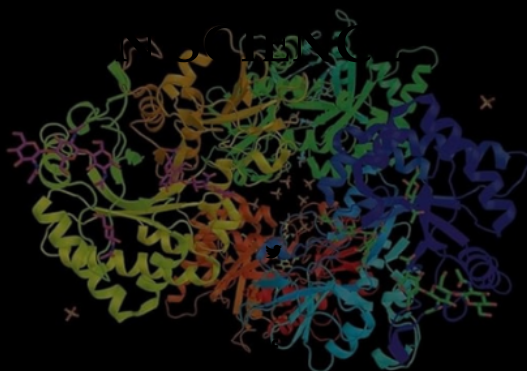


Mechanisms in Science

Method or Metaphysics?

Stavros Ioannidis
and Stathis Psillos



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Mechanisms in Science: Method or Metaphysics?[□]

Stavros Ioannidis and Stathis Psillos

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In *Mechanisms in Science: Method or Metaphysics?* Ioannidis and Psillos offer a metaphysically minimal account of the concept of mechanism as it is used in science. They believe that what scientists mean when they talk about mechanisms can be adequately captured by what they call 'causal mechanism': 'a mechanism is a causal pathway described in theoretical language' (p. 3). Simply put, they argue that mechanism in science is a methodology, not an ontology. The larger aim of the book is to defend this claim on the grounds of both metaphysics and the practices of science.

Their defence of causal mechanism and the deflationary metaphysical stance is divided into three parts. Part 1 traces the history of the concept of mechanism in science from its development in the seventeenth century, by thinkers like Descartes, Boyle, Huygens, and Leibniz, to its contemporary instantiations. Part 2 develops a 'science-first' account of difference-making, and defends this account in comparison to other metaphysical accounts of causation and differences making. Finally, part 3 characterizes how this account goes beyond that of previous new mechanism accounts.

The history of the concept of mechanism in science provided in the first two chapters of this book will be of interest and use to any philosopher interested in either philosophical accounts of causation, or the history and philosophy of science. Chapter 1 details the development of 'old mechanism', which Ioannidis and Psillos maintain has a metaphysical foundation. They argue that this view is committed to 'a reductionist account of all worldly phenomena' (p. 16). The old mechanism account, Ioannidis and Psillos contend, starts from a metaphysical commitment to a particular way the world is, and on that basis attempts to develop scientific theories of various kinds. They also detail the development in the 2000s of the 'new mechanism' account, arguing that while all the most important accounts focus on mechanism as a 'concept-in-use' (Machamer et al. [2000]; Glennan [2002]; Bechtel and Abrahamsen [2005]), they also make metaphysical commitments. Ultimately, Ioannidis and Psillos are interested in defending a metaphysically agnostic account of mechanism.

Chapter 2 explores two arguments about why the scientific use of mechanism does not (or should not) commit us to anything about their metaphysical status. The first argument finds its origin in the work of Poincaré and tells us that the complete structure of any mechanism is always underdetermined. Thus, even though mechanisms are ubiquitous in the world, it does not follow that we can know which definite mechanical structure is the one found in nature. The second argument finds its origins in Hegel and tells us that function comes first, then mechanism. In other words, the unity of a mechanism is not intrinsic but depends on the function it is meant to perform. The function, however, is external to the mechanism itself. Ioannidis and Psillos take these points to jointly indicate that the description of a mechanism is theoretical, and does not (or ought not) commit us to any particular metaphysical structure of the world.

Part 2 of this book itself comes in two parts. The first two chapters (chapters 3 and 4) introduce Ioannidis and Psillos's metaphysically minimal account of mechanism in more detail, and motivates it using episodes from the practice of science (apoptosis in chapter 3 and scurvy in chapter 4). The second half (chapters 5–7) takes a deep-dive into the metaphysics of causation, and the role that counterfactuals play in understanding 'difference-making'.

Ioannidis and Psillos find the cause of apoptosis to be a particularly useful case study. Apoptosis is a ubiquitous mechanism for the regulation of cell populations, found across many different sub-fields of biology (including cytology, developmental biology, pathology, molecular biology, and so on). The paper

credited with the first description of apoptosis was published by Kerr and colleagues in 1972. There, they outlined 'a distinctive morphological process [...] which plays a complementary but opposite role to mitosis in the regulation of animal cell populations' (Kerr et al. [1972], pp. 255–56). This is significant because Kerr et al. identified a causal pathway in the absence of a 'full understanding' of its workings, since at that point the actual mechanism of condensation (a key stage in the apoptosis process) was unknown. Ioannidis and Psillos note that Kerr et al.'s work in identifying the function of apoptosis (controlling cell populations) was key in identifying the causal pathway, thus supporting Ioannidis and Psillos's claim that 'causal mechanism' is a sufficient description of what 'mechanism' means in science. While such minimal descriptions can be (as apoptosis has been) 'enriched by offering more detailed or fine-grained descriptions' (p. 79), the minimal description of a mechanism only requires causal pathways with certain function to be described in theoretical language.

Chapter 4 further illuminates the 'metaphysical agnosticism' that Ioannidis and Psillos take to be a novel feature of their account of causal mechanism. They assert that a description of a pathway 'has to be given in the theoretical terms of the specific scientific field (or fields) and not in terms, for example, of entities and activities' (p. 93). While Ioannidis and Psillos do take their reliance on difference-making to be logically independent of their metaphysical agnosticism, nonetheless their defence of the conceptual sufficiency of their agnosticism is tied up in their reliance on difference-making as a metaphysically agnostic concept. This chapter describes another case study, the discovery of the mechanism that causes scurvy, to highlight that difference-making is what is important to biological practice when discovering a new mechanism. In 1748 James Lind conducted a controlled experiment in which participants were given different proposed treatments, including citrus fruits, revealing the efficacy of citrus fruits in preventing the worse cases of scurvy. However, it was not until the 1920s that vitamin C was discovered to be the difference-making mediator involved in preventing scurvy. Ioannidis and Psillos take this to illustrate the importance of difference-making to mechanism discovery.

This case alone, however, is insufficient justification for not requiring something that 'grounds the difference-making' (p. 98), such as a productive view of causation. Here Ioannidis and Psillos ask, 'What is added to scientific practice by insisting that a description of a mechanism has to be couched in some preferred philosophical categories, for example, entities and activities, powers or whatnot?' (p. 104). They believe the answer is nothing. Scientists do not need to be committed to any particular ontology to make use of mechanisms in their work, and thus our philosophical account ought to reflect that practice. Ioannidis and Psillos emphatically deny that science makes use of 'metaphysically inflated' notions of mechanism, and argue that the burden is on those philosophers interested in offering such accounts to show how scientists are making use of metaphysically inflated understandings of mechanisms in practice. Their assertion is that 'when scientists look for mechanisms that produce some phenomena, they seek to describe the causal pathways that lead from the initial event of the pathway to the resulting state', but this does not make 'an ontological claim about the structure of the world' (p.107).

Chapters 5–7 connect these conversations about the use of mechanism in scientific practice to discussions of the metaphysics of causation and counterfactuals. Perhaps most importantly, chapter 6 directly criticizes the idea that the productivity of mechanisms requires a commitment to 'activities' as an ontological category. In particular, Ioannidis and Psillos criticize the approaches of Machamer et al. ([2000]), Glennan ([2017]), and Illari and Williamson ([2011]). Ioannidis and Psillos believe both that no

particular ontology is derivable from scientific practice (pp. 160–61) and that there are good independent reasons to be sceptical of an ontology that includes activities (pp. 143–45). Chapter 7 takes on the reliance of difference-making accounts of causation on counterfactuals. Ioannidis and Psillos criticize interventionist-style accounts and instead argue in favour of a Lewis-style understanding of the truth of counterfactuals.

The final part of the book returns to the explication and defence of Ioannidis and Psillos's main novel claims. Chapter 8 looks at the common division the new mechanists propose between causal and constitutive mechanistic explanation. Ioannidis and Psillos examine Craver's ([2007]) widely adopted account but ultimately argue that it is 'not appropriate or useful to view typical and paradigmatic biological mechanisms in constitutive terms' (p. 205). They argue that so-called constitutive explanations are versions of causal explanations, given that we adopt their understanding of unproblematic inter-level causation (chapter 9). Chapter 9 offers many examples of mechanisms that include components from several levels of composition—including apoptosis (chapter 3), visual transduction, scurvy (chapter 4), diabetes, and natural selection—which are used to illustrate the conceptual coherence of inter-level causation. Finally, chapter 10 defends what Ioannidis and Psillos call 'methodological mechanism' or the 'methodological tenet', which is the view that 'commitment to mechanism in science is adopting a *methodological postulate* which licenses looking for the causal pathways for the phenomena of interest' (p. 227).

Part of their defence of the methodological tenet involves the assertion that such a postulate is in tension with ontologically inflated understandings of mechanism. They argue that the adoption of an inflated ontological understanding of mechanism unfairly constrains scientific practices (section 10.4), and thus that adopting the methodological tenet means we need an ontologically minimalistic account of mechanism (like their own causal mechanism). However, this line of reasoning isn't quite satisfactory, and there are philosophers who have argued that mechanism inescapably involves a kind of ontological commitment. For example, Nicholson ([2018]) argues that such thinking is committed to a 'machine conception of the organism'. Further, Gerber and Hiernaux ([2022]) make a similar argument about plant biology specifically, and Esposito and Baravalle ([2023]) argue that the 'machine analogy' has powerful metaphysical assumptions built into it. Ioannidis and Psillos seem to think it is a sufficient response to this line of thinking to say that the scientist who offers mechanistic explanations or accounts of phenomena 'does not have to' (p. 106) be interpreted in a way that commits them to a mechanistic ontology. Elsewhere, they recognize that making sense of the 'kind of talk one finds in science' (pp. 160–61) is often cited as a reason for taking mechanistic science to have metaphysical commitments. However, Ioannidis and Psillos assert that how scientists talk is not sufficient reason to assume they are committed to a mechanical (or any particular) ontology. Given that many authors have argued that there are powerful ways to see an implied mechanical ontology operating in the practice of science, a response to these concerns deserved more careful consideration from Ioannidis and Psillos. It might not be good for science to have such built-in metaphysical assumptions; but merely because it constrains practices doesn't mean that scientists aren't, in fact, being so constrained.

This book has a lot to offer, especially in terms of synthesizing the existing literature and history of mechanism in the philosophy of science, and engaging with metaphysical accounts of causation that conceptually overlap with discussions of mechanism in philosophy of science. Overall, this book is likely to

spark interest from both friends and foes of the new mechanism view, and is a worthy addition to a rich, ongoing conversation about mechanisms in the philosophy of science.

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