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(*b*. Hamburg, Germany, 26 September 1891; *d*. Los Angeles, California, 9 April 1953)

philosophy of science, logic.

Reichenbach was one of five children of Bruno Reichenbach, a prosperous wholesale merchant, and the former Selma Menzel. Both parents were members of the Reformed Church; his paternal grandparents were Jewish. The family was cultured, with a lively interest in music, chess, books, and the theater.

From 1910 to 1911 Reichenbach studied engineering in Stuttgart but, dissatisfied, turned to mathematics, physics, and philosophy, attending the universities of Berlin, Munich, and Gottingen. Among his teachers were Planck, Sommerfeld, Hilbert, Born, and Cassirer. He took his doctorate in philosophy at the University of Erlangen in 1915, and another degree by state examination in mathematics and physics at Göttingen in 1916. His doctoral dissertation was on the validity of the laws of probability for physical reality. He wrote it without academic guidance, for he could find no professor interested in the topic. The completed dissertation consisted of an epistemological treatise and a mathematical calculus. After traveling in vain to several universities in search of a sponsor willing and able to read both parts, Reichenbach found at Erlangen a philosopher and a mathematician, each willing to sponsor the part within his competence and together willing to accept the dissertation as a whole. Decades later he would chuckle when he cited their decision as a fallacy of composition, adding: “But I did not point that out to the good professors at that time!”

Reichenbach served for two and a half years in the Signal Corps of the German army, contracting a severe illness at the Russian front. Throughout his life he regarded war as catastrophe and considered it a duty of intellectuals to combat the attitudes from which wars arise. From 1917 to 1920 he worked in the radio industry, continuing his studies in the evening. He was one of the five to attend Einstein’s first seminar in relativity theory at the University of Berlin. From 1920 to 1926 he taught surveying, radio techniques, the theory of relativity, philosophy of science, and history of philosophy at the Technische Hochschule in Stuttgart.

In 1926 Reichenbach obtained a professorial appointment at the University of Berlin. Opposition to his appointment, due in part to his social activism during his student days and in part to his outspoken disrespect for many traditional metaphysical systems, was overcome by Einstein’s persistent and witty pleading. In 1930 Reichenbach and Rudolf Carnap founded and edited the journal *Erkenntnis*, which for many years was the major organ of the Vienna Circle of logical positivists, of the Berlin Gřoup for Empirical Philosophy, and of the International Committee for the Unity of Science. He also broadcast over the German state radio the lectures published in 1930 as *Atom und Kosmos*.

Within a few days of Hitler’s election to power in 1933, Reichenbach was dismissed from the University of Berlin and from the state radio. Anticipating this action, he was on his way to Turkey before the dismissal notices were delivered. From 1933 to 1938 he taught philosophy at the University of Istanbul, where he was charged with reorganizing instruction in that subject. He was delighted to find that among his students there were many excellent young teachers, who had been given paid leave of absence by Ataturk’s government so that they might profit from the presence in Turkey of German refugee professors.

In 1938 Reichenbach received his immigration permit to enter the United States, and from then until his death in 1953 was professor of philosophy at the University of California at Los Angeles, frequently lecturing at other universities and at congresses in the United States and Europe. Shortly before his death a volume was planned for the Library of Living Philosophers (edited by P. A. Schilpp) to include both Carnap and Reichenbach, but his death prevented fulfillment of the project.

As a teacher Reichenbach was extraordinarily effective. Carl Hempel, who studied under him at Berlin, stated: “His impact on his students was that of a blast of fresh, invigorating air; he did all he could to bridge the wide gap of inaccessibility and superiority that typically separated the German professor from his students.” His pedagogical technique consisted of deliberately oversimplifying each difficult topic, after warning students that the simple preliminary account would be inaccurate and would later be corrected. Students who pursued advanced work with him found him kindly, witty, morally courageous, and loyal. Those whose interests or convictions differed from his sometimes found him arrogant and intolerant.

