropriate neuroscience methods for psychological research;
- Possess skills to come up with own research proposals;
- Possess skills to understand and present scientific articles.

After completing the study of the discipline "Neuroscience" the student should have the following competences:

<table>
<thead>
<tr>
<th>Competence</th>
<th>Code</th>
<th>Code (UC)</th>
<th>Descriptors (indicators of achievement of the result)</th>
<th>Educative forms and methods aimed at generation and development of the competence</th>
</tr>
</thead>
<tbody>
<tr>
<td>The ability to reflect on the methods of activity studied.</td>
<td>CK-1</td>
<td>CK-M1</td>
<td>The student is able to reflect on the methods of activity studied based on cognitive neuroscience approaches.</td>
<td>Seminars</td>
</tr>
<tr>
<td>The ability to propose a model to invent and test methods and tools of professional activity.</td>
<td>CK-2</td>
<td>CK-M2</td>
<td>The student is able to propose a model to invent and test methods and tools of cognitive neuroscience.</td>
<td>Seminars</td>
</tr>
<tr>
<td>---</td>
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</tr>
<tr>
<td>The ability to independently become acquainted with new research methods, to change scientific profile of activity.</td>
<td>CK-3</td>
<td>CK-M 3</td>
<td>The student is able to independently become acquainted with new methods of cognitive neuroscience.</td>
<td>Tutorials, presentations.</td>
</tr>
<tr>
<td>The ability to improve and develop intelligent and cultural level, to build track of professional development and career.</td>
<td>SC-4</td>
<td>SC-M4</td>
<td>The student is able to improve and develop intelligent and cultural level, to build track of professional development and career based on the theories of cognitive neuroscience.</td>
<td>Lectures, group discussions, colloquium, projects in mini-groups, discussions of essays.</td>
</tr>
<tr>
<td>The ability to analyze, verify and assess the completeness of information during professional activity and work under ambiguity.</td>
<td>CK-6</td>
<td>CK-M 6</td>
<td>The student is able to analyze, verify and assess the completeness of information to solve cognitive neuroscience problems.</td>
<td>Tutorials, presentations, tests.</td>
</tr>
<tr>
<td>The ability to conduct professional (including research) activity in international environment.</td>
<td>SC-8</td>
<td>SC-M8</td>
<td>The student is able to conduct professional (including research) activity in international environment regarding main concepts of cognitive neuroscience.</td>
<td>Lectures, group discussions, colloquium, projects in mini-groups, discussions of essays.</td>
</tr>
<tr>
<td>Capability to organize independent scientific, research, consulting and applied activity on the basis of juridical and professional standards and duties.</td>
<td>РС-1</td>
<td>ИК-М1.2п/н/н/к/рп_6.1</td>
<td>The student is able to organize independent scientific, research, consulting and applied activity on the basis of cognitive neuroscience approach.</td>
<td>Lectures, group discussions, colloquium, projects in mini-groups, discussions of essays.</td>
</tr>
<tr>
<td>---------------------------------------------------------------</td>
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<td>----------------------</td>
<td>---------------------------------------------------------------------------------</td>
<td>---------------------------------------------------------------------</td>
</tr>
<tr>
<td>The ability to communicate orally and in written form in English in the frame of professional and scientific intercourse.</td>
<td>ПК-2</td>
<td>ИК-М2.1_2.2..2.4.1_2.4.2</td>
<td>The student is able to discuss problems of cognitive neuroscience both orally and in written form.</td>
<td>Seminars, tests.</td>
</tr>
<tr>
<td>The ability to use modern IT technologies for search and processing of information, work with professional databases and net communication.</td>
<td>РС-4</td>
<td>ИК-М4.1_4.3_4.4</td>
<td>The student is able to use modern IT technologies for search and processing of information, work with professional databases and net communication to solve cognitive neuroscience problems.</td>
<td>Tutorials, group discussions, presentations.</td>
</tr>
<tr>
<td>The ability to describe the problems and situations of the professional activity using the language and the apparatus of the humanitarian, economical and social sciences for solving problems at the intersection of scientific fields, in related professional fields.</td>
<td>РС-5</td>
<td>ИК-М5.3_5.4_5.6_2.4.1</td>
<td>The student is able to use the language and terminology of cognitive neuroscience for solving problems at the intersection of scientific fields, in related professional fields.</td>
<td>Seminars, tests.</td>
</tr>
</tbody>
</table>
4. **Place of the discipline in the Master’s program structure**

The course "Cognitive Neuroscience" belongs to major basic disciplines in the Master’s program "Cognitive sciences and technologies: from neuron to cognition".

