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Phenomena, data and theories: a special issue of *Synthese*

Peter Machamer

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The papers collected here are the result of an INTERNATIONAL SYMPOSIUM: "Data · Phenomena · Theories: What's the notion of a scientific phenomenon good for?" held in Heidelberg in September 2008. The event was organized by the research group "Causality, Cognition, and the Constitution of Scientific Phenomena" in cooperation with Philosophy Department at the University of Heidelberg (Peter McLaughlin and Andreas Kemmerling) and the IWH Heidelberg. The symposium was supported by the "Emmy-Noether-Programm der Deutschen Forschungsgemeinschaft" and by "Stiftung Universitat Heidelebrg". The workshop was held in honor of Daniela Bailer-Jones, who died on 13 November 2006 at the age of 37 (cf. my 2007 "Daniela Bailer-Jones").[1] Bailer-Jones was an Emmy Noether fellow, and the symposium was arranged and run by those who were working in her research group at the time of her death: Monika Dullstein, Jochen Apel, and Pavel Radchencko. To them goes the credit for the conception, planning, and carrying out of the symposium.

1 A brief prolegomena to phenomena

In philosophy of science, the origin of much of the contemporary discussion about phenomena and data came with the publication of Bogen and Woodward (1988). There they made the important distinction between *phenomena* and *data*.

> Data, which play the role of evidence for the existence of phenomena for the most part can be straightforwardly observed. However, data typically cannot be

[1] Machamer (2007).

P. Machamer (✉)
Department of History and Philosophy of Science, University of Pittsburgh,
1017 Cathedral of Learning, Pittsburgh, PA 15260, USA
e-mail: pkmach@pitt.edu

> predicted or systematically explained by theory. By contrast, well developed scientific theories do predict and explain facts about phenomena, Phenomena are detected through the use of data, but in most cases are not observable in any interesting sense of the term (pp. 305–306).

Here Bogen and Woodward seem to assume that phenomena are constructed from data obtained by experiment. In more detail as Woodward wrote later:

> Phenomena are stable, repeatable effects or processes that are potential objects of prediction and systematic explanation by general theories and which can serve as evidence for such theories (Woodward 2000, p. S163).

Presumably, to be consistent with original, the phenomena spoken of are “repeatable effects or processes’ of experiments or other data producing activities. Data, by contrast, are what was produced by experiments, usually the result of measurements. Again, the later Woodward:

> Data are public records…produced by measurement and experiment that serve as evidence for the existence of phenomena or for their possession of certain features (Woodward 2000, p. S163).[2]

Despite the influence of their work, it is important to note that the Bogen and Woodward treatment of phenomena is non traditional, and somewhat limited. Traditionally, what we seek for a definition of “phenomena” is something more crude and open such as *phenomena are the “stuff” in the world that we may study*. I realize “stuff” is not exactly perspicacious. I mean something like the kinds of entities and activities that are in or of the world. These would include objects, properties, events, processes, artifacts, effects, and probably many other kinds. Classically, Duhem and others took phenomena to be observable happenings. For example, observed planetary positions, risings and settings of stars, or eclipse observations were the phenomena that needed to be saved. Theories (or models), instrumental or realistic, were then constructed that would ‘save the phenomena’. As G.E.L. Owen put it “the *phainomena* in question are empirical observations” (1967, p. 169).[3] Of course, Owen goes on to list other uses of “phenomena” in Aristotle, but none of them correspond to Bogen and Woodward’s use.

There is no consistent usage across the existing literature (in many fields) as to what “Phenomena” means. There are many uses in many fields, and many distinctions, many of which are quite unclear and unhelpful. The concept of data, by contrast, is surprisingly clearer, but still not exactly unproblematic.

Connecting phenomena with particular observations (*pace* Bogen and Woodward) could give rise to particular models or theories, e.g., about planetary orbits. But very often scientists were interested in general kinds of phenomena, e.g., falling bodies. This raises questions about how are we to classify, categorize, identify, or count kinds? This is a serious problem across many areas of science. It is not always clear what are the criteria for identifying something as one kind of thing. Is schizophrenia one disease or many? Does it have essential or prototypical characteristics or properties?

