

Mechanisms in psychology: The road towards unity?

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Abstract

The focus of this special issue of *Theory & Psychology* is on explanatory mechanisms in psychology, especially on problems of particular prominence for psychological science such as theoretical integration and unification. Proponents of the framework of mechanistic explanation claim, in short, that satisfactory explanations in psychology and related fields are causal. They stress the importance of explaining phenomena by describing mechanisms that are responsible for them, in particular by elucidating how the organization of component parts and operations in mechanisms gives rise to phenomena in certain conditions. We hope for cross-pollination between philosophical approaches to explanation and experimental psychology, which could offer methodological guidance, in particular where mechanism discovery and theoretical integration are at issue. Contributions in this issue pertain to theoretical integration and unification of psychology as well as the growing importance of causal mechanistic explanations in psychological science.

Keywords

integration, mechanism, psychological mechanisms, scientific explanation, unification

Psychological mechanisms

In contemporary philosophy of science, the mechanistic framework, as defended by Bechtel (2008); Craver (2007); Glennan (2017); Hedström and Ylikoski (2010); Machamer, Darden, and Craver (2000); Miłkowski (2013); and Piccinini (2015), among

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others, is currently the most influential approach to explanation in life, behavioral, cognitive, and social sciences. Proponents of the framework claim, in short, that satisfactory explanations, at least in the aforementioned sciences, are causal. They stress the importance of explaining phenomena by describing mechanisms that are responsible for them, in particular by elucidating how the organization of component parts and operations in mechanisms gives rise to phenomena in certain conditions.

However, in spite of the mechanistic framework's massive influence on the debates in the philosophy of science, philosophy of psychology, neuroscience, and cognitive science (Glennan & Illari, 2017), the framework is not yet fully appreciated by scientists working in behavioral and brain sciences. It remains, unfortunately, very much outside the limelight in debates in psychological science. Our claim may seem surprising because experimental psychology textbooks have spoken off-handedly of mechanisms of behavior, response mechanisms, neural mechanisms, recognition mechanisms, and such for years (Bermúdez, 2014; Boring, Langfeld, & Weld, 1948; Eysenck & Keane, 1990; Gardner, 1985; Hebb, 1958; Neisser, 1967). The point is to take the notion of mechanisms seriously. A stringent view on mechanistic explanation implies fairly stringent standards.

First of all, mechanistic explanations are causal. But not all fields of psychology appeal to causal factors in their explanations, either because of limitations of current experimental and observational methodologies or owing to embracing other explanatory standards. For example, personality research usually appeals to factor analysis and some consider this style of explanation to be opposed to causal-mechanistic explanations (Gurova, 2013). Defenders of the mechanistic framework claim that their account of explanation should also replace functionalist approaches to explanation in psychology because these are outdated and methodologically deficient. Mechanists have argued that functionalism licenses notorious boxologies, instead of accounting for both the structure and function of psychological entities (Piccinini & Craver, 2011), but the debate is far from over (Shapiro, 2016; Weiskopf, 2016). Defenders of the mechanistic view argue that boxologies are notoriously difficult to map onto a causal structure of psychological mechanisms. They stress that proper understanding of tasks performed by experimental participants is causal and mechanistic; in other words, the essential part of the psychological explanation is not to describe experimental effects but to elucidate them causally (Cummins, 2000).

