Welcome to the Cognitive Science Master's Program

The Master's program focuses on conveying in-depth, research-orientated knowledge in the field of cognitive science. Social science and psychology are combined with IT and biology/neuroscience to create a broader field of science from which qualifications for cognitive science are acquired. The combination of those separate fields gives the ability to precisely use the knowledge already acquired within those sciences to further examine the aspects of humans, technology, economy, organization, communication and social behavior, which are all interconnected.

The Master in Cognitive Science is made up of several different interdisciplinary modules which can be completed within four semesters, and most of the lectures are held in English.

Structure of the Program

The first semester is made up of two introductory modules, one focusing on the theoretical background and the other on methodology. After completing these two modules, the student selects three of five main thematic fields:
1. Perception,
2. Cognition and Knowledge,
3. Language and Linguistics,
4. Cognitive Neuroscience and
5. Computation.

In each of these fields, the student must pass a module of elective seminars and/or lectures to earn a total of 9 Credit Points. In addition, the student must attend a methods seminar and an obligatory Laboratory Rotation (total 9 CPs) in each of the selected thematic fields. Exception: In the field Computation the student earns 12 Credit Points in the elective seminars and/or lectures and 6 Credit Points in the Laboratory Rotation.

An Internship forms a vital part of this course of studies (duration: 6 weeks).

The Methods Seminar requirement (1 CP per Advanced Module; total of 3 CP) is met through either fixed method courses or special method courses, typically depending on the research topic of the selected Laboratory Rotation. Possible special method courses include topics related to Eye Tracking Methods, Reaction Time Measurement, EEG Methods, fMRI Methods, Programming and Analysis using MATLAB, and similar. Actual offerings may change from year to year depending on student need and instructor availability. Information about individual courses offered each semester that meets the Methods Seminars requirement will be provided by e-mail to students registered in the program.

The final semester consists of writing the Master's Thesis.

If there are any questions, please consult our homepage (https://www.sowi.uni-kl.de/en/study/cognitive-science/) or make an appointment with the academic advisor:

Petra Ludowicy, (M.Sc.)

Building 57, Room 524

Phone: 0631-205-5038

E-Mail: petra.ludowicy[at]sowi.uni-kl.de
<table>
<thead>
<tr>
<th>Nr.</th>
<th>Module (Name and Method of Examination)</th>
<th>SWS</th>
<th>CP</th>
<th>Name of the Lecture/Seminar</th>
<th>Course Achievement</th>
<th>Comment</th>
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<tr>
<td></td>
<td><strong>Basic Modules</strong></td>
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<tr>
<td></td>
<td>Basic Module 1: Foundations of Cognitive Science (12 CP)</td>
<td>2</td>
<td>3</td>
<td>Perception, Cognition and Knowledge</td>
<td>Participation in moderated discussions</td>
<td>Elective courses (choose 4 out of 5)</td>
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<td></td>
<td><em>Written exam (90min)</em></td>
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<td>Basic Module 2: Principles and Techniques of Research in Cognitive Science (16 CP)</td>
<td>2</td>
<td>4</td>
<td>Introduction to Stochastic Modeling of Cognitive Processes</td>
<td>Discussion, presentation¹ and/or practical exercises</td>
<td>Mandatory courses</td>
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<td></td>
<td><em>Paper in &quot;Design and Analysis of Experiments&quot; &amp; &quot;Scientific Writing&quot;</em></td>
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<tr>
<td></td>
<td>Basic Module 1: Perception - Specialized Seminars (9 CP)</td>
<td>2</td>
<td>3</td>
<td>Psychophysics and Signal Detection</td>
<td>Presentation or written exam or paper¹</td>
<td>Mandatory courses</td>
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<td></td>
<td><em>Oral exam (15-30 min.)</em></td>
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<td></td>
<td>Basic Module 1: Perception - Research and Methods (9 CP)</td>
<td>4</td>
<td>8</td>
<td>Laboratory Rotation for Advanced Module 1: Perception</td>
<td>Practical work</td>
<td>Mandatory course</td>
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<td><em>Present a poster or presentation or paper (students have to prepare all three exam forms – one for each Research and Methods Module)</em></td>
<td>1</td>
<td>1</td>
<td>Methods Seminar for Advanced Module 1: Reaction Time Analysis</td>
<td>Exercises</td>
<td>Elective courses (choose 1 out of 2)</td>
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<td>Methods Seminar for Advanced Module 1: Special Methods</td>
<td>Exercises</td>
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<td><strong>Advanced Modules (choose 3 out of 5)</strong></td>
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<td>SO-07-260 3-M-6-a</td>
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<td>4</td>
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<td>Mandatory course</td>
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<td><em>Present a poster or presentation or paper (students have to prepare all three exam forms – one for each Research and Methods Module)</em></td>
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<td>Exercises</td>
<td>Elective courses (choose 1 out of 2)</td>
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¹ As specified at the beginning of the course.
### Advanced Modules 2: Cognition and Knowledge

<table>
<thead>
<tr>
<th>SO-08-2605-M-6-a</th>
<th>Advanced Module 2: Cognition and Knowledge - Specialized Seminars (9 CP)</th>
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<tr>
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<td><strong>Elective courses (choose 3 out of 9)</strong></td>
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<tr>
<td></td>
<td><strong>1. Collaborative Intelligence (lecture)</strong></td>
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<td><strong>2. Collaborative Intelligence (seminar)</strong></td>
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<td></td>
<td><strong>3. Judgment and Decision-Making</strong></td>
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<td><strong>4. Learning and Behavior</strong></td>
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<td><strong>5. Cognitive Aging</strong></td>
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<td></td>
<td><strong>6. Reading</strong></td>
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<td></td>
<td><strong>7. Eye Movements and Cognition</strong></td>
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<td></td>
<td><strong>8. Human Intelligence, Problem Solving and Creative Thinking</strong></td>
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<td></td>
<td><strong>9. Human Memory: Behavioral and Neural Basis</strong></td>
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<td><strong>Mandatory course</strong></td>
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<tr>
<td></td>
<td><strong>1. Methods Seminar for Advanced Module 2: Special Methods</strong></td>
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<td></td>
<td><strong>2. Methods Seminar for Advanced Module 2: Mental Chronometry</strong></td>
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<td><strong>Practical work</strong></td>
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<td><strong>Elective courses (choose 1 out of 2)</strong></td>
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### Advanced Modules 3: Language and Linguistics

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<tr>
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<tr>
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<td><strong>1. Reading</strong></td>
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<td><strong>2. Syntax</strong></td>
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<td><strong>3. Sentence Processing</strong></td>
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<td><strong>4. Language Development</strong></td>
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<td></td>
<td><strong>5. Computational Linguistics</strong></td>
</tr>
<tr>
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<td><strong>Mandatory course</strong></td>
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<tr>
<td></td>
<td><strong>1. Methods Seminar for Advanced Module 2: Mental Chronometry</strong></td>
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<tr>
<td></td>
<td><strong>Practical work</strong></td>
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*Fehler! Textmarke nicht definiert.*
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<tr>
<th>Module</th>
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<th>Notes</th>
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<tr>
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<td><strong>Advanced Module 3: Language and Linguistics - Research and Methods</strong> (9 CP)&lt;br&gt;&lt;br&gt;<em>Present a poster or presentation or paper (students have to prepare all three exam forms – one for each Research and Methods Module)</em></td>
<td>2 3 Heritage Language Acquisition</td>
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<td>2 3 Psycholinguistics</td>
<td>Presentation or written exam or paper</td>
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<td>2 3 Neural Basis of Language</td>
<td>Presentation or written exam or paper</td>
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<td><strong>Advanced Module 4: Cognitive Neuroscience</strong></td>
<td>6 8 Laboratory Rotation for Advanced Module 3: Language and Linguistics</td>
<td>Practical work</td>
<td>Mandatory course</td>
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<td>Elective courses (choose 1 out of 2)</td>
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<td>1 1 Methods Seminar for Advanced Module 3: Special Methods</td>
<td>Practical work</td>
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<td><strong>Advanced Module 5: Computation</strong>&lt;br&gt;&lt;br&gt;<em>Oral exam (15-30 min.)</em></td>
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<td>Elective courses (choose 3 out of 10)</td>
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<td>2 4 Biologically Motivated Robots (lecture)</td>
<td>Presentation or written exam or paper</td>
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<td>2 4 Biologically Motivated Robots (tutorial)</td>
<td>Presentation or written exam or paper</td>
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<td>2 4 Visualization and HCl</td>
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<td>2 4 Data Visualization</td>
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<td><strong>Computational Linguistics</strong></td>
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<td>Presentation or written exam or paper¹</td>
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<td><strong>Collaborative Intelligence (lecture)</strong></td>
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<td>Presentation or written exam or paper¹</td>
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<td><strong>Collaborative Intelligence (seminar)</strong></td>
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<td>4</td>
<td>Presentation or written exam or paper¹</td>
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<td><strong>Neurocomputing (lecture/tutorial)</strong></td>
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<td>Oral exam and presentation</td>
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<td><strong>Sensorsignalprocessing (lecture/tutorial)</strong></td>
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<td>Oral exam and presentation</td>
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<td>6</td>
<td>Laboratory Rotation for Advanced Module 5: Computation Option 3: Neurocomputing &amp; Sensorsignalprocessing (Prerequisite: Lecture Neurocomputing and/or Sensorsignalprocessing)</td>
<td>Prototype and Presentation</td>
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<td>Laboratory Rotation for Advanced Module 5: Computation Option 1: Visualization and Human Computer Interaction (Prerequisite: Lecture Human Computer Interaction)</td>
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<td>3</td>
<td>6</td>
<td>Laboratory Rotation for Advanced Module 5: Computation Option 2: Service Robots and Assistance Systems (Prerequisite: Lecture Biologically Motivated Robots)</td>
<td>Practical work</td>
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<tr>
<td>Internship Module (8 CP)</td>
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<td>Master’s Thesis</td>
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<tr>
<th>Semester</th>
<th>Modules</th>
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<tr>
<td>1st Semester</td>
<td>Basic Modules</td>
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<tr>
<td>2nd/3rd Semester</td>
<td>Advanced Modules 1: Perception</td>
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<tr>
<td>2nd/3rd Semester</td>
<td>Advanced Modules 2: Cognition and Knowledge</td>
</tr>
<tr>
<td>2nd/3rd Semester</td>
<td>Advanced Modules 3: Language and Linguistics</td>
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<tr>
<td>2nd/3rd Semester</td>
<td>Advanced Modules 4: Cognitive Neuroscience</td>
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<tr>
<td>2nd/3rd Semester</td>
<td>Advanced Modules 5: Computation</td>
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<td>2nd/3rd Semester</td>
<td>Internship</td>
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<td>4th Semester</td>
<td>Master’s Thesis</td>
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**List of abbreviations:**

