Paradigm shift

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Paradigm Shift

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Abstract

A paradigm shift is a radical instance of scientific change in which the dominant scientific paradigm of a discipline is replaced by a new one. This concept, central to Thomas Kuhn's account of scientific change, involves wholesale transformations in fundamental theories, concepts, methods, and standards governing a scientific discipline. Paradigm shifts are characterized by incommensurability, i.e., the inability to neutrally compare competing paradigms due to deep conceptual and methodological differences. While many examples of paradigm shifts can be found in the history of natural sciences, the applicability of this framework to psychology remains contested, as shifts like the so-called cognitive revolution arguably lack the kind of incommensurability characteristic of genuine paradigm change.

Keywords: Paradigm, Scientific Revolution, Kuhn, Cognitive Revolution, Behaviorism, Cognitive Science, Specialization.

1 Introduction

A paradigm shift is a radical instance of scientific change, in which the dominant scientific paradigm of a discipline gets replaced by a new one. The idea of paradigm shifts as fundamental types of change in the history of science is most commonly associated with Thomas S. Kuhn's book *The Structure of Scientific Revolutions* (Kuhn, 1962).

2 Background and Context

Kuhn introduces the idea of paradigm shifts in the context of his general account of how scientific disciplines evolve. According to Kuhn, the history of every scientific discipline can be fundamentally divided into two qualitatively different periods: an immature and a mature phase. In the immature period of

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a science, there are often many different schools or approaches that coexist at a given time. These different schools practice science in independent ways, sharing almost no fundamental theory, law, model, or methodology with each other. The immature phase of a scientific discipline ends, for Kuhn, when the first scientific paradigm of the discipline arises. That is, when a particularly successful and universally acclaimed scientific result creates a whole set of theoretical and methodological assumptions unquestionably shared, from that moment onward, by all practitioners of the scientific discipline.

The creation of the first scientific paradigm makes the discipline transition into its mature phase. In the mature phase of a science, normal scientific practice is centered around the articulation, modification, and extension of the dominant scientific paradigm. Scientists tackle known open problems and questions, apply the dominant theories and models to new domains, conduct confirmatory experiments, and engage in many other scientific activities, all within the context of the dominant scientific paradigm. The important point, for Kuhn, about this normal scientific practice of mature science is that the paradigm itself is never put into question. Questioning the dominant scientific paradigm is, in fact, an extraordinary event in the history of a scientific discipline, as it means putting into question the very fundamental laws, concepts, models, methods, and experimental practices that guide the whole discipline. It involves nothing less than a complete rethinking of the nature and scope of a given science. This is why paradigms shifts are deemed by Kuhn, in analogy with political revolutions, scientific revolutions. Scientific revolutions happen when the dominance of a given paradigm over a certain scientific discipline is broken by the rise of a new scientific paradigm. Just like political revolutions, in scientific revolutions, the emergence and consolidation of a new scientific paradigm is usually preceded by a period of crisis of the old paradigm and by a confused interregnum phase, where neither the old nor the new paradigm is completely dominant over a scientific discipline, but each has its own group of supporters.

Classical examples of paradigm shifts include the Copernican revolution in astronomy, the Einsteinian revolution in physics, the Chemical Revolution in chemistry, and the Darwinian revolution in biology (cf. Kuhn 1962; Thagard 1992). The Copernican Revolution transformed astronomy by replacing the Earth-centered Ptolemaic system with a Sun-centered model of the solar system. This shift involved not merely a rearrangement of celestial positions but a fundamental reconceptualization of Earth's place in the cosmos, the nature of planetary motion, and the standards for astronomical explanation. Similarly, the Chemical Revolution, led by Lavoisier in the late eighteenth century, overthrew the phlogiston theory of combustion and replaced it with an oxygen-based theory, introducing new concepts like chemical elements as fundamental substances and conservation of mass as a basic principle. This revolution also brought a whole new experimental methodology to chemistry, focusing its attention to precise quantitative measurements. The Darwinian revolution in biology replaced the view of species as fixed, divinely created types with the theory of evolution by natural selection, fundamentally changing how biologists understood the diversity of life, the relationship between organisms, and the nature of biological explanation itself.

