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UNDERSTANDING THOMAS KUHN'S CONCEPTS AND IDEAS ON THE STRUCTURE OF SCIENTIFIC REVOLUTIONS

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Abstract: Throughout the course of human history, countless events have unfolded across distinct stages and temporal contexts, each leaving a discernible imprint on the trajectory of civilization's development. The emergence of science marked a profound transformation in modes of thought, wherein rationality became the principal foundation of reasoning. As Aristotle notes, Thales, Anaximander, and Anaximenes - Ionian philosophers of the sixth century BCE - were the first to inquire systematically into natural phenomena. These early stages of inquiry represent the formative phases of scientific investigation, during which science evolved through the formulation of increasingly sophisticated methods aimed at uncovering truth - if such a notion can be said to exist - or, more precisely, at establishing irrefutable facts. In his landmark work, The Structure of Scientific Revolutions (1962), Kuhn introduced a transformative framework for the philosophy of science. His shift from physics to the historical study of science was motivated by an interest in the quotidian practices of scientists and the mechanisms through which scientific knowledge evolves over time. The Structure of Scientific Revolutions was recognized by the Times Literary Supplement as one of the twenty most influential books published in the latter half of the twentieth century. The work generated widespread debate, as its central ideas resonated across disciplines - engaging natural and social scientists alike, as well as scholars within the humanities.

Keywords: *scientific revolution, paradigm shifts, knowledge, development.*
Field: Social Sciences

1. INTRODUCTION

Thomas Kuhn began his academic career as a physicist before transitioning to the history and philosophy of science. According to Kuhn (1962), scientific development occurs in two alternating phases: normal science and extraordinary or revolutionary science. Traditionally, scientific progress has been viewed as a continuous, cumulative process, advancing steadily from one stage to the next. Kuhn, however, challenged this linear perspective, arguing that scientific development cannot be understood solely as a progressive accumulation of knowledge. Instead, it fundamentally depends on shifts in scientific paradigms and generational differences in scientific understanding. Kuhn introduced key concepts that reshaped the philosophy of science, including: pre-science, normal science, paradigm shifts and scientific revolutions. These concepts not only enriched the discourse on science but also provided a framework for understanding how scientific knowledge evolves over time (Bird, 2017). On his article Normal science: not uncritical or dogmatic, Samuel Schindler explains normal science in a nutshell based on Thomas Kuhn's conceptions. Thus, Schindler explains the division of science into two periods, those being: normal and revolutionary. He writes: 'Periods of normal science are characterized by the scientific community adhering to a paradigm, which encompasses a governing theory (such as Newtonian mechanics) metaphysical views (such as action-at-a-distance), certain types of experimental practices, instruments, skills and 'exemplars', i.e., examples of good scientific practice. In scientific revolutions, paradigms are replaced by new, radically different, paradigms.' (Schindler, 2024).

2. MATERIALS AND METHOD

This paper adopts a conceptual and historical-analytical approach, grounded in Kuhn's (1962) theory of scientific paradigms and interpreted through Bird (2017). It examines the evolution of scientific disciplines by analyzing the phases of pre-science, normal science, crisis, and scientific revolution, emphasizing how paradigms shape legitimate problems, methods, and theoretical development. The study further applies this framework to the social sciences, particularly sociology, to explore the emergence, competition, and transformation of disciplinary paradigms.

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3. RESULTS

3.1. Unpacking Scientific Progress: Kuhn's Vision of How Knowledge Evolves

Bird (2017) distinguishes between the philosophy of science before and after Kuhn. Pre-Kuhnian thought, termed old rationalism, focused on how scientists should infer conclusions from evidence and choose between competing hypotheses. In contrast, the new paradigm represents Kuhn's revolutionary perspective, emphasizing the historical and sociological dimensions of scientific practice. Old rationalists generally assumed a cumulative, linear model of scientific progress, wherein knowledge builds incrementally and uniformly. Kuhn (1962) rejected this notion, arguing that scientific development proceeds through distinct phases influenced by scientific paradigms, disciplinary conventions, and generational factors. 'Until Kuhn emerged with The Structure of Scientific Revolutions, science scholars impression that the history of science was linear, i.e. not circular. Then, he came up with a work in which he claimed that the development of scientific discovery is cyclical (circular by revolutions that indicate significant changes in the comprehension of science.' (Ochichi, 2023)

Before a scientific discipline establishes a coherent paradigm, it exists in a state of pre-science. In this phase, scientific methods, theories, and standards are largely unstructured. Pre-science does not indicate the absence of knowledge but rather a lack of a unified framework, leaving room for methodological experimentation and theoretical development (Kuhn, 1962). Whereas, once a paradigm is established, science enters a phase Kuhn calls normal science. In this phase, scientific activity is guided by the paradigm, which defines legitimate problems and acceptable methods of inquiry. Kuhn (1962) describes this process as "puzzle-solving," where scientists work to refine and extend the paradigm. Normal science can be categorized into three primary activities: identification of significant facts, matching facts to theoretical expectations and articulation and refinement of theories. However, anomalies may emerge -phenomena that the current paradigm cannot explain. When such anomalies persist and the paradigm proves inadequate, science enters a crisis, which can ultimately lead to a scientific revolution (Kuhn, 1962).