<table>
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<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tr>
<td>CP</td>
<td>Credit Points</td>
</tr>
<tr>
<td>ge req. en</td>
<td>German; if required, the course can be offered in English</td>
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<tr>
<td>ge</td>
<td>German</td>
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<tr>
<td>en</td>
<td>English</td>
</tr>
<tr>
<td>MOD</td>
<td>Mode</td>
</tr>
<tr>
<td>AT</td>
<td>Attendance time</td>
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<tr>
<td>RC</td>
<td>Regular Cycle</td>
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<tr>
<td>La</td>
<td>Language</td>
</tr>
<tr>
<td>PS</td>
<td>Private Study (preparation + follow up)</td>
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<tr>
<td>ST</td>
<td>Summer Term</td>
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<td>CH</td>
<td>Contact hours per week</td>
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<td>PL</td>
<td>Participant limit</td>
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<td>WST</td>
<td>Winter and Summer Term</td>
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<td>WT</td>
<td>Winter Term</td>
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Please note: You can find the course achievement of every course in the description of the particular content.
1st Semester: Basic Modules

Basic Module 1: Foundations of Cognitive Science

<table>
<thead>
<tr>
<th>Code:</th>
<th>Module Coordinator:</th>
<th>Teaching Staff:</th>
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<tbody>
<tr>
<td>SO-07-2601-M-5</td>
<td>Prof. Dr. Thomas Schmidt</td>
<td>Prof. Dr. Thomas Schmidt</td>
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<tr>
<td></td>
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<td>Prof. Dr. Thomas Lachmann</td>
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<tr>
<td></td>
<td></td>
<td>Jun.-Prof. Dr. Daniela Czernochowski</td>
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<tr>
<td></td>
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<td>Prof. Dr. Shanley Allen</td>
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<td></td>
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<td>Prof. Dr. Achim Ebert</td>
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<tr>
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<td>Prof. Dr. Karen Joisten</td>
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<th>Workload:</th>
<th>Duration:</th>
<th>Regular cycle:</th>
<th>Recommended Semester:</th>
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<tr>
<td>12 CP</td>
<td>360 h</td>
<td>1 Term/s</td>
<td>Winter Term</td>
<td>cf. study schedule</td>
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Parts of the module/courses:
Courses marked with an (M) are mandatory whereas courses marked with an (E) are elective. In this module, students have to choose and pass at least four courses (for 12 CP).

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<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Type</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Duration</th>
<th>Regular cycle</th>
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<td>60</td>
<td>20</td>
<td>ge req. en</td>
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<td>WT 3</td>
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<tr>
<td>SO-00-26.1000-V</td>
<td>Lecture Perception, Cognition and Knowledge</td>
<td>E</td>
<td>2</td>
<td>30</td>
<td>60</td>
<td>30</td>
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<td>WT 3</td>
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<td>SO-04-26.8000-V-5</td>
<td>Lecture Philosophy of Mind</td>
<td>E</td>
<td>2</td>
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<td>WT 3</td>
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<tr>
<td>SO-12-26.1000-S-5</td>
<td>Lecture Cognitive Neuroscience</td>
<td>E</td>
<td>2</td>
<td>30</td>
<td>60</td>
<td>25</td>
<td>en</td>
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<tr>
<td>SO-12-8.1000-S-3</td>
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<td>40</td>
<td>en</td>
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<td>WT 3</td>
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Content:

**Lecture Introduction to Programming**
The lecture deals with basic programming concepts (variables, algorithms, data types, control structures). These concepts will be practiced through written exercises and implementation tasks.
This course is highly recommended for all students without a BA in Computer Science. Students with a BA in Computer Science are encouraged to voluntarily attend the course “Complex Network Analysis” for extra credit points (CP).

*Course achievement:* Satisfactory completion of a specific number of exercises

**Lecture Perception, Cognition and Knowledge**
Understanding of basic concepts, phenomena, and experimental paradigms, with a focus on behavioral cognitive psychology and mental chronometry.
This course is highly recommended for all students without a BA in Psychology. Students with a BA in Psychology are encouraged to voluntarily attend the course for extra credit points (CP).

*Course achievement:* Participation in moderated discussions

**Lecture Philosophy of Mind**
The lecture will discuss different concepts of mind from a historical and systematic perspective. We will read and study original articles in the field.
This course is highly recommended for all students without a BA in Philosophy or Integrative Social Science. Students with a BA in Philosophy or Integrative Social Science are encouraged to voluntarily attend the course for extra credit points (CP).

*Course achievement:* Presentation or exam or paper (as specified at the beginning of the course)

**Lecture Cognitive Neuroscience**
The lecture will provide information about the basic aspects of brain structure and function and how they relate to cognition. The major focus is on contemporary methods of cognitive neuroscience (EEG, fMRI, TMS, etc.), and how each method can inform us about cognitive processes.
This lecture will cover basic aspects of neurophysiology, including the principles of excitability and synaptic connectivity. However, participants with no or very limited knowledge in biology will be required to acquire relevant aspects of neurobiology in guided self-study during this course (e.g., structure of the nervous system, neurotransmitters).
This course is highly recommended for all students without a BA in Biology. Students with a BA in Biology are encouraged to voluntarily attend the course for extra credit points (CP).

**Course achievement:** Method paper (2-4 pages)

## Lecture Linguistics and Language Processing
Students will learn foundations of the structure of language, language development, and language processing as understood within the framework of cognitive science.

This course is highly recommended for all students without a BA in Linguistics. Students with a BA in Linguistics are encouraged to voluntarily attend the course for extra credit points (CP).

### Competencies and Intended Learning Outcomes:

**Intended Learning Outcomes:**
On successfully completing the module students will be able to,

- gain an understanding of how perceptual and cognitive processes function and interact in humans, animals and artificial systems.
- learn how cognitive science is understood within its central component disciplines, especially psychology, computer science, biology, linguistics, and philosophy.

<table>
<thead>
<tr>
<th>Prerequisites for attending</th>
<th>Requirements for receiving credit points</th>
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<tbody>
<tr>
<td><strong>Formal admission requirements/Contentual prerequisites:</strong> None</td>
<td>Successful completion of requirements for four elective lectures as well as one written exam (90 min.) covering the entire module. Students with a relevant degree (in psychology, biology, computer science, philosophy, linguistics) should take at least 4 courses not related to the study program where they obtained their degree. All students are encouraged to also voluntarily take the course related to their BA for extra credit points (CP).</td>
</tr>
</tbody>
</table>

### Determination of grade:
Grade of the written exam.

### Applicability of the module/suitability:

- As a obligatory module:
- As a mandatory module:

### Hints for preparation:

**Recommended literature:**

*Lecture Introduction to Programming*

*Recommended literature:*

*Lecture Perception, Cognition and Knowledge*

*Recommended literature:*

*Lecture Philosophy of Mind*
Will be announced at the beginning of the course.

*Recommended literature:*

*Lecture Cognitive Neuroscience*

*Recommended literature:*

*Lecture Linguistics and Language Processing*
# Basic Module 2: Principles and Techniques of Research in Cognitive Science

<table>
<thead>
<tr>
<th>Code:</th>
<th>Module Coordinator:</th>
<th>Teaching Staff:</th>
</tr>
</thead>
<tbody>
<tr>
<td>SO-04-2602-M5</td>
<td>n. N.</td>
<td>Department of Mathematics</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Prof. Dr. Shanley Allen</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Prof. Dr. Achim Ebert</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Dr. Radha Nila Meghanathan</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ph.D. Sven Panis</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Dipl.-Psych. René Reinhard</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Credit Points (CP):</th>
<th>Workload:</th>
<th>Duration:</th>
<th>Regular cycle:</th>
<th>Recommended Semester:</th>
</tr>
</thead>
<tbody>
<tr>
<td>16 CP</td>
<td>480 h</td>
<td>1 Term/s</td>
<td>Winter Term</td>
<td>cf. study schedule</td>
</tr>
</tbody>
</table>

## Parts of the module/courses:
Courses marked with an (M) are mandatory whereas courses marked with an (E) are elective. In this module, students have to pass all courses listed in this module (for 16 CP).

<table>
<thead>
<tr>
<th>Code</th>
<th>Course</th>
<th>MOD</th>
<th>CH</th>
<th>AT</th>
<th>PS</th>
<th>PL</th>
<th>La</th>
<th>RC</th>
<th>CP</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAT-00-70-V0</td>
<td>Lecture Introduction to Stochastic Modeling of Cognitive Processes</td>
<td>M</td>
<td>2</td>
<td>30</td>
<td>90</td>
<td>30</td>
<td>en</td>
<td>WT</td>
<td>4</td>
</tr>
<tr>
<td>SO-01-26.2000-S-5</td>
<td>Master`s Seminar Design and Analysis of Experiments</td>
<td>M</td>
<td>2</td>
<td>30</td>
<td>90</td>
<td>30</td>
<td>en</td>
<td>WT</td>
<td>4</td>
</tr>
<tr>
<td>SO-07-26.2000-S-5</td>
<td>Master`s Seminar Data analysis with SPSS and R</td>
<td>M</td>
<td>2</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>en</td>
<td>WT</td>
<td>2</td>
</tr>
<tr>
<td>SO-12-26.100-S-6</td>
<td>Master`s Seminar Human Subjects</td>
<td>M</td>
<td>1</td>
<td>15</td>
<td>15</td>
<td>30</td>
<td>en</td>
<td>WT</td>
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</tr>
<tr>
<td>SO-12-36.1000-S-0</td>
<td>Master`s Seminar Scientific Writing</td>
<td>M</td>
<td>2</td>
<td>30</td>
<td>60</td>
<td>30</td>
<td>en</td>
<td>WT</td>
<td>3</td>
</tr>
<tr>
<td>INF-80-10-U-2</td>
<td>Tutorial Introduction to Programming</td>
<td>M</td>
<td>2</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>ge req.</td>
<td>en</td>
<td>WT</td>
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</tbody>
</table>

## Content:

### Lecture Introduction to Stochastic Modeling of Cognitive Processes
- Introduction to basics of probability theory
- Markov chains
- Basic modeling of cognitive processes
- Competences and intended learning outcomes
- This course focuses on the following competences: The students are introduced to simple stochastic models of learning processes. Methods for parameter estimation and testing the fit of the model to the data are presented.
- On successfully completing the course students will be able to appreciate the usefulness of formal modeling of cognitive processes and learn about more complex models by self-study.

