Scientific Paradigm

Matteo De Benedetto*

Entry for the *The Palgrave Encyclopedia of Theoretical and Philosophical Psychology*

Abstract

A scientific paradigm is the set of theoretical and methodological assumptions shared by practitioners of a scientific discipline, including laws, models, concepts, experimental techniques, and the implicit know-how needed to apply them. Originating from Thomas Kuhn's *The Structure of Scientific Revolutions*, the notion of a scientific paradigm remains for many a fundamental unit for understanding scientific practice and change. While paradigms seems to effectively describe the structure of mature natural sciences like physics, their applicability to psychology and other human sciences remains contested.

Keywords: Paradigm, Kuhn, Scientific Change, Theory, Model, Experiment, Scientific Practice.

1 Introduction

A scientific paradigm is the set of theoretical and methodological assumptions shared by the practitioners of a given scientific discipline. It includes the fundamental components of the dominant theoretical and experimental framework of a discipline, such as its laws, models, theoretical concepts, as well as the relevant experimental practices and techniques.[1] Importantly, a scientific paradigm is usually assumed to include not just the actual laws, models, concepts, and experimental techniques that dominate a discipline, but also the implicit know-how necessary to properly employ and apply these laws, models, concepts, and techniques. As such, a given scientific paradigm is generally assumed to include also the conditions of application of the general laws of the discipline, together with exemplary solutions of concrete scientific problems, the acceptable idealizations and abstractions of the models employed, the operationalizations of the

*IMT School for Advanced Studies Lucca, Piazza San Francesco 19, Lucca, 55100, Italy, matteo.debenedetto@imtlucca.it, ORCID:0000-0002-8155-6750.

[1] As such, a scientific paradigm should not be confused with what is usually called in psychology the "experimental paradigm" employed in a certain study (or series of studies). An experimental paradigm, in the latter sense, is only a proper part of an actual scientific paradigm, which is a far (far) bigger unit of analysis that is supposed to encompass the totality of the scientific practice of a given discipline.

theoretical concepts, the evidential criteria and standards for assessing a certain theory or model, and all the experimental protocols and expertise needed to properly carry out the experimental work of the discipline.

2 Background and Context

A classic example of a scientific paradigm is Newtonian mechanics (cf. Kuhn 1962; Friedman 2001). The Newtonian paradigm encompassed not only Newton's three laws of motion and the law of universal gravitation, but also a comprehensive framework for understanding physical phenomena. The paradigm included specific definitions of core theoretical concepts, such as absolute space and time, mass, force, and inertia. It provided exemplary problem solutions, like the calculation of planetary orbits or projectile trajectories, which served as models for addressing new problems in new domains. The paradigm also specified acceptable idealizations (such as treating planets as point masses or ignoring air resistance), mathematical techniques (differential calculus), experimental procedures (e.g., pendulums-based measurements of gravitational acceleration), and certain methodological preferences (favoring mathematical precision and predictive accuracy overall). Practitioners of Newtonian mechanics learned not only its explicit theory and models but (crucially, again) also when and how to best apply them to different physical phenomena. Similarly, to mention another classical example of a scientific paradigm (cf. Kuhn 1962; Chang 2012), Lavoisier's oxygen paradigm in chemistry, not only provided a theoretical framework centered around the role of oxygen in combustion and the conservation of mass, but also a whole new set of experimental techniques for careful balancing chemical reactions and separating gas from other substances, as well as a new methodological attention to quantitative predictions in research practice.

The notion of a scientific paradigm as a fundamental theoretical unit for understanding science is most commonly associated with the work of Thomas S. Kuhn and his epoch-making book *The Structure of Scientific Revolutions* (Kuhn, 1962). In a nutshell, Kuhn's idea is that the practice of modern science is characterized by the fact that all the practitioners of a given science wholeheartedly accept a whole package of shared explicit and implicit scientific knowledge, i.e., a scientific paradigm. This means that the validity of the paradigm is never put into serious question in the everyday scientific practice of the relevant discipline. This passive, shared acceptance of a paradigm is what, according to Kuhn, distinguishes mature scientific disciplines from immature sciences, as well as from ancient scientific knowledge or from other intellectual endeavors like philosophy or literature. As such, Kuhn argued that the scientific paradigm is the fundamental theoretical unit for understanding the epistemic dynamics of modern science and, thus, the adequate unit of analysis for the history and the philosophy of science.

3 Debates and Challenges

In the decades after Kuhn's book, philosophers of science have critically discussed Kuhn's notion of a paradigm, revising some of its features and proposing alternative theoretical macro-units of scientific change.[2] Influential alternative units of scientific change are, for instance, research programs (Lakatos, 1978), research traditions (Laudan, 1978), scientific practices (Longino, 1990; Kitcher, 1995; Chang, 2011, 2014), repertoires (Ankeny and Leonelli, 2016).[3] Despite the philosophical differences between all these units of scientific change, they all share the core idea of a scientific paradigm that modern scientific knowledge is meaningfully understood only if we look at a shared set of assumptions bigger than the single theory, model, or experiment.

4 Possibilities

Like most ideas in twentieth-century philosophy of science, Kuhn developed his idea of a scientific paradigm thinking about natural sciences (physics, in particular) and their history. The extent to which the notion of a scientific paradigm (and the other macro-units of scientific change proposed by philosophers of science) can be properly applied to human and social sciences is a matter of contention in philosophical and scientific literature. In particular, in the case of psychology, if we look at contemporary psychological theories and their histories, it is not easy to find appropriate candidates for forming a scientific paradigm. Most psychological research seems in fact more organized around finding broad types of explanations for psychological phenomena and developing specific models of mental faculties. These models are often only locally valid and do not share many theoretical and methodological assumptions with other models of other mental faculties (and similarly for explanations). The extent to which contemporary and modern psychology can be described in terms of paradigm dynamics is the subject of the entry "Paradigm shift".

5 Cross References

Words in the text	Crossreference to
Kuhn	Kuhn, Thomas
Paradigm shift	Paradigm shift

[2] Interestingly for psychology-oriented readers, there have also been some tentative explications of Kuhn's notion of a paradigm with the tools of cognitive psychology. See, for instance, (Thagard, 1992; Andersen, Barker, and Chen, 2006).

[3] It should be noted that Kuhn (Kuhn, 1970, 1974, 1983, 1989, 1990) himself, after the publication of *Structure*, grew dissatisfied with the term 'paradigm', which he initially applied in a quite ambiguous manner to refer (quite indiscriminately) to: a scientific paradigm; the seminal scientific book from which a paradigm originated, and the specific exemplary solutions that a paradigm contains. To solve these ambiguities, Kuhn started to employ other names to refer to a paradigm-like macro-unit of change, such as 'disciplinary matrix' or 'lexicon'. For different exegetical takes on the nature, scope, and significance for Kuhn's thought of these changes, see (Hoyningen-Huene, 1993; Bird, 2000, 2002; Wray, 2021).

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