A scientific crisis signals the inability of an existing paradigm to resolve recurring problems. In such cases, a new paradigm emerges to replace the old one, a process Kuhn (1962) identifies as a scientific revolution. Unlike political revolutions, Kuhn's concept is intellectual and methodological. It represents a fundamental transformation in how science is practiced and understood. Importantly, Kuhn argued that abandoning an old paradigm is not a purely rational process; rather, it occurs through the demonstration of successful practice within the new paradigm and the gradual conversion of the scientific community (Kuhn, 1962).

Alexander Krauss on his article Debuking revolutionary paradigm shifts: evidence of cumulative scientific progress across science, writes about dominant approaches of science evolution. Krauss notes that Thomas Kuhn offered the most influential model where by applying case studies, theories in a scientitfic field may go through fundamental changes over time (Krauss, 2024). Anna Martin-Michalska highlights the narratives that blame Kuhn for shattering the vision of science by his revolutionary mode: 'According to his historical findings, scientific theories do not tend to simply crumble under the weight of counterevidence. For it is only a provision of an alternative conceptualization that can cause a theory to be dropped.' (Michalska, 2023)

Kuhn's ideas extended beyond natural sciences, profoundly influencing sociology and other social sciences. Sociologists, concerned with the disciplinary status of sociology, embraced Kuhn's paradigm concept. Ritzer (2000), applying Kuhn's framework, argued that sociology operates as a science of paradigms, identifying three major competing frameworks:

1. **Social Facts Paradigm** – emphasizes abstract theories, such as functionalism and conflict theory, employing empirical and statistical methods.
2. **Social Action Paradigm** – focuses on social phenomena through observation, rejecting abstract theorizing; examples include symbolic interactionism and phenomenological sociology.
3. **Social Behavior Paradigm** – combines abstract theory with behavioral and exchange theories, often using experimental methods aimed at social improvement.

Kuhn's philosophy also contributed to the sociology of science by incorporating external social factors into the understanding of scientific practice, contrasting with Merton's focus on internal scientific norms (Baber, 2017). Kuhn's work established a foundation for a sociology of science that integrates epistemic justification with social context, demonstrating how scientific knowledge becomes accepted within a community.

4. DISCUSSIONS

4.1. Debating Kuhn's Theory of Scientific Change

Despite its influence, Kuhn's framework has faced considerable criticism regarding its account of scientific progress. Scholars have highlighted historical revisionism, pointing to selective interpretations of past scientific events (Hekint, 2017), as well as the influence of non-scientific biases, where sociological or cultural factors shape what counts as "normal science" (Hekint, 2017). Critics also note exceptions to paradigm-based progress, citing cases of advancement that cannot be explained solely by paradigm shifts (Hekint, 2017).

Conceptually, Kuhn's notions of paradigms and revolutions have been challenged for their ambiguity and inconsistent application, while historical evidence suggests that smaller paradigms can supplant larger ones, blurring the distinction between normal and revolutionary science (Hekint, 2017). His stance on theory choice has also been critiqued for undermining rational decision-making, contrasting with modern expectations of reasoned inference (Hekint, 2017). Furthermore, Kuhn's sociological thesis, grounded in an idealist perspective, implies that thought shapes reality, a position at odds with the scientific aim of describing an observer-independent world (Hekint, 2017).

Galina Weinstein on her article Einstein, Evolution of Knowledge, and the Anthropocine: A critical reading of Jurgen Renn's Historigraphy, writes on the furthermore crutiques like those of Renn's concerning Thomas Kuhn's core concepts. She writes: 'Renn problematizes its core assumptions. He challenges Kuhn's conception of scientific revolutions as abrupt, Gestalkt-like transformations and instead frames conceptual change as a gradual, structurally embedded process. In this light, revolutions are extended reconfigurations rather than dramatic breaks.' (Weinstein, 2025). According to Schindler, Popper and Watkins also criticized Kuhn's work on Scientific Revolution being dogmatic and a danger to the science itself. 'Popper denied that this kind of work was in any way 'normal' in science and that if it were it would be a 'danger to science and, indeedm to our civilization. Watkins - who alongside Popper in the same volume criticized Kuhn's concept of normal science - also picks up on the dogmatism theme and concludes that 'Kuhn sees the scientific community on the analogy of a religios community and sees science as the scientist's religion.' (Schindler, 2024)

The process of paradigm shifts presents additional difficulties: establishing a new paradigm demands extensive empirical validation, and the entrenched dominance of existing paradigms often obstructs the adoption of new frameworks (Hekint, 2017). These critiques underscore the ongoing debates surrounding Kuhn's theory, highlighting both its enduring impact and its limitations in explaining the complexities of scientific progress.

