The Explanatory Role of Mechanisms in Neuroscience

Tobias Huber[*][1]

[1]Unaffiliated – Tobias Huber Schachenstrasse 42 Spiez, Switzerland

Abstract

Explanations in the biological sciences and neuroscience often make reference to mechanisms. Recent mechanism-based philosophical approaches to explanation and experimentation have thus successfully captured important features of neuroscientific research. In this paper, I explore the explanatory role of mechanisms across different fields in neuroscience. Based on current debates concerning the compatibility of dynamicalmathematical and causal-mechanistic accounts of neuroscientific practice (see Kaplan and Craver 2011; Bechtel 2011, Silberstein and Chemero 2012), I argue that an adequate philosophical theory of the nature of neuroscientific explanation must integrate both mechanistic and computational explanatory strategies.

As I show, research in cognitive and systems neuroscience combines experimental methods, which provide lower-level mechanistic information about brain structure and function, with mathematical models, which target the higher-level complex dynamical behavior of multiscale cognitive systems. Whereas abstract and idealized computational models explain complex neurobiological phenomena in quantitative terms, mechanistic explanations make explicit how a mechanism's organization of structural components and qualitatively specified operations generates the cognitive or behavioral phenomena under investigation. By complementing qualitative with quantitative explanations, neuroscientists are able to develop more realistic models of the brain. I argue that an analysis of the explanatory strategies being practiced in cognitive and systems neuroscience suggests that qualitative mechanistic explanations and quantitative computational models jointly contribute to the explanatory knowledge of neuroscience.

I further argue that this integration of causal-mechanism and dynamical-mathematical models demonstrates the need for a philosophical account of neuroscientific explanation, which can accommodate the explanatory and methodological plurality of neuroscientific research.

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[*]Speaker