THE ROLE OF OBSERVATION IN THEORY FORMATION IN SCIENCE

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Abstract
From the last quarter of the twentieth century into the twenty-first century, scientists and philosophers of science have debated the role of observation in theory formation. Specifically, the debate is between two dominant and competing traditions: inductivism and falsificationism. On the one hand, the inductivists argue that observation constitutes the starting point of science and that general laws are derived from repeated empirical observation through inductive reasoning. On the other hand, the falsificationists, associated with Karl Popper, reject inductivism arguing that scientific observations are theory-laden and that general laws are tested deductively with the aim of refuting them. Using library research and logical analysis, this study revisits the inductivist-falsificatinist debate on the role of observation in theory formation. The study found that both positions, though influential represent incomplete accounts of scientific practice. The inductivists' position is undermined by the problem of induction, the theory-laden nature of observation, and the logical impossibility of deriving universal laws from particular instances. Falsificationists' position, though methodologically rigorous, fails to reflect the actual practice of science, where theories are rarely abandoned in the face of anomalies but often protected by ad hoc hypotheses. Based on this, the study argues that observation does not act as a neutral foundation for theory formation but operates within conceptual and theoretical frameworks that shapes its meaning and interpretation. The study concludes that scientific progress is better explained as a dynamic and interactive process involving the interaction of observation, theoretical imagination, hypothesis construction, and critical testing. Therefore, neither pure inductivism nor strict falsificationism adequately explains scientific theory formation. Instead scientific knowledge emerges from the continuous interplay between empirical evidence and theoretical creativity, underscoring the indispensable but non-autonomous role of observation in scientific inquiry.

Keywords: Observation; theory formation; Inductivism; Falsificationism, Scientific Method; Philosophy of Science

Introduction

The astonishing progress made by science from the seventeenth century onward, led many scholars to assume that science possesses a special method (the scientific method) responsible for its stupendous success. According to Newton Smith, (1981), traditional accounts of science portrayed it as a paradigm of rationality grounded in the application of a special method through which reliable knowledge about the world is generated. Within this framework, observation was understood as the foundation of scientific inquiry and the primary source of rationality and progress. Consequently, for over two hundred years, observation occupied a central position and remained the unquestioned foundation upon which scientific knowledge and progress were believed to rest.

This dominant position accorded to observation in traditional accounts of the scientific method is closely related to some of the most fundamental questions in the philosophy of science, including theory formation, theory testing, theory choice, and scientific progress. At issue is whether observation alone can explain why scientists come to formulate theories, accept one theory rather than another and how scientific knowledge advances over time. In this context, classical empiricists and inductivists viewed observation as the ultimate source of scientific knowledge. The origin of this tradition is commonly traced to Francis Bacon, who argued in *Novum Organum* that scientific knowledge should be derived from systematic observation and experimentation rather than speculative reasoning (Bacon, 2000). For the inductivists, scientific laws emerge through a process of induction whereby repeated observation of particular instances lead to the formulation of general principles. In this regard, observation is not merely a component of science but its very foundation. As Bacon (2000, 15) maintains: human understanding has two ways of proceeding. One flies from the senses and particulars to the most axioms… The other derives axioms from the senses and particulars, rising by a gradual and unspoken ascent, so that it arrives at the most general axioms last of all. This is the true way, but as yet untried.

However, this inductivist understanding of scientific method later came under severe attack particularly from David Hume and Karl Popper. Hume (2007) questioned the logical justification of induction, arguing that no finite number of observations can conclusively establish the truth of a universal statement. According to him, the inference from particular observation to general laws lacks a rational foundation because there is no logical necessity that the future will resemble the past. This challenge, commonly known as the problem of induction or Hume's problem, cast serious doubt on the claim that scientific theories can be logically derived from observational evidence, and by extension called into question the traditional empiricist conception of scientific rationality

Popper developed this criticism further and proposed a falsificationist account of scientific rationality. Rejecting induction as the foundation of science, Popper argues that scientific theories originate as bold conjectures rather than as logical products of observation. According to Popper (2002), science does not make progress through the accumulation of observational data but through the formulation of hypotheses that are subjected to rigorous attempts at refutation. Observation, he insists, does not verify theories, rather it serves as a critical instrument for testing and potentially refuting them. In the Popperian account therefore, scientific progress occurs through a process of conjectures and refutations rather than through the accumulation of confirming observations.
The challenge to induction posed by Philosophers such as Hume and Popper and the spirited effort by the logical positivists of the Vienna Circle to defend it gave rise to one of the most influential debates in the philosophy of science: the controversy between inductivism and falsificationism. The significance of this debate lies in its concern with the role of observation in the formation and justification of scientific theories. Whereas inductivists regard observation as the foundation of scientific knowledge, falsificationists emphasize the creative formulation of hypotheses and their subsequent critical testing. The controversy has further stimulated important discussions about the objectivity of observation, the nature of scientific reasoning, and the actual practices of scientists (Chalmers, 2013).