As Craig A. Layman and Andrew L. Rypel write on their paper Beyond Khunian paradigms: Normal science and the theory dependence in ecology: 'Kuhnian normal science is neither intended nor expected to produce novel discoveries or significant alternations to an existing paradigm. Scientists are expected to expand and contextualize existing scientific theories, not disprove them. Anomalous findings may discredit the scientist, not the accepted theory. Kuhn likened normal science to puzzle-solving-successful scientists are those who are successful puzzle solvers. It is known a priori that puzzles have solutions, so scientists are not bound by the fear they may be working on an impossible problem.' (Layman, Rypel, 2023)

In synthesizing these diverse interpretations and critiques of Kuhn's framework, it becomes evident that the historiography of science remains a contested terrain shaped by competing epistemological commitments. Scholars such as Renn and Weinstein encourage a reconceptualization of Kuhn's abrupt "revolutions" into a more evolutionary, cumulative model of conceptual change, one that accounts for the structural and cognitive continuities underlying scientific progress. This shift from rupture to reconfiguration does not merely reinterpret Kuhn's legacy; it reflects broader transformations in how contemporary historians and philosophers of science understand knowledge production within complex socio-material systems.

At the same time, critics like Popper and Watkins remind us that the dialogic tension between normal and revolutionary science cannot be dismissed as a mere semantic dispute. Their concerns about dogmatism, conformity, and the quasi-religious aspects of scientific paradigms point to enduring questions about the autonomy of reason and the dynamics of consensus in scientific communities. Krauss's and Michalska's analyses reinforce this point by illustrating that, even when revolutions occur, they do so against a backdrop of cumulative refinement and sustained problem-solving - suggesting that radical change and incremental progress may not be as mutually exclusive as Kuhn's original formulation implied.

5. CONCLUSIONS

Kuhn's inquiry into the structure of scientific revolutions reflects philosophical questioning similar to that of traditional philosophers, yet applied to the scientific corpus. In The Structure of Scientific Revolutions (1962), Kuhn emphasizes the fallibility and revisability of scientific knowledge, rejecting the notion of immutable truths. He advocates for the reassessment, reconstruction, and reevaluation of theories, paradigms, and research methods, acknowledging that their efficacy may vary according to historical and temporal contexts.

Kuhn promotes the development of entirely new theories and the replacement of existing paradigms, contributing to science in a revolutionary sense. By challenging rigid frameworks and supporting methodological innovation, Kuhn demonstrates that scientific progress is not strictly linear and allows for the creation of entirely new conceptual structures (Kuhn, 1962). His perspective also fosters a more liberal approach to social sciences, including sociology and psychoanalysis, by highlighting the influence of external factors on scientific practice (Bird, 2017; Ritzer, 2000). Kuhn's framework thus provides a conceptual lens for interpreting scientific achievements, positioning much of the history and philosophy of science as "normal science" within a new paradigm.

Ultimately, the evolution of the debate surrounding Kuhn's Structure reveals less about the obsolescence of his ideas than about their generative capacity to inspire reinterpretation. The enduring scholarly engagement - from Renn's structural embeddedness to Schindler's reappraisal of normal science - demonstrates the vitality of Kuhn's conceptual vocabulary in framing how we think about knowledge, progress, and transformation. As science itself continues to evolve in response to global challenges, so too must our historiographical models evolve - moving beyond rigid dichotomies of revolution and normality toward a more integrated understanding of the dynamics that drive scientific change.

In light of recent scholarship, the narrative of scientific development as purely revolutionary warrants reconsideration. As Krauss (2024) argues, empirical evidence across disciplines increasingly points to cumulative progress rather than radical paradigm shifts. Yet, dismissing Kuhn's model entirely would overlook its enduring theoretical power. As Martin-Michalska (2023) notes, Kuhn revealed that scientific theories do not collapse merely under counterevidence but through the emergence of superior conceptual alternatives. This insight remains vital for understanding the social and epistemic mechanisms of scientific change. Thus, rather than positioning cumulative and revolutionary models as oppositional, it may be more productive to view them as complementary dimensions of how science evolves - through gradual refinement punctuated by moments of conceptual transformation.

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