Reichenbach never substantially altered his episte-mological stance, which can be briefly characterized as anti-Kantian, antiphenomenalistic empiricism. In his first book, *Relativitätstheorie und Erkenntnis apriori* (1920), he began his attack upon the Kantian doctrine of synthetic a priori knowledge, although at that time he still regarded the "concept of an object" as a priori. He declared, however, that this concept is a priori only in the sense of being a conceptual construction contributed by the mind to sense data, and not also, as Kant had believed, a priori in the sense of necessarily true for all minds. By 1930 Reichenbach had replaced this view with the thesis that the concept of a physical object results from a projective inductive inference. From that time on, he maintained that there is no synthetic a priori knowledge, defending this thesis by showing that every knowledge claim held by Kant to be a synthetic a priori truth could be classified as analytic a priori, synthetic a posteriori, or decisional. In accord with Helmholtz, Frege, and Russell, Reichenbach regarded the axioms and theorems of arithmetic as analytic a priori. He classified the parallel postulate and the theorems of Euclidean geometry as synthetic a posteriori if, in combination with congruence conventions, they are taken as descriptive of physical spatial relations. The Kantian principle of universal causality was also classified as synthetic a posteriori. In his later work, after reformulating the principle of causality in terms of inductive inference, Reichenbach denied that it applies to the subatomic realm of quantum theory. As for the Kantian moral synthetic a prioris, he regarded them as volitional decisions, neither true nor false.

By 1924 Reichenbach had developed his theory of "equivalent descriptions," a central tenet of his theory of knowledge. It is formulated in his *Axiomatik der relativistischen Raum-Zeit-Lehre* (1924), in *Philosophie der Raum-Zeit-Lehre* (1928), in *Atom und Kosmos* (1930), in *Experience and Prediction* (1938), and in the less technical *Rise of Scientific Philosophy* (1951); and it is developed with new applications in his works on quantum mechanics and time. This theory attributes an indispensable role in physical theory to conventions but rejects the extreme conventionalism of Poincaré and his school. Reichenbach insisted that a completely stated description or physical theory must include conventional elements, in particular such "coordinating definitions" as equal lengths and simultaneous times. These definitions are not bits of knowledge, for such questions as whether or not two rods distant from each other have the same length are not empirically answerable. Hence such coordinations must be regarded as conventions, as definitions, as neither true nor false.

Physical theory contains much more than these conventional elements, however. The truth of a theory, the complete statement of which must include a set of coordinating definitions, is not a matter of convention but of empirical confirmation. Furthermore, one theory using one set of congruence conventions may be empirically equivalent to another theory using another set of conventions. For example, Riemannian geometry combined with the usual coordinating definitions of equal times, equal lengths, and straight lines yields a description of physical space equivalent to Euclidean geometry combined with coordinating definitions which attribute systematic changes to lengths of rigid rods.

This equivalence Reichenbach explicated as follows: When all possible observations confirm to the same degree two descriptions, one of which uses one set of congruence conventions and the other another set, the two descriptions are equivalent, that is, have the same knowledge content or cognitive meaning.

Theories of meaning had long been a focal concern of logical positivists, to whose work Reichenbach acknowledged indebtedness, offering his own theory of meaning as a development and correction of the positivists' verifiability theory. He disagreed with the positivists on two crucial points. First, their theory made complete verifiability (as true or false) a condition of cognitive meaningfulness. This, Reichenbach pointed out, denies that statements confirmed with probability have cognitive meaning,and hence consigns to the category "meaningless" all generalizations and all predictions of science. The strictness of their limitation on cognitive meaning had forced the positivists into a phenomenalism which equated the conclusions of physical science with statements about sensory data. Reichenbach proposed to give the neglected but all-important concept of probability the central role in theory of meaning which it actually plays in scientific method. He regarded the relation between observational data and physical theory as a probability inference, not a logical equivalence. This permits a "realistic" (as opposed to the positivists' phenomenalistic) view of the objects of scientific knowledge.

Reichenbach's second disagreement with the positivists' theory of knowledge involved the logical status of any criterion of cognitive meaningfulness. The positivists assumed that their theory was itself an item of knowledge, a description of the class of meaningful statements. Reichenbach declared that any definition of "knowledge" or of "cognitive meaning" is a volitional decision without truth character (see *Experience and Prediction,* ch. 1, esp. pp. 41, 62). He continued to use the label "theory of meaning" because each decision concerning what is to be accepted as cognitively meaningful is connected with two cognitive questions: whether the decision accords with the actual practice of scientists, and what subordinate decisions are logically entailed by the definition of meaning.

