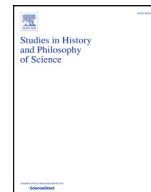




Contents lists available at ScienceDirect

Studies in History and Philosophy of Science

journal homepage: www.elsevier.com/locate/shpsa

The role of orientation experiments in discovering mechanisms

Raoul Gervais^{a,b,*}, Erik Weber^a^a Centre for Logic and Philosophy of Science, Ghent University (UGent), Blandijnberg 2, B-9000 Gent, Belgium^b Tilburg Center for Logic, Ethics, and Philosophy of Science, Tilburg University, Warandelaan 2, 5037 AB Tilburg, The Netherlands

ARTICLE INFO

Article history:

Received 27 January 2015

Received in revised form

18 August 2015

Available online 11 September 2015

Keywords:

Experiments;

Orientation experiments;

Inter-level experiments;

Mechanism;

Mechanistic explanation;

Mechanism discovery

ABSTRACT

Many types of experiments have been recognized in the literature. One important type we discuss in this article is the orientation experiment. While orientation experiments are like other types of experiments in that they are tests for causal relevance, they also have other qualities. One important (but not the only) goal of these experiments is to offer a rough, qualitative characterization of the mechanism responsible for a capacity of interest, effectively constraining future research. This makes them particularly useful during the early stages of investigation, when an explanandum-phenomenon has just been identified and several (often competing) hypotheses as to the qualitative character of the mechanism responsible for it are proposed. We illustrate our claims, and explicate a number of additional aims that orientation experiments can sometimes serve, by considering three case studies from different eras, namely the discovery of the mechanisms responsible for i) the capacity of eels to produce numbing sensations (17th and 18th century), ii) puerperal fever in Semmelweis' Vienna Maternity Hospital (19th century), and iii) the capacity of pigeons to home (20th century).

© 2015 Elsevier Ltd. All rights reserved.

When citing this paper, please use the full journal title *Studies in History and Philosophy of Science*

1. Introduction

This paper is about the way scientists discover mechanisms, in particular, about the *reasoning* employed that leads to such discoveries. Underlying discussions of these issues in the literature, is a general tendency to move away from the Popperian focus on the logic of discovery and justification, and towards a view of discovery as a problem-solving activity. According to Darden “Philosophers should move beyond talk of the (lack of) a logic of discovery and a logic of justification to study reasoning strategies for generation, evaluation, and revision in the discovery of mechanisms” (2009, p. 54).

Two dimensions are of importance to this project. First, there is the *epistemological dimension of the process of discovering mechanisms*. Here, Darden and others have developed a quite elaborate framework over the years, according to which this process can be

* Corresponding author.

E-mail addresses: Raoul.Gervais@UGent.be (R. Gervais), Erik.Weber@ugent.be (E. Weber).

partitioned into phases such as identifying the explanandum-phenomenon, the generation, the evaluation, and the revision of mechanistic hypotheses (Darden, 2009). Second, there are the *types of reasoning strategies and experiments* that are carried out during these stages of the investigation. Again, many different types of experiments and reasoning-patterns have been described—inter-level intervention experiments, as described by Craver (2007), constitute an important example. It would seem that in order to make progress, philosophers should concentrate on increasing this stock of strategies for discovery, and show how these strategies fit into the epistemological order (e.g. whether a strategy belongs primarily to the phase of revision, or is particularly useful when attempting to identify the explanandum-phenomenon). Regarding the question as to where we should look, Darden suggests the history of science as a particularly promising source (2002, p. S364).

In this article, we will follow this suggestion. Inter-level experiments as envisaged come with certain presuppositions regarding the knowledge of the mechanism we must have before we can execute them. However, these presuppositions are not always met. Sometimes, the mechanism is largely unknown, or

different mechanistic hypotheses might be competing. Instead of inter-level experiments, in these circumstances scientists perform a different kind of experiment. We call these experiments *orientation experiments*. In Section 3, we will spell out in detail the different structural features orientation experiments have. For now, let us confine ourselves to a rough characterization. Orientation experiments are a special type of intervention experiments used to provide evidence for or against a qualitative characterization of a mechanism. They do not go ‘in depth’, actively identifying entities and activities of the mechanism, but instead remain on the level of the explanandum and the environment. As such, they are epistemologically prior to inter-level experiments, which require more detailed knowledge.

We will argue that orientation experiments serve a number of purposes. In particular, they are important in the discovery of mechanisms, because they guide and constrain future, more detailed investigation into the mechanism, and exclude alternative mechanisms. As such, they can be used to settle the competition between rival hypothetical types of mechanisms. To give a very brief example (discussed in more detail below), if we wonder how ants are able to find the shortest way between their nests and a food source, an orientation experiment can tell us that the mechanism is chemical rather than visual. Though abstract, such a characterization is by no means trivial, since it has implications for future research.

