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Popper, Karl Raimund (1902–94)

1. Popper's Life

Karl Raimund Popper was born in Vienna, Austria, on July 28, 1902. His father, Simon [Siegmond Carl] Popper (1856–1932), who had come from Bohemia to Vienna, was a well-established lawyer with his offices and family residence in the center of Vienna. Karl Popper's mother, Jenny Popper (née Schiff) (1864–1938) came from a musical family and was a gifted pianist herself. Both Simon and Jenny Popper were Jews by origin, but converted later in their lives to Protestantism. Besides their son Karl, they had two older daughters, Dora (1893–1932) and Anna Lydia (1898–1975).

Karl Popper left high school (Franz Josef Gymnasium) at the age of 16 without a degree, moved out of his parents' home and attended lectures at the University of Vienna on various subjects, in particular mathematics, philosophy, physics, and psychology. Besides occasional jobs to earn his living (e.g., coaching American students), Popper was engaged in social activities. For some time, he worked as an assistant of Alfred Adler on neglected children. Hints in Popper's autobiography indicate that this connection (through which he got acquainted with Adler's 'individual psychology') contributed to Popper's later critique of psychoanalysis as a 'pseudoscience.' In his youth, Popper had a strong favor for democratic socialism. For a few months, he even considered himself a communist, from which he refrained, in 1919, after witnessing a shooting incident in which socialist workers were killed by police forces. This experience of a useless sacrifice of lives demonstrated to him the futility of ideologies. A second, more intellectual

experience in 1919 was his taking interest in Eddington's test of Einstein's eclipse predictions carried out at an expedition of the Royal Astronomical Society, whose results gained widespread publicity at the time. During a total solar eclipse which was observed from West Africa and Brazil, a shift of apparent position of stars in the presence of the sun's gravitational field could be established, as predicted by the general theory of relativity. This coined Popper's later insistence that scientific theories develop by exposing them to possibly falsifying experience. Around that time, Popper visited a lecture by Einstein in Vienna.

The young Popper also tried manual work. From 1922 to 1924 he was an apprentice to a cabinet maker. At the same time, he passed the high school exams ('Matura') as an external participant and formally enrolled as a student at the University of Vienna. He also considered becoming a musician. After being disappointed with the sort of music cultivated in the Schönberg circle, he enrolled as a student of Church Music at the Vienna Academy of Music ('Konservatorium') and stayed there for one year. He was admitted upon submission of a fugue for organ in F sharp minor. Besides his scientific studies at the University of Vienna, in 1924 he qualified as a primary school teacher. Since no appropriate teacher's post was available at the time, Popper worked as a social worker with neglected children.

In 1925 Popper became a student at the Pedagogic Institute of the City of Vienna, where he stayed until 1927. This institute, which Popper was admitted to due to his status of a social worker, had been newly founded. It was linked to the University, though formally independent. In today's terms, its purpose was to scientifically accompany and evaluate the school reform movement. This school reform movement had been politically supported by the Austrian social democrats since 1919 and was in 1925 still very strong in Vienna. It was characterized by ideas of abolishing school learning as an accumulation of facts in favor of developing a more autonomous and participating attitude. The influence of these ideas on Popper should not be underestimated. His later criticism of what he calls the 'bucket theory of knowledge,' i.e., the inductive generation of knowledge by collecting facts, is related to pedagogic proposals on how learning proceeds or should proceed. Actually, Popper's first published papers were in this field and appeared in journals belonging to the school reform movement. The very first one *Über die Stellung des Lehrers zu Schule und Schüler (On the teacher's attitude towards school and students, 1925)* is very significant in this respect.

At the pedagogic institute, Popper met Josefine Henninger (1906–85), who was training as a teacher and who was to become his wife in 1930. (They had no children.) He also met the psychologist Karl Bühler and the philosopher Heinrich Gomperz, both of them

professors at the University. They were of crucial importance to Popper's intellectual development. It was through discussions with Gomperz and reading his works that Popper shifted away from any psychological approach to the philosophy of science. From Bühler he adopted the distinction of expressive, signaling, and descriptive functions of language, which still figured prominently in Popper's late metaphysical writings.