From the foregoing, this paper critically interrogates the inductivist and falsificationist models of the role of observation in theory formation and within that context seeks to illuminate the actual practice of scientists and process of scientific discovery. While arguing that observation is indispensable to scientific discovery, it maintains that observation alone cannot account for the formation of scientific theories. Rather, scientific theories emerge through a dynamic interaction between observation, imaginative hypothesis formation, conceptual analysis, and critical testing. Accordingly, neither the inductivist nor the falsificationist account provides a complete explanation of scientific process; each captures an important aspect of the complex relationship between observation and theory formation.

The Inductivists Conception of Observation
The inductivist conception of observation is the earliest and most influential account of the method of science. At the core is the belief that scientific knowledge originates from observation and progresses through the process of induction. In this context, induction refers to a form of reasoning in which general conclusions are inferred from observations. Induction refers to a form of reasoning in which general conclusions are derived from observations. Through repeated observation of similar events or phenomena, scientists. For example, after repeatedly observing that different types of metals conduct electricity, a scientist may infer the general principle that all metals conduct electricity. This inductive inference proceeds from the particular to the general and seeks to establish a scientific based on empirical evidence

The inductivist tradition emerged as a reaction against speculative and purely deductive approaches to knowledge that characterized much of medieval Philosophy. Its early advocates argued that reliable approach to knowledge should be grounded in experience rather than what they regarded as medieval overreliance on abstract deductive reasoning. For the inductivists therefore observation constitutes the starting point of the scientific method. The scientific enterprise begins with the careful and systematic collection of observational data. Once a sufficient body of facts has been accumulated, scientists identify recurring patterns and regularities from which broader laws and theories can be inferred. Observation is therefore regarded as both the source and justification of scientific knowledge. According to Chalmers (2013), this position is often summarized in the slogan that science moves "from facts to theories." In order words, scientific theories are not viewed as imaginative creations imposed upon nature but as conclusions logically derived from observation.
The philosophical foundations of inductivism is usually traced to the work of Francis Bacon, who is widely regarded as the founder of modern empirical science. Bacon's approach encouraged scientists to free themselves from what he described as the "idols" of the mind (various prejudices and assumptions that distort objective observation). He criticized the tendency of scholars to rely on preconceived ideas and abstract speculation. Instead, he advocated a method based on careful observation and experimentation. In Novum Organum, Bacon argued that genuine scientific knowledge must be built gradually from experience through the systematic accumulation of facts. As Bacon (2000, 36) observed, "The true method of discovery derives axioms from the senses and particulars, rising by a gradual and unspoken ascent." Bacon believes that through disciplined observation and experimentation, humanity could acquire reliable knowledge of nature and improve human condition

Bacon's emphasis on empirical investigation, particular the role of observation in scientific discovery influenced subsequent developments in scientific methodology. Later empiricists and philosophers of science such as John Locke, George Berkley, David Hume and logical atomists and logical Positivists particularly the members of the Vienna Circle, all emphasized the foundational role of experience in the acquisition of knowledge. The inductivist position is succinctly captured by Rudolf Carnap (2013, 24), a leading member of the Vienna Circle, who describes science as follows: Science is a system of statement based on direct experience, and controlled by experimental verification. Verification in science is not, however, of a single statement but of the entire system or sub-system of such statement

Carnap's assertion reflects the central assumption of inductivism: that observation provides a neutral and objective foundation for scientific knowledge. Defenders of inductivism have identified several advantages of the inductive approach that makes it to stand out as both the method and logic of scientific discovery. The most important of these include its emphasis on observation as the foundation of scientific methodology, its encouragement to systematic observation and experimentation, and its commitment to objectivity through reliance on publicly observable facts (Chalmers, 2013; Okasha, 2002).