Second, mechanistic explanations appeal to components of mechanisms and their operations. The study of components and operations relies on heuristics of decomposition and localization. In other words, one must find joints in nature, along which components are to be carved. This is by no means easy for, say, personality research based on factor analysis. Moreover, as some argue, the highly complex structure of neural systems does not allow such decomposition to be neatly performed (Anderson, 2015). This difficulty is raised mostly by defenders of dynamical modeling in psychology and behavioral sciences. Mechanists, however, reply that a dynamical explanation is a kind of mechanistic explanation (Kaplan, 2015; Zednik, 2011). They also stress that mechanisms need not be fully decomposable into self-standing component structures; decomposition is merely a heuristic and it could fail (Bechtel & Richardson, 2010). Similarly, there can be highly spatially distributed mechanisms: a mechanism should not be confused with a spatiotemporal system. Mechanisms are causal structures that are responsible for their

phenomena. Such causal structures need not be neatly confined to a single spatial location, and their temporal dynamics could be highly organized. Importantly, these mechanisms need not be understood exclusively in neuroscientific terms: for example, it has been argued that distributed cognitive systems are prime examples of mechanisms, whose functioning need not “bottom out” exclusively in molecular or cellular neuroscience (Miłkowski et al., 2018).

Third, mechanistic norms of explanation require that explanatory texts be complete, i.e., contain all and only causally relevant factors (Baetu, 2015; Craver & Kaplan, 2018). This means that gaps, black boxes, or filler terms (such as “trigger,” “behavior,” or “representation”) must be replaced with detailed causal models in the ideal explanatory texts. As a result, most existing mechanistic explanations are unsatisfactory: they fall short of fulfilling this norm.

In other words, the notion of mechanism as used in contemporary philosophy of science is fairly thick compared to what is meant by “mechanisms” in psychological texts. At the same time, this thickness implies merely that there are further requirements and discovery heuristics available for researchers. Thus, we believe that theoretical debates in psychology would be enriched if they included the current philosophical work on mechanisms. We suggest this not only because the notion of mechanism is used frequently by scientists in their explanatory practices but also because the mechanistic approach offers a theoretical framework that has the potential to further develop the everyday explanatory practice of psychologists. This cross-pollination could offer methodological guidance, in particular where mechanism discovery and theoretical integration are at issue.

What psychology gains from mechanistic explanation

Defenders of the mechanistic framework are particularly sensitive to issues of theoretical integration and unification (Craver & Darden, 2013; Miłkowski, 2016a, 2016b). These issues remain crucial to both psychology and neuroscience (Bechtel & Abrahamsen, 1993; Henriques, 2013; Staats, 1986; Stam, 2015; Sternberg & Grigorenko, 2001; for a review, see Gaj, 2016).

Not only does the work on the nature of mechanisms relate to the process and heuristics of scientific discovery (Bechtel & Richardson, 2010), it also includes novel accounts of organizational levels of mechanisms that are designed to support integrative efforts in science (Bechtel, 1994; Craver, 2007; Eronen, 2015). In particular, the mechanists object to the received view in the philosophy of science that the only way to integrate theories is to reduce them to some other fundamental theory (for a defense of the received view, see Bickle, 1998). The received view is not only difficult to apply in practice but also does not account for piecemeal and partial integration between different theories, models, and frameworks. The difficulty lies in the fact that reduction is traditionally modeled in terms of inferential links between theories considered as sets of propositions. However, few scientific theories in psychology, biology, or cognitive science are fully expressed in terms of explicit axioms or propositions. In contrast, different facts about mechanisms, for example, about the temporal dynamics or geometric shapes of their components, can constrain mosaic-like mechanistic explanations that piece various kinds of evidence together (Craver, 2007; Miłkowski, 2016a).

Recently, mechanists have claimed there has been a silent revolution in cognitive science that has meshed it effectively with neuroscience, forming cognitive neuroscience as a result (Boone & Piccinini, 2016), as well as enriched cognitive science with heuristics that stem from “wide cognition”: embodied, embedded, extended, enactive, or distributed approaches to the study of psychological phenomena (Miłkowski et al., 2018). These revolutions are silent inasmuch as they do not require complete abandonment of previous theoretical approaches; instead, they rely on the continuous integration of constraints on mechanistic explanations.