In 1928 Popper completed his Ph.D. in Psychology with Karl Bühler and Moritz Schlick as examiners. The subject of the thesis was *Zur Methodenlehre der Denkpsychologie* (*On the Methodology of the Psychology of Thinking*, unpublished), a work which combined Popper's interest in psychology with his methodological bias that he had finally shifted to during his time at the Pedagogic Institute. In 1929 Popper qualified as a teacher for secondary schools ('Hauptschulen'), and in 1930 he became a teacher in Vienna.

Since 1922 Popper had been in contact with members of the Vienna circle, a group of philosophers around Moritz Schlick who propagated what they called 'logical positivism,' a version of empiricism which made strong use of modern mathematical logic as a tool of philosophical analysis. Mathematical logic had already been developed by Gottlob Frege (1848–1925) and Bertrand Russell (1872–1970) decades ago, but had not been appropriately appreciated within the established academic philosophy. Though never a member of the circle, Popper attended its sessions occasionally and was in contact with several of its members, in particular Rudolf Carnap, Victor Kraft, and Herbert Feigl. Although he shared certain basic attitudes of the Vienna Circle, in particular the plea for a scientifically oriented philosophy, he was highly critical of other tenets such as the theory of meaning and the form of empiricism propagated. Motivated by Feigl, he put this criticism into a large manuscript in two volumes *Die beiden Grundprobleme der Erkenntnistheorie* (*The Two Basic Problems of Epistemology*, published in 1979, the second volume only as a fragment). A shorter version of the second volume of this manuscript was published in 1934 as *Logik der Forschung* (*Logic of Scientific Discovery*), which was to become his main work.

The book was well received. Reviews appeared in many journals. Even Einstein wrote Popper a letter after the book was sent to him through intermediates. In 1935 and 1936 Popper received invitations to England, where he lectured at Bedford College and Imperial College, London, at the London School of Economics and at Cambridge. He made a lot of contacts. Of most importance for his later career were those with Ernst Gombrich and Fritz Hayek. However, attempts to find a position in England did not materialize, and in 1937 he emigrated with his wife to New Zealand, accepting an offer of a lectureship at Canterbury University College.

During the time in exile Popper intensified his interest in social and political philosophy and in the philosophy of history, besides continuing his research in logic and philosophy of science. From that time on, he published mainly in English. He wrote a series of articles *The Poverty of Historicism* (Popper 1957a originally 1944–5); and, more importantly, his two-volume classic *The Open Society and Its Enemies* (Popper 1945). For both works he had to struggle to find a publisher. Due to the *Open Society*, he acquired his initial postwar reputation and, in particular, his post, from which he carried out all subsequent work. Through the intervention of Hayek who, together with Gombrich, had made the publication of the *Open Society* with the publisher Routledge possible, he was offered a readership in 'Logic and Scientific Method' at the London School of Economics in 1945, which Popper took up early in 1946, shortly after publication of the *Open Society*. In 1949 he received a professorship of the same title at the London School of Economics, which he held until his retirement in 1969.

During the first five years of his stay in Britain, he was sort of a 'star.' The *Open Society* made him a quite popular theoretician of political liberalism. It has often been said that this book filled some intellectual vacuum in the postwar period. Popper was invited to many places and, at the same time, had a substantial audience at the London School of Economics. In the 1950s, he shifted more to working from home with less institutional involvement. At the same time, his research interests moved away from political and social philosophy and back towards the subject of the *Logik der Forschung*, i.e., the methodology of the natural sciences. However, the first English edition of this book appeared only in 1959, with a lot of material added compared with the German original. Many other books and plenty of papers followed. Up to his death, Popper produced an enormous scientific output and had a vast correspondence. From the mid-1960s on, Popper received a great number of prizes and honorary degrees in many countries, including Knighthood and Membership of the Royal Society in Britain. He died on 17 September 1994 in London. His ashes were buried in Vienna, where his wife had died in 1985.