Prerequisites:
The course is based on the knowledge in biology, physiology, anatomy and psychology. The following knowledge and competence are required to study the discipline:

- A good command of English language.
- Basic knowledge of brain anatomy.

Main competences developed after completing the study of this course are required for the study of the following disciplines of the Master’s Program "Cognitive sciences & technologies: from neuron to cognition", including:

- Thinking and Emotional Modulation of Cognition
- Computational Neuroscience
- Memory, Learning and Cognitive Development
- Behavioral Genetics and Neurogenetics
- Decision Science and Neuroeconomics
5. Thematic Plan of the Course

<table>
<thead>
<tr>
<th>№</th>
<th>Topic</th>
<th>Total hours</th>
<th>Class hours</th>
<th>Self-study</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Lectures</td>
<td>Seminars</td>
</tr>
<tr>
<td>1.</td>
<td>Perception</td>
<td>34</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>2.</td>
<td>Attention</td>
<td>34</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>3.</td>
<td>Memory</td>
<td>44</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>4.</td>
<td>Language</td>
<td>22</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>5.</td>
<td>Emotions</td>
<td>12</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>6.</td>
<td>Mirror system</td>
<td>22</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>7.</td>
<td>Neuroscience and music</td>
<td>12</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Total:</td>
<td>180</td>
<td>32</td>
<td>32</td>
</tr>
</tbody>
</table>

6. Requirements and Grading

<table>
<thead>
<tr>
<th>Type of grading</th>
<th>Type of work</th>
<th>1st year</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continuous</td>
<td>Paper presentation</td>
<td>*</td>
<td>Talk on the seminar on the topic related to the lectures, 60 minutes each.</td>
</tr>
<tr>
<td>Continuous</td>
<td>Research proposal</td>
<td>*</td>
<td>Choice of tasks that will help students to develop their own research ideas. Finally should be presented to the class.</td>
</tr>
<tr>
<td>Continuous</td>
<td>Attendance</td>
<td>*</td>
<td>Evaluation of attendance lectures and seminars</td>
</tr>
<tr>
<td>Final</td>
<td>Exam</td>
<td>*</td>
<td>Exam will include multiple choice questions, short answers</td>
</tr>
</tbody>
</table>
6.1. Course Grading Criteria

**Continuous assessment:**

- **Paper presentations.** Students have to present one paper or to make a short literature review on the subject that is relevant to the course topics. Presentations can be made by groups of student but not more than 3 people in each group. Presentation should last 45 minutes and then 15 minutes discussions take place. Main criteria for evaluation are relevance of the topic, understanding of the material and presentation skills.

- **Research proposal.** As a homework students should choose one of the tasks described above.
  - *Media Critique (25%).* Students will find a news article of 500 words or more that reports on a neuroscientific finding relevant for course topic. Based on the news article (published since 1995) and the original journal article on which it is based, students are to prepare a 2-4 page (double-spaced) critique of the news article’s claims and assess the degree to which it correctly represents the research finding and whether it might mislead the public’s understanding of neuroscience and behavior.
  - *Research ideas (25%).* Students will write down a research proposal based their ideas related on the main sections of the course (Perception, Attention, Memory, Language, Emotion, Plasticity, Mirror System). They will introduce their hypothesis, methods, collecting data and expected results. Moreover if they will test their paradigm on a sample of subjects, they may get extra score.
  - *Commentary (25%).* Students will write down a Commentary paper on a recent original research published in the Cognitive Neuroscience field. Commentary is a critical paper that aim to highlight positive and negative aspect of the published research.
  - *Amazon Mechanical Turk (25%).* Students will figure out how to use Amazon Mechanical Turk for developing and test their ideas. The will explain and document the potential of this service. AMT is a crowdsourcing marketplace for work that requires human intelligence. Mechanical Turk provides an on-demand and flexible work force in the cloud that requesters can tap into through its web user interface, command line tool, or its web service. Developers can leverage this service to build human intelligence directly into their applications.

Work should be done in three parts:
1) Abstract;
2) Report in a written form;
3) Presentation of the work on the seminar. 15 minutes to present and 10 minutes for discussion.

