ROUND TABLE

Organizer: IRINI SKALIORA

Discussants:

WOLF SINGER

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PHILIP KARGOPOULOS

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Can we ever hope to find a naturalistic explanation for consciousness?

Consiousness is a complex mental phenomenon that has hitherto defied a naturalistic explanation. This is, at least partly, due to the so-called "hard problem of consciousness" a term coined by David Chalmers to refer to the issue of subjective experience: why (and how) we have 'qualia'; or how (and why) sensations are transformed (?) into experiential qualities (e.g. the quality of deep blue, the sensation of a sweet fruit). According to some, there is "no good explanation of why and how such qualia arise. Why should physical processing give rise to a rich inner life at all? It seems objectively unreasonable that it should, and yet it does (Chalmers, 1995)". At the same time, others (Dennet, Dehaene, Novella) dispute the very existence of problem.

Are we presently any closer to a naturalistic explanation of consciousness? Do the (neuro) scientific attempts to explain simpler aspects of conscious experience, such as visual awareness, have any bearing on the 'hard problem'? Is the view that "the so-called hard problem will be solved in the process of answering the "easy" ones" - as argued by Dennet? Do we need new laws of physics in order to tackle the issue? And to what extent are we limited by our language in this search?

This discussion will bring together experts from Neuroscience and Philosophy to debate these matters. Professors Singer and Kargopoulos will make brief introductory statements, followed by a discussion with the other members of the panel and with the audience.

SYMPOSIUM

Organizer: STAVROS IOANNIDIS

Participants:

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MICHAEL VINOS [1,2]
AMALIA TSAKIRI VINOS[1]

Commentators:

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New Mechanism and the System Approach to Biological Complex Systems

What methodological strategies should we adopt for the investigation of complex systems such as organisms and brains? The aim of this symposium is to critically examine some common views within philosophy of biology, cognitive science and neuroscience regarding this question, by comparing prominent philosophical views with examples from scientific practice.

The focal point of the symposium will be the recent so-called new mechanistic philosophy (or 'New Mechanism') within philosophy of science (cf. Craver & Tabery 2016). According to New Mechanism, the search for mechanisms and mechanical explanations is a (perhaps the) main aim in sciences such as biology and cognitive science. There exists a widespread consensus among philosophers of science that an adequate philosophical account of the practice of many sciences must be structured around this basic notion (cf. Glennan & Illari 2018, Part 4).

New mechanists take 'mechanisms' to be entities (complex systems) in their own right which are characterised by a certain ontological structure. The following represents a broad consensus about what a mechanism is: "a mechanism for a phenomenon consists of entities and activities organised in such a way that they are responsible for the phenomenon" (Illari & Williamson, 2012, 120). Mechanistic explanations, then, explain complex systems by identifying the mechanisms that produce the systems' behaviour.

It is not clear, however, whether many explanations offered by science in fields such as systems biology or systems neuroscience conform to the model of a mechanistic explanation as commonly understood. In particular, it is not clear whether systems that exhibit systemic or emergent properties and complex dynamics can indeed be characterised as 'mechanisms' and analysed mechanistically. Let us call the 'system approach' the various methodologies employed in science to analyse such complex systems. There are three options regarding the relation between the system approach and the mechanistic approach: first, the system approach is a subcategory of the mechanistic approach; second, the approaches are distinct, and only the former is appropriate for understanding certain kinds of systems; third, the approaches are distinct but complementary—both should be used, as each of them is useful for understanding different aspects of the system under study. There is currently no consensus among philosophers about which of those three options is correct.

In the symposium we are going to illuminate the contrast between the mechanistic and the system approach and attempt to answer the following questions by focusing on examples of explanations from current neuroscience and cognitive science: How should the mechanistic approach be characterised in general terms? In particular, is it a reductionist strategy or not? Should mechanism be seen as an ontological or merely as a methodological stance? What is the role of decomposition in the examinations of complex systems? What are the relations between different kinds of decompositions and decomposable systems, on the one hand, and the contrast between the mechanistic and the system approach, on the other?