**Course achievement:** Regular and active participation in the lecture; at the end of the semester, each student has to prove familiarity with the concepts of the lecture e.g. during an oral discussion with the teacher or by giving a short presentation. The exact mode of examination will be announced in the beginning of the semester.

### Master`s Seminar Design and Analysis of Experiments
Theoretical foundation and history of quantitative approach to research, fundamentals of experimental design, practical aspects of experiment preparation and procedure, analysis of experimental data.

**Course achievement:** Practical exercise

### Master`s Seminar Data analysis with SPSS and R
In this course students will learn how to calculate descriptive statistics, visualize data, evaluate assumptions, and perform correlational analysis, simple and multiple regression, logistic regression, t-tests, ANOVA, and generalized linear mixed effects regression (i.e., event history analysis). Course achievement: Practical exercise

### Master`s Seminar Human Subjects
The importance of respecting research participants as fellow human beings, ethical principles for conducting research, writing applications for ethics approval for research studies, writing informed consent forms and debriefing forms, and managing research data to ensure participant confidentiality.

**Course achievement:** Application for ethics approval for a research study

### Master`s Seminar Scientific Writing

In this course, students will learn how to structure and write papers for scientific journals. Furthermore, essential qualities required in scientific writing, such as being clear, concise, convincing, fluid, interesting, and organized are thought and practiced. Exercises will enable students to assess their strengths and weaknesses in scientific writing.

**Course achievement:** Practical exercises

### Tutorial Introduction to Programming

Practical exercises to reinforce the contents of the associated lecture.

**Course achievement:** Practical exercises

### Competencies and Intended Learning Outcomes:

**Intended Learning Outcomes:**

On successfully completing the module students will be able to,

- develop an understanding of the design and analysis of experiments.
- develop fundamental skills in computer programming and data analysis.
- gain knowledge about the fundamentals of ethics and philosophy of science and their relevance to cognitive science research.
- hone skills in scientific writing.

### Prerequisites for attending:

**Formal admission requirements/Contentual prerequisites:** Students will need basic knowledge of descriptive and inferential statistics (sets, functions, sample, population, probability function, random variable, sampling distributions of sample statistics etc.). For students who do not have sufficient knowledge in statistics – as rated by the examination board – a bridge course/tutorium “Introduction to Statistics” will be offered at the beginning of the winter term on demand.

**Requirements for receiving credit points:**

Successful completion of requirements for all seminars, as well as a paper (approx. 15 pages) in "Design and Analysis of Experiments" and "Scientific Writing".

### Determination of grade:

Grade of the paper.

### Applicability of the module/suitability:

As a obligatory module:

- 

As a mandatory module:

- 

### Hints for preparation:

**Recommended literature:**

**Lecture Introduction to Stochastic Modeling of Cognitive Processes**


**Master’s Seminar Design and Analysis of Experiments**


**Master’s Seminar Data analysis with SPSS and R**


**Master’s Seminar Human Subjects**


<table>
<thead>
<tr>
<th>Recommended literature:</th>
</tr>
</thead>
</table>

**Master’s Seminar Scientific Writing**
Recommended literature:

**Tutorial Introduction to Programming**
## Advanced Module 1: Perception - Specialized Seminars

| Code: SO-07-2603-M-6-a | Module Coordinator: Prof. Dr. Thomas Schmidt | Teaching Staff: Prof. Dr. Thomas Schmidt, Sven Panis, PhD, Dr. Radha Nila Meghanathan |

| Credit Points (CP): 9 CP | Workload: 270 h | Duration: 1 Term/s | Regular cycle: Summer/Winter Term | Recommended Semester: cf. study schedule |

### Parts of the module/courses:
Courses marked with an (M) are mandatory whereas courses marked with an (E) are elective. In this module, students have to pass at least three courses (for 9 CP).

<table>
<thead>
<tr>
<th>Mod</th>
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<tbody>
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<td>RC</td>
<td>CP</td>
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<tr>
<td>M</td>
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<tr>
<td>M</td>
<td>2</td>
<td>30</td>
<td>60</td>
<td>30</td>
<td>en</td>
<td>WT</td>
<td>3</td>
</tr>
</tbody>
</table>

### Content:

**Master’s Seminar Psychophysics and Signal Detection**
The seminar reviews the most important psychophysical models, including signal detection and threshold theories. Special emphasis is on experimental techniques and practical calculation.

Lecture on Perception, Cognition and Knowledge (part of Basic Module 1) is highly recommended.

*Course achievement:* Presentation or exam or paper (as specified at the beginning of the course)

**Master’s Seminar Visual Attention and Awareness**
The seminar reviews important models and experimental paradigms in attention and awareness research, using classic and recent original papers. Lecture on Perception, Cognition and Knowledge (part of Basic Module 1) is highly recommended.

*Course achievement:* Presentation or exam or paper (as specified at the beginning of the course)

**Master’s Seminar Eye Movements and Cognition**
The seminar will cover the basics of eye movements, the relationship between eye movements and cognition, which information eye movements can provide about cognition and the eye movements outside the healthy adult.

The lecture on Perception, Cognition and Knowledge (part of Basic Module 1) is highly recommended.

*Course achievement:* Presentation or exam or paper (as specified at the beginning of the course)

### Competencies and Intended Learning Outcomes:

**Intended Learning Outcomes:**
On successfully completing the module students will be able to,

- present their knowledge of special topics from the field of Perception
- apply the acquired understanding of perceptual processes
- read and interpret scientific English literature in this field
- summarize and compare research papers and highlight relevant information from these papers
- debate scientific issues with peers or lecturers and thereby refer to complex concepts

### Prerequisites for attending:

**Formal admission requirements/Contentual prerequisites:** Successful completion of Basic Modules 1 and 2 is recommended.

**Determination of grade:**
Grade of the oral exam.

### Requirements for receiving credit points:

Successful completion of requirements for three elective seminars, as well as one oral exam covering the entire module (15-30 min.).
<table>
<thead>
<tr>
<th>Applicability of the module/suitability:</th>
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<tbody>
<tr>
<td>As a obligatory module:</td>
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<tr>
<td>-</td>
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<tr>
<td>As a mandatory module:</td>
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<td>-</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Hints for preparation:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recommended literature:</td>
</tr>
</tbody>
</table>

**Master’s Seminar Psychophysics and Signal Detection**


**Recommended literature:**

**Master’s Seminar Visual Attention and Awareness**

Itti, Rees, & Tsotsos (1995): "Neurobiology of Attention". Elsevier

**Recommended literature:**
Advanced Module 1: Perception - Research and Methods

<table>
<thead>
<tr>
<th>Code:</th>
<th>Module Coordinator:</th>
<th>Teaching Staff:</th>
</tr>
</thead>
<tbody>
<tr>
<td>SO-07-2603-M-6-b</td>
<td>Prof. Dr. Thomas Schmidt</td>
<td>Prof. Dr. Thomas Lachmann</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Prof. Dr. Thomas Schmidt</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ph.D. Sven Panis</td>
</tr>
</tbody>
</table>

Credit Points (CP): 9 CP  
Workload: 270 h  
Duration: 1 Term/s  
Regular cycle: Winter Term  
Recommended Semester: cf. study schedule

Parts of the module/courses:  
Courses marked with an (M) are mandatory whereas courses marked with an (E) are elective. In this module, students have to attend and pass the Laboratory Rotation and the associated Method Seminar (for 9 CP).

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>MOD</th>
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<th>PS</th>
<th>PL</th>
<th>La</th>
<th>RC</th>
<th>CP</th>
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</thead>
<tbody>
<tr>
<td>SO-07-26.2900-L-7</td>
<td>Laboratory Rotation for Advanced Module 1: Perception</td>
<td>M</td>
<td>4</td>
<td>90</td>
<td>18</td>
<td>0</td>
<td>30</td>
<td>en</td>
<td>WT</td>
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<tr>
<td>SO-07-26.3000-S-6</td>
<td>Master’s Seminar Methods Seminar for Advanced Module 1: Reaction Time Analysis</td>
<td>E</td>
<td>1</td>
<td>15</td>
<td>15</td>
<td>30</td>
<td>en</td>
<td>ST</td>
<td>1</td>
</tr>
<tr>
<td>SO-07-26.3000-S-7</td>
<td>Master’s Seminar Methods Seminar for Advanced Module 1: Special Methods</td>
<td>E</td>
<td>1</td>
<td>15</td>
<td>15</td>
<td>30</td>
<td>en</td>
<td>WS</td>
<td>1</td>
</tr>
</tbody>
</table>

Content:  
Laboratory Laboratory Rotation for Advanced Module 1: Perception  
Group work on a practical research project (e.g. response priming effects) under the supervision of one of the teaching staff. Successful completion of Basic Modules 1 and 2 and the lecture on Perception, Cognition and Knowledge (part of Basic Module 1) are highly recommended.  
Course achievement: Practical work

Master’s Seminar Methods Seminar for Advanced Module 1: Reaction Time Analysis  
Students will learn how to design a RT experiment, and measure, preprocess and analyse reaction time and accuracy data. Next to classical methods (outlier detection, repeated-measures analysis-of-variance), students will also learn more advanced methods including (macro- and micro-level) speed-accuracy trade-off functions, and describing RT data using statistics such as hazard and survivor functions. Prerequisites: Successful completion of Basic Modules 1 and 2 is highly recommended.  
Course achievement: Exercises

Master’s Seminar Methods Seminar for Advanced Module 1: Special Methods  
Essential mathematical and modeling techniques, experimental design, animal and human participant selection and recruitment, development and preparation of experimental materials, research software (e.g. Experiment Builder), specialized experimental equipment (e.g. response time equipment, eye-tracker), interpretation of experimental results. Successful completion of Basic Modules 1 and 2 is highly recommended.  
Course achievement: Exercises

Competencies and Intended Learning Outcomes:  
Intended Learning Outcomes:  
On successfully completing the module students will be able to,

- recognize and define basic and some more advanced methods in research related to Perception  
- transfer the acquired knowledge to related experimental designs  
- prepare and conduct an experiment in the laboratory; apply practical research skills  
- Summarize and present the results obtained with these specific research methods

Prerequisites for attending:  
Formal admission requirements/Contentual prerequisites: Successful completion of Basic Modules 1 and 2 is recommended.

