**Empirical Rationality**

**Empirical Rationality** or **Empiricism** is a [theory of knowledge](http://en.wikipedia.org/wiki/Epistemology) which states that [knowledge](http://en.wikipedia.org/wiki/Knowledge) comes only or primarily from [sensory experience](http://en.wikipedia.org/wiki/Empirical_evidence).[[1]](http://en.wikipedia.org/wiki/Empiricism#cite_note-1) One of several views of [epistemology](http://en.wikipedia.org/wiki/Epistemology), the study of human knowledge, along with [rationalism](http://en.wikipedia.org/wiki/Rationalism), [idealism](http://en.wikipedia.org/wiki/Idealism), and [historicism](http://en.wikipedia.org/wiki/Historicism), empiricism emphasizes the role of [experience](http://en.wikipedia.org/wiki/Experience) and [evidence](http://en.wikipedia.org/wiki/Empirical_evidence), especially sensory experience, in the formation of ideas, over the notion of [innate ideas](http://en.wikipedia.org/wiki/Innate_idea) or [traditions](http://en.wikipedia.org/wiki/Traditions);[[2]](http://en.wikipedia.org/wiki/Empiricism#cite_note-2) empiricists may argue however that traditions (or customs) arise due to relations of previous sense experiences.[[3]](http://en.wikipedia.org/wiki/Empiricism#cite_note-3)

Empiricism in the [philosophy of science](http://en.wikipedia.org/wiki/Philosophy_of_science) emphasizes evidence, especially as discovered in [experiments](http://en.wikipedia.org/wiki/Experiment). It is a fundamental part of the [scientific method](http://en.wikipedia.org/wiki/Scientific_method) that all [hypotheses](http://en.wikipedia.org/wiki/Hypotheses) and [theories](http://en.wikipedia.org/wiki/Theory) must be tested against [observations](http://en.wikipedia.org/wiki/Observation) of the [natural world](http://en.wikipedia.org/wiki/Natural_world) rather than resting solely on [*a priori*](http://en.wikipedia.org/wiki/A_priori_(philosophy)) [reasoning](http://en.wikipedia.org/wiki/Reasoning), [intuition](http://en.wikipedia.org/wiki/Intuition_(knowledge)), or [revelation](http://en.wikipedia.org/wiki/Revelation).

Empiricism, often used by natural scientists, asserts that “knowledge is based on experience” and that “knowledge is tentative and probabilistic, subject to continued revision and falsification.”[[4]](http://en.wikipedia.org/wiki/Empiricism#cite_note-4)One of the epistemological tenets is that sensory experience creates knowledge. The scientific method, including experiments and validated measurement tools, guides empirical research.

The English term "empirical" derives from the [Greek](http://en.wikipedia.org/wiki/Ancient_Greek) word ἐμπειρία, which is cognate with and translates to the Latin *experientia*, from which we derive the word "experience" and the related "experiment". The term was used by the[Empiric school](http://en.wikipedia.org/wiki/Empiric_school) of ancient Greek medical practitioners, who rejected the three doctrines of the [Dogmatic school](http://en.wikipedia.org/wiki/Dogmatic_school), preferring to rely on the observation of [*"phenomena"*](http://en.wikipedia.org/wiki/Phenomenalism).[[5]](http://en.wikipedia.org/wiki/Empiricism#cite_note-sini-5)

### Background

A central concept in [science](http://en.wikipedia.org/wiki/Science) and the [scientific method](http://en.wikipedia.org/wiki/Scientific_method) is that it must be *empirically* based on the evidence of the senses. Both [natural](http://en.wikipedia.org/wiki/Natural_science) and [social sciences](http://en.wikipedia.org/wiki/Social_science) use working [hypotheses](http://en.wikipedia.org/wiki/Hypothesis) that are [testable](http://en.wikipedia.org/wiki/Testable) by [observation](http://en.wikipedia.org/wiki/Observation) and [experiment](http://en.wikipedia.org/wiki/Experiment). The term *semi-empirical* is sometimes used to describe theoretical methods that make use of basic [axioms](http://en.wikipedia.org/wiki/Axiom), established scientific laws, and previous experimental results in order to engage in reasoned model building and theoretical inquiry.

Philosophical empiricists hold no knowledge to be properly inferred or deduced unless it is derived from one's sense-based experience.[[6]](http://en.wikipedia.org/wiki/Empiricism#cite_note-6) This view is commonly contrasted with [rationalism](http://en.wikipedia.org/wiki/Rationalism), which states that knowledge may be derived from [reason](http://en.wikipedia.org/wiki/Reason) independently of the senses. For example [John Locke](http://en.wikipedia.org/wiki/John_Locke) held that some knowledge (e.g. knowledge of God's existence) could be arrived at through [intuition](http://en.wikipedia.org/wiki/Intuition_(knowledge)) and reasoning alone. Similarly [Robert Boyle](http://en.wikipedia.org/wiki/Robert_Boyle), a prominent advocate of the experimental method, held that we have innate ideas.[[7]](http://en.wikipedia.org/wiki/Empiricism#cite_note-7)[[8]](http://en.wikipedia.org/wiki/Empiricism#cite_note-8) The main continental rationalists ([Descartes](http://en.wikipedia.org/wiki/Descartes), [Spinoza](http://en.wikipedia.org/wiki/Spinoza), and [Leibniz](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz)) were also advocates of the empirical "scientific method".[[9]](http://en.wikipedia.org/wiki/Empiricism#cite_note-9)[[10]](http://en.wikipedia.org/wiki/Empiricism#cite_note-10)

### Early empiricism

The notion of [*tabula rasa*](http://en.wikipedia.org/wiki/Tabula_rasa) ("clean slate" or "blank tablet") connotes a view of mind as an originally blank or empty recorder (Locke used the words "white paper") on which experience leaves marks. This denies that humans have [innate ideas](http://en.wikipedia.org/wiki/Innate_ideas). The image dates back to [Aristotle](http://en.wikipedia.org/wiki/Aristotle);

What the mind ([*nous*](http://en.wikipedia.org/wiki/Nous)) thinks must be in it in the same sense as letters are on a tablet (*grammateion*) which bears no actual writing (*grammenon*); this is just what happens in the case of the mind. (Aristotle, [*On the Soul*](http://en.wikipedia.org/wiki/On_the_Soul), 3.4.430a1).

Aristotle's explanation of how this was possible, was not strictly empiricist in a modern sense, but rather based on his theory of [potentiality and actuality](http://en.wikipedia.org/wiki/Potentiality_and_actuality), and experience of sense perceptions still requires the help of the [active *nous*](http://en.wikipedia.org/wiki/Active_intellect). These notions contrasted with [Platonic](http://en.wikipedia.org/wiki/Platonism) notions of the human mind as an entity that pre-existed somewhere in the heavens, before being sent down to join a body on Earth (see Plato's [*Phaedo*](http://en.wikipedia.org/wiki/Phaedo) and *Apology*, as well as others). Aristotle was considered to give a more important position to sense perception than [Plato](http://en.wikipedia.org/wiki/Plato), and commentators in the middle ages summarized one of his positions as "*nihil in intellectu nisi prius fuerit in sensu*" (Latin for "nothing in the intellect without first being in the senses").

During the [middle ages](http://en.wikipedia.org/wiki/Middle_ages) Aristotle's theory of [*tabula rasa*](http://en.wikipedia.org/wiki/Tabula_rasa) was developed by [Islamic philosophers](http://en.wikipedia.org/wiki/Islamic_philosophy) starting with [Al Farabi](http://en.wikipedia.org/wiki/Al_Farabi), developing into an elaborate theory by [Avicenna](http://en.wikipedia.org/wiki/Avicenna)[[11]](http://en.wikipedia.org/wiki/Empiricism#cite_note-Rizvi-11) and demonstrated as a[thought experiment](http://en.wikipedia.org/wiki/Thought_experiment) by [Ibn Tufail](http://en.wikipedia.org/wiki/Ibn_Tufail).[[12]](http://en.wikipedia.org/wiki/Empiricism#cite_note-Russell-12) For Avicenna ([Ibn Sina](http://en.wikipedia.org/wiki/Avicenna)), for example, the a *tabula rasa* is a pure potentiality that is actualized through [education](http://en.wikipedia.org/wiki/Education), and knowledge is attained through "empirical familiarity with objects in this world from which one abstracts universal concepts" developed through a "[syllogistic](http://en.wikipedia.org/wiki/Syllogism) method of [reasoning](http://en.wikipedia.org/wiki/Reasoning) in which observations lead to propositional statements which when compounded lead to further abstract concepts." The [intellect](http://en.wikipedia.org/wiki/Intellect) itself develops from a [material intellect](http://en.wikipedia.org/wiki/Passive_intellect) (*al-'aql al-hayulani*), which is a [potentiality](http://en.wikipedia.org/wiki/Potentiality) "that can acquire knowledge to the [active intellect](http://en.wikipedia.org/wiki/Active_intellect) (*al-*[*'aql*](http://en.wikipedia.org/wiki/%27Aql)*al-fa'il*), the state of the human intellect in conjunction with the perfect source of knowledge".[[11]](http://en.wikipedia.org/wiki/Empiricism#cite_note-Rizvi-11) So the immaterial "active intellect", separate from any individual person, is still essential for understanding to occur.

In the 12th century CE the [Andalusian](http://en.wikipedia.org/wiki/Al-Andalus) [Muslim](http://en.wikipedia.org/wiki/Muslim) philosopher and novelist Abu Bakr [Ibn Tufail](http://en.wikipedia.org/wiki/Ibn_Tufail) (known as "Abubacer" or "Ebn Tophail" in the West) included the theory of *tabula rasa* as a [thought experiment](http://en.wikipedia.org/wiki/Thought_experiment) in his [Arabic philosophical novel](http://en.wikipedia.org/wiki/Arabic_literature), [*Hayy ibn Yaqdhan*](http://en.wikipedia.org/wiki/Hayy_ibn_Yaqdhan) in which he depicted the development of the mind of a [feral child](http://en.wikipedia.org/wiki/Feral_child) "from a *tabula rasa* to that of an adult, in complete isolation from society" on a [desert island](http://en.wikipedia.org/wiki/Desert_island), through experience alone. The [Latin](http://en.wikipedia.org/wiki/Latin) translation of his [philosophical novel](http://en.wikipedia.org/wiki/Philosophical_novel), entitled *Philosophus Autodidactus*, published by [Edward Pococke](http://en.wikipedia.org/wiki/Edward_Pococke) the Younger in 1671, had an influence on [John Locke](http://en.wikipedia.org/wiki/John_Locke)'s formulation of *tabula rasa* in [*An Essay Concerning Human Understanding*](http://en.wikipedia.org/wiki/An_Essay_Concerning_Human_Understanding).[[12]](http://en.wikipedia.org/wiki/Empiricism#cite_note-Russell-12)

A similar [Islamic theological](http://en.wikipedia.org/wiki/Islamic_theology) novel, [*Theologus Autodidactus*](http://en.wikipedia.org/wiki/Theologus_Autodidactus), was written by the Arab theologian and physician [Ibn al-Nafis](http://en.wikipedia.org/wiki/Ibn_al-Nafis) in the 13th century. It also dealt with the theme of empiricism through the story of a feral child on a desert island, but departed from its predecessor by depicting the development of the protagonist's mind through contact with society rather than in isolation from society.[[13]](http://en.wikipedia.org/wiki/Empiricism#cite_note-Roubi-13)

During the 13th century [Thomas Aquinas](http://en.wikipedia.org/wiki/Thomas_Aquinas) adopted the [Aristotelian](http://en.wikipedia.org/wiki/Aristotelianism) position that the senses are essential to mind into [scholasticism](http://en.wikipedia.org/wiki/Scholasticism). [Bonaventure](http://en.wikipedia.org/wiki/Bonaventure) (1221–1274), one of Aquinas' strongest intellectual opponents, offered some of the strongest arguments in favour of the Platonic idea of the mind.

### Renaissance Italy

In the late [renaissance](http://en.wikipedia.org/wiki/Renaissance) various writers began to question the [medieval](http://en.wikipedia.org/wiki/Medieval) and [classical](http://en.wikipedia.org/wiki/Classical_philosophy) understanding of knowledge acquisition in a more fundamental way. In political and historical writing [Niccolò Machiavelli](http://en.wikipedia.org/wiki/Niccol%C3%B2_Machiavelli) and his friend [Francesco Guicciardini](http://en.wikipedia.org/wiki/Francesco_Guicciardini) initiated a new realistic style of writing. Machiavelli in particular was scornful of writers on politics who judged everything in comparison to mental ideals and demanded that people should study the "effectual truth" instead.

Their contemporary, Leonardo da Vinci (1452–1519) said,[[14]](http://en.wikipedia.org/wiki/Empiricism#cite_note-14)

If you find from your own experience that something is a fact and it contradicts what some authority has written down, then you must abandon the authority and base your reasoning on your own findings.

The decidedly anti-Aristotelian and anti-clerical music theorist [Vincenzo Galilei](http://en.wikipedia.org/wiki/Vincenzo_Galilei) (ca. 1520–1591), father of [Galileo](http://en.wikipedia.org/wiki/Galileo_Galilei) and the inventor of [monody](http://en.wikipedia.org/wiki/Monody), made use of the method in successfully solving musical problems, firstly, of tuning such as the relationship of pitch to string tension and mass in stringed instruments, and to volume of air in wind instruments; and secondly to composition, by his various suggestions to composers in his *Dialogo della musica antica e moderna*(Florence, 1581). The Italian word he used for "experiment" was *esperienza*. It is known that he was the essential pedagogical influence upon the young Galileo, his eldest son (cf. Coelho, ed. *Music and Science in the Age of Galileo Galilei*), arguably one of the most influential empiricists in history. Vincenzo, through his tuning research, found the underlying truth at the heart of the misunderstood myth of '[Pythagoras' hammers](http://en.wikipedia.org/wiki/Pythagorean_hammers)' (the square of the numbers concerned yielded those musical intervals, not the actual numbers, as believed), and through this and other discoveries that demonstrated the fallibility of traditional authorities, a radically empirical attitude developed, passed on to Galileo, which regarded "experience and demonstration" as the *sine qua non* of valid rational enquiry.

### British empiricism

British empiricism, though it was not a term used at the time, derives from the 17th century period of [early modern philosophy](http://en.wikipedia.org/wiki/Early_modern_philosophy) and [modern science](http://en.wikipedia.org/wiki/Modern_science). The term became useful in order to describe differences perceived between two of its founders [Francis Bacon](http://en.wikipedia.org/wiki/Francis_Bacon), described as empiricist, and [René Descartes](http://en.wikipedia.org/wiki/Ren%C3%A9_Descartes), who is described as a rationalist. [Thomas Hobbes](http://en.wikipedia.org/wiki/Thomas_Hobbes) and [Baruch Spinoza](http://en.wikipedia.org/wiki/Baruch_Spinoza), in the next generation, are often also described as an empiricist and a rationalist respectively. [John Locke](http://en.wikipedia.org/wiki/John_Locke), [George Berkeley](http://en.wikipedia.org/wiki/George_Berkeley), and [David Hume](http://en.wikipedia.org/wiki/David_Hume) were the primary exponents of empiricism in the 18th century [Enlightenment](http://en.wikipedia.org/wiki/The_Enlightenment), with Locke being the person who is normally known as the founder of empiricism as such.

In response to the early-to-mid-17th century "[continental rationalism](http://en.wikipedia.org/wiki/Rationalism#History)" [John Locke](http://en.wikipedia.org/wiki/John_Locke) (1632–1704) proposed in [*An Essay Concerning Human Understanding*](http://en.wikipedia.org/wiki/An_Essay_Concerning_Human_Understanding) (1689) a very influential view wherein the *only* knowledge humans can have is [*a posteriori*](http://en.wikipedia.org/wiki/A_posteriori), i.e., based upon experience. Locke is famously attributed with holding the proposition that the human mind is a [*tabula rasa*](http://en.wikipedia.org/wiki/Tabula_rasa), a "blank tablet," in Locke's words "white paper," on which the experiences derived from sense impressions as a person's life proceeds are written. There are two sources of our ideas: sensation and reflection. In both cases, a distinction is made between simple and complex ideas. The former are unanalysable, and are broken down into primary and secondary qualities. Primary qualities are essential for the object in question to be what it is. Without specific primary qualities, an object would not be what it is. For example, an apple is an apple because of the arrangement of its atomic structure. If an apple was structured differently, it would cease to be an apple. Secondary qualities are the sensory information we can perceive from its primary qualities. For example, an apple can be perceived in various colours, sizes, and textures but it is still identified as an apple. Therefore its primary qualities dictate what the object essentially is, while its secondary qualities define its attributes. Complex ideas combine simple ones, and divide into substances, modes, and relations. According to Locke, our knowledge of things is a perception of ideas that are in accordance or discordance with each other, which is very different from the quest for [certainty](http://en.wikipedia.org/wiki/Certainty) of [Descartes](http://en.wikipedia.org/wiki/Descartes).

A generation later, the Irish [Anglican](http://en.wikipedia.org/wiki/Anglican) bishop, [George Berkeley](http://en.wikipedia.org/wiki/George_Berkeley) (1685–1753), determined that Locke's view immediately opened a door that would lead to eventual [atheism](http://en.wikipedia.org/wiki/Atheism). In response to Locke, he put forth in his [*Treatise Concerning the Principles of Human Knowledge*](http://en.wikipedia.org/wiki/Treatise_Concerning_the_Principles_of_Human_Knowledge) (1710) an important challenge to empiricism in which things *only* exist either as a *result* of their being perceived, or by virtue of the fact that they are an entity doing the perceiving. (For Berkeley, God fills in for humans by doing the perceiving whenever humans are not around to do it). In his text *Alciphron*, Berkeley maintained that any order humans may see in nature is the language or handwriting of God.[[15]](http://en.wikipedia.org/wiki/Empiricism#cite_note-15) Berkeley's approach to empiricism would later come to be called [subjective idealism](http://en.wikipedia.org/wiki/Subjective_idealism).[[16]](http://en.wikipedia.org/wiki/Empiricism#cite_note-16)[[17]](http://en.wikipedia.org/wiki/Empiricism#cite_note-MEP2-17)

The Scottish philosopher [David Hume](http://en.wikipedia.org/wiki/David_Hume) (1711–1776) responded to Berkeley's criticisms of Locke, as well as other differences between early modern philosophers, and moved empiricism to a new level of[skepticism](http://en.wikipedia.org/wiki/Skepticism). Hume argued in keeping with the empiricist view that all knowledge derives from sense experience, but he accepted that this has implications not normally acceptable to philosophers. He wrote for example, "Mr. Locke divides all arguments into demonstrative and probable. In this view, we must say, that it is only probable all men must die, or that the sun will rise to-morrow."[[18]](http://en.wikipedia.org/wiki/Empiricism#cite_note-18) And, "Mr. Locke, in his chapter of power, says that, finding from experience, that there are several new productions in nature, and concluding that there must somewhere be a power capable of producing them, we arrive at last by this reasoning at the idea of power. But no reasoning can ever give us a new, original, simple idea; as this philosopher himself confesses. This, therefore, can never be the origin of that idea."[[19]](http://en.wikipedia.org/wiki/Empiricism#cite_note-19)

Hume divided all of human knowledge into two categories: *relations of ideas* and *matters of fact* (see also [Kant's](http://en.wikipedia.org/wiki/Immanuel_Kant) [analytic-synthetic distinction](http://en.wikipedia.org/wiki/Analytic-synthetic_distinction)). Mathematical and logical propositions (e.g. "that the square of the hypotenuse is equal to the sum of the squares of the two sides") are examples of the first, while propositions involving some [contingent](http://en.wikipedia.org/wiki/Contingent) observation of the world (e.g. "the sun rises in the East") are examples of the second. All of people's "ideas", in turn, are derived from their "impressions". For Hume, an "impression" corresponds roughly with what we call a sensation. To remember or to imagine such impressions is to have an "idea". Ideas are therefore the faint copies of sensations.[[20]](http://en.wikipedia.org/wiki/Empiricism#cite_note-Hume1-20)

Hume maintained that all knowledge, even the most basic beliefs about the [natural world](http://en.wikipedia.org/wiki/Natural_world), cannot be conclusively established by reason. Rather, he maintained, our beliefs are more a result of accumulated *habits*, developed in response to accumulated sense experiences. Among his many arguments Hume also added another important slant to the debate about [scientific method](http://en.wikipedia.org/wiki/Scientific_method) — that of the [problem of induction](http://en.wikipedia.org/wiki/Problem_of_induction). Hume argued that it requires inductive reasoning to arrive at the premises for the principle of inductive reasoning, and therefore the justification for inductive reasoning is a circular argument.[[20]](http://en.wikipedia.org/wiki/Empiricism#cite_note-Hume1-20) Among Hume's conclusions regarding the problem of induction is that there is no certainty that the future will resemble the past. Thus, as a simple instance posed by Hume, we cannot know with certainty by [inductive reasoning](http://en.wikipedia.org/wiki/Inductive_reasoning) that the sun will continue to rise in the East, but instead come to expect it to do so because it has repeatedly done so in the past.[[20]](http://en.wikipedia.org/wiki/Empiricism#cite_note-Hume1-20)

Hume concluded that such things as belief in an external world and belief in the existence of the self were not rationally justifiable. According to Hume these beliefs were to be accepted nonetheless because of their profound basis in instinct and custom. Hume's lasting legacy, however, was the doubt that his skeptical arguments cast on the legitimacy of inductive reasoning, allowing many skeptics who followed to cast similar doubt.

### Phenomenalism

Most of Hume's followers have disagreed with his conclusion that belief in an external world is *rationally* unjustifiable, contending that Hume's own principles implicitly contained the rational justification for such a belief, that is, beyond being content to let the issue rest on human instinct, custom and habit.[[21]](http://en.wikipedia.org/wiki/Empiricism#cite_note-21) According to an extreme empiricist theory known as [Phenomenalism](http://en.wikipedia.org/wiki/Phenomenalism), anticipated by the arguments of both Hume and George Berkeley, a physical object is a kind of construction out of our experiences.[[22]](http://en.wikipedia.org/wiki/Empiricism#cite_note-22) Phenomenalism is the view that physical objects, properties, events (whatever is physical) are reducible to mental objects, properties, events. Ultimately, only mental objects, properties, events, exist — hence the closely related term [subjective idealism](http://en.wikipedia.org/wiki/Subjective_idealism). By the phenomenalistic line of thinking, to have a visual experience of a real physical thing is to have an experience of a certain kind of group of experiences. This type of set of experiences possesses a constancy and coherence that is lacking in the set of experiences of which hallucinations, for example, are a part. As [John Stuart Mill](http://en.wikipedia.org/wiki/John_Stuart_Mill) put it in the mid-19th century, matter is the "permanent possibility of sensation".[[23]](http://en.wikipedia.org/wiki/Empiricism#cite_note-23) Mill's empiricism went a significant step beyond Hume in still another respect: in maintaining that induction is necessary for *all* meaningful knowledge including mathematics. As summarized by D.W. Hamlin:

[Mill] claimed that mathematical truths were merely very highly confirmed generalizations from experience; mathematical inference, generally conceived as deductive [and *a priori*] in nature, Mill set down as founded on induction. Thus, in Mill's philosophy there was no real place for knowledge based on relations of ideas. In his view logical and mathematical necessity is psychological; we are merely unable to conceive any other possibilities than those that logical and mathematical propositions assert. This is perhaps the most extreme version of empiricism known, but it has not found many defenders.[[17]](http://en.wikipedia.org/wiki/Empiricism#cite_note-MEP2-17)

Mill's empiricism thus held that knowledge of any kind is not from direct experience but an inductive inference from direct experience.[[24]](http://en.wikipedia.org/wiki/Empiricism#cite_note-24) The problems other philosophers have had with Mill's position center around the following issues: Firstly, Mill's formulation encounters difficulty when it describes what direct experience is by differentiating only between actual and possible sensations. This misses some key discussion concerning conditions under which such "groups of permanent possibilities of sensation" might exist in the first place. Berkeley put God in that gap; the phenomenalists, including Mill, essentially left the question unanswered. In the end, lacking an acknowledgement of an aspect of "reality" that goes beyond mere "possibilities of sensation", such a position leads to a version of subjective idealism. Questions of how floor beams continue to support a floor while unobserved, how trees continue to grow while unobserved and untouched by human hands, etc., remain unanswered, and perhaps unanswerable in these terms.[[17]](http://en.wikipedia.org/wiki/Empiricism#cite_note-MEP2-17)[[25]](http://en.wikipedia.org/wiki/Empiricism#cite_note-MEP6-25) Secondly, Mill's formulation leaves open the unsettling possibility that the "gap-filling entities are purely possibilities and not actualities at all".[[25]](http://en.wikipedia.org/wiki/Empiricism#cite_note-MEP6-25) Thirdly, Mill's position, by calling mathematics merely another species of inductive inference, misapprehends mathematics. It fails to fully consider the structure and method of [mathematical science](http://en.wikipedia.org/wiki/Mathematical_science), the products of which are arrived at through an internally consistent [deductive](http://en.wikipedia.org/wiki/Deductive_reasoning) set of procedures which do not, either today or at the time Mill wrote, fall under the agreed meaning of [induction](http://en.wikipedia.org/wiki/Inductive_reasoning).[[17]](http://en.wikipedia.org/wiki/Empiricism#cite_note-MEP2-17)[[25]](http://en.wikipedia.org/wiki/Empiricism#cite_note-MEP6-25)[[26]](http://en.wikipedia.org/wiki/Empiricism#cite_note-26