2. Popper's Work

Popper's work covers nearly all areas of theoretical philosophy. His overall profile is that of a great philosophical classic. However, most important are his contributions to the methodology of science, where he established falsificationism as one of the basic orientations in the modern philosophy of science.

The basic claims of falsificationism are put forward in the *Logik der Forschung* (1934, official year given in

the book: 1935). Most of Popper's later methodological contributions can be viewed as elaborations or amendments of what was already stated in his first book. Even Popper himself treated the *Logik der Forschung* like a classical text, with all changes in the first English translation (*The Logic of Scientific Discovery* 1959) as well as in the later 10 German and 10 English editions, as a system of footnotes and appendices to the 1934 edition.

Falsificationism can be described as a 'why not' methodology in contradistinction to a 'why' methodology with respect to scientific theories. According to Popper, a scientific theory is posed without any prior justification. It gains its confirmation, or 'corroboration,' which is Popper's preferred term in later writings, not by experimental evidence demonstrating *why* it should hold, but by the fact that all attempts at showing *why* it does *not* hold have failed. The main activity of an experimental researcher is trying to refute or '*falsify*' a scientific theory, rather than to justify or '*verify*' it. Theoreticians who design theories should do this in such a way that they can be refuted most easily. In no case must a theory be immunized against possible falsification, e.g., by the introduction of *ad hoc* hypotheses. We rely on a theory only because we have not managed to falsify it (so far), not because we have any positive or direct reasons in its favor.

His own theorizing, and especially the idea of falsificationism, is considered by Popper as proposing 'methodological rules.' These methodological rules have to prove fruitful in the understanding of scientific research and, particularly, of scientific progress. The main argument in favor of his falsificationist proposal is that the converse proposal, which is called 'verificationist,' is bound to fail. Verificationism, which underlies the 'inductivist' methodology, claims that a scientific theory is supported by a collection of verifying instances. However, as has already been established by David Hume (1711–76), the inductive reasoning from a finite set of observations to a general statement is not logically valid if the domain of reasoning is infinite or at least indefinite. Furthermore, any attempt at creating a special nondeductive form of reasoning (an 'inductive logic') can only be justified by means of induction itself, thus ending up in a vicious circle. To quote Popper's famous example, no observation of white swans can verify the general statement that all swans are white.

Popper's falsificationist methodology rests on the assumption that unlike verification, falsification of a general statement by experimental or observational means is logically without any problem. The statement 'All swans are white' can be falsified by the observation of a single black swan. The logic involved here is just ordinary deductive logic, due to which the falsity of an instance derived from a general hypothesis falsifies the hypothesis itself. Seemingly singular statements such as 'The planet Pluto has a moon,' which at first glance seem to be verifiable but not falsifiable, are viewed by

Popper not in isolation but as embedded in a general theory and therefore are no counterexample to what he calls the 'asymmetry between verification and falsification.'

More complicated is the example of statistical theories where definite falsification is not possible. Here Popper applied as an additional methodological rule that what is extremely unlikely can be neglected as something which cannot be reproduced deliberately. This allows Popper to cope with the standard way of rejecting statistical theories by means of a critical test (usually defined by stipulating a level of significance).

In traditional methodology, particularly that of the Vienna Circle, inductivism was tied to empiricism and guaranteed the connection between theoretical statements and their empirical basis. In falsificationism, the empirical significance of theoretical statements is kept by relating them to basic statements which possibly falsify them. However, these basic statements are no longer purely observational in some epistemological sense, but are themselves theory-laden from the very beginning. Even elementary perceptual evidence has to rely on theoretical assumptions. Thus Popper rejects any semantic division between theoretical and observational statements and, especially, the claim that a particular sort of certainty comes with the latter. According to Popper, the validity of basic statements can only be fixed in the course of the testing of a theory, and, in the end, this fixing is a matter of convention. This variant of conventionalism, which enters Popper's approach in addition to the conventionalism inherent in the choice of methodological rules, has repeatedly been the subject of criticism.