These continuous assessments will be evaluated with following criteria:
Syllabus for the course «Neuroscience» for 030300.68 «Cognitive sciences and technologies: from neuron to cognition», Master of Science

<table>
<thead>
<tr>
<th>Ten-point grade</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 – not accepted</td>
<td>Less 5%, or the test was not taken</td>
</tr>
<tr>
<td>1 – very bad</td>
<td>Not less than 5, but less than 15%</td>
</tr>
<tr>
<td>2 – bad</td>
<td>Not less than 15, but less than 25%</td>
</tr>
<tr>
<td>3 – no pass</td>
<td>Not less than 25, but less than 35%</td>
</tr>
<tr>
<td>4 – pass</td>
<td>Not less than 35, but less than 45%</td>
</tr>
<tr>
<td>5 – highly pass</td>
<td>Not less than 45, but less than 55%</td>
</tr>
<tr>
<td>6 – good</td>
<td>Not less than 55, but less than 65%</td>
</tr>
<tr>
<td>7 – very good</td>
<td>Not less than 65, but less than 75%</td>
</tr>
<tr>
<td>8 – almost excellent</td>
<td>Not less than 75, but less than 85%</td>
</tr>
<tr>
<td>9 – excellent</td>
<td>Not less than 85, but less than 95%</td>
</tr>
<tr>
<td>10 – perfect</td>
<td>Not less than 95% and greater</td>
</tr>
</tbody>
</table>

- **Attendance.** Attendance will be evaluated as a percentage of seminars and lectures that a student was present on.

**Final assessment** is the final exam. This exam will cover all topics that have been discussed during lectures and seminars. It will consist of multiple-choice, short answer questions and one essay question with opportunity to choose between topics. The main source to prepare the exam is slides from the lectures.

<table>
<thead>
<tr>
<th>Ten-point grade</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 – not accepted</td>
<td>No answer</td>
</tr>
<tr>
<td>1 – very bad</td>
<td>No criteria met</td>
</tr>
<tr>
<td>2 – bad</td>
<td>Less then 2 criteria met</td>
</tr>
<tr>
<td>3 – no pass</td>
<td>Less then 3 criteria met</td>
</tr>
<tr>
<td>4 – pass</td>
<td>At least 3 criteria are partially met</td>
</tr>
<tr>
<td>5 – highly pass</td>
<td>At least 3 criteria are met</td>
</tr>
<tr>
<td>6 – good</td>
<td>At least 4 criteria are partially met</td>
</tr>
<tr>
<td>7 – very good</td>
<td>At least 4 criteria are met</td>
</tr>
<tr>
<td>8 – almost excellent</td>
<td>All criteria are met.</td>
</tr>
<tr>
<td>9 – excellent</td>
<td>All criteria are met, and at least 3 criteria are fully met.</td>
</tr>
<tr>
<td>10 – perfect</td>
<td>All criteria are fully met</td>
</tr>
</tbody>
</table>

**6.2. The cumulative grade formulae**

<table>
<thead>
<tr>
<th>Ten-point Grading Scale</th>
<th>Five-point Grading Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 - very bad</td>
<td>Unsatisfactory – 2</td>
</tr>
<tr>
<td>2 – bad</td>
<td></td>
</tr>
<tr>
<td>3 – no pass</td>
<td></td>
</tr>
<tr>
<td>4 – pass</td>
<td>Satisfactory – 3</td>
</tr>
<tr>
<td>5 – highly pass</td>
<td>PASS</td>
</tr>
</tbody>
</table>

Table of Grade Correspondence
The final grade, which is the resultant grade for the course, goes to the certificate of Master’s degree.

7. Course Content

**TOPIC 1. PERCEPTION**

- Anatomy of the visual system: Retina and Chiasm
- Visual cortex: Dorsal and Ventral stream
- Bottom up processing of object recognition
- Top-down processing of object recognition
- Physical characteristics of a visual stimulus: Spatial Frequencies
- Visual perception deficits: Visual Agnosia
- Object recognition and context valence
- Face recognition

*Classes: 12 hours
Self-study: 22 hours*

**Obligatory reading:**


**TOPIC 2. ATTENTION**

- What is attention?
- Selective attention: Dichotic listening, Stroop test, Visual Search
- Divided attention
- Sustained attention
- Neural correlates of attention: Orienting attention network, Executive attention network, Frontal eye Field, Pulvinar Nucleus, Superior Colliculus
- Attention impairments in every day life: attentional blindness
• Attention impairments in patients: blindsight and neglect
• Consciousness

Classes: 12 hours
Self-study: 22 hours

Obligatory reading:
The Oxford Handbook of Cognitive Neuroscience, Volume 1. Edited by Kevin Ochsner and Stephen M. Kosslyn. The Cutting Edge. Part 2, Attention: Chapter 11,12,16.