Keywords: mechanism, mechanistic explanation, system approach, complex systems, decomposition

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FIRST TALK

MICHAEL VINOS, IRINI SKALIORA

Self-Organized Criticality and the Brain

As any complex system, the functioning brain, probably the most complex of the biological ones, can be studied under two complementary groups of approaches: these that utilize the bottom-up direction, according to which the hypotheses for the macroscopic level are based on the observations of the microscopic dynamics (e.g. neurons, small local networks) or the top-down approaches, which hold that conjectures for the microscopic level are based on more global observations, regarding even the whole brain. Self-Organized Criticality (SOC) (Bak, Tang, & Wiesenfeld, 1987, 1988) is a viewpoint from which the two levels of activity can be realized as connected. Criticality is a kind of behavior which can be observed during a second order (i.e. continuous) phase transition of a system. Such a system can remain sustained between the two phases and this is the state of criticality, a status really "on the edge of chaos" (Hesse & Gross, 2014; Langton, 1990). The *hypothesis of criticality* for the brain posits that this organ has evolved in such a way for specifically allowing this type of function to emerge because the latter endows the system with certain fitness benefits (Hesse & Gross, 2014). The balancing at criticality or near it optimizes the brain regarding the dynamic range of its responses, information transmission and information capacity (Shew & Plenz, 2013).

The SOC approach for brain dynamics is, in essence, an attempt for providing insights for the fundamental problem in the field of neurosciences, the one that is usually been kept hidden "under the rug": how this "very large conglomerate of interconnected neurons produce a repertoire of given behaviors in a flexible and self organized way" (Chialvo, 2010). Regarding the same question (D. Plenz & Niebur, 2014) maintain that the standard view that the brain networks are analogous to stable, permanently connected, electronic circuits is giving its place to a different one under which the circuitry elements continuously alter their interrelations, "leading to the emergence of complex spatio-temporal patterns". It seems that the assumption which triggered the current main bulk of work regarding SOC and neural systems was that of *neuronal avalanches* in the cortical networks (Beggs & Plenz, 2003, 2004). The term denotes a phenomenon which encompasses the observed critically balanced transmission of information across the brain cortex and which exhibits multiple features of complex organization in different scales as also in different dimensions. A rather astounding fact is the similarity of neuronal avalanches to other well-established expressions of SOC in very different physical systems, with the most prominent being the analogies with tectonic earthquakes (Plenz, 2014), such as the specific relation between the organization of avalanches in time and their organization as magnitudes in space that results in "cascades of cascades", in repeating and nested sequences of events of neuronal activity. Either under the scope of avalanches or regarding a possibly broader interpretation of SOC in the brain, it must be noted that the most significant element regarding this phenomenon is the proper identification of the SOC "phenotype" (Watkins, Pruessner, Chapman, Crosby, & Jensen, 2016):

1. Scale invariance or lack of a characteristic scale
2. Spatio-temporal correlations in the form of power-laws
3. Self-tuning to the critical point (of an underlying second order phase transition)

Relevant experimental work will be outlined as examples for this type of investigation of cortical networks dynamics.

Keywords: Self-Organized Criticality, Neuronal Avalanches, brain dynamics, cortical networks

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SECOND TALK

AMALIA TSAKIRI VINOS

To decompose or not to decompose… phenomena in Cognitive Science

The aim of this presentation is to illuminate the distinction between two seemingly contrasting explanatory strategies in Cognitive Science (CogSci), namely *dynamical systems approach* and *mechanistic approach*. The main contrast concerns the notion of decomposition which will be the central theme of my inquiry. Decomposition is a concept which can be applied both to a system and to a phenomenon. When applied to a system it typically refers to a hierarchy of components which are subsystems themselves and they can also have subsystems as components and so on. The crucial point is that the interactions between the components in every subsystem are very strong while there are no interactions between components of different subsystems. This results to a modular organization. A phenomenon which is being observed on the top level of such a system can be reducibly explained and predicted by decomposing and localizing it in functions and components. From a philosophical point of view decomposition is considered compatible with mechanistic approach.

