The Meaning of 'Understanding' in Brain Research

Special Topic Graduate Course
Spring Term 2015
Tuesday, 14:00-16:00, Meyer 808

Yadin Dudai, CNS

What do we mean when we wish or claim to understand a natural phenomenon? Specifically, when you select a brain process or mechanism to study, what do you expect to 'understand' and how would you know that you have understood it, if ever?

'Understanding' as a cognitive accomplishment is intuitively understood but its meaning in science is debated. The issue is the topic of discourse in epistemology and in the philosophy of science, but much less so in the active research community, and even then the discourse is mostly confined to physics. With the impressive advances in the armamentarium of neuroscience, the increasing pace of discovery of neuronal and brain mechanisms at multiple levels of description, and the expected integration of such findings into models of the brain, discussion of what 'understanding' means in brain research becomes even more timely.

This course will address 'understanding' in the brain sciences from the point of view of practicing neuroscientists but also drawing on concepts, reasoning and observations from a multitude of disciplines, including philosophy, history of science, psychology and cognition.

The course will combine frontal lectures and discussions, accompanied by reading and analysis of selected experimental papers to be distributed before the class, and guest presentations and discussions by members of the NYU faculty on what they consider as 'understanding', with examples from their own studies in sub-disciplines ranging from molecular neuroscience to systems and computational neuroscience. All these examples will focus on the aim to understand the target system including why the specific paradigms and methods were selected to achieve this goal.

The course is expected to provide the student with literacy and knowledge concerning philosophical and methodological underpinnings of practicing brain research. It may contribute to the identification and shaping of expectations in selecting independent research projects.

Topics to be covered:

Classes 1-3 (2/17, 2/24, 3/3):

Brief historical and conceptual background to the notion of 'understanding'
Knowledge: Implicit vs. explicit; Procedural, by-acquaintance, declarative, epistemic; Descriptive vs. explanatory (mechanistic); qualitative vs. quantitative
Knowledge vs. belief vs. understanding
Evolutionary considerations concerning intuition and understanding
Novice vs expert, domain-specific understanding
Research meta-methods and the expectations involved in using them
The role of apparent causality in explanation, correlation vs. causality vs. supervenience
The role of contemporary technological metaphors

Classes 4-6 (3/10, 3/24, 3/31):
The notion of complex system, complex adaptive system, levels of description and analyses and translation rules
(Guest speakers/discussants: 3/10, J. Anthony Movshon; 3/24, David Heeger; 3/31 (TBC), Eero Simoncelli; Roozbeh Kiani)

Agents, boundaries, and emergence in complex systems, views on inter-level accessibility
Bottom-up vs. top-down approaches to understanding processes and mechanisms
The role of implicit and explicit models and schemata in understanding
The question of epistemic opacity in understanding complex systems

Classes 7-11:
Selected examples

Understanding relatively simple neural systems:
Class 7 (4/7): NMDA receptor as a coincidence detector; molecular and cross-level explanations of coincidence-detection and synaptic persistence (Guest speaker/discussant, Andre Fenton)
Class 8 (4/14): Sensitization of the gill-withdrawal reflex in *Aplysia* and the encoding and storage of elementary memory (Guest speaker/discussant, Cristina Alberini)

Understanding more complex systems:
Class 9 (4/21): Sound localization in the brain stem (barn owl, gerbil) (Guest speaker/discussant, Dan Sanes)
Class 10 (4/28): Perceptual decision in the primate brain (Guest speaker/discussant, Roozbeh Kiani)
Class 11 (5/5): Cognitive assessments and decision making (Guest speaker/discussant, Paul Glimcher)

Class 12 (date TBD): Conclusions, including arguments concerning realistic research programs; Q&A and rehearsal/overview.

Evaluation of the students for credit will be based on performance in class discussions (40% of the grade) and on a paper on one among selected topics to be presented at the end of the course, which will combine independent analysis of a published research program with suggestions for deepening understanding in that project.