As seen in the introductory section, despite its considerable influence and enduring contribution to scientific practice, inductivism has been subjected to sustained philosophical attacks. These concerns, which will be discussed under evaluation, became particularly significant in the twentieth century and stimulated the development of alternative account of scientific methodology. Amongthe most influential was Poppers's Falsificationism, which challenged the inductivist conception of scientific reasoning. To Popper's falsificationism the paper now turns to.

The Falsificationist View of Observation

As already seen, the shortcomings of inductivism, especially the problem of induction identified and powerfully formulated by Hume, inspired some philosophers to seek alternative account of scientific methodology. Among the most influential responses was Popper's principle of falsificationism. Rejecting inductivism's claim that scientific theories are derived from observation, Popper contends that science makes progress through conjectures and refutations. Hence, in the Popperian framework, observation no longer serves as the starting point of scientific knowledge but rather as a critical instrument for evaluating and potentially refuting scientific theories.

Popper's Critique of Induction

The fundamental problem of induction as famously formulated by Hume was that induction lacks logical justification. While accepting Humean position, Popper extended his insight into a broader rejection of inductivism as a method of science. Hume had earlier argued that the foundation of science is defective because induction is empirically unjustifiable. Popper pushed this further by arguing that scientists never use induction. His case against induction is that scientific statements are universal in scope, while observational evidence is necessarily limited. In order words, no amount of observational evidence can ever conclusively establish the truth of a universal scientific law. It is therefore logically impossible to infer universal laws with certainty from observations.

From this perspective, Popper rejects the traditional inductivist claim that science proceeds from observation to theory. According to him, scientific inquiry does not begin with passive accumulation of facts but with problems that require explanation. Scientists approach nature with tentative hypotheses, expectations, and theoretical ideas, rather than neutral observation. Observation is therefore never independent of conceptual framework but is always directed by theoretical concerns. For Popper (2002, 59): the belief that science proceeds from observation to theory is still so widely and firmly held that my denial of it is often met with incredulity. Yet there is no such thing as pure observation, free from theoretical explanations.

There are at least two key implications to this Popperian claim. The first is the asymmetry between inductivist confirmation and Popperian refutation. While no number of confirming observations can conclusively verify a universal theory, a single counter-instance is sufficient to refute it. For Popper, this asymmetry undermine the inductivist assumption that scientific knowledge grows through the accumulation of positive instances. The second, and more important for this study is that observation does not function as a means of generating or verifying theories. Rather, it serves as a critical tool for testing them. Scientific progress, therefore, depends not on the accumulation of confirming evidence but on the rigorous elimination of error through attempts at refutation.

Conjectures and Refutations

In place of inductivism, Popper proposed a model of scientific methodology, which he famously called "conjectures and refutations." According to this approach, scientific theories originate as imaginative conjectures or hypotheses formulated by scientists in response to specific problems. Theses conjectures according to Popper are not derived mechanically from observation; they involve creativity, intuition and intellectual innovation.

Once a theory has been proposed, it is subjected to rigorous empirical testing. If the theory survives repeated attempts at refutation, it may be provisionally accepted. However, it is never regarded as conclusively verified because future evidence may still reveal its inadequacies or cause it to "come to grief" in Poperian terms (Popper, 1963, 374-375). This is how Popper (1963, 313) summarizes the process: The way in which knowledge progresses, and especially our scientific knowledge, is by unjustified anticipation, by guesses, by tentative solutions to our problems, by conjectures. These conjectures are controlled by criticism; that is, by attempted refutations.

This view places critical testing at the centre of scientific activity. Scientific progress occurs not because theories accumulate confirmations but because weaker theories are replaced by stronger ones that withstand more severe tests. In this context, the falsificatinist model emphasizes the fallibility of human knowledge. Scientific theories are regarded as tentative and revisable rather than absolutely certain. Even highly successful theories remain open to criticism and possible replacement in the light of new evidence. Popper (1963, 94), captures this insight in one of his most memorable remarks:

> Science does not rest upon solid bedrock, rather, scientific theories resemble a structure erected on piles driven into a swamp, firm enough for the time being but never resting on an infallible foundation. This underscores the provisional character of scientific knowledge and the continual possibility of revision.