For Popper the distinction between a theory which can be falsified by means of basic statements and one which is not falsifiable serves as a demarcation criterion for empirical science vs. metaphysics. However, metaphysics, though not falsifiable, is not meaningless. Metaphysical statements may serve useful purposes, even within science. For example, the principle of causality ('any event can be causally explained'), which cannot be falsified and is therefore metaphysical, can be viewed as the useful methodological rule never to abandon the search for laws which explain observed facts. This view of metaphysics is less rigid than that of the Vienna Circle, who considered metaphysics to be meaningless throughout. It allows Popper to sharply criticize certain nonfalsifiable theories as 'pseudosciences' (such as psychoanalysis) but nevertheless to make sense of certain traditional philosophical claims or to appreciate the fruitful role of metaphysical research programs in the history of physics ('A metaphysical epilogue,' in *Quantum Theory and the Schism in Physics* 1956, published 1982b).

In his later works, Popper extended the methodological approaches of the *Logik der Forschung* towards a general account of the dynamics of scientific theories ('Truth, rationality, and the growth of scientific knowledge,' in *Conjectures and Refutations* 1963).

According to this view, theoretical progress is made by successive critique and revision of existing theories, which is governed by the idea of objective truth. Scientific progress works by replacing a falsified theory with a new one which, in the ideal case, is more encompassing than the previous one in that, while coping with the new results, it also covers the unfalsified instances of the old theory. This appeared to be the case with classical and relativistic gravitational theories in the presence of the results of the 1919 solar eclipse observations, which were so impressive to the young Popper. His later claim is that the new and more encompassing theory is nearer to the truth than the older and more special one, even if it should at some point become falsified itself. Popper has tried to characterize the distance of a theory from truth, its 'truthlikeness' or 'verisimilitude,' in numeric terms. Considerable work has been carried out in recent decades to develop improved measures.

Within the revision of scientific theories, Popper strongly distinguishes between hypotheses being tested and background knowledge which, though testable in principle, is not being questioned at the same time. This distinction makes the falsification of parts of a theory possible, and not only the falsification of a theory as a whole. Therefore Popper pleads to formulate theories in a modular way such that its parts can be tested independently of each other. He is opposed to 'holistic' views of theories, according to which, in a single test, the whole theory (Pierre Duhem) or, even more radically, all our theoretical knowledge including logic and mathematics (W. V. O. Quine) is at stake. Popper defended his model of scientific progress as a change of scientific hypotheses by means of falsification against historic approaches which denied the rational character of scientific change. So he was strongly opposed to Thomas S. Kuhn's account of scientific revolutions as irrational changes without the concept of 'progress' being applicable. Similarly, he argued with Imre Lakatos (1922–74) and Paul K. Feyerabend (1924–94), who started as Popperians, but later on made changes in falsificationist methodology by weakening and relativizing Popper's strict idea of progress by critical testing.

In *Evolution and the Tree of Knowledge* (1961, published 1972 in *Objective Knowledge*), Popper embedded the idea of theory change by falsification and revision within a general theory of the evolution of knowledge. Here 'knowledge' is viewed as a form of adaptation of an organism to the environment. Popper's schema of progress from problems via falsification to new problems is interpreted as the evolutionary transition from organisms via natural selection to organisms which are better adapted. By viewing all life as problem solving (*All Life is Problem Solving* 1994c), Popper claimed to combine theories of biological evolution with theories of scientific progress, relating his approach to evolutionary epistemology in the sense of D. Campbell. However, it must be

emphasized that, unlike most evolutionary epistemologists, Popper was not a naturalist. He insisted that the cultural-scientific evolution is rational and based on conscious and deliberate criticism, not on natural selection governed by chance.