An important feature of paradigm shifts is the so-called incommensurability between different paradigms. With this term, originally employed in measure theory to denote quantities that lack a common measure, Kuhn denotes the impossibility of comparing two different paradigms from a completely neutral standpoint. That is, since a scientific paradigm encompasses a whole way of doing science, different paradigms cannot be easily compared in the same way that two different simple empirical generalizations about a given domain of phenomena can be compared with each other. This is because each paradigm brings with it a whole set of concepts, standards, and criteria for articulating and evaluating scientific problems, questions, and answers. As such, the clash between paradigms is often a clash between incompatible ways of conducting science. In Kuhn's own terms, this clash between different ways of conducting science cannot be easily and neutrally assessed because paradigms are constitutive of the research activity carried out within them:

> "Through the theories they embody, paradigms prove to be constitutive of the research activity. They are also, however, constitutive of science in other respects, and that is now the point. In particular, our most recent examples show that paradigms provide scientists not only with a map but also with some of the directions essential for mapmaking. In learning a paradigm the scientist acquires theory, methods, and standards together, usually in an inextricable mixture. Therefore, when paradigms change, there are usually significant shifts in the criteria determining the legitimacy both of problems and of proposed solutions." (Kuhn, 1962, p. 114)

Philosophers of science have distinguished two complementary dimensions of incommensurability that different paradigms might exhibit: semantic and methodological incommensurability.

Semantic incommensurability is the dimension of incommensurability that sees this phenomenon as a linguistic one, denoting differences in meaning between parts of different scientific paradigms.[1] Different paradigms often employ radically different concepts and linguistic frameworks to understand phenomena. As such, paradigms not only specify how scientific questions can be answered but also what scientific questions can be meaningfully asked, to the point that it is often impossible to meaningfully translate a certain scientific question from one paradigm into the language of another.

The other dimension of Kuhn's multifaceted concept of incommensurability is methodological incommensurability. This second dimension sees incommensurability as a non-linguistic phenomenon that denotes radical differences in

[1] Semantic incommensurability is sometimes also called conceptual, linguistic, meaning, or taxonomic incommensurability. Some Kuhn scholars employ these terms to distinguish between different versions of the idea semantic incommensurability, belonging to different moments of Kuhn's thought (cf. Hoyningen-Huene 1993; Sankey 1994, 1997; Bird 2000; Hoyningen-Huene and Sankey 2001.). Here, I blur the (minor, in my opinion) distinctions between different versions of semantic incommensurability in order to focus instead on the core difference between the semantic dimension and the methodological dimension of incommensurability.

methods and standards between different scientific communities working within different paradigms. In his original discussion of incommensurability, Kuhn (1962) makes clear that changing a paradigm involves not only changes in language but also a radical change in scientific methodology. The standards and methods of the research practice of a scientific community crucially depend on the paradigm that the community has chosen. As such, scientific communities working under different paradigms might have different methodologies, which are often incommensurable with each other. The incommensurability between two different methodologies might lead two scientific communities to develop incommensurable standards for assessing the adequacy of a given scientific theory. That is, scientific communities working under different scientific paradigms might assess the goodness of a scientific hypothesis in radically different ways, thus precluding the possibility of a neutral ground for choosing among different theories (cf. Kuhn 1970, 1974, 1977, 1983, 1990).

