



Exeter College Oxford Summer Programme Cognitive Neuroscience

Course Description

This course aims to provide you with an understanding of the biological bases of behaviour and to discuss some of our cognitive functions such as memory, learning, decision making, emotion, and the cognitive aspect under social behaviour. Cognitive neuroscience studies the biological processes that underlie human cognition, especially in regards to the relation between brain structures, activity, and cognitive functions. Cognitive neuroscience is an interdisciplinary field as it combines both psychology, physiology and neuroscience. There has been a number of recent significant advances and interesting research concerning how the brain encodes cognitive processes and this provides us with a better understanding of certain brain pathologies such as Alzheimer's disease, Parkinson's disease, and amnesia. The significant advance in our understanding of brain-behaviour/cognition relationships are in part due to technological advances such as functional brain imaging and human brain recording.

Syllabus Overview

1. What is Cognitive Neuroscience? Historical overview
2. Introduction to memory systems and amnesia
3. Mechanisms of non-declarative Memory
4. Object and semantic declarative memory systems
5. Spatial, temporal, and episodic declarative memory systems
6. Declarative Memory Systems Beyond the Medial Temporal Lobe (MTL)
7. Prefrontal cortex and Decision-making
8. Introduction to neural plasticity/Hippocampal LTP and memory
9. Mechanisms of sleep
10. Synaptic plasticity and sleep
11. Emotion and Memory
12. Social Neuroscience

The course is composed by 12 lectures, 6 seminars, and 4 tutorials. It requires the students to read in advance in order to gain an understanding of the contents to be discussed. The course will help you to sharpen your analytical skills, improve your abilities to critically interpret primary scientific data, improve your confidence in academic debate, and develop your presentation skills. It will also give you a chance to learn to write clearly and advocate ideas for our debates (tutorials). This course is suitable for students who have a strong interest and curiosity about brain and

behaviour. There are no prerequisites, and no previous knowledge of neuroscience is necessary, but some knowledge of human neurobiology would be an advantage. The course will require that you read in advance each lecture and will aim to be interactive and stimulate you to debate.

Teaching Methods and Assessment

- 12 x 1.25hr Lectures (15hrs)
- 6 x 1.25hr Seminars (7.5hrs)
- 4 x 1.25hr Tutorials (5hrs)

Twice weekly lectures will present the key points of the topics. Students will be expected to have completed the readings before the relevant lecture. A weekly seminar will focus in-depth study of lecture themes and provide opportunities to read, interpret, discuss and critique scientific literature. In addition, students will be expected to give a short oral presentation on a particular primary research article relevant to the topics discussed in the course.

Assessments:

Final assessment: An essay of no more than 3,000 words (40%), a final three-hour written examination (40%), oral presentation (10%) and participation in seminar/tutorials discussions (10%).

Lecture Schedule:

First Lecture: Introduction

General Introductory Reading

Ward J (2014) *The Student's Guide to Cognitive Neuroscience*. Psychology Press
Physiology of Behaviour NR Carlson (Pub: Pearson) – Chapter 13: Learning and Memory

Lecture 2: General Intro to Memory and Amnesia

A more detailed introduction to basic mechanisms of learning and memory:
Zigmond et al (1999). Good introductory textbook with chapters covering all aspects of learning and memory: Gluck et al (2008).

Squire, L. R. (1987). *Memory and Brain*. New York: Oxford University Press.

Squire, L. R., & Kandel, E. R. (1999). *Memory: from mind to molecules*. New York: Scientific American Library.

Squire, L. R., & Zola-Morgan, S. (1988). Memory - Brain Systems and Behavior. *Trends in Neurosciences*, 11(4), 170-175.

What was the true extent of H.M's lesion?: Corkin et al (1997)

Lecture 3: Nondeclarative memory

Squire, L. R., & Zola, S. M. (1996). Structure and function of declarative and nondeclarative memory systems. *Proceedings of the National Academy of Sciences of the United States of America*, 93(24), 13515-13522

Lecture 4: Declarative Memory and Medial Temporal Lobe

- For a reviews of Medial Temporal Lobe (MTL) involvement in object memory and perception see: Buckley and Gaffan (2006).
Lee, A. C. H., Buckley, M. J., Gaffan, D., Emery, T., Hodges, J. R., & Graham, K. S. (2006). Differentiating the roles of the hippocampus and perirhinal cortex in processes beyond long-term declarative memory: a double dissociation in dementia. *Journal of Neuroscience*, 26, 5198-5203.
- In favour of a general MTL declarative memory system: Squire and Zola-Morgan (1991).
- In favour of distinct recollection vs familiarity networks: Aggleton and Brown (2006).