We will argue that orientation experiments are typical of the early stages of investigation, when an explanandum-phenomenon has only recently been addressed. There is a stage in between the identification of the explanandum-phenomenon and the discovery of the mechanism, in which orientation experiments are devised and performed. We will call this the *orientation-phase*. To illustrate this, we will consider three case studies of different eras: the capacity of eels to produce numbing sensations (18th century), cadaverous poison as famously discovered by Semmelweis (19th century), and the capacity of pigeons to home (20th century). Besides illustrating the structural features of orientation experiments, the case study also help us to flesh out the different goals these experiments can serve—goals that set them apart from inter-level experiments.

In order to avoid misunderstanding of our project in this paper, it is important to emphasise that other authors have acknowledged the existence of different types of experiments in the discovery of mechanisms (e.g. Craver & Darden, 2013, chapter 8). Our contribution lies in the fact that we develop philosophical insights about the structure and epistemic role(s) of one of these types, the type that we call orientation experiments.

Let us conclude with an overview. In Section 2, we will first clarify some terminology and sketch the state of the art in the literature about the discovery of mechanisms, both with respect to the different phases of this research and the experimental strategies used during these phases. In particular, we will focus on Craver’s (2007) inter-level experiments. In Section 3, we will argue that these experimental techniques presuppose knowledge that is not always present, and that in fact, in between the identification of the explanandum-phenomenon and the constructing of detailed models of the mechanism, lies a phase which we dub the orientation phase, during which what we call orientation experiments are carried out. We spend the remainder of Section 3 characterizing the structural features of this type of experiment. In Sections 4 to 6 respectively, we illustrate the points developed in Section 3, and flesh out the different goals orientation experiments serve, by considering the case studies mentioned above. Finally, in Section 7 we describe how our ideas on orientation experiments fit into an overall view on (various types of) experiments and their role in the discovery of mechanisms.

2. The literature on mechanisms, their discovery, and inter-level experiments

2.1. Mechanisms, organization and explanation

A decade and a half have passed since Machamer, Darden and Craver’s seminal article (2000) sparking the debate about mechanistic explanations, so by now, most readers will be familiar with the most important concepts involved. Therefore, we shall not rehearse this debate in detail, but simply limit ourselves to giving some working definitions of the concepts involved. We adopt these definitions from Illari & Williamson (2012):

A mechanism for a phenomenon consists of entities and activities organized in such a way that they are responsible for the phenomenon (p. 123)

Illari and Williamson present this definition as an expression of the core consensus among philosophers in the mechanistic tradition. Many slightly different characterizations have been given in the last two decades.¹ Having compared these different characterizations, Illari & Williamson argue that the definition above is the best one. We think they have done a very good job, so we adopt their definition. In this definition, the term *entities* refers to “the bits and pieces of the mechanism” (p. 125), while the term *activities* refers to “what those bits and pieces do” (Illari & Williamson, 2012). About *organisation* they write:

Most generally, organization is whatever relations between the entities and activities discovered produce the phenomenon of interest [...] (Illari & Williamson, 2012, p. 128)

...

[I]n our understanding of organization as when activities and entities each do something and do something together to produce the phenomenon, *whatever* relations amongst the activities and entities produces the phenomenon is the relevant organization. (Illari & Williamson, 2012, p. 131)

Organisation then, is about the relations between the entities and activities.

Illari & Williamson characterise mechanistic explanations as follows:

All mechanistic explanations begin with (a) the identification of a phenomenon or some phenomena to be explained, (b) proceed by decomposition into entities and activities relevant to the phenomenon, and (c) give the organization of entities and activities by which they produce the phenomenon (Illari & Williamson, 2012, p. 123).

This is a dynamic characterisation, which tells us how mechanistic explanations are construed. Illari & Williamson do not give a (static) definition of the end product. The following definition is complementary to what they say:

A mechanistic explanation for a phenomenon is a description of the mechanism that produces this phenomenon.

¹ For instance: “A mechanism is a structure performing a function in virtue of its component parts, component operations, and their organization. The orchestrated functioning of the mechanism is responsible for one or more phenomena” (Bechtel & Abrahamsen, 2005, p. 423); and “[M]echanisms are entities and activities organized such that they exhibit the explanandum phenomenon” (Craver, 2007, p. 6, italics removed).

Download English Version:

<https://daneshyari.com/en/article/1160211>

Download Persian Version:

<https://daneshyari.com/article/1160211>

[Daneshyari.com](https://daneshyari.com)