Different scientific revolutions might involve different degrees of semantic and methodological incommensurability, but all the most famous historical examples of paradigm shifts arguably involved a significant degree of incommensurability in both these two dimensions. The Copernican Revolution, for instance, clearly exemplified both forms of incommensurability. Semantically, key terms like "planet" changed meaning: in the Ptolemaic system, the Sun and Moon were planets (understood as wandering celestial bodies), while Earth was not; in the Copernican system, the opposite was the case: Earth became a planet, while the Sun and Moon were not planets anymore. The very concept of "motion" was incommensurable, as what counted as "natural motion" for celestial bodies was fundamentally different in the two systems. Methodologically, the standards for evaluating astronomical theories shifted dramatically. The Ptolemaic paradigm mostly valued mathematical precision in predicting planetary positions and consistency with Aristotelian physics; the Copernican paradigm prioritized instead mathematical simplicity and physical plausibility, accepting initially less accurate predictions in exchange for a more unified and elegant system. The Chemical Revolution similarly displayed a combination of semantic and methodological incommensurability. Semantically, the concept of a "chemical element" was radically redefined: phlogiston theorists considered phlogiston itself an element and treated many compounds as elementary, while Lavoisier's oxygen theory established a new taxonomy of elements based on their inability to be decomposed. Key terms like "acid" and "combustion" acquired entirely new meanings tied to oxygen's pivotal role in the new system. Methodologically, the standards of chemical practice radically transformed: phlogiston chemistry tolerated qualitative accounts and vague descriptions of substance transformations, while Lavoisier's paradigm insisted on quantitative measurements, precise weighing, and mass balance as fundamental criteria for good scientific practice. Analogous considerations can be made for the Darwinian and the Einsteinian revolutions.

3 Debates and Challenges

Given the central role of incommensurability for identifying genuine paradigm shifts, it becomes crucial to examine whether alleged revolutions in psychology exhibit similar characteristics. The question of whether psychology has experienced genuine paradigm shifts remains contentious among philosophers and historians of science. The most frequently cited candidate for a revolutionary change in psychology is the so-called cognitive revolution, i.e., the shift from behaviorism to cognitivism that occurred roughly between the 1950s and 1970s. However, closer examination reveals that this transition may not possess the degree of incommensurability characteristic of genuine Kuhnian revolutions.

Here is a very brief historical recap of the cognitive revolution, following "revolutionary" histories of this change (cf. Gardner 1985; Baars 1986). Behaviorist psychology, dominant in American psychology from the 1920s through the 1950s, championed a way of doing psychological research that focused exclusively on observable behavior and rejected any reference to internal mental states as unscientific. Famous behaviorists like John B. Watson and B.F. Skinner emphasized stimulus-response relationships, conditioning, and reinforcement schedules, insisting that psychology should study only what could be directly observed and measured. This approach was grounded in a philosophical commitment to operationism, which demanded that scientific concepts ought to be defined purely in terms of observable operations. Behaviorists conducted extensive research on learning using animal subjects, developing sophisticated theories of classical and operant conditioning that could predict and control behavior without invoking mental processes (e.g., Skinner 1938, 1953). Cognitivism, which emerged in the 1950s and 1960s, challenged the behaviorist restriction to observable variables by treating mental processes as legitimate objects of scientific inquiry. Cognitivist psychologists started to study memory, attention, perception, and problem-solving by inferring internal mental representations and computational processes from behavioral data. The rise of this cognitive approach was heavily influenced by developments in computer science, information theory, and linguistics. Indeed, many protagonists of the cognitive revolution came from outside psychology (i.e., the protagonists of the revolution that Baars calls "nucleators"). For instance, a classical reference for the cognitivist rejection of the behaviorist dogmas is Noam Chomsky's (1959) famous critique of Skinner's account of language. Other key figures of the cognitivist camp were scientists like George Miller, Ulric Neisser, Allen Newell, and Herbert Simon, who first conceptualized the mind as an information-processing system analogous to a computer, i.e., in terms of inputs, outputs, and internal computational transformations (cf. Miller 1956; Neisser 1967; Newell and Simon 1972).

At first glance, this transition appears quite revolutionary: behaviorism and cognitivism seem to embody fundamentally different views about the proper subject matter and methods of psychology. Indeed, several histories of the cognitive revolution explicitly narrate this episode of scientific change as a Kuhnian paradigm shift (see Gardner 1985; Baars 1986). However, as several philosophers and historians of science have highlighted, the shift from behaviorism to cognitivism displays considerably less incommensurability than actual paradigm shifts in the natural sciences. Semantically, while cognitivism introduced much new theoretical vocabulary (e.g., schemas, information processing, mental representations, etc.), many core psychological concepts remained stable across the transition (see Thagard 1992; Greenwood 1999; Feest 2022). Terms like 'learning', 'memory', and 'perception' continued to refer to the same psychological phenomena, even if explained differently. Moreover, behaviorist notions were often reinterpreted rather than abandoned (see Mandler 2007; Watrin and Darwich 2012). Behaviorist reinforcement schedules, for instance, were incorporated into cognitive accounts of learning, rather than just discarded by the new wave of research. The pivotal behaviorist concept of "stimulus" remained central also to much cognitivist research, but was expanded to include internal representations. Even radical behaviorists' functional analyses of behavior found parallels in cognitive theories of goal-directed processing. The two paradigms shared enough conceptual common ground that meaningful debate and comparison were possible throughout the transition period, as evidenced by the substantive, prolonged debates between Skinner and cognitive critics in journals and conferences during the 1960s and 1970s (cf. Leahey 1992; Mandler 2002).