Requirements for receiving credit points:  
EITHER prepare and present a poster OR presentation at an annual “mini- conference” (15 min talk and 5 – 10 min discussion) OR write a paper (approx. 15 pages) about laboratory rotation work. Overall, students have to prepare all three exam forms – one for each advanced module.

Determination of grade: none
Applicability of the module/suitability:
As a obligatory module:
- 
As a mandatory module:
- 

Hints for preparation:
Recommended literature:

**Laboratory Laboratory Rotation for Advanced Module 1: Perception**
Miller & Haden (2006): "Statistical Analysis with the General Linear Model". Creative Commons Recommended literature:

**Master’s Seminar Methods Seminar for Advanced Module 1: Reaction Time Analysis**

**Master’s Seminar Methods Seminar for Advanced Module 1: Special Methods**
# 2nd/3rd Semester: Advanced Modules 2: Cognition and Knowledge

## Advanced Module 2: Cognition and Knowledge - Specialized Seminars

<table>
<thead>
<tr>
<th>Code:</th>
<th>Module Coordinator:</th>
<th>Teaching Staff:</th>
</tr>
</thead>
</table>
| SO-08-2605-M-6-a | Prof. Dr. Thomas Lachmann | Prof. Dr. Thomas Schmidt  
Jun.-Prof. Dr. Daniela Czernochowski  
Prof. Dr. Maria Klatte  
Prof. Dr. Andreas Dengel  
Prof. Dr. Thomas Lachmann  
Dr. Saskia Jaarsveld  
Dr. Francisca Rodríguez  
Dr. Radha Nila Meghanathan |

### Credit Points (CP):

<table>
<thead>
<tr>
<th>Credit Points (CP):</th>
<th>Workload:</th>
<th>Duration:</th>
<th>Regular cycle:</th>
<th>Recommended Semester:</th>
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<tbody>
<tr>
<td>9 CP</td>
<td>270 h</td>
<td>1 Term/s</td>
<td>Summer &amp; Winter Term</td>
<td>cf. study schedule</td>
</tr>
</tbody>
</table>

### Parts of the module/courses:

Courses marked with an (M) are mandatory whereas courses marked with an (E) are elective. In this module, students have to pass at least three courses (for 9 CP).

<table>
<thead>
<tr>
<th>Code:</th>
<th>Course:</th>
<th>MOD</th>
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<th>AT</th>
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<th>RC</th>
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<tbody>
<tr>
<td>INF-71-58-V-7</td>
<td>Lecture Collaborative Intelligence</td>
<td>E</td>
<td>2</td>
<td>30</td>
<td>60</td>
<td>20</td>
<td>en</td>
<td>ST</td>
<td>3</td>
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<tr>
<td>INF-71-58-U-7</td>
<td>Master’s Seminar Collaborative Intelligence</td>
<td>E</td>
<td>2</td>
<td>30</td>
<td>60</td>
<td>10</td>
<td>en</td>
<td>WT</td>
<td>3</td>
</tr>
<tr>
<td>SO-08-26.2100-S-7</td>
<td>Master’s Seminar Judgment and Decision-Making</td>
<td>E</td>
<td>2</td>
<td>30</td>
<td>60</td>
<td>30</td>
<td>en</td>
<td>ST</td>
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</tr>
<tr>
<td>SO-08-26.2300-S-7</td>
<td>Master’s Seminar Learning and Behavior</td>
<td>E</td>
<td>2</td>
<td>30</td>
<td>60</td>
<td>30</td>
<td>en</td>
<td>ST</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Master’s Seminar Cognitive Aging</td>
<td>E</td>
<td>2</td>
<td>30</td>
<td>60</td>
<td>30</td>
<td>en</td>
<td>WT</td>
<td>3</td>
</tr>
<tr>
<td>SO-08-27.1000-S-6</td>
<td>Master’s Seminar Human Intelligence, Problem Solving and Creative Thinking</td>
<td>E</td>
<td>2</td>
<td>30</td>
<td>60</td>
<td>30</td>
<td>en</td>
<td>ST</td>
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<tr>
<td>SO-08-27.1020-S-6</td>
<td>Master’s Seminar Human Memory: Behavioral and Neural Basis</td>
<td>E</td>
<td>2</td>
<td>30</td>
<td>60</td>
<td>30</td>
<td>en</td>
<td>ST</td>
<td>3</td>
</tr>
</tbody>
</table>

### Content:

**Lecture Collaborative Intelligence**

Methods supporting personal knowledge work; organizational memories; modeling of attention and working context; foundations of Information Retrieval search with respect to mobility, tasks and interests; agile knowledge workflows and emergent systems; enterprise platforms and social networks; success criteria and evaluation methods. Participation in optional exercise sessions is recommended.

Lecture on Perception, Cognition and Knowledge (part of Basic Module 1) is recommended.

**Course achievement:** Presentation or exam or paper (as specified at the beginning of the course)

**Master’s Seminar Collaborative Intelligence**

Selected topics in socio-technical knowledge work (see topics for the course on “Collaborative Intelligence”). Based on a set of publications, participants are trained in writing scientific (summary) papers and presenting in a quasi-scientific setting. The students are also introduced to the process of paper reviewing. The final presentation will be organized as a one-day-event, where participants of the seminar will present their findings and discuss them with the audience.

**Prerequisites:** Lecture “Collaborative Intelligence”

**Course achievement:** Presentation or exam or paper (as specified at the beginning of the course)

**Master’s Seminar Judgment and Decision-Making**

- Probability and judgment
- models of individual and group decision making, including choices between complex options involving risk and time
- reasoning with uncertainty
• methods of measurement
• practical implication

Lecture on Perception, Cognition and Knowledge (part of Basic Module 1) is recommended.

Course achievement: Presentation or exam or paper (as specified at the beginning of the course)

Master’s Seminar Learning and Behavior

• Behavioral and cognitive theories of animal and human learning, skills and procedural learning
• neural basis of learning and behavior
• interaction between cognition, motivations and emotion

Lecture on Perception, Cognition and Knowledge (part of Basic Module 1) is recommended.

Course achievement: Presentation

Master’s Seminar Eye Movements and Cognition

The seminar will cover the basics of eye movements, the relationship between eye movements and cognition, which information eye movements can provide about cognition and the eye movements outside the healthy adult.

The lecture on Perception, Cognition and Knowledge (part of Basic Module 1) is highly recommended.

Course achievement: Presentation or exam or paper (as specified at the beginning of the course)

Master’s Seminar Cognitive Aging

The seminar will focus on cognition changes while aging. Topics include

• Theories on cognitive aging
• Normal and abnormal cognitive aging
• Mild cognitive impairment (MCI)
• Dementia and Alzheimer’s disease
• Measuring cognitive impairment and diagnosing dementia

The lecture on Perception, Cognition and Knowledge (part of Basic Module 1) is highly recommended.

Course achievement: Presentation or exam or paper (as specified at the beginning of the course)

Master’s Seminar Reading

• Normal processes of reading
• reading disorders
• dyslexia

Prerequisites: Lecture on Linguistics and Language Processing (part of Basic Module 1) is recommended.

Course achievement: Presentation or exam or paper (as specified at the beginning of the course)

Master’s Seminar Human Intelligence, Problem Solving and Creative Thinking

Convergent and divergent thinking skills in open and closed problem spaces, intelligence, creative production. Lecture on Perception, Cognition and Knowledge (part of Basic Module 1) is recommended.

Course achievement: Presentation

Master’s Seminar Human Memory: Behavioral and Neural Basis

• Structures and processes in human memory
• working memory theories
• memory development
• memory and attention

Lecture on Perception, Cognition and Knowledge (part of Basic Module 1) is recommended.

Course achievement: Presentation or exam or paper (as specified at the beginning of the course)

Competencies and Intended Learning Outcomes:

Intended Learning Outcomes:

On successfully completing the module students will be able to,

• present their knowledge of special topics from the field of Cognition and Knowledge
- apply the acquired understanding of human and artificial cognitive structures and processes, the acquisition and structure of human knowledge and the organization of artificial knowledge
- read and interpret scientific English literature in this field
- summarize and compare research papers and highlight relevant information from these papers
- debate scientific issues with peers or lecturers and thereby refer to complex concepts

<table>
<thead>
<tr>
<th>Prerequisites for attending:</th>
<th>Requirements for receiving credit points:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Formal admission requirements/Contentual prerequisites:</strong> Successful completion of Basic Modules 1 and 2 is recommended.</td>
<td>One oral exam covering the entire module (15 - 30 min)</td>
</tr>
</tbody>
</table>

**Determination of grade:**
Grade of the oral exam.

**Applicability of the module/suitability:**
As a obligatory module:
- 
As a mandatory module:
- 

**Hints for preparation:**
Recommended literature:
- **Lecture Collaborative Intelligence**
- **Master’s Seminar Collaborative Intelligence**
- **Master’s Seminar Judgment and Decision-Making**
- **Master’s Seminar Learning and Behavior**
- **Master’s Seminar Human Intelligence, Problem Solving and Creative Thinking**
- **Master’s Seminar Human Memory: Behavioral and Neural Basis**
  Baddeley, Eysenck, Anderson: Memory (Psychology Press, 2009)

Available documents:
Advanced Module 2: Cognition and Knowledge - Research and Methods

**Code:** SO-08-2605-M-6-b

**Module Coordinator:** Prof. Dr. Thomas Lachmann

**Teaching Staff:**
- Prof. Dr. Thomas Schmidt
- Prof. Dr. Thomas Lachmann
- Prof. Dr. Maria Klatte
- Dr. Kirstin Bergström
- Dr. Patricia de Brito Castilho Wesseling
- Dr. Saskia Jaarsveld

**Credit Points (CP):** 9 CP

**Workload:** 270 h

**Duration:** 1 Term/s

**Regular cycle:** Winter Term

**Recommended Semester:** cf. study schedule

**Parts of the module/courses:**
Courses marked with an (M) are mandatory whereas courses marked with an (E) are elective. In this module, students have to attend and pass the Laboratory Rotation and the associated Method Seminar (for 9 CP).