Mechanists have paid somewhat less attention to the issue of theoretical unity, sometimes even conflating it with piecemeal integration (Craver, 2007; Fagan, 2017). Arguably, however, unified theories are not mere integrated bodies of knowledge. To be unified, they should also cover their subject domain systematically and completely, while remaining consistent, simple, parsimonious, and single (Miłkowski, 2016b). The distinction can be elucidated by showing when an integrated explanatory text is not really unified: this can happen, for example, when it contains parts whose confirmation is independent. In other words, one part of a theory may be refuted by evidence, leaving another part intact. In such a case, this theory is merely a collection of independent claims, thus, it could be termed *monstrous* (Votsis, 2015). The point, therefore, is that models of, say, psychological mechanisms should be substantiated by a theoretical framework that provides a deeper understanding of the whole domain of psychological phenomena, while avoiding monstrosity and spurious complexity. This is not merely a point of beauty but of complete and systematic understanding, which is, according to a recent account (Hoyningen-Huene, 2013), a hallmark of science.

Contents of the issue

The purpose of this special issue of *Theory & Psychology* (Miłkowski, Hohol, & Nowakowski, 2019), broadly construed, was to solicit original papers from defenders and opponents of mechanistic explanation and theorists of psychology and neuroscience who address problems of special prominence for the psychological community. The special issue is partly based on the workshop we hosted in Warsaw, Poland in June 2016, which was devoted mostly to issues of explanatory unity and integration from the mechanistic perspective.

The special issue proceeds as follows. It opens with an article by Eric Hochstein (2019) that investigates metaphysical commitments involved in the study of cognitive mechanisms. The author underlines the place of philosophy in cognitive (neuro)science, which is an inherently interdisciplinary research enterprise. His claim is not, however, only that philosophy is a full-fledged part of cognitive science, but also that an experimenter should simultaneously be a good metaphysician. The author argues that metaphysical considerations about cognitive phenomena, including their starting and termination conditions, should be carried out not only with regard to the interpretation of experimental findings, but should also precede selecting the method of testing, specifying variables, and experimental design. Since metaphysical commitments are tightly interwoven—as Hochstein argues—with empirical practice, it is reasonable to make them explicit and controlled instead of letting them affect the experiment from backstage.

Furthermore, careful tracking of metaphysical commitments allows us, as Hochstein (2019) claims, to not only avoid shoals and mistakes but can also be fruitful in the project of unification/integration of sometimes mutually inconsistent models of cognitive functions by revealing their points of compatibility.

Marek Pokropski's (2019) paper investigates the possibility of integrating phenomenology, which has a rich tradition as a method of examining consciousness, and the new mechanistic approach to explanation, which is widely applied to psychology and cognitive (neuro)science as a methodological framework. The main reason for an attempt at integration of both fields is an insufficiency of purely mechanistic models to elucidate consciousness, with particular emphasis on its first-person perspective. To this end, the author compares three approaches: integrated information theory (IIT), front-loaded phenomenology, and neurophenomenology. These approaches can be understood as interfield theories (Darden & Maull, 1977), which aim to establish a bridge between phenomenology and mechanistic cognitive science. The weakness of the first, IIT, is related to deriving axioms about the physical implementation of consciousness immediately from phenomenological axioms (furthermore, as the author notes, IIT uses the notion of axiom in a confusing way). The second, front-loaded phenomenology, fails since it does not sufficiently constrain possible mechanisms of consciousness. The third, neurophenomenology, has insufficient explanatory power to deliver dynamical models of consciousness.

Pokropski proposes modifications in front-loaded phenomenology and neurophenomenology to improve their theoretical stance and to use them in further projects integrating phenomenology with the mechanistic framework. According to the author, phenomenological analysis can supply descriptions of phenomena that are explained mechanistically analogically to traditional functional analysis (Piccinini & Craver, 2011).

William Bechtel (2019) claims that the study of the mental should go beyond a view that human cognitive mechanisms primarily transform sensory information to highly adequate representations of the surrounding world. Instead, the author argues that the crucial function of cognitive mechanisms is providing the organism with behavioral control. Drawing from cases of animals without their cortex, e.g., jellyfish and lesioned organisms, the author proposes a theoretical framework for heterarchically organized neural mechanisms of behavioral control.