Several historians have also highlighted how the behaviorist and the cognitivist camps were far from being completely separated from each others, both conceptually and methodologically. Many supposedly revolutionary cognitive concepts had precursors in earlier psychological work, including within behaviorism itself. In this respect, for instance, Edward Tolman's work on cognitive maps and Clark Hull's specific use of intervening variables can be seen as proto-cognitive ideas that originated within the behaviorist camp (cf. Smith 1986; Leahey 1992; Greenwood 1999; Feest 2025). Moreover, the narrative of a sudden revolutionary break often obscures the gradual, piecemeal nature of the transition from behaviorist to cognitivist theories, in which different subfields of psychology adopted cognitive approaches at different rates and to different degrees (see Mandler 2007). Some areas, like learning theory, maintained strong behavioral traditions well into the 1980s, while others, like perception, had always retained mentalistic elements even during behaviorism's heyday. Indeed, one must also not forget that behaviorism was predominantly an American phenomenon and that, even in the 1930s and 40s, many important European psychologists like Piaget, Bartlett, Wertheimer, Kofka, Köhler, did not adhere to behaviorist dogmas (cf. Danziger 1990; Mandler 2007).

Methodologically, the continuity between behaviorist and cognitivist psychology is even more striking (cf. Greenwood 1999; O'Donohue et al. 2003; Watrin and Darwich 2012). Both approaches relied heavily on controlled laboratory experiments with similar experimental designs. The basic experimental logic that guided much of behaviorist research (i.e., manipulating independent variables and measuring behavioral dependent variables) remained fundamentally unchanged after the cognitive turn. Cognitive psychologists continued to use many experimental techniques developed by behaviorists, such as maze learning and operant conditioning chambers, which remained the bases of many experimental paradigms behind much cognitivist research. The standards for evaluating theories also showed substantial overlap: both behaviorists and cognitivists valued, above all, empirical testability and predictive accuracy. As Mandler (2002; 2007) emphasizes in his detailed historical account as both participant and observer of the cognitive revolution, the methodology of much cognitive psychology seems best described as an addition and expansion to, rather than a replacement of, behaviorist methods.

Furthermore, the transition between behaviorism and cognitivism was relatively smooth compared to paradigmatic cases of scientific revolutions in the natural sciences. Many researchers who began as behaviorists contributed to cognitive psychology, and the shift occurred through a gradual, slow change in dominance from one approach to the other, differently instantiated in nature and in time by the various subdisciplines of psychology, rather than through a dramatic, general crisis and revolutionary overthrow (see Greenwood 1999; Mandler 2002; O'Donohue et al. 2003).

For all these reasons, while the rise of cognitivist psychology involved a significant degree of conceptual and methodological innovation, as well as a considerable expansion of psychology's scope as a discipline, it arguably lacked the deep semantic and methodological incommensurability that define true paradigm shifts in Kuhn's sense. Indeed, as argued by several philosophers and historians (e.g., Smith 1986; Thagard 1992; Leahey 1992; O'Donohue et al. 2003), both behaviorism and cognitivism seem to lack the necessary generality, compactness, and dominance to be called scientific paradigms, and appear instead better characterized as different methodological approaches. The arguably non-paradigmatic character of behaviorist psychology is also one of the main reason against the revolutionary character of another popular candidate for a scientific revolution in psychology, i.e., the rise of behaviorism in the US and the related overthrown of introspectionist psychology. As highlighted by several historical and philosophical analyses of this episode (see Danziger, 1990; Leahey, 1992; Thagard, 1992; Mandler, 2007), the rise of behaviorism does not appear a solid candidate for being considered a paradigm shift, since both introspectionist and behaviorist psychology exhibited a very significant degree of variety in their theories and methods, and the alleged radical shift determined by the rise of behaviorism does not appear very radical (in both the conceptual and methodological dimension) nor very absolute on a closer historical look.[2]

