

# Seminar Syllabus: Neurocognitive models for reasoning

## Block Seminar:

- Assignment: 23.10. 16:00, Technical Faculty, Building 101, Room 01 016
- Seminar takes place at the weekend 23.1. / 24.1. from 8:15-16:00

**Abstract:** Neuro-based methods as diverse as functional Magnetic Resonance Imaging (fMRI) or electro-encephalography (EEG) reveal far preciser information about underlying cognitive processes than behavioral data alone. Consequently, cognitive architectures do not only integrate findings about brain functions, but recently even make precise and predictions about the time shifts of brain activations (e.g., ACT-R; Anderson, 2007). This seminar deals with recent progresses and current limits in cognitive models on neuro-based information. The objective of the seminar is to discuss different approaches to modeling Neuroimaging data and the connection between symbolic models and neuro-image data and fitting the data.

**Objective:** This seminar explores the cognitive and neural processes that support deductive reasoning. The first part consists of a brief introduction into basic principles of cognitive neuroscience relevant for human reasoning. In a second part recent cognitive and neuropsychological experiments are discussed. You will learn about modeling cognitive processes, comparing cognitive models and its connections to human working memory.

**Background knowledge:** You should have a basic understanding of (or read about):

1. Cortex and Brodmann areas
2. Cognitive models and architectures e.g.,  
ACT-R: <http://act-r.psy.cmu.edu/about> and Nengo <http://nengo.ca/>
3. Neuroscientific methods, e.g., fMRI
4. Working memory, e.g., [http://www.scholarpedia.org/article/Working\\_memory](http://www.scholarpedia.org/article/Working_memory)
5. Brain [http://www.scholarpedia.org/article/Modular\\_models\\_of\\_brain\\_function](http://www.scholarpedia.org/article/Modular_models_of_brain_function)

## You may

- read parts of the excellent book by  
**Ward, Jamie (2006). The Student's Guide To Cognitive Science. Psychology Press**
- and install the brain tutor: <http://www.brainvoyager.com/products/braintutor.html>

**Task:** Teach all other participants methods and fundamental knowledge for one of the topics below. Be as instructive as possible: Select material, understand it, and write a (brief) tutorial in LaTeX. All participants will give a brief feedback for your effort.

## Topics

**Part 0:** Basic knowledge about Neuroscience

**Topic 1-3:** e.g.

- Ward, Jamie (2006). The Student's Guide To Cognitive Science. Psychology Press: **Chapters 2,3, and 4**
- Neurocognitive methods in higher cognition, RG Morrison, BJ Knowlton  
[http://canlab.org/uploads/2/8/1/3/2813551/06\\_holyoak\\_ch06\\_final.pdf](http://canlab.org/uploads/2/8/1/3/2813551/06_holyoak_ch06_final.pdf)
- How to test cognitive theory with fMRI C. Chatham, D. Badre  
<http://arxiv.org/pdf/1404.2917v2.pdf>
- How can we study reasoning in the brain? D. Papo

<http://www.ncbi.nlm.nih.gov/pmc/articles/PMC4408754/pdf/fnhum-09-00222.pdf>

**Part 1:** Introduction to neural correlates of reasoning

**Topic 4:** e.g.

- Cognitive Neuroscience of Thinking, V. Goel, 2007  
[http://www.yorku.ca/vgoel/reprints/Goel\\_HNBS\\_chapter.pdf](http://www.yorku.ca/vgoel/reprints/Goel_HNBS_chapter.pdf)
- Anatomy of deductive reasoning, V. Goel, 2007  
[http://www.yorku.ca/vgoel/reprints/Goel\\_TiCS.pdf](http://www.yorku.ca/vgoel/reprints/Goel_TiCS.pdf)  
  
<http://ir.nmu.org.ua/bitstream/handle/123456789/120902/9defe3ebbd48ace52d37b793129338.pdf?sequence=1 - page=470>

**Topic 5:** e.g.

- Dual-process theories, J. Evans & K. Stanovich:  
[https://www.researchgate.net/profile/Keith\\_Stanovich/publication/258179748\\_Dual-Process\\_Theories\\_of\\_Higher\\_Cognition\\_Advancing\\_the\\_Debate/links/540606c40cf23d9765a7e87d.pdf](https://www.researchgate.net/profile/Keith_Stanovich/publication/258179748_Dual-Process_Theories_of_Higher_Cognition_Advancing_the_Debate/links/540606c40cf23d9765a7e87d.pdf)
- Dual-process J. Evans  
[http://faculty.weber.edu/eamsel/Classes/Methods \(3610\)/Old Sections/Fall 2010/Fall 2010 Project/Evans \(2003\).pdf](http://faculty.weber.edu/eamsel/Classes/Methods (3610)/Old Sections/Fall 2010/Fall 2010 Project/Evans (2003).pdf)
- An evaluation of dual-process theories of reasoning M. Osman  
<http://link.springer.com/article/10.3758/BF03196730>