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>MOD</th>
<th>CH</th>
<th>AT</th>
<th>PS</th>
<th>PL</th>
<th>La</th>
<th>RC</th>
<th>CP</th>
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<tbody>
<tr>
<td>SO-08-26.2020-S-7</td>
<td>Laboratory Laboratory Rotation for Advanced Module 2: Cognition and Knowledge</td>
<td>M</td>
<td>6</td>
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<td>Master’s Seminar Methods Seminar for Advanced Module 2: Special Methods</td>
<td>E</td>
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**Content:**

**Laboratory Laboratory Rotation for Advanced Module 2: Cognition and Knowledge**
Group work on a practical research project (e.g. document analysis, eye tracking, programming in MATLAB) under the supervision of one of the teaching staff.
Successful completion of Basic Modules 1 and 2 is highly recommended.

**Course achievement:** Practical work

**Master’s Seminar Methods Seminar for Advanced Module 2: Special Methods**
- Essential mathematical and modeling techniques
- experimental design
- participant selection and recruitment
- development and preparation of experimental materials
- research software (e.g. E-Prime, Experiment Builder)
- specialized experimental equipment (e.g. response time equipment, eye-tracker, EEG)
- interpretation of experimental results

**Course achievement:** Practical work

**Master’s Seminar Methods Seminar for Advanced Module 2: Mental Chronometry**
How to measure reaction time data, how to identify outliers, how to prepare data for analyses, statistical analyses for between und within- participants designs

**Course achievement:** Practical work

**Competencies and Intended Learning Outcomes:**

Intended Learning Outcomes:
On successfully completing the module students will be able to,

- recognize and define basic and some more advanced methods in research related to Cognition and Knowledge
- transfer the acquired knowledge to related experimental designs
- prepare and conduct an experiment in the laboratory; apply practical research skills
- summarize and present the results obtained with these specific research methods

**Prerequisites for attending:**

**Requirements for receiving credit points:**
<table>
<thead>
<tr>
<th>Formally admission requirements/Contentual prerequisites:</th>
<th>Successful completion of Basic Modules 1 and 2 is recommended.</th>
<th>EITHER prepare and present a poster OR presentation at an annual “mini-conference” (15 min talk and 5 – 10 min discussion) OR write a paper (approx. 15 pages) about laboratory rotation work. Overall, students have to prepare all three exam forms – one for each advanced module.</th>
</tr>
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<tbody>
<tr>
<td>Determination of grade:</td>
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<td>Applicability of the module/suitability:</td>
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<td>As a obligatory module:</td>
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<td>Hints for preparation:</td>
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<tr>
<td>Recommended literature:</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Laboratory Laboratory Rotation for Advanced Module 2: Cognition and Knowledge</strong></td>
<td>M. W. Eysenck &amp; M. T. Keane. Cognitive Psychology. Psychology Press. Recommended literature:</td>
<td></td>
</tr>
<tr>
<td><strong>Master’s Seminar Methods Seminar for Advanced Module 2: Special Methods</strong></td>
<td>D. Scarborough &amp; S. Sternberg. Methods, Models, and Conceptual issues, Cambridge, MA: MIT Press. Recommended literature:</td>
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<td>Available documents:</td>
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</table>
## Advanced Module 3: Language and Linguistics - Specialized Seminars

<table>
<thead>
<tr>
<th>Code:</th>
<th>Module Coordinator:</th>
<th>Teaching Staff:</th>
</tr>
</thead>
<tbody>
<tr>
<td>SO-12-2607-M-6-a</td>
<td>Prof. Dr. Shanley Allen</td>
<td>Prof. Dr. Shanley Allen Jun.-Prof. Dr. Daniela Czernochowski Prof. Dr. Thomas Lachmann Dr. Kalliopi Katsika Dr. Leigh Fernandez Dr. Gunnar Jacob Dr. Kirstin Bergström</td>
</tr>
</tbody>
</table>

### Credit Points (CP):
- 9 CP

### Workload:
- 270 h

### Duration:
- 1 Term/s

### Regular cycle:
- Summer Term

### Recommended Semester:
- cf. study schedule

### Parts of the module/courses:
Courses marked with an (M) are mandatory whereas courses marked with an (E) are elective. In this module, students have to pass at least three courses (for 9 CP).

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<td>E</td>
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<td>SO-12-1700-S-8</td>
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<td>E</td>
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<td>en</td>
<td>ST</td>
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<td>E</td>
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<td>60</td>
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<tr>
<td>SO-12-26.2000-S-7</td>
<td>Master’s Seminar Psycholinguistics</td>
<td>E</td>
<td>2</td>
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<td>40</td>
<td>en</td>
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<td>SO-12-26.3000-S-7</td>
<td>Master’s Seminar Neural Basis of Language</td>
<td>E</td>
<td>2</td>
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<td>60</td>
<td>30</td>
<td>en</td>
<td>ST</td>
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### Content:

**Master’s Seminar Reading**
- Normal processes of reading
- reading disorders
- dyslexia

Prerequisites: Lecture on Linguistics and Language Processing (part of Basic Module 1) is recommended.

**Course achievement:** Presentation or exam or paper (as specified at the beginning of the course)

**Master’s Seminar Syntax**
- Structural relations between elements in a sentence
- syntactic properties
- syntactic categories and how they differ from semantic categories
- details of and constraints on 'movement' in syntax
- extent of shared syntactic properties across all natural languages
- theories of syntactic structure

Prerequisites: Lecture on Linguistics and Language Processing (part of Basic Module 1) is recommended.

**Course achievement:** Written exam (as specified at the beginning of the course) and exercises

**Master’s Seminar Sentence Processing**
- Theories and mechanisms of sentence processing in children and adults
- cross-linguistic influence in sentence processing of bilinguals
- fundamentals of sentence processing methods (e.g., priming, self-paced reading, eye tracking, ERP)

Prerequisites: Syntax (should ideally be taken before or at the same time as Sentence Processing) Lecture on Linguistics and Language Processing (part of Basic Module 1) is recommended.

**Course achievement:** Presentation or exam or paper (as specified at the beginning of the course)
Master’s Seminar Computational Linguistics
This is an introduction to Computational Linguistics using the Python programming language. We’ll learn how to solve a set of problems related to Linguistics and explore linguistic data available in the web. We will introduce the concept of corpus, and understand how we can use corpus data to answer linguistic questions. In addition, we will have a simple introduction to Machine Learning, which will allow us to take advantage of corpus annotations; and talk a little about tokenization and lemmatization, useful for generating our own corpora. Some final remarks on distributional semantics will finish this introduction.

Course achievement: Presentation or exam or paper (as specified at the beginning of the course)

Master’s Seminar Heritage Language Acquisition
This seminar focuses on the grammatical development of Heritage Languages and Heritage Language speakers in light of current theoretical claims and recent experimental research. Heritage Language speakers are individuals whose first language (L1) is a language that is spoken in their family, which is, however, different from the dominant language of the community. Through the analysis of the grammatical characteristics of heritage languages around the globe, we are going to see how language develops in heritage language speakers, and how different or similar heritage language speakers are in comparison to native speakers and second language learners of the dominant language.

Course achievement: Presentation or exam or paper (as specified at the beginning of the course)

Master’s Seminar Language Development
- Theories of language development
- first and second language acquisition
- bilingualism
- language disorders
- relations between language development and cognitive development

Prerequisites: Lecture on Linguistics and Language Processing (part of Basic Module 1) is recommended.

Course achievement: Presentation or exam or paper (as specified at the beginning of the course)

Master’s Seminar Psycholinguistics
- theories and mechanisms of language perception, comprehension, and production
- relations between language, memory and other cognitive processes

Prerequisites: Lecture on Linguistics and Language Processing (part of Basic Module 1) is recommended.

Course achievement: Presentation or exam or paper (as specified at the beginning of the course)

Master’s Seminar Neural Basis of Language
Objectives:
- to introduce and familiarize students with the relationship between brain and language
- to familiarize students with ways in which language and the brain are investigated
- to understand how language is represented in the “typical” brain
- to provide a foundation for students to understand how language breaks down as a result of acquired brain injury
- to understand how language is represented and breaks down in bi/multilingual brains and in visuospatial languages (i.e. sign language)
- to give students the practical skills to properly report, review, and reference research articles in the field

The course focuses on how the brain and language relate from an interdisciplinary perspective. Students will learn about: the history of brain and language, brain anatomy and functions, language and hemispheric specialization, methodological approaches (PET, fMRI, MEG, EEG/ERP, neurostimulation), aphasia (childhood and acquired), the breakdown of language (spoken, auditory, reading, and writing), bilingualism, and the brain and sign language.

Prerequisites: Lecture on Cognitive Neuroscience (part of Basic Module 1) and Lecture on Linguistics and Language Processing (part of Basic Module 1) is highly recommended.

Course achievement: Presentation or exam or paper (as specified at the beginning of the course)

Competencies and Intended Learning Outcomes:
Intended Learning Outcomes:
On successfully completing the module students will be able to,

- present their knowledge of special topics from the field of language and (psycho)linguistics
- apply the acquired understanding of sentence processing and language development, detect structural relations between elements in a sentence and classify syntactic properties and categories, and compare language and reading disorders
- read and interpret scientific English literature in this field
- summarize and compare research papers and highlight relevant information from these papers
- debate scientific issues with peers or lecturers and thereby refer to complex concepts

Prerequisites for attending:

<table>
<thead>
<tr>
<th>Formal admission requirements/Contentual prerequisites:</th>
<th>Requirements for receiving credit points:</th>
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<tbody>
<tr>
<td>Successful completion of Basic Modules 1 and 2 is recommended.</td>
<td>Oral exam covering the entire module (15-30 min.).</td>
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Determination of grade:
Grade of the oral exam.