In his later work, Popper also replaced the narrow concept of 'falsification' with a broader concept of 'criticism' or 'critical examination.' This broader concept not only applies to scientific theories which are formulated in a logical language but to philosophical claims which are metaphysical. It involves tests of consistency and the investigation of how far the theory in question is able to solve particular problems. This orientation, with critical examination as its cornerstone, was called 'critical rationalism' by Popper and has since become the standard denomination of the Popper school. The main examples of Popper's dealings with metaphysical problems are his treatment of determinism and his philosophy of mind. Quite independent of problems of quantum mechanics, which often serve as arguments against determinism, in *The Open Universe: An Argument for Indeterminism* (1956, published 1982a), he developed an indeterministic world view. In 'Of clouds and clocks' (1966, reprinted in *Objective Knowledge* 1972), he extended this view with arguments for the openness of the future for free action. In the mind–body debate, Popper defended a mind–body dualism ('Language and the body–mind Problem,' 1953, reprinted in *Conjectures and Refutations* 1963), which he later extended to a model of three worlds of (a) physical entities, (b) mental states, and (c) objective contents of thought, which causally interact. This approach gained much attention through his discussions with J. R. Eccles which, together with their separate contributions, are presented in their joint book *The Self and its Brain* (1977).

Epistemologically, Popper was an outspoken objectivist and realist. On the Popperian view, our theories are not just methodological instruments or means of acquiring (some degree of) certainty about something, but attempts at explaining the real world. As reality is described by means of true sentences, this is another way of claiming that the goal of science is truth. Part of Popper's objectivism and realism is his rejection of any subjective interpretation of probability. In particular, he was strongly opposed to Bayesianism and its view that scientific progress is just changing the probabilistic degree of belief in certain propositions, which means that scientific dynamics is probability dynamics (*Probability Magic or Knowledge out of Ignorance* 1957b). Both the probability of hypotheses, for which Popper coined the term 'logical probability,' and statistical probability, which may be part of a hypothesis, are objective probabilities reflecting properties of what they are attributed to. Logical probabilities are inversely proportional to the content of a theory, the less probable theory having a higher content. Statistical probabilities which, in the *Logik*

der Forschung, were interpreted as relative frequencies, were later viewed as objective ‘propensities’ of experimental designs to develop certain outcomes (*Realism and the Aim of Science*, 1956, published 1983). This propensity interpretation of probability claims to be a solution of the problem of assigning probabilities to singular events, rather than only to events as members of a given sequence or set of related events.

Popper’s attitude against probabilities as degrees of belief does not contradict the fact that he attempted to measure the degree of corroboration of a theory in probabilistic terms. However, first of all, Popper’s degree of corroboration, though relying on probabilities, is not a probability itself, i.e., does not obey the laws of the calculus of probability. Second, the degree of corroboration is intended as a strictly objective measure which reflects the way the hypothesis in question was subjected to falsification, and is definitely not meant as a degree of rational belief in a hypothesis. According to Popper, epistemology is the methodological treatment of objective scientific contents and not a theory of the knowing subject (‘Epistemology without a knowing subject,’ 1967, reprinted in *Objective Knowledge* 1972).

Popper’s social and political philosophy which was developed during his emigration in New Zealand and published in *The Poverty of Historicism* (1944–5) and *The Open Society and its Enemies* (1945) can, to some extent, be viewed as an application of falsificationism to the area of social interaction. By ‘historicism’ Popper denoted the claim that the methodology in the historical and social sciences differs fundamentally from those in the natural sciences but, nevertheless, allows one to formulate objective laws of historical development, which cannot be changed by subjective action. The standard example is Marxist philosophy of history (historical materialism). In contradistinction to that, Popper put forward the idea of ‘piecemeal social engineering,’ i.e., of a development of social institutions in small steps which can be revised and whose potential damage can be controlled. According to Popper, piecemeal social engineering can be combined with a falsificationist form of social research, which is based on trial and error as it generates models for social development. For areas of historical and sociological research which are interested in the explanation of single events rather than the testing of general laws, Popper proposed the procedure of a ‘logic of the situation’ which describes the acting of individuals under the hypothesis of rational purpose-oriented behavior within a certain social situation. In this context he defends the autonomy of sociology against psychologism, as this situation is described in objective terms by reference to social institutions, etc. Since 1961, Popper defended this account of social theorizing against representatives of the neo-Marxist Frankfurt school in Germany, in particular, Theodor W. Adorno and Jürgen Habermas, in a dispute which became known as the ‘positivist dispute in German

sociology,’ and which made Popper well known to a wider audience in the German-speaking countries.