**Topic 6:** e.g.

- Heuristics and biases in the brain: Dual neural pathways for decision making W De Neys, V Goel  
[http://ppw.kuleuven.be/reason/wim/data/De\\_Neys&Goel\\_v1.doc](http://ppw.kuleuven.be/reason/wim/data/De_Neys&Goel_v1.doc)
- Evidence for dual neural pathways for syllogistic reasoning, Goel, V.  
[https://www.researchgate.net/profile/Vinod\\_Goel2/publication/228393145\\_Evidence\\_for\\_dual\\_neural\\_pathways\\_for\\_syllogistic\\_reasoning/links/54db88e30cf28d3de65ba52e.pdf](https://www.researchgate.net/profile/Vinod_Goel2/publication/228393145_Evidence_for_dual_neural_pathways_for_syllogistic_reasoning/links/54db88e30cf28d3de65ba52e.pdf)

**Topic 7:** e.g.

- The Brain Network for Deductive Reasoning: A Quantitative Meta-analysis of 28 Neuroimaging Studies, J. Prado et al.  
[http://www.mitpressjournals.org/doi/pdf/10.1162/jocn\\_a\\_00063](http://www.mitpressjournals.org/doi/pdf/10.1162/jocn_a_00063)
- fMRI evidence for a three-stage model of deductive reasoning, Fangmeier, T. et al., [http://www.uni-giessen.de/cms/fbz/fb06/psychologie/abt/kognition/dateien/fkrs\\_JoCN\\_2006.pdf/view](http://www.uni-giessen.de/cms/fbz/fb06/psychologie/abt/kognition/dateien/fkrs_JoCN_2006.pdf/view)

**Topic 8:** e.g.

- The cognition and neuroscience of relational reasoning  
[http://www.brainhealth.utdallas.edu/pdfs/The\\_cognition\\_and\\_neuroscience\\_of\\_relational\\_reasoning.pdf](http://www.brainhealth.utdallas.edu/pdfs/The_cognition_and_neuroscience_of_relational_reasoning.pdf)

- Indeterminate/Determinate relational reasoning:  
<http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2749900/>

**Topic 9:** e.g.,

- Neural substrates of fluid reasoning: an fMRI study of neocortical activation during performance of the Raven's Progressive Matrices Test  
[https://www.researchgate.net/profile/Vivek\\_Prabhakaran/publication/14006179\\_Neural\\_Substrates\\_of\\_Fluid\\_Reasoning\\_An\\_fMRI\\_Study\\_of\\_Neocortical\\_Activation\\_during\\_Performance\\_of\\_the\\_Raven's\\_Progressive\\_Matrices\\_Test/inks/02bfe51099e1c2edc7000000.pdf](https://www.researchgate.net/profile/Vivek_Prabhakaran/publication/14006179_Neural_Substrates_of_Fluid_Reasoning_An_fMRI_Study_of_Neocortical_Activation_during_Performance_of_the_Raven's_Progressive_Matrices_Test/inks/02bfe51099e1c2edc7000000.pdf)
- An fMRI investigation of the role of the basal ganglia in reasoning: Melrose et al., [http://conte.bu.edu/articles/PDF\\_Melrose\\_Brain\\_res.pdf](http://conte.bu.edu/articles/PDF_Melrose_Brain_res.pdf)

**Part 2:** Recent approaches to model human reasoning

**Topic 10:** e.g.

- What are NEF and NENGO?  
A Large-Scale Model of the Functioning Brain, C. Eliasmith  
<http://www.sciencemag.org/content/338/6111/1202.short>

**Topic 11:** e.g.

- The use and abuse of large-scale brain models, C. Eliasmith  
[http://ac.els-cdn.com/S095943881300189X/1-s2.0-S095943881300189X-main.pdf?\\_tid=98f8ced4-562e-11e5-839a-00000aacb360&acdnat=1441719564\\_59945cfff8e0515699ba4e9d92d3b749](http://ac.els-cdn.com/S095943881300189X/1-s2.0-S095943881300189X-main.pdf?_tid=98f8ced4-562e-11e5-839a-00000aacb360&acdnat=1441719564_59945cfff8e0515699ba4e9d92d3b749)
- Computational neuroscience: beyond the local circuit, H. Sompolinsky  
<http://www.sciencedirect.com/science/article/pii/S0959438814000373>

**Topic 12:** e.g.,

- ACT-R as a neurocognitive model (not online; only for reference)  
<https://books.google.de/books?id=ro9JCAAQBAJ>