Moreover, his contribution lies in updating the account of mechanism in the study of the mental: namely, he stresses that some mechanisms are not only causal structures but that they constrain energy flows in other mechanisms, allowing them to play control roles in biological organisms. This notion of mechanism stresses the importance of control in psychology and life sciences, which also implies that the most recent work on mechanistic explanation embraces insights from cybernetics that have remained somewhat out of the limelight in mainstream psychology, though appreciated by proponents of enactive views on cognition (Thompson, 2007; Varela, Thompson, & Rosch, 1991).

Cognitive science, including cognitive psychology, was traditionally perceived as autonomous from neuroscience. Although this perception has generally changed in recent decades, as evidenced by the emergence of cognitive neuroscience (Gazzaniga, Ivry, & Mangun, 1998), some functionalists still defend autonomy, claiming that

neuroscientific findings leave many degrees of freedom for constructing theories about cognitive functions (Weiskopf, 2011a, 2011b).

In the next article, Mark Povich (2019) shows that model-based cognitive neuroscience (MBCN) delivers a promising perspective for integration of mathematical cognitive psychology (the computational/algorithmic level) and neuroscience (the implementational level) thanks to mutual constraining of these fields, when the notion of a field is used in the technical sense proposed by Darden and Maull (1977).

According to MBCN, a cognitive model composed of the mathematical description of representations and processes can, on the one hand, elucidate the modulation of neural activations in a given task. Neural data, on the other hand, allow us to infer which of the competing models is best, even though these models yield similar behavioral predictions (Palmeri, Love, & Turner, 2017).

Next, Paweł Gładziejewski (2019) explores the issue of explanatory unification under the free energy principle (FEP; Friston, 2010) and within the predictive processing framework of brain and cognition (Clark, 2016; Hohwy, 2013). According to the author, the predictive processing framework indeed promotes unification, but at the same time, a frequently recurring claim that understanding the brain as a predictive engine leads to the final unification of cognitive (neuro)science is a misunderstanding. The FEP, which is associated with the idea that living organisms are entropy-avoiding systems, delivers, as Gładziejewski notes, only a functional sketch or schema, which may be implemented by many distinct neural mechanisms. Therefore, using the terminology of Danks (2014), the author claims that the predictive processing framework of brain and cognition delivers a scheme-centered account of unification.

Gładziejewski (2019) also discusses a more general issue, namely the value of unification for the mechanistic account of scientific explanation. He defends the claim that although unification is not a must-have component of a satisfactory mechanistic explanation, it may be epistemically useful in the process of selection of directly competing explanatory models when no explanatory proposal can be inferred as “best” with other principles.

Sabrina Golonka and Andrew Wilson (2019) focus on ecological mechanisms in cognitive science. Their starting point is the causal mechanistic explanation of dynamic phenomena, developed by Bechtel and Abrahamsen (2010) with particular reference to the phenomenon of circadian rhythms. Golonka and Wilson defend the claim that for explanatory purposes in mechanistic spirit, cognitive phenomena should be decomposed and localized at the proper scale, that of ecological perceptual information. For example, biochemistry allows one to understand fermentation, in contrast to the scale of quantum chemistry or general physiology. The reason is that the processing at the ecological scale triggers time-constrained interactions between the individual and its surroundings. Golonka and Wilson illustrate their thesis by referring to research on coordinated rhythmic movement highlighting two classes of component parts that should be taken into account: dynamical affordances that are task-specific, and kinematic information variables. To sum up, as the authors claim, a neo-Gibsonian ecological framework of perception and action supports mechanistic analyses. This approach to explanation in psychology is unique in uniting previously disparate worlds. While many mainstream cognitive (neuro)science models can be analyzed in mechanistic terms, the contribution of Golonka and Wilson points to an exciting possibility of

making ecological psychology mechanistic and mechanistic explanation more ecological. We can see this contribution as pursuing the silent mechanistic revolution in cognitive science even further than before (Miłkowski et al., 2018).