[2] Woodward (1989, 2000).

[3] Owen (1967).

Is hearing voices one such essential or necessary symptom? Or again, is Long Term Potentiation (LTP) of a neuron, one phenomenon or many? In all cases it seems agreed that it is the strengthening of a connection between two neurons that enhances their communication. But some LTP depends on NMDA receptor while another, even in the hippocampus, depends upon metabotropic glutamate receptor (mGluR).[4] Then there is the difference between E-LTP and late LTP. Yet somehow it is thought that they serve the same or quite similar functional roles in the nervous system, a role that allows memories to be formed and maintained. So maybe something like *the same functional role in a variety of systems* is sufficient to count as an identity condition. However, this would seem to depend on the use we are going to make of the phenomenon as identified.

When we are speaking of phenomena in the context of science, and more specifically experimental science, there are certain concerns that the concept is supposed to address. One of the most important I think is a concern about external or ecological validity. Does the experiment actually show us something important about what is going on in the real world that lies outside of the experimental setting? One form of this worry is gleaned by making a distinction between *phenomena* and *artifacts* (see Feest 2003, 2005, 2008).[5] This problem arises when operationalizing a phenomenon so it may be experimentally investigated in a laboratory or other non-natural setting. Basically, we want to make sure that when we create an experimental design, we are reasonably sure that we are 'catching' the aspects of the phenomenon that originally sparked our interest or which we were seeking to explain. We want our experiments to tell us something about the world, about the phenomena. When we design experiments we try to simplify situations so that we may control the relevant variables, which will then allow us to intervene and observe what happens as a result of the intervention. We design experiments to generate data, which then may be used to tell us something about how the world is or how it works. But often we know something about the phenomenon of interest before setting up the experiment.

Moreover, I am not sure these entities and activities have to be stable (whatever that means) or even naturally existing in the real world to count as Bogen and Woodward phenomena. Consider an experimentally constructed phenomenon inferred from the data, which seems to fit Bogen and Woodward's original definition: Element 115, named Ununpentium (Uup) in 2004, decayed after a fraction of a second.[6] What kind of stability is that? Maybe phenomena should be repeatable in principle, but there seem to be one-time events, like the *supernova of 1604*. *Supernovae* is a general class, but the one in 1604 was unique and important in singular ways. And surely history is

[4] See Malenka and Bear (2004).

[5] Feest (2003, 2005, 2008); Sullivan (2007).

[6] Each calcium nucleus contains 20 protons and americium 95. Since the number of protons determines where an element goes in the periodic table, simple addition shows the new element to bear the atomic number 115, which had never been seen before. Within a fraction of a second, the four atoms of Element 115 decayed radioactively to an element with 113 protons. That element had never been seen, either. The atoms of 113 lasted for as long as 1.2 s before decaying radioactively to known elements.

Scientists generally do not give permanent names to elements and write them into textbooks until the discoveries have been confirmed by another laboratory. By an international convention based on the numbers, element 113 will be given the temporary name Ununtrium. From *NY Times*, Feb 1, 2004.

filled with one-time events, *such as Caesar crossed the Rubicon in 49 BC and the die was cast*.

It is thoughtful to build into the definition of *phenomena* that they are potential objects of prediction or systematic explanation by general theories. But I am not convinced we have or can have general theory that may explain why Caesar thought to confront Pompey by crossing the river. In the other, evidential direction, I am not sure that the event of Jim's evincing psychotic behavior on the occasion of seeing a particular fireworks display, is ever going to serve as evidence, by itself, for any general theory of psychosis. But I think these cavils about what are included in the class of phenomena should only force us to re-cast the main problem. I am sure however that in many cases, part of the vindication of classifying things as being of a kind does depend upon the usefulness of that classification. Often part of the use of identifying or categorizing some thing is to warrant inferences about its to etiology or mechanisms of production. Classification also licenses predictions and expectations of what things of that kind are likely to do. Both types of inference, to etiology or production and to predictions of future behaviors or events, depend heavily on the goals or purposes that the categorization scheme is to serve. Some categorizations may be useful for some purposes, e.g. psychiatric treatment, even though they do not correspond well, or even at all, to other ways in which we think of the phenomena that constitute the world. Some engineering categories maybe like this.