TOPIC 3. MEMORY
• The Atkinson & Shiffrin's model
• The Alan Baddeley Model
• Sensory register
• Working Memory: Encoding, Short-term memory, Rehearsal
• Long Term Memory: Explicit and Implicit Memory (Declarative and Procedural memory), episodic memory, semantic memory, Skill Learning, Priming, Conditioning.
• Deep and shallow episodic encoding
• Consolidation processing
• Neural Correlates of memory
• Classical memory processes effects
• Long-term potentiation and long-term depression at a gross level and at a cellular level
• Gross level: Perceptual learning, Classical Conditioning, Instrumental Conditioning, Relational learning
  • Role of Dopamine
  • Role of Hippocampus
  • Patient HM and his memory disorder.
  • Interfering transiently with brain function (TMS and rTMS)
  • The Baddeley “episodic buffer” model
  • The H.E.R.A. model
  • Anterograde and Retrograde Amnesia.

Classes: 16 hours
Self-study: 28 hours
Obligatory reading:
The Oxford Handbook of Cognitive Neuroscience, Volume 1. Edited by Kevin Ochsner and Stephen M. Kosslyn. The Cutting Edge. Part 3, Attention: Chapter 17,18,19,21,23.


**TOPIC 4. LANGUAGE**

- Language Comprehension
- Language Production
- Relevance of context and top-down processing in language comprehension
- Digressions on the relationship between language and culture: Pragmatics, Linguistic relativity
- Relationship between sensory processing and language
- Hebbian Cell Assembly
- Timing of linguistic brain processes
- Serial model
- Comprehension of written text
- Different types of Aphasia
- Language production: speaking, writing
- Word learning processes
- Non-verbal communication: Embodied Cognition
- Neuroanatomy of Broca aphasia.
- Dislexia
- Language fluency and age of second language acquisition.
- Problems in studying spoken language understanding
- Use of MMN in neurolinguistic studies
- TMS studies of action verbs
- Differences for bilingual people
Classes: 8 hours
Self-study: 14 hours

Obligatory reading:


**TOPIC 5. EMOTIONS**

- What is emotion?
- Methods to study physiological changes.
- Relationship between physiological changes and Six basic emotions
- Reasoning
- Neurobiology of emotions: amygdala, hypothalamus, Limbic System, Brainstem
- Emotion regulation

Classes: 4 hours
Self-study: 8 hours

Obligatory reading:

The Oxford Handbook of Cognitive Neuroscience, Volume 2. Edited by Kevin Ochsner and Stephen M. Kosslyn. The Cutting Edge. Part 1, Emotions: Chapter 2

**TOPIC 6. MIRROR NEURONS SYSTEM**

- The mirror-neuron system in monkey
- Relation between their visual and motor properties
- Time-course of human mirror-effect
- The mirror-neuron system in humans: anatomy
- Properties
- Mirror System and Autism
• Cortico-cortical connectivity of motor imagery and action observation
  Plasticity of motor and sensory brain maps
• Mirror therapy (MT) in neurorehabilitation
• History of MT
• Methodology of MT
• Clinical use of MT
• Physiological mechanisms of MT

Classes: 8 hours
Self-study: 14 hours

Obligatory reading:

The Oxford Handbook of Cognitive Neuroscience, Volume 2. Edited by Kevin Ochsner and Stephen M. Kosslyn. The Cutting Edge. Part 2, Self and social cognition: Chapter 16


Brain 2009 The use of visual feedback, in particular mirror visual feedback, in restoring brain function. V. S. Ramachandran, Eric L. Altschuler. DOI: http://dx.doi.org/10.1093/brain/awp135 1693-1710


TOPIC 7. NEUROSCIENCE AND MUSIC

• Auditory–motor interactions during musical performance.
• Motor Timing
• Cerebellar and basal ganglia contributions to interval timing
• Perception of simple rhythms
• Perception of more complex rhythms
• Auditory Motor interaction: feedforward and feedback interactions
• Neural Correlates of music perception
• Brain structures involved in music-evoked emotions
• EEG study on musicians playing in ensemble

Classes: 8 hours
Self-study: 14 hours

Obligatory reading:


8. Educational Technology

The following educational technologies are used in the study process:
- Lectures involving continuous use of multimedia presentations and educational movies
- Seminars involving paper presentations
- Seminars involving development and presentation of own research ideas
- Self-study of presentation
- Self-study of recommended literature

8.1. Recommendations for course lecturer
Course lecturer is advised to use interactive learning methods, which allow participation of the students, such as discussions and developing of own ideas. It is also expected that multimedia presentations and video materials will be intensively used for the study process.