When philosophers try to understand how life sciences researchers investigate phenomena they apprehend that they discover, identify, and describe mechanisms. A minimal definition of the term *mechanism* is the following: "a mechanism for a phenomenon consists of entities (or parts) whose activities and interactions are organized so as to be responsible for the phenomenon" (Glennan, 2017, p. 17) This captures a decomposing strategy which is the main methodological trend in cognitive science as well. Specifically, a cognitive phenomenon is modeled as a complex hierarchical system which instantiates it. On the top –psychological– level lies the behavior which is analyzed in sub functions which are further analyzed in processes which are localized in brain areas, neural circuits, and activation patterns and so on. The strategy of full decomposition and localization is principally reductive and a sufficient understanding of the interactions of the bottom parts presumably explains the phenomenon.

At the other end someone can find the dynamical systems approach. Generally, with this approach, in the CogSci point of view, we refer to the *dynamical hypothesis (DH)* and related ideas, initially proposed by Tim van Gelder (1998) which states that cognitive agents are dynamical systems. In the DH a cognitive phenomenon is studied without decomposing it in smaller processes and without localizing it in interacting parts which would explain the behavior of the system. On the contrary, the focus of research methodologies is system properties and mathematical analytical tools are used for investigating them. This can be done in various scales, ranging from the dynamics in neural assemblies to the emergent properties that arise in coupled agent-environment systems.

Simon and Ando (1961) in their seminal paper "Aggregation of variables in dynamic systems" and later Simon (1962) in "The architecture of complexity" argued that there is a special kind of complex hierarchical systems that are not fully decomposable. This means that there exist interactions between the subcomponents of the system that instantiates a given phenomenon, which are weak but cannot be neglected. These interactions give rise to properties in an aggregate way. I propose that mind, which is an information processing system, can be studied as a so-called near-decomposable system and thus, a unified explanatory strategy which combines elements from both mechanistic and dynamical approaches is feasible.

Keywords: complexity, dynamical systems, near-decomposability, mechanistic explanation

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THIRD TALK

STAVROS IOANNIDIS

Defending Methodological Mechanism

The main aim of the talk is to defend a position that I will call Methodological Mechanism (MM) against the ontological turn within recent mechanistic philosophy ('New Mechanism') in philosophy of science (cf. Glennan 2017). New Mechanism is commonly understood to include two broad theses, an ontological and a methodological. According to the former, the world consists of mechanisms; according to the latter, the main objective of science is to find mechanisms and construct mechanistic explanations of the phenomena. A central issue among new mechanists is how exactly the concept of mechanism as used in science should be characterised in general terms. I will argue that almost all well-known general characterisations found in the literature lend themselves easily to an ontological interpretation and so provide the necessary content for the ontological thesis of New Mechanism. However, this is a move that should be resisted, as it cannot be properly grounded in scientific practice.

I will argue that 'mechanism' as used in scientific practice is actually a very thin concept: a theoretically described causal pathway that produces the phenomena (cf. Ioannidis & Psillos 2017). As such, it cannot lead to some substantive 'mechanistic' ontological picture, contra the claims of several new mechanists. Mechanism, then, as a general view, should best be viewed as primarily a methodological rather than an ontological stance. I will use some of the early work on decompositional explanations of complex systems (e.g. Kauffman 1970, Wimsatt 1972) to further support MM and to argue against the recent ontological turn in mechanistic philosophy.

I will suggest that MM has the following consequences:

- First, that we have to distinguish between the thin concept of 'mechanism' in scientific practice, and methodological strategies/modelling techniques of complex systems that can be described as 'mechanistic'.

- Second, that this distinction leads to two different senses of what a 'mechanistic explanation' is: an explanation can be mechanistic either because it identifies a mechanism qua causal pathway, or because it involves a 'mechanistic model'.

- Third, that top-down approaches to complex systems are compatible with a general mechanistic outlook, i.e. that to explain the behaviour of a system one should search for the underlying mechanisms.

Keywords: mechanistic explanation, causal pathway, methodological mechanism, mechanistic model, decomposition, complex systems

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