Applicability of the module/suitability:
As a obligatory module:
- 
As a mandatory module:
- 

Hints for preparation:
Recommended literature:

**Master's Seminar Reading**
Snowling & Hulme. The Science of Reading Blackwell
Willows Kruk Corcos. Visual Processes in reading and reading disability. Erlbaum
T. Lachmann, and T. Weis. Reading and Dyslexia. From basic functions to higher order cognition. Springer. Recommended literature:

**Master’s Seminar Syntax**

**Master’s Seminar Sentence Processing**

**Master’s Seminar Computational Linguistics**
The literature will be recommended during the course.

**Master’s Seminar Heritage Language Acquisition**

**Master’s Seminar Language Development**

**Master’s Seminar Psycholinguistics**

**Master’s Seminar Neural Basis of Language**
Available documents:
<table>
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<tr>
<th>Code:</th>
<th>Module Coordinator:</th>
<th>Teaching Staff:</th>
</tr>
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<tbody>
<tr>
<td>SO-12-2607-M-6-b</td>
<td>Prof. Dr. Shanley Allen</td>
<td>Jun.-Prof. Dr. Daniela Czernochowski</td>
</tr>
<tr>
<td></td>
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<td>Prof. Dr. Maria Klatt</td>
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<td>Prof. Dr. Thomas Lachmann</td>
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<td>Prof. Dr. Shanley Allen</td>
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<td>Dr. Kalliopi Katsika</td>
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<td>Dr. Kirstin Bergström</td>
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<td>Dr. Gunnar Jacob</td>
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<td>Dr. Leigh Fernandez</td>
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<table>
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<th>Credit Points (CP):</th>
<th>Workload:</th>
<th>Duration:</th>
<th>Regular cycle:</th>
<th>Recommended Semester:</th>
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<tbody>
<tr>
<td>9 CP</td>
<td>270 h</td>
<td>1 Term/s</td>
<td>Winter Term</td>
<td>cf. study schedule</td>
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**Parts of the module/courses:**

Courses marked with an (M) are mandatory whereas courses marked with an (E) are elective. In this module, students have to attend and pass the Laboratory Rotation and the associated Method Seminar (for 9 CP).

<table>
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<tr>
<th>Code</th>
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<tr>
<td>SO-12-26.3010-S-7</td>
<td>Laboratory Laboratory Rotation for Advanced Module 3: Language and Linguistics</td>
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**Content:**

**Laboratory Laboratory Rotation for Advanced Module 3: Language and Linguistics**

Group work on a practical research project using psycholinguistic methods (e.g., priming, eye-tracking, self-paced reading, ERP) under the supervision of one of the teaching staff.

Prerequisites: Successful completion of Basic Modules 1 and 2

**Course achievement:** Practical work

**Master’s Seminar Methods Seminar for Advanced Module 3: Eye-tracking**

**Course achievement:** Practical work

**Master’s Seminar Methods Seminar for Advanced Module 3: Special Methods**

Experimental design for longitudinal and cross-sectional studies, participant selection and recruitment, development and preparation of experimental materials, research software (e.g. DMDX, E-Prime, Experiment Builder), specialized experimental equipment (e.g. eye-tracker, EEG), interpretation of experimental results.

**Course achievement:** Practical work

**Competencies and Intended Learning Outcomes:**

Intended Learning Outcomes:

On successfully completing the module students will be able to,

- recognize and define basic and some more advanced methods in research related to Linguistics
- transfer the acquired knowledge to related experimental designs
- prepare and conduct an experiment in the laboratory; apply practical research skills such as eye tracing
- summarize and present the results obtained with these specific research methods

**Prerequisites for attending:**

Formal admission requirements/Contentual prerequisites: Successful completion of Basic Modules 1 and 2 is recommended.

**Requirements for receiving credit points:**

EITHER prepare and present a poster OR presentation at an annual “mini-conference” (15 min talk and 5 – 10 min discussion) OR write a paper (approx. 15 pages) about laboratory rotation work. Overall, students have to prepare all three exam forms – one for each advanced module.
<table>
<thead>
<tr>
<th>Determination of grade:</th>
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<td>As a obligatory module:</td>
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<td>As a mandatory module:</td>
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<td><strong>Hints for preparation:</strong></td>
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<td><strong>Recommended literature:</strong></td>
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<td><strong>Recommended literature:</strong></td>
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<td>Master’s Seminar Methods Seminar for Advanced Module 3: Eye-tracking</td>
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<td><strong>Recommended literature:</strong></td>
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<td>Master’s Seminar Methods Seminar for Advanced Module 3: Special Methods</td>
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## Advanced Module 4: Cognitive Neuroscience - Specialized Seminars

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<tr>
<th>Code</th>
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</tr>
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<tbody>
<tr>
<td>SO-15-2609-M-6-a</td>
<td>Jun.-Prof. Dr. Daniela Czernochowski</td>
<td>Jun.-Prof. Dr. Daniela Czernochowski</td>
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<td>Prof. Dr. Maria Klatte</td>
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<td>Dr. Leigh Fernandez</td>
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</table>

### Credit Points (CP): Workload: Duration: Regular cycle: Recommended Semester:
- 9 CP 270 h 1 Term/s Summer Term cf. study schedule

### Parts of the module/courses:
Courses marked with an (M) are mandatory whereas courses marked with an (E) are elective. In this module, students have to pass at least three courses (for 9 CP).

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<td>Master’s Seminar Human Memory: Behavioral and Neural Basis</td>
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<td>ST 3</td>
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<td>Master’s Seminar Introduction to Neuropsychology</td>
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<td>ST 3</td>
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</table>

### Content:

#### Master’s Seminar Human Memory: Behavioral and Neural Basis
- Structures and processes in human memory
- working memory theories
- memory development
- memory and attention

Lecture on Perception, Cognition and Knowledge and Cognitive Neuroscience (part of Basic Module 1) is recommended. **Course achievement:** Presentation or exam or paper (as specified at the beginning of the course)

#### Master’s Seminar Neural Basis of Language

Objectives:
- to introduce and familiarize students with the relationship between brain and language
- to familiarize students with ways in which language and the brain are investigated
- to understand how language is represented in the “typical” brain
- to provide a foundation for students to understand how language breaks down as a result of acquired brain injury
- to understand how language is represented and breaks down in bi/multilingual brains and in visuospatial languages (i.e. sign language)
- to give students the practical skills to properly report, review, and reference research articles in the field

The course focuses on how the brain and language relate from an interdisciplinary perspective. Students will learn about: the history of brain and language, brain anatomy and functions, language and hemispheric specialization, methodological approaches (PET, fMRI, MEG, EEG/ERP, neurostimulation), aphasia (childhood and acquired), the breakdown of language (spoken, auditory, reading, and writing), bilingualism, and the brain and sign language. Prerequisites: Lecture on Cognitive Neuroscience (part of Basic Module 1) and Lecture on Linguistics and Language Processing (part of Basic Module 1) is highly recommended. **Course achievement:** Presentation or exam or paper (as specified at the beginning of the course)

#### Master’s Seminar Introduction to Neuropsychology

Understanding of the structure and function of the brain as it relates to specific psychological processes and behaviors. Topics include foundations of neuropsychology, structure of the nervous system, functional specialization of the brain, cognitive functions, research methods, and clinical assessment and rehabilitation. Prerequisites: Lecture on Cognitive Neuroscience (part of Basic Module 1) is highly recommended. **Course achievement:** Presentation or exam or paper (as specified at the beginning of the course)
Competencies and Intended Learning Outcomes:

Intended Learning Outcomes:
On successfully completing the module students will be able to,

- gain an understanding of the neuronal mechanisms underlying cognitive functions in healthy and patient populations, the functioning of neurons, and the essential methods of cognitive neuroscience.
- present their knowledge of special topics from the field of Cognitive Neuroscience
- apply the acquired understanding of the neuronal mechanisms underlying cognitive functions in healthy and patient populations, explain the functioning of neurons and compare the essential methods of Cognitive Neuroscience
- read and interpret scientific English literature in this field
- summarize and compare research papers and highlight relevant information from these papers
- debate scientific issues with peers or lecturers and thereby refer to complex concepts

Prerequisites for attending:  

Formal admission requirements/Contentual prerequisites: Successful completion of Basic Modules 1 and 2 is recommended.

Requirements for receiving credit points:

One oral exam covering the entire module (15 - 30 min).

Determination of grade:
Grade of the oral exam.

Applicability of the module/suitability:
As a obligatory module:
- 
As a mandatory module:
- 

Hints for preparation:

Recommended literature:
Master’s Seminar Human Memory: Behavioral and Neural Basis
Baddeley, Eysenck, Anderson: Memory (Psychology Press, 2009) Recommended literature:
Master’s Seminar Neural Basis of Language
Recommended literature:
Master’s Seminar Introduction to Neuropsychology
Advanced Module 4: Cognitive Neuroscience - Research and Methods

<table>
<thead>
<tr>
<th>Code: SO-15-2609-M-6-b</th>
<th>Module Coordinator: Jun.-Prof. Dr. Daniela Czernochowski</th>
<th>Teaching Staff: Jun.-Prof. Dr. Daniela Czernochowski</th>
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**Credit Points (CP):**
- **9 CP**

**Workload:**
- **270 h**

**Duration:**
- **1 Term/s**

**Regular cycle:**
- **Winter Term**

**Recommended Semester:**
- cf. study schedule

**Parts of the module/courses:**
Courses marked with an (M) are mandatory whereas courses marked with an (E) are elective. In this module, students have to attend and pass the Laboratory Rotation and the associated Method Seminar (for 9 CP).

**Laboratory Rotation for Advanced Module 4: Cognitive Neuroscience**
Group work on a practical research project (e.g. computational neuroscience, electrophysiological recordings, MEG for structural and functional analysis) under the supervision of one of the teaching staff.

**Prerequisites:** Successful completion of Basic Modules 1 and 2 is highly recommended.

**Course achievement:** Practical work

**Master’s Seminar Methods Seminar for Advanced Module 4: EEG Recording and Analysis**
Preparation of experimental materials, specialized experimental equipment and related software (i.e., EEG), analyzing and correlating neuronal activity with behavior using specific software, interpretation of experimental results.

**Course achievement:** Practical work

**Master’s Seminar Methods Seminar for Advanced Module 4: Special Methods**
Experimental design for human and animal studies, participant selection and recruitment, development and preparation of experimental materials, specialized experimental equipment and related software (e.g., EEG, TMS), correlating neuronal activity with behavior, interpretation of experimental results.

**Course achievement:** Practical work

**Competencies and Intended Learning Outcomes:**
Intended Learning Outcomes:
On successfully completing the module students will be able to,

- recognize and define basic and some more advanced methods in research related to Cognitive Neuroscience
- transfer the acquired knowledge to related experimental designs
- prepare and conduct an experiment in the laboratory; apply practical research skills such as EEG
- summarize and present the results obtained with these specific research methods

**Prerequisites for attending:**
- **Formal admission requirements/Contentual prerequisites:** Successful completion of Basic Modules 1 and 2 is highly recommended.