8.2. Recommendations for Students
Students are required to study the lecture presentations and the recommended reading. Students are required to actively participate in seminars presentations.

9. Grading

9.1. Final exam: sample of "true or false" questions:
Decide whether the statement is true or false:

1. Short-term memory is a sub-component of long term memory
2. Broca area is involved in comprehension processes
3. Action observation activate mirror neurons of the primary motor cortex
4. Auditory cortex has linked with premotor cortex in music production.
5. Neglect is an attentional deficit
6. Prosopagnosia is a memory deficit
9.2. Final exam essay questions (contents):

1. Anatomy of the visual system: Retina and Chiasm
2. Visual cortex: Dorsal and Ventral stream
3. Bottom up processing of object recognition
4. Top-down processing of object recognition
5. Visual perception deficits: Visual Agnosia and prosopagnosia
6. Object recognition and context valence
7. Face recognition
8. Selective attention: Dichotic listening, Stroop test, Visual Search
9. Divided attention
10. Sustained attention
11. Neural correlates of attention: Orienting attention network, Executive attention network, Frontal eye Field, Pulvinar Nucleus, Superior Colliculus
12. Attention impairments in every day life: inattentional blindness
13. Attention impairments in patients: blindsight and neglect
14. The Atkinson & Shiffrin's model
15. The Alan Baddeley Model
16. Working Memory: Encoding, Short-term memory, Rehearsal
17. Long Term Memory: Explicit and Implicit Memory (Declarative and Procedural memory), episodic memory, semantic memory, Skill Learning, Priming, Conditioning.
18. Deep and shallow episodic encoding
19. Neural Correlates of memory
20. Classical memory processes effects (primacy and recency effect)
21. Long-term potentiation and long-term depression at a gross level and at a cellular level
22. Patient HM and his memory disorder.
23. Interfering transiently with brain function (TMS and rTMS)
24. The Baddeley “episodic buffer” model
25. The H.E.R.A. model
27. Language Comprehension
28. Language Production
29. Timing of linguistic brain processes
30. Different types of Aphasia
31. Non-verbal communication: Embodied Cognition
32. Neuroanatomy of Broca aphasia.
33. TMS studies of action verbs
34. Differences for bilingual people
35. The mirror-neuron system in monkey
36. The mirror-neuron system in humans: anatomy
37. Mirror System and Autism
38. Cortico-cortical connectivity of motor imagery and action observation
39. Mirror therapy (MT) in neurorehabilitation
40. Clinical use of MT
41. Physiological mechanisms of MT
42. Auditory–motor interactions during musical performance.
43. Cerebellar and basal ganglia contributions to interval timing
44. Perception of simple and complex rhythms
45. Neural Correlates of music perception
46. Brain structures involved in music-evoked emotions

10. Reading and Materials

10.1. Obligatory reading


The Oxford Handbook of Cognitive Neuroscience, Volume 1. Edited by Kevin Ochsner and Stephen M. Kosslyn. The Cutting Edge. Part 2, Attention: Chapter 11,12,16.


The Oxford Handbook of Cognitive Neuroscience, Volume 1. Edited by Kevin Ochsner and Stephen M. Kosslyn. The Cutting Edge. Part 3, Attention: Chapter 17,18,19,21,23.


Brain 2009 The use of visual feedback, in particular mirror visual feedback, in restoring brain function. V. S. Ramachandran, Eric L. Altschuler DOI: http://dx.doi.org/10.1093/brain/awp135 1693-1710


Brain 2009 The use of visual feedback, in particular mirror visual feedback, in restoring brain function. V. S. Ramachandran, Eric L. Altschuler. DOI: http://dx.doi.org/10.1093/brain/awp135 1693-1710


10.2. Additional reading
As additional reading students will receive papers presented on the seminars. These papers will be chosen by students and will vary from year to year.

11. Course telemaintenance
All materials of the discipline are posted in informational educational site at NRU HSE portal www.hse.ru. Students are provided with links on relevant papers, tests, electronic books, articles, etc.

12. Equipment
The course requires a computer or laptop, projector, and acoustic systems for multimedia presentations and video.