The identity criteria for phenomena and the phenomena-artifact problem raises issues about how we may decide what the phenomena of the world really are. Individuation of phenomena, as noted, is not at all straightforward. Phenomena *per se* are not isolated entities, activities, things, or events. We treat them as individuals because of the interests we have in them. This is one major insight of the social constructivists and historical epistemologists. Ian Hacking's example of *rent* as a causally efficacious, social phenomenon is apt here.[7] Sometimes we countenance relational properties as part of the nature of an entity and sometimes not. The symmetry properties of a crystal are essential relational properties that determine many of its optical behaviors. In many cases, the legitimacy of classifications depends on the goals and functions the classifications are supposed to serve. Yet the problems do not stop here.

As we run our experiments or build our models of phenomena we often discover aspects that we had not foreseen, and so come to change our view of what and how the phenomena really are. When we model, experimentally in the lab or mathematically, a phenomenon already known (in some sense), as Daniela Bailer-Jones says, we often come to learn more about the phenomenon and clarify more precisely what the phenomenon is.[8] And sometimes we get it wrong. My favorite case here were the French astronomers who were doing gas chromatic analyses of stars, and encountered random sodium flashes on their screen. They tried very hard for along time to explain the origin and relation of the sodium presence to what other data they acquired about the stars. And it was not until some one noticed that the sodium flashes were correlated

[7] Hacking (2000).

[8] Bailer-Jones (2009).

with the lighting of the astronomers' cigarettes (probably *Gauloise*) that the sodium emission was subtracted from the gaseous identity of the star.

These considerations would naturally lead to further discussion of reliability, types of validity, and the concept of categorization. But in an introduction such as this there is no time to pursue these discussions.

References

Bailer-Jones, D. (2009). *Models in philosophy of science*. Pittsburgh: University of Pittsburgh Press.

Bogen, J., & Woodward, J. (1988). Saving the phenomena. *Philosophical Review, 97*, 303–352.

Feest, U. (2003). Operationism, experimentation and concept formation. PhD dissertation, Pittsburgh.

Feest, U. (2005). Operationism in psychology—what the debate is about, what the debate should be about. *Journal for the History of the Behavioral Sciences, XLI*(2), 131–150.

Feest, U. (2008). Exploring implicit memory: On the interrelation between operationalizations, concept formation, and experimental artifacts. http://www.mpiwg-berlin.mpg.de/GenExpKnowl/feest.html.

Hacking, I. (2000). *The social construction of what?* Cambridge, M.A.: Harvard University Press.

Machamer, P. (2007). Daniela Bailer-Jones. *International Studies in Philosophy of Science, 21*(2), 211–212.

Malenka, R., & Bear, M. (2004). LTP and LTD: An embarrassment of riches. *Neuron, 44*(1), 5–21. http://en.wikipedia.org/wiki/Long-term_potentiation.

Owen, G. E. L. (1967). Tithenai ta Phainomena. In J. M. E. Moravsik (Ed.), *Aristotle: A collection of critical essays, Doubleday anchor* (pp. 167–190).

Sullivan, J. A. (2007). Reliability and validity of experiment in the neurobiology of learning and memory. PhD dissertation, Pittsburgh.

Woodward, J. (1989). Data and phenomena. *Synthese, 79*, 393–472.

Woodward, J. (2000). Data, phenomena and reliability. *Philosophy of Science, 67*. Proceedings of the 1998 biennial meetings of the philosophy of science association, Part II, symposia papers, September 2000, pp. S163–S179.