Lecture 5: Spatial, Temporal and Episodic Memory

A double-dissociation in perceptual deficits in patients with neurodegenerative MTL lesions involving the hippocampus and perirhinal cortex to different extents: Lee et al (2006). Can animals recall the past and plan for the future? – Clayton et al (2003a).

- For reviews of Episodic Memory Theory see: Tulving:(1972; 1983; 2002).
Hippocampal activity during retrieval of autobiographical events: Maguire and Mummery (1999).
- Navigation and human brain activity: Maguire et al (1998).
- The hippocampus and recollection-related activity: Montaldi et al. (2006).
Dickerson, B., Eichenbaum, H. The Episodic Memory System: Neurocircuitry and Disorders. *Neuropsychopharmacol* 35, 86–104 (2010).
<https://doi.org/10.1038/npp.2009.126>

Lecture 6: Declarative Memory Systems Beyond the Medial Temporal Lobe (MTL)

Memory circuit and Korsakoff's syndrome: Delay and Brion (1969).
Extended hippocampal-diencephalic system underlies episodic recollection: Aggleton and Brown (1999).

Lecture 7: Prefrontal cortex and Decision-making

Gazzaniga, Ivry, Mangun 3rd Edition: chapter 12, pp555-589 or 5th Edition Chapter 12 pp517-526 and 539-553

Lara AH and Wallis JD (2015) The Role of Prefrontal Cortex in Working Memory: A Mini Review. *Front. Syst. Neurosci.* 9:173. doi: 10.3389/fnsys.2015.00173

Miller, E. The prefrontal cortex and cognitive control. *Nat Rev Neurosci* **1**, 59–65 (2000). <https://doi.org/10.1038/35036228>
An Integrative Theory of Prefrontal Cortex Function, Earl K. Miller Jonathan D. Cohen, *Annual Review of Neuroscience* 2001 24:1, 167-202

Lecture 8: Introduction to neural plasticity/Hippocampal LTP and memory

Maguire et al., (2000) Navigation-related structural change in the hippocampi of taxi drivers. *PNAS (USA)* 97:4398-4403.

Whitlock JR, Heynen AJ, Shuler MG, Bear MF (2006) Learning induces long-term potentiation in the hippocampus. *Science*, **313**, 1093-1097.

Martin, S.J., Grimwood, P.D. & Morris, R.G. (2000) Synaptic plasticity and memory: an evaluation of the hypothesis. *Annu Rev Neurosci*, **23**, 649-711.

Whitlock et al., 2006

Lecture 9: Mechanisms of sleep

Rasch and Born (2013) General introduction to sleep – see “Physiology of Behaviour” by Neil R Carlson (Tenth Edition) – Chapter 9: Sleep and Biological Rhythms pp 295-328.

Lecture 10: Plasticity, Sleep and Memory

Rasch B, Born J (2013) About sleep’s role in memory. *Physiology Reviews*, 93; 681-766.

Tononi G, Cirelli C (2014) Sleep and the price of plasticity: from synaptic and cellular homeostasis to memory consolidation and integration. *Neuron*, 81:12-34.

Lecture 11: Emotion and Memory

Schacter, S. & Singer, J.E. (1962). Cognitive, social and physiological determinants of emotional state. *Psychological Review*, 69, 379-399.

Lecture 12: Social Neuroscience

Augoustinos, M., & Walker, I. (1995). *Social cognition: An integrated introduction*. London: Sage.

Fiedler, K, & Bless, H. (2001). Social cognition. In M. Hewstone & W. Stroebe (Eds.), *Introduction to social psychology* (3rd edition, pp. 115-150). Oxford: Blackwell.

Fiske, S.T., & Taylor, S.E. (2013). *Social cognition: From brains to culture* (2nd edition). London: Sage (chapter 1).