Observation as a Means of Testing Theories

One of the defining characteristics of falsificationism is its understanding of the role of observation in scientific discovery. Whereas the inductivist see observation as the source of scientific theories, Popper maintains that observation functions primarily as a means of testing theories. In the Poperian framework therefore, observation is subordinate to theory rather than prior to it. What Popper was saying in this regard is that scientists formulate hypotheses before conducting observation. The hypotheses in essence generate predictions that can be confirmed or refuted with observational evidence. If empirical results contradict a theory's predictions, the theory is falsified. If the results agree, it is tentatively retained since it can never be conclusively verified. What this means for Popper's concept of scientific methodology is that a theory that survives testing is considered scientifically valuable because it has demonstrated resilience in the face of potential falsification

The history of science provides numerous instances of this process. Newtonian physics dominated the field of science for almost two hundred years because it successfully accounted for a wide range of observations. However, it was eventually superseded by the Einsteinian model, which provided more information content and explanatory power. In Popper's interpretation, such examples illuminate how scientific progress occurs through continual, crucial testing and revision of theories. As he observes, science does not advance through the accumulation of confirmed observations, but through the replacement of less satisfactory theories by those with greater explanatory power and empirical content (Popper, 2002, 215).

The Criterion of Falsifiability

Contrary to the inductivists who claim that the distinctive feature of scientific theory is its confirmability or verifiability, Popper argues that distinguishing mark of a scientific theory is not that it can be verified but that it can in principle be falsified. In this context, he insists that a scientific theory is scientific to the extent that it makes definite predictions that expose it to the possibility of empirical refutation. As such, a theory is falsifiable if there are conceivable observations that could demonstrate it to be false. Conversely, a theory that is compatible with all possible observations cannot be tested and hence does not qualify as scientific.

Popper applies this criterion of falsifiability to address the problem of demarcation of science, which is one of the most vexing problems in the history of the philosophy of science. In the main, the problem of demarcation of science seeks to establish how to distinguish science from non-science or pseudoscience. According to Popper (1963, 36), therefore, a theory which is not empirically refutable is non-scientific. Irrefutability is not a virtue of a theory as people often think, but a vice. Popper's criterion of falsifiability has had profound implications for scientific methodology because it shifted attention away from inductivist's search for confirming instances to the design of crucial tests capable of exposing theoretical weaknesses.

A reasonable number of philosophers and scientists found Popper's approach intellectually compelling because it provided a rational and more satisfactory account of scientific methodology while avoiding the logical difficulties associated with induction. In this sense, Popper's falsificationist conception of observation represents a significant departure from classical inductivism. Within this framework, observation is no longer viewed as the starting point of scientific method but as an instrument for evaluating and justifying theoretical claims. Depite these commendations, falsificationism like inductivism has also been subjected to spirited criticisms questioning its suitability as both the logic and method of scientific discovery. The proceeding section will examine these criticisms. It will particularly demonstrate not just why inductivist and faalsificationist accounts of the role of observation in theory formation fail to adequately represent the actual practice of science, but why scientific inquiry is dynamic and creative enterprise that cannot be fully accommodated within either the inductivist or the falsificationist framework.

Evaluation: Observation and Theory Formation

As has been emphasized throughout this paper, from the introduction to this point, the debate between inductivism and falsificationism has been the dominant controversy in philosophy of science throughout much of the twentieth and twenty-first centuries. Whereas inductivism emphasizes the foundational role of observation in theory formation, falsificationism prioritizes hypothesis over observation arguing that all observation is theory-laden and hence cannot serve as neutral foundation of scientific discovery.

Subjecting both frameworks to critical evaluation, this section demonstrates that while each framework has contributed important insights into scientific practice, none standing alone provides a fully adequate account of how scientific knowledge is acquired. This conclusion is in line with most recent discoveries in postmodern philosophy of science, which has shown that observation and theory are mutually dependent, that observation is often theory-laden, and that scientific progress results from a complex interaction amongst empirical evidence, conceptual frameworks and theoretical creativity.

Limits of Inductivism: Why Observation Cannot Ground Theory

The fundamental failure of inductivism stems from its assumption that observation provides a neutral self-sufficient foundation for scientific knowledge. This presumption is undermined not only by Hume's problem but also by the general fact that no finite number of observations can justify universal claims. Hume's formulation of the problem establishes that there is no logical bridge from observed instances to unobserved cases. In this sense, induction lacks rational necessity (Hume 2007, 26).

Furthermore, inductivism as a method of science is not only undermined by this logical problem. The more damaging attack is the recognition that observation is not epistemologically autonomous. As Hanson (1958, 19) demonstrates, observation is shaped by conceptual expectations and "seeing is a theory-laden undertaken." What scientists observe is therefore influenced by what they already know, meaning that observation cannot function as a purely objective foundation of theory formation.

These criticisms collectively suggest that inductivism is mistaken not only about inference, but also about epistemic priority. Observation does not precede theory in any pure form, instead, it operates within conceptual framework that guides selection, description and interpretation of data. These difficulties undermine the inductivist model of scientific methodology and motivate alternative accounts of scientific reasoning, particularly falsificationism.

Limits of Falsificationism: Why Refutation is Never Decisive

Inductivism rests on two fundamental claims: first, that scientific theories originate from observation, and second, that they are justified through the accumulation of confirming instances. Popper's contribution to scientific methodology lies in his powerful critique of both claims. He is right to insist that scientific inquiry does not begin with neutral observation but with conjectures that precede and guide observation. Likewise, he correctly rejects the view that scientific theories can be verified through repeated confirmation, arguing instead that they must be subjected to rigorous empirical tests designed to expose their errors. However, while falsificationism successfully undermines the inductivist conception of scientific reasoning, it overstates the logical decisiveness of empirical refutation.

A central objection to falsificationism is that scientists do not typically abandon theories immediately after encountering anomalies. Instead of treating conflicting evidence as decisive refutation, scientists usually interpret anomalies as problems to be resolved within existing theoretical frameworks. This challenge was famously articulated by Thomas Kuhn (2012), who argues that scientific activity takes place within paradigms. Anchoring this on what he called normal and abnormal science, Kuhn explains that within "normal science", scientists are not primarily engaged in testing fundamental assumptions but in solving puzzles defined by the paradigm. Anomalies are typically absorbed, ignored, or postponed than treated as falsifications. It is only in the context of abnormal science, when anomalies accumulate and destabilize the paradigm does scientific revolution becomes possible. Kuhn (2012, 24) writes, "No part of the aim of normal science is to call forth new sorts of phenomena; indeed those that will not fit the box are often not seen all."

Similarly, Imre Lakatos offers a complementary explanation. I his model of scientific research programmes, theories are not isolated units but parts of structured systems consisting of a "hard core" protected by a "protective belt" of auxiliary hypotheses. When anomalies arise, scientists typically modify the protective belt rather than abandon the core theory. This according to Lakatos (1978, 5), makes falsification non-decisive in practice, since failure can always be absorbed through adjustments in auxiliary assumptions. Overall, Kuhn, Lakatos and others, demonstrate that paradigm based-stability within scientific communities and the methodological structures that protect core theoretical commitments from immediate rejection undermine falsificationism as an adequate epistemological foundation for scientific methodology.

Scientific Practice: Why Both Models Are Incomplete

Besides the challenges discussed above, historical episodes in the development of science provide additional evidence that neither inductivism nor falsificationism accurately captures the actual method of scientific discovery. A classic challenge to falsificationism is provided by the discovery of the planet Neptune. In the nineteenth century, astronomers observed anomalies in the orbit of Uranus that appeared inconsistent with Newtonian mechanics. According to falsificationism, such anomalies should have counted as evidence against Newton's theory. However, scientists did not abandon Newtonian physics. Rather, they modified auxiliary assumptions by postulating the existence of an unseen planet whose gravitational influence accounted for the irregularities. The subsequent discovery of Neptune in 1946 confirmed this hypothesis and strengthened confidence in Newtonian physics rather than falsifying it (Lakatos, 1978; Chalmers, 1999). This example demonstrates that scientists often protect established theories by adjusting surrounding assuptions instead of immediately rejecting the core theory.

The history of astronomy also exposes the weakness of inductivism. Nicolaus Copernicus did not just arrive at heliocentrism through the simple accumulation of observational data. Rather, he proposed a theoretical framework motivated by considerations of mathematical simplicity and coherence. In the same vein, Johannes Kepler's laws and Issac Newton's theory of gravitation involved creative theoretical innovations that went far beyond what could be logically derived from observation alone (Popper, 2002; Kuhn, 2012). These instances demonstrate that scientific discovery is not simply an inductive generalization from facts but also requires imaginative conjectures and theoretical creativity.

Collectively, therefore, the history of science demonstrates that scientific development is neither a simple accumulation of inductive generalizations nor a strict sequence of conjectures and refutations. Rather, it is a historically situated and theoretically structured process in which observations and are interpreted through conceptual frameworks, anomalies are often tolerated, and theories are replaced only when more progressive and explanatory powerful alternatives become available.

Philosophical Implication: Towards an Interactive Model of Scientific Methodology

The collapse of inductivism and falsificationism as satisfactory explanations of the role of observation in theory formation suggests that the relationship between observation and theory needs to be reconceived. In order words, Observation is not a neutral foundation from which theories are derived, nor is it simply an external test applied to independently formed hypotheses. Instead, observation and theory are epistemically independent.

Methodologically, observation constrains theory by exposing it to empirical resistance, but theory simultaneously structures observations by determining what is seen as relevant and observable. This symbiotic approach shows that scientific reasoning cannot be reduced to single linear method as proposed by the inductivists and falsificationists. To this extent, the most rationally defensible position is that scientific knowledge emerges from an ongoing interaction between observation and theory. Scientific progressive is hence best understood as a dynamic process of conceptual adjustment in response to experience, rather than either inductive verification or deductive falsification. Nevertheless, this conclusion does not eliminate the distinction between observation and theory, rather, it rejects any attempt to treat either as epistemically superior or autonomous. It instead situates scientific reasoning within a continuous cycle of interpretation, revision and conceptual innovation

Conclusion

This study sets out to interrogate the role of observation in scientific theory formation by critically engaging two dominant movements in the philosophy of science: inductivism and falsificationism. The inductivists claim is that scientific discovery proceeds as a linear progression from observation to theory through the generalization of empirical regularities. Falsificationists, led by Popper, reject induction argue that scientific theories are conjectures subjected to rigorous attempts at refutation. The debate between these positions raises fundamental questions about the epistemic status of observation and the logical structure of scientific reasoning.

To address these questions, this study was structured into five sections. The first section, which serves as the introduction, outlines the syntactic and sematic dimensions of the debate between inductivists and falsificationists and situates the direction of the investigation. The second and third sections examine and analyze the respective positions of inductivism and falsificationism on the roles of observation in scientific discovery were presented and analyzed. The fourth section provides a critical evaluation of both perspectives showing why neither offers a satisfactory solution to the problem of the role of observation in theory formation. Highlighting the need for a more adequate understanding of observation in scientific methodology, the section also proposes a new model that conceives the relationship between observation and theory in scientific inquiry as dynamic and symbiotic. The fifth and concluding section recapitulates the major arguments of the paper and highlights why the model of scientific methodology advanced in this study is superior to both inductivism and falsificationism.

Overall, the key finding of this study is that observation is indispensable to scientific inquiry because scientific claims ultimately require confrontation with empirical evidence. Observation and experimentation provide the principal means by which theories are constrained by reality. Observation therefore function as a necessary condition for scientific practice and remains central to the evaluation and justification of theoretical claims. Nevertheless, the study also demonstrates that observation cannot function as a neutral foundation for theory formation. The inductivist assumption that theories can be derived from accumulation of observations is undermined by Hume's problem, the theory-laden character of observation, and the finite scope of empirical data. Hence, observation does not automatically yield explanatory structures, rather, it acquires scientific significance only within conceptual and theoretical frameworks that guide interpretation.

Similarly, falsificationism, while correctly rejecting verificationism and emphasizing critical testing offers an incomplete account of scientific methodology. The history of science shows that theories are not typically abandoned in response to a single counter-instance. Rather, scientific theories are often protected from apparent refutations through auxiliary assumptions, background theories, and broader research commitments. This shows that falsification is not a decisive logical event but a complex methodological process embedded within theoretical frameworks and scientific communities.

The most plausible position regarding the role of observation in theory formation, therefore, is that scientific theories emerge through a structured interaction between observation and theoretical activity. Observation constrains scientific reasoning by providing empirical resistance, while theory shapes observation by determining what is observable and how it is interpreted. Scientific knowledge thus, develops through a continuous cycle of interpretation, hypothesis formation, testing, and revision, rather than through a linear movement from data to theory or from conjecture to refutation alone. In this sense, the relationship between observation and theory is best understood as dialectical rather than hierarchical. Neither observation nor theory operates independently as each gains epistemic force only in relation to the other. Scientific progress, therefore, is not the product of either inductive accumulation or deductive falsification in isolation, but of their ongoing interaction within evolving conceptual frameworks. This interaction provides a more coherent explanation of both the stability and revisibility of scientific knowledge than inductivism or falsificationism.

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