[2] For similar reasons, even less likely candidates for constituting a paradigm shift are more recent alleged revisions of the traditional cognitivist approach to psychology, such as connectionism or the so-called 4E cognition. Although supporters of these views often refer to their approaches as instantiating a new paradigm of human cognition, the term appears to be used in a very loose sense, as simply referring to some change in the background assumptions of a psychological model or theory, performing mostly a rhetorical function in the scientific and philosophical debate (cf. Thagard 1992; O'Donohue et al. 2003).

4 Possibilities

The present analysis of whether and how the history of psychology exhibits scientific revolutions quickly connects to broader debates about psychology's status as a mature science. Contemporary psychology seems, in fact, not fully structured into a unified scientific paradigm, but rather organized as a patchwork of different, localized models and approaches. This realization has led scholars to two opposite conclusions. Some philosophers and psychologists take this non-paradigmatic character of contemporary psychology (and of its history) as evidence for the immaturity of psychological science (e.g., Thagard 1992; Staats 1999). Their idea is that psychology has simply not yet reached the maturity stage where scientific knowledge is organized into a proper paradigm and may be stuck at what Kuhn called the "school" phase of a science, where different small communities practice different ways of doing science without agreeing with each other on a shared theoretical and methodological framework. This conclusion echoes the many critical assessments of the lack of general explanatory theories in psychology, that periodically (re-)emerge within methodological debates (cf. Meehl 1978; Open Science Collaboration 2015; Eronen and Bringmann 2021).

In contrast, other philosophers take the non-paradigmatic character of much of contemporary psychology, and other human and social sciences, not as evidence for the immaturity of these sciences, but rather as evidence against the ideal that every mature science must be organized around a dominant scientific paradigm. Indeed, starting from the 1980s, a growing number of philosophers has questioned the applicability of Kuhnian paradigms (and similar macro-units of scientific change) to the social and human sciences, developing alternative philosophical frameworks for understanding this kind of scientific activity (e.g., Hacking 1983; Cartwright 1999; Chang 2004; Ankeny and Leonelli 2016).[3] A core idea of many of these alternative frameworks is that the research activity of human sciences like psychology or medicine is not so much organized around the development and articulation of a general abstract theory ranging over a whole domain of phenomena, but it rather centers around the creation, manipulation, and understanding of specific experimental effects (cf., Hacking 1983; Franklin 1986; Galison 1987). According to this wave of philosophical studies, we should therefore not expect to find the kind of theoretical unity we find in modern physics in sciences like psychology or medicine, either in the present or in the future, simply because the goals, scopes, and methods of these sciences are radically different from those of the natural sciences. These considerations suggest that Kuhn's model of paradigm replacement through revolutionary crisis may not adequately capture the dynamics of scientific change in psychology and that other, less theory-oriented, models of conceptual and scientific change might be more appropriate to describe the dynamics of such a science. As usual

[3]It should be noted that Kuhn (1990; 1993) himself, in his last writings, proposed (mostly through evolutionary analogies) other notions of scientific change, such as for instance his notion of scientific specialization (cf. Wray, 2011; De Benedetto and Luchetti, 2023), that might be more suitable than paradigm shifts for describing certain instances of scientific change in the human and social sciences.

in philosophy, the debate is far from being settled one way or the other.

5 Cross References

Words in the text	**Crossreference to**
Kuhn	Kuhn, Thomas
Scientific paradigm	Scientific Paradigm
Darwinian	Darwin, Charles
Behaviorism	Behaviourism
Cognitivism	Cognitive Psychology
Skinner	Skinner, Burrhus
Watson	Watson, John Broadus
Newell	Newell, Allen

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