The *Open Society* extends the critique of historicism to a critique of the philosophical theories of state and society by Plato, Hegel, and Marx, which Popper considers to be philosophical precursors of political totalitarianism. According to Popper, they advocate the idea of a closed society, which is a collectivistic and organismic whole, without the distinction between natural and cultural laws. In an open society, which Popper strongly favors, individuals are personally responsible for their decisions and can therefore be critical to social regulations. Popper argues that the traditional question ‘who should rule’ ought to be replaced by the question of how to minimize the risk of bad rulers and how to get rid of them once they are in power. For Popper, the long-standing philosophical discussion about the best rulers belongs to justificationist thinking that has to be abandoned in favor of critical thinking, just as in general methodology. The utilitarian principle of maximization of happiness should give way to the idea of minimizing suffering.

Although there appears to be a lot of moralizing both in the *Open Society* and in many short papers and interviews on questions of morals and politics given towards the end of his life, this should not be understood as fragments of an ethical theory. For Popper, there is no such thing as ethics, because ethical sentences are not propositions in the logical sense that one could argue for or that one could reject. However, there are moral actions. These are actions which are carried out by someone who is aware of their consequences. Since the consequences of actions can be critically examined in the sense of critical rationalism, moral decisions are not irrational.

3. *Relevance and Impact of Popper’s Philosophy*

Popper’s methodological program was revolutionary as it reverted the established conceptual order between certain fundamental notions. He put ‘negative’ concepts such as ‘falsification’ and ‘rejection’ first, and made ‘positive’ concepts such as ‘acceptance’ or ‘corroboration’ dependent on them. Whereas according to the traditional philosophical view of science established ever since Bacon, acceptance of a theory is based on the direct generalization from observation, according to Popper, it can only rely on failed rejection. It is therefore correct to speak of Popper’s ‘negative methodology.’ As Popper tried to show in his later writings, this is not just a program for the natural sciences, but applies to any area of scientific reasoning and even to metaphysics, where negative concepts such as that of ‘criticism’ come first. The credit we give to a conjecture is based on the fact that refuting it by criticism has been unsuccessful. This program is even the basis of Popper’s political phil-

osophy. The negative question of how to restrain political power and to remove bad rulers from power is of primary concern compared with the positive one of whom to give power. Popper's negative methodology is a unified view of rationality under the header 'critical rationalism.'

This comprehensive perspective of theoretical reasoning and social and political action makes Popper's philosophy comparable with that of great classics like Aristotle or Kant. It was also one of the sources of the great success which Popper enjoyed still during his lifetime. As a general and unifying view, 'critical rationalism' is, of course, liable to oversimplification and, among certain adherents of Popper there has, in fact, been a considerable amount of that. On the other hand, it was only critical rationalism as a general orientation that could publicly compete with the eloquence of hermeneutic or neo-Marxist approaches. Philosophical theories like logical empirism, though with respect to intellectual clarity and responsibility by no means behind Popper's, would have been too academic to develop any major public significance.

In fact, it is not very difficult to give an outline of the basic principles of critical rationalism to somebody who is not a trained philosopher. Critical rationalism is an approach which offers something at any depth of understanding. Popper's works both cover extremely intricate discussions, e.g., of the methodological role of probability, whose significance can only be judged by highly specialist researchers, and general questions of reasoning, society, and politics at a level accessible to anybody who is really interested. With the exception of the chapters on probability and on quantum mechanics and of the appendices, the *Logik der Forschung* can easily be studied without deep expertise in academic philosophy. Even from a first reading, the average student would gain a preliminary understanding of falsificationism. Matters of presentation are very important in philosophy, and Popper was a master in that. His language is extremely clear and nonpretentious, which distinguishes him from many other philosophers, particularly in the German tradition.

Popper made a strong impression on politicians of various directions, although he was himself never involved in party politics. Both conservative and social democratic or labor politicians have referred to Popper to justify their respective programs and proposals. The term 'open society,' which Popper coined, has become widely accepted as a designation of basic features of a democratic state.

Popper's lasting impact on the shape of philosophy of science was not only due to his methodology in the narrower sense, but also due to his drawing attention to the *dynamics* of science. It is significantly due to Popper's influence that the philosophical and logical reconstruction of scientific reasoning is not just a modeling of static theories in logical terms but, to a great extent, an account of theory dynamics, i.e., of

what it logically means that a theory is being given up or revised. The combination of philosophy of science with the history of science, which is reflected in many divisions of university departments, denominations of chairs, etc. emerged on this background, as philosophical theories of theory dynamics have to be tested against the historical development of theories, and, conversely, the proper understanding of historical developments requires appropriate methodological tools. Although today's theorizing differs in many respects from what Popper argued for and often contradicts his claims (i.e., Bayesian approaches in the field of belief revision), the research program of putting dynamics of theories first in the methodology of science is unthinkable without Popper's revival of the induction problem and his negative methodology as a proposed solution.

The influence of Popperian theories on the 'working scientist' should not be underestimated. If scientists have any interest in the methodology of science at all, they would know of Popper's approach. This is particularly true of the social and behavioral sciences. There, falsificationism figures prominently in textbook chapters dealing with methodological questions. One may speculate why falsificationism is so appealing to social scientists. A possible answer might be that statistical methodology, which lies at the heart of the social sciences, has a bias towards falsification. According to the most widespread statistical methodology, which is a combination of accounts by R. A. Fisher and by J. Neyman and E. Pearson, the rejection or falsification of a statistical null hypothesis at a certain level of significance is a direct and uncontroversial result, whereas the acceptance of a positively formulated statistical hypothesis is only indirect and preliminary (as it depends on features such as sample size) and, in any case, is technically more involved.

Certain results of modern computer science have challenged Popper's view on induction. His methodology comes along with the claim that we always start with theories or hypotheses which, in the course of time, are then revised to better hypotheses by trial and error. How a new hypothesis is formed was for Popper not the subject of rational investigation. In artificial intelligence and, in particular, in learning theory, algorithms have been developed to generate theories that fit given data. This does not contradict falsificationism, as these heuristically developed hypotheses would then have to be tested, just as falsificationism claims. However, the availability of such procedures destroy the myth that a theory is the extrarational product of a genius or some sort of accidental mutation, and lays the foundation for algorithmic inductive heuristics as a rational enterprise.

There are a lot of questions in the technical development of the Popperian approach, e.g., his treatment of probability and of logic, whose significance for future developments has still to be proven.

Something similar holds for Popper's metaphysical theories. However, these are less important details compared with his basic methodological claims, which will remain a standing challenge.

See also: Causation (Theories and Models): Conceptions in the Social Sciences; Causation: Physical, Mental, and Social; Explanation: Conceptions in the Social Sciences; Hayek, Friedrich A von (1899–1996); Historicism; Liberalism; Liberalism: Historical Aspects; Liberalism: Impact on Social Science; Positivism, History of; Positivism: Sociological; Scientific Reasoning and Discovery, Cognitive Psychology of

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Popular Culture

For most of us, popular culture is a source of entertainment. It encapsulates mass media (such as film, television, print media), and includes sports events, advertisements, street fairs, and tourism. We engage with popular culture because we get pleasure from it; at the same time, we are also informed by it. We usually associate information with news rather than with entertainment. But other forms of popular culture that we often associate with 'mere entertainment'—for instance, tourist practices, popular music, films, sports, and television programs—also inform us in profound ways. For example, the US sitcom, the *Cosby Show*, may shape our ideas not just of what an ideal family is, but also about the relationship between race and upward mobility; a romance novel might instill in us expectations about intimacy as well as about gender and sexuality. Popular culture plays an important role in shaping our personal and collective identities. It also provides us with an analytic lens to understand sociohistorical processes such as class, gender and sexuality, nationalism, and transnationalism.

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