Reichenbach formulated his own decision concerning cognitive meaning in two principles: a proposition has meaning if it is possible to determine a degree of probability for it; and two sentences have the same meaning if they obtain the same degree of probability through every possible observation (for complete formulation, see *Experience and Prediction*, p. 54). The second of these principles he regarded as a modern version of Ockham's razor, core of the anti-metaphysical attitude of every consistent empiricism. As examples of its application he cited Mach's criticism of the concept of force and Einstein's principle of the equivalence of gravitation and acceleration.

Throughout his life Reichenbach maintained that the mathematical or frequency concept of probability suffices and needs no supplementation by a priori equal probabilities or by such concepts as "degree of credibility." For prediction of individual events the probability was the "best wager," determined by the frequency of the narrowest class for which there were reliable statistics. He applied the frequency concept of probability to general hypotheses by regarding them as members of classes of hypotheses having known success ratios. These views were opposed by Russell in *Human Knowledge*, *Its Scope and Limits*, and were supported by Wesley Salmon in *Foundations of Scientific Inference*.

Reichenbach's work on induction was closely connected with his theory of probability, for it introduced the distinction between appraised and unappraised (or "blind") posits. The former have frequency probabilities attached to them; the latter admit of no probability estimate. One blind posit is involved in every inductive inference: the posit that frequencies of series of events converge toward limits. (Causal or one-to-one regularities are simply one case of statistical regularities.) With this thesis Reichenbach reopened the old question of the justification of induction. He accepted Hume's argument that inductive inferences admit of neither deductive (demonstrative) justification nor inductive justification (at pain of circularity). Thus there can be no proof of any sort that inductive inferences will ever succeed in the future, let alone succeed more often than they fail.

Nevertheless, Reichenbach offered the following "pragmatic justification" of our use of inductive inferences. He showed that if the world becomes such that inductive inferences usually fail, as would happen if no past regularities were to continue into the future, then no principles of predictive inference could succeed. Hence inductive procedures offer us our only chance of making successful predictions, although we cannot know whether they will succeed or not. If there are series of events with frequencies which converge toward limits, inductive methods will lead to increasingly successful predictions as observed frequencies approach those limits; if this condition does not obtain, no method whatsoever of making predictions will succeed. Since we cannot know that this necessary condition of successful prediction will not obtain, it would be unreasonable to renounce the method which will yield success if it does obtain. The choice is between certain cognitive failure and our only chance of success. Hence, Reichenbach concluded, it is reasonable to make inductive inferences—that is, to adopt and act on the blind posit that frequencies of series of events will converge toward limits (*see Experience and Prediction*, secs. 38–40).

In "Philosophy: Speculation or Science?" (1947) and in *The Rise of Scientific Philosophy* (1951) Reichenbach drew the corollaries for ethics of his theory of knowledge. His definition of cognitive meaning precluded any extrascientific kinds of knowledge. Hence moral principles and ethical aims are volitional decisions, not items of knowledge. He condemned traditional Philosophical systems for conflating flating cognition and volition in the mistaken hope of establishing knowledge of ultimate values, and he also rejected John Dewey's attempt to test moral judgments by scientific methods. "There is no such thing as "the good' in the sense of an object of knowledge" ("Philosophy: Speculation or Science?" p. 21). In his brief writings on the nature of moral judgments, his style and tone are as dogmatic as the style and tone of other ethical noncognitivists of the era. He does not mention that his classification of moral judgments as volitional decisions is a classification dependent upon his own decisional definition of cognitive meaning.

The Direction of Time, nearly completed before Reichenbach's death and published posthumously, is the culmination of his epistemological investigations of relativity physics and quantum theory. In it he applied his analyses of conventions, equivalent descriptions, probability inferences, and three-valued logic to subjective (experienced) time, to the time concepts of macrophysics, and to the possibility of establishing time order and time direction among subatomic events. He found that among the equivalent descriptions of the "interphenomena" of quantum theory, every possible description contains causal anomalies, reversals of time direction, or both. He concluded that both time order and time direction are statistical macrocosmic properties which cannot be traced to microcosmic events. To the question "Why is the flow of psychological time identical with the direction of increasing entropy?" his answer was "Man is a part of nature, and his memory is a registering instrument subject to the laws of information theory" (The Direction of Time, p. 269).

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