**Requirements for receiving credit points:**
- EITHER prepare and present a poster OR presentation at an annual “mini-conference” (15 min talk and 5 – 10 min discussion) OR write a paper (approx. 15 pages) about laboratory rotation work. Overall, students have to prepare all three exam forms – one for each advanced module.

**Determination of grade:**
- none

**Applicability of the module/suitability:**
- As a obligatory module:
As a mandatory module:

### Hints for preparation:

Recommended literature:

**Laboratory Laboratory Rotation for Advanced Module 4: Cognitive Neuroscience**


**Master’s Seminar Methods Seminar for Advanced Module 4: EEG Recording and Analysis**


**Master’s Seminar Methods Seminar for Advanced Module 4: Special Methods**

### Advanced Module 5: Computation - Specialized Seminars

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<th>Teaching Staff</th>
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<tr>
<td>SO-08-2611-M-6-a</td>
<td>Prof. Dr. Achim Ebert</td>
<td>Prof. Dr. Karsten Berns</td>
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<td>Prof. Dr.-Ing. Andreas König</td>
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<td>Prof. Dr. Achim Ebert</td>
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<tr>
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<td>Prof. Dr. Heike Leitte</td>
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#### Credit Points (CP): Workload: Duration: Regular cycle: Recommended Semester:

| 12 CP | 360 h | 1 Term/s | Winter Term | cf. study schedule |

### Parts of the module/courses:
Courses marked with an (M) are mandatory whereas courses marked with an (E) are elective. In this module, students have to pass at least three courses (for 12 CP).

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<th>Hours</th>
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<th>Tutorial</th>
<th>Seminar</th>
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<td>E</td>
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<td>E</td>
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<td>E</td>
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### Content:

#### Lecture Human-Computer Interaction
The course introduces students to the theory and applications of human computer interaction (HCI). Students should achieve an understanding of human perception and psychology related to HCI, as well as learn about concepts and methods of interactive systems. The course builds on theoretical principles and numerous examples from research and practice.

**Prerequisites:** Lecture on Introduction to Programming or Analysis of Complex Systems (part of Basic Module 1) is highly recommended.

**Course achievement:** Worksheet Presentation or exam or paper (as specified at the beginning of the course)

#### Lecture Biologically Motivated Robots
Biologically motivated robots (Bio Bots) are systems whose mechanical construction, sensor and perception concepts and control methods have been inspired by nature. The following themes will be considered:

- status of research and requirements for the development of BioBots
- sensor systems, sensor fusion and actuation concepts;
- adaptive control (neural networks, fuzzy-control, reinforcement learning, genetic algorithms and neuro-oscillators);
• behavior-based control architectures;
• bipedal locomotion
• Interaction concepts for humanoid robots
• application for BioBots

Prerequisites: Basic knowledge of artificial intelligence and Lecture “Biologically Motivated Robots”

Course achievement: Presentation or exam or paper (as specified at the beginning of the course)

Tutorial Biologically Motivated Robots
State of the art in science and development of biologically motivated robots (BioBots), including sensors, sensor fusion, propulsion systems, adaptive approaches to steering, neuronal networks, fuzzy control, reinforcement learning, genetic algorithms, neuro-oscillators and behavioral control architectures.
Prerequisites: Basic knowledge of artificial intelligence and Lecture “Biologically Motivated Robots”

Course achievement: Presentation or exam or paper (as specified at the beginning of the course)

Master’s Seminar Visualization and HCI
Selected topics from visualization, such as:

• information visualization
• scientific visualization
• adaptive/mobile visualization
• visualization of medical and biological data

Prerequisites: Lecture “Human Computer Interaction” is highly recommended.

Course achievement: Presentation or exam or paper (as specified at the beginning of the course)

Lecture Data Visualization
The lecture will cover the following topics:
- History of visualization
- Human perception
- Processing chain in visualization (visualization of tables / visualization of high-dimensional data)
- Visualization of graphs
- Interaction and data exploration
- Visualization of scalar and vector data

Course achievement: Presentation or exam or paper (as specified at the beginning of the course)

Master’s Seminar Computational Linguistics
This is an introduction to Computational Linguistics using the Python programming language. We'll learn how to solve a set of problems related to Linguistics and explore linguistic data available in the web. We will introduce the concept of corpus, and understand how we can use corpus data to answer linguistic questions. In addition, we will have a simple introduction to Machine Learning, which will allow us to take advantage of corpus annotations; and talk a little about tokenization and lemmatization, useful for generating our own corpora. Some final remarks on distributional semantics will finish this introduction.

Course achievement: Presentation or exam or paper (as specified at the beginning of the course)

Lecture Collaborative Intelligence
Methods supporting personal knowledge work; organizational memories; modeling of attention and working context; foundations of Information Retrieval search with respect to mobility, tasks and interests; agile knowledge workflows and emergent systems; enterprise platforms and social networks; success criteria and evaluation methods.

Participation in optional exercise sessions is recommended.

Lecture on Perception, Cognition and Knowledge (part of Basic Module 1) is recommended.

Course achievement: Presentation or exam or paper (as specified at the beginning of the course)

Master’s Seminar Collaborative Intelligence
Selected topics in socio-technical knowledge work (see topics for the course on “Collaborative Intelligence”). Based on a set of publications, participants are trained in writing scientific (summary) papers and presenting in a quasi-scientific setting. The
students are also introduced to the process of paper reviewing. The final presentation will be organized as a one-day-event, where participants of the seminar will present their findings and discuss them with the audience.

**Prerequisites:** Lecture “Collaborative Intelligence”

**Course achievement:** Presentation or exam or paper (as specified at the beginning of the course)

### Lecture/Tutorial Neurocomputing

**Qualification aims:**

- Understanding of the concepts of dedicated neural and bio-inspired hardware and its application potential and limitations
- Understanding of design principles of circuits with alternative signal representation and adaptive structures
- Understanding of the effect of simplified implementations
- Understanding of fault-tolerance and robustness issues
- Ability of contents/result abstraction to MEMS/microsystems application

**Teaching contents:**

- Introduction to the field of innovative computer architectures and systems for the technical implementation of biological information processing principles
- Presentation of diverse aims and solution concepts: Hardware for technical cognition systems, biological-technical interfaces, simulation and verification of models of biological evidence
- Rehearsal of relevant and commonly applied neural algorithms, including deep-learning and spiking neural networks, and analysis of computational requirements and operators
- Presentation and effect of potential simplification options for the regarded algorithms
- Basics of circuit technology (digital, analog, opto-elektronic/optisch) and related implementation technologies (CMOS, WSI, MEMS, etc.) for neural hardware
- Overview of fundamental architectural principles of neurochips, -processors and -computers
- Assessment criteria and taxonomy for neural HW
- Presentation and detailed discussion of selected, representative implementations
- Outlook on new lines in the field, e.g., evolvable hardware, organic computing, and self-monitoring and repairing sensor systems

The 2 hour lecture is accompanied by a 1 hour computer-based lab, where students will have the opportunity to explore typical neural simulation environments for amplitude and time domain representation in neural networks, e.g., the Neuron simulator, the Caffe environment, the Brian simulator etc. Further, available Neurocomputers Siliman (analog) and ZISC (digital) with their dedicated application software and GUI will be applied. Additionally, custom FPGA-based platforms programmed by, e.g., VHDL will be considered for students with corresponding experience, too. Step by step the lab guides students to the design of neurocomputing modules & systems, e.g., for real-time classification with the Siliman, learning intelligent systems, or adaptive signal processing.

**Prerequisites:** Basic programming in Matlab/Python, interest in hardware design, e.g., FPGA programming; Lecture on Introduction to Programming or Analysis of Complex Systems (part of Basic Module 1) is highly recommended.

**Course achievement:** Oral examination based on semester project given after lab completion. Topics for semester projects, as individual or group projects will be given to students, which shall be elaborated, documented, and presented. The projects focus on the design and implementation of a real-world task by either neurocomputing algorithms or hardware. (20 min. slide presentation, discussed, and assessed in the oral examination. Examples of prior students work: ISE-NEUCOM-Page)

### Lecture/Tutorial Sensorsignalprocessing

**Qualification aims:**

- Understanding of relevant principals and methods from the field of Computational Intelligence/Machine Learning, in particular for the field of sensor technology
- Mastery of application of selected relevant methods and their configuration in a common design environment (Matlab/Python)
- Ability to design, validate, and optimize complete application-specific system system from sensory acquisition to perception & cognition.
- Develop ability to adapt and extend the achieved implementation to changing needs
• Understanding of interdependence of system solution with available, potentially restricted implementation platforms (Sensors/Hardware)

Teaching contents:

• Basic methods of multi-dimensional signal analysis and the computation of characteristic and invariant descriptors (features)
• Processing of signals from single sensors and homogeneous or heterogeneous Sensor-Arrays
• Dimensionality reduction of high-dimensional sensor data by linear and non-linear methods, e.g., by explicit selection of features
• Methods of cluster analysis
• Methods for multi-dimensional sensor data analysis: projection and visualization, fusion
• Methods for classification of sensor data: statistical pattern recognition, artificial neural networks, rule-based and fuzzy classification
• Advanced optimization methods for parameter or structure optimization of sensor systems for automated intelligent system design
• Relations, dependencies, and optimization potential between sensor realization, electronics, and algorithmics.

New aspects of reliable sensor systems (self-x properties)
The 2 hour lecture is accompanied by a 2 hour computer-based lab, where students will have the opportunity to acquire sensory data from, e.g., visual range, infrared, depth, and hyperspectral cameras, as well as acoustic, acceleration, magnetic, impedance, EEG-like and other sensors for typical application scenarios. Step by step the lab guides students to the design of a dedicated intelligent system, e.g., from general quality control, food inspection to behavior and/or intention recognition of humans.

Prerequisites: Basic programming in Matlab/Python and Arduino systems preferably on Linux; Lecture on Introduction to Programming or Analysis of Complex Systems (part of Basic Module 1) is highly recommended.

Course achievement: Oral examination based on semester project given after lab completion. Topics for semester projects, as individual or group projects will be given to students, which shall be elaborated, documented, and presented. The work will be presented (20 min. slide presentation, discussed, and assessed in the oral examination. Examples of prior students work: ISE-SENSIG-Page )

Competencies and Intended Learning Outcomes:

Intended Learning Outcomes:
On successfully completing the module students will be able to,

• prepare and manage a scientific discussion on specific topics related to the module
• explain fundamental models and methods in human computer interaction (HCI)
• explain state-of-the-art concepts and methods for designing complex robotic systems
• characterize the control of biological movement systems and basic methods of soft computation
• explain methods for controlling complex biologically motivated robots (e.g. humanoid robots)
• prepare special topics and present them to the audience comprehensibly using electronic media
• understand the concepts of dedicated neural and bio-inspired hardware and its application potential and limitations
• understand the design principles of circuits with alternative signal representation and adaptive structures
• understand the effect of simplified implementations
• understand the relevant principals and methods from the field of Computational Intelligence/Machine Learning

Prerequisites for attending:

Formal admission requirements/Contentual prerequisites: Successful completion of Basic Modules 1 and 2 is recommended

Requirements for receiving credit points:
One oral exam covering the entire module (15 - 30 min).

Determination of grade:

Grade of the oral exam.

Applicability of the module/suitability:
As a obligatory module:
As a mandatory module:

**Hints for preparation:**

Recommended literature:

**Lecture Human-Computer Interaction**

Buxton: Sketching User Experience

Dix, Finlay, Abowd, Beale: Human-Computer Interaction

Kerren, Ebert, Meyer: Human-Centered Visualization Environments

Maeda: The Laws of Simplicity

Sharp, Rogers, Preece: Interaction Design

**Recommended literature:**

**Lecture Biologically Motivated Robots**

S. Kajita (Ed.), “Humanoid Roboter”, AKA

Gerdes, F. Klawonn, R. Kruse, “Evolutionäre Algorithmen”, Vieweg

Hamill, K.M. Knutzen, “Biomechanical Basis of Human Movement”, LWW


Other textbooks and research papers will be announced in the lecture

**Recommended literature:**

**Tutorial Biologically Motivated Robots**

Kajita (Ed.), “Humanoid Roboter”, AKA

Gerdes, F. Klawonn, R. Kruse, “Evolutionäre Algorithmen”, Vieweg

Hamill, K.M. Knutzen, “Biomechanical Basis of Human Movement”, LWW


Other textbooks and research papers will be announced in the lecture

**Recommended literature:**

**Master’s Seminar Visualization and HCI**

Buxton: Sketching User Experience

Dix, Finlay, Abowd, Beale: Human-Computer Interaction

Kerren, Ebert, Meyer: Human-Centered Visualization Environments

Maeda: The Laws of Simplicity

Sharp, Rogers, Preece: Interaction Design

**Recommended literature:**

**Lecture/Tutorial Neurocomputing**


R. Hecht-Nielsen, Neurcomputing, Addison Wesley, 1991

**Recommended literature:**

**Lecture/Tutorial Sensors/Signal Processing**


Available documents:
Advanced Module 5: Computation - Research and Methods

<table>
<thead>
<tr>
<th>Code:</th>
<th>Module Coordinator:</th>
<th>Teaching Staff:</th>
</tr>
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<tbody>
<tr>
<td>SO-08-2611-M-6-b</td>
<td>Prof. Dr. Achim Ebert</td>
<td>Prof. Dr. Karsten Berns</td>
</tr>
<tr>
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<td>Prof. Dr. Karsten Berns</td>
<td>Prof. Dr.-Ing. Andreas König</td>
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<tr>
<td></td>
<td>Prof. Dr. Achim Ebert</td>
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<tr>
<td>6 CP</td>
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<td>Winter and Summer Term</td>
<td>cf. study schedule</td>
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**Parts of the module/courses:**
Courses marked with an (M) are mandatory whereas courses marked with an (E) are elective. In this module, students have to attend and pass the Laboratory Rotation and the associated Method Seminar (for 6 CP).

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<td>EIT-ISE-703-S-7 Project Laboratory Rotation for Advanced Module 5: Computation</td>
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<td></td>
<td>165</td>
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<td>Summer Term</td>
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**Content:**

**Project Laboratory Rotation for Advanced Module 5: Computation Option 3: Neurocomputing & Sensorsignalprocessing**

The participants will be involved in the active research of the ISE group in self-x multi-sensory systems, bio-inspired and neuromorphic computing systems, adaptive technical cognition systems. Depending on the previous exposure and skills of the participants, topics will be entirely algorithmic and software oriented or encompass the application and/or design of dedicated hardware realizations as contributions to adaptive technical cognition systems. In particular, the exploration of concepts from biology, e.g., physiology and sensing principles, neural cells and assemblies, learning/adaptation, higher-level brain functions to psychological knowledge on perception and cognition shall provide the leverage for the design of capable as well as robust technical cognition systems and their physical embodiment by, e.g., modern integration technologies. The work will be demonstrated, presented (20-40 min slide presentation), discussed, and assessed in the oral examination. Prerequisites: Lecture Neurocomputing and/or Sensorsinalprocessing; Basic programming in Matlab/Python, application of dedicated tools/simulators, e.g., for deep-learning or spiking neural networks (Caffe, Brian, etc.), basic Arduino programming ability, interest in hardware design, e.g., FPGA programming, welcome.

**Course achievement:** Prototype of Technical Cognition System Component Presentation

**Project Laboratory Rotation for Advanced Module 5: Computation Option 1: Visualization and Human Computer Interaction**

Different tasks from visualization, such as

- visualization in scalar fields (implementation of algorithm like marching cubes, volume rendering, etc.)
- visualization of vector fields (implementation of algorithms like stream lines and surfaces, turbulence detection, detection of topology, etc.)
- construction of visualization framework for the implemented algorithms with interactive graphical output

Methods seminars are included in the project. Prerequisites: Lecture Human Computer Interaction

**Course achievement:** Practical work

**Project Laboratory Rotation for Advanced Module 5: Computation Option 2: Service Robots and Assistance Systems**

- Learning the development tool MCA
- programming of DSPs basic
• sensor processing
• specification of a service robot or an assisting system
• implementation of a complex control task

Methods seminars are included in the project.
Prerequisites: Lecture Biologically Motivated Robots
Course achievement: Practical work

### Competencies and Intended Learning Outcomes:

**Intended Learning Outcomes:**
On successfully completing the module students will be able to,

- design human-centered man-machine interfaces and prototypically implement them
- design and perform evaluations for hard- and software systems
- design and develop some basic functions a robot system
- design, validate, and optimize complete application-specific systems from sensory acquisition to perception & cognition
- adapt and extend the achieved implementation to changing needs
- prepare special topics and present them to the audience comprehensibly using electronic media
- prepare and manage a scientific discussion on specific topics related to the module

**Prerequisites for attending:**

| Formal admission requirements/Contentual prerequisites: Successful completion of Basic Modules 1 and 2 is recommended. |
| Requirements for receiving credit points: EITHER prepare and present a poster OR presentation at an annual “mini-conference” (15 min talk and 5 – 10 min discussion) OR write a paper (approx. 15 pages) about laboratory rotation work. Overall, students have to prepare all three exam forms – one for each advanced module. |

**Determination of grade:**

none

**Applicability of the module/suitability:**

As a obligatory module:
- 
As a mandatory module:
- 

**Hints for preparation:**

Recommended literature:

- **Project Laboratory Rotation for Advanced Module 5: Computation Option 3: Neurocomputing & Sensorsignalprocessing**

- **Recommended literature:**
  - Buxton: Sketching User Experience
  - Dix, Finlay, Abowd, Beale : Human-Computer Interaction
  - Kerren, Ebert, Meyer: Human-Centered Visualization Environments
  - Maeda: The Laws of Simplicity
  - Sharp, Rogers, Preece: Interaction Design

- **Project Laboratory Rotation for Advanced Module 5: Computation Option 2: Service Robots and Assistance Systems**
  - Will be announced at the beginning of the course.
# Internship Module

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<tr>
<td>SO-00-2613-M-7</td>
<td>Prof. Dr. Thomas Lachmann</td>
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<td>240</td>
<td>-</td>
<td>en</td>
<td>WS</td>
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## Content:

### Internship

The student will gain practical experience in the field of cognitive science and can associate this experience to the contents of the Master’s program. This Module further requires a total of 20 hours of participation in experiments related to cognitive science.

Duration: 6 weeks

**Course achievement:** Submit a letter from the supervisor(s) confirming successful completion of the Internship as well as an Internship report (1-2 pages) to the Examination Office (Abteilung für Prüfungsangelegenheiten).

### Competencies and Intended Learning Outcomes:

**Intended Learning Outcomes:**

On successfully completing the module students will be able to,

- associate these experiences to the contents of the master study.
- get practical experiences in the field of cognitive science.

### Prerequisites for attending:

**Formal admission requirements/Contentual prerequisites:** Successful completion of Basic Modules 1 and 2 is recommended.

### Requirements for receiving credit points:

- The Internship application form must be submitted to the Examination Committee at least 2 weeks before starting the Internship.
- The Internship should be performed during the lecture-free time to avoid overlap with lectures and seminars.

### Determination of grade:

- not graded

### Applicability of the module/suitability:

- As an obligatory module:
- As a mandatory module:

### Hints for preparation:

**Recommended literature:**

- Internship

**Available documents:**

- Internship
Master`s Thesis

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<td>SO-00-2614-M-7</td>
<td>Prof. Dr. Thomas Lachmann</td>
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**Credit Points (CP):**

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**Parts of the module/courses:**
Courses marked with an (M) are mandatory.

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**SO-00-2614-V-7 Master`s Thesis**

**Content:**

**Master´s Thesis**

The master thesis serves as a final exam. The Master`s thesis reports original empirical research in the field of cognitive science conducted by the candidate as outlined in the “Learning Objectives” for the Master’s Thesis Module. The thesis is prepared under the supervision of two instructors, preferably from different fields of research.

**Competencies and Intended Learning Outcomes:**

Intended Learning Outcomes:
On successfully completing the module students will be able to,

- argue and discuss his/her results and conclusions.
- demonstrate interdisciplinary knowledge, skills and competencies in the cognitive sciences.
- develop a research agenda.
- prove his/her ability to conduct and complete a research project, including planning and preparation, technical implementation, analysis, and communication of the research and its results.
- reflect on methodological and theoretical aspects of his/her research.

**Prerequisites for attending:**

Formal admission requirements/Contentual prerequisites: See examination regulation.

**Requirements for receiving credit points:**

Master`s thesis.

**Determination of grade:**

Grade of the Master`s thesis.

**Applicability of the module/suitability:**

As a obligatory module:

- 

As a mandatory module:

- 

**Hints for preparation:**

Recommended literature:
Master`s Thesis
Available documents:
Master`s Thesis