The two papers that conclude the issue are more skeptical about the prospects of mechanistic explanation of the mental. In the first, Matteo Colombo and Andreas Heinz (2019) explore the issue of explanatory integration in psychiatry. Drawing from the case of an alcohol use disorder (AUD), they argue that the integrated explanation of the phenomenon should include a description of a mechanism, computation, and phenomenological analysis of perceptions, affects, and cognitive states. Considering three theoretical frameworks, namely a network of symptoms framework, new mechanism, and their own dimensional framework, the authors claim that the latter is the most promising as an effective integrative explanation of AUD and other psychiatric maladies. The new dimensional framework is based on the concept of a computational phenotype, namely, “a measurable behavioural or neural type defined in terms of some computational model” (Montague, Dolan, Friston, & Dayan, 2012, p. 72), and allows us, the authors claim, to reach beyond the limits of traditional phenomenological methods of description (Carel, 2011) and computational psychiatry (Montague et al., 2012), as well as avoiding the problems associated with reducing one account to another (Schaffner, 2013).

The integrative framework defended by Colombo and Heinz (2019) can also be considered a contribution to the ongoing debate about research domain criteria (RDoC) as a possible successor of symptom-based categorization in psychiatry (Insel et al., 2010; LeDoux, 2016; Persson, 2019) in the face of symptom-based nosology inherent in standard diagnostic manuals (Wakefield, 2016) and insufficient communication between psychiatry and neuroscience within the DSM/ICD framework. On one hand, the authors admit that their dimensional framework is in line with RDoC, which assumes quantitative differences (instead of qualitative ones) between neurotypical and pathological states. On the other hand, Colombo and Heinz list several differences between RDoC and their integrative account. First of all, according to the authors, it is not always possible to localize the exact neural correlates of mental disorders. Furthermore, they note that levels of mental function cannot always be defined in terms of genetic dysfunctions. Instead, Colombo and Heinz propose elucidating mental disorders by taking into account clinically relevant properties of a computational phenotype, such as the tension between model-based and model-free control.

In the final article of the issue, Lawrence Shapiro (2019) claims that although new mechanism delivers a vital strategy of explanation in psychology, it does not mean that traditional functional analysis is redundant and thus should be completely rejected in the field. The same is true, according to him, for dynamical explanation. He also disagrees with the tenet held by some proponents of mechanisms that other explanatory strategies can have a heuristic role, but they should eventually be incorporated into a mechanistic form. Piccinini and Craver (2011), for instance, noted that functional analysis is the first step of a mechanistic decomposition. Rejecting such a position, therefore, implies, according to Shapiro, a version of explanatory pluralism.

Shapiro (2019) claims that although the components and the organization of functional analysis cannot be directly mapped onto the neural components and their organization, that is not a sufficient reason to state that such functional units do not really exist.

He notes that neural data do not completely constrain mechanistic models due to theory underdetermination (meaning that for every mechanism explaining some cognitive phenomenon, there are infinitely more models fitting empirical evidence). If so, new mechanism is exposed to the same charges as functional analysis. Moreover, according to the author, an abstract characteristic of functional analysis does not have to be perceived as a disadvantage, since it may deliver new perspectives on explanandum. Finally, the fact that functional sketches drive experimental research indicates that they should not be considered as “just-so stories.”

When selecting contributions for the special issue, we had in mind two features. First, these articles should be informative both for experimental psychologists and philosophers. Second, they should not be mere reviews of existing work. We are certain that the final selection indeed has these features. These papers provide a crucial update to the theory of mechanistic organization and unification, a number of new applications and extensions, and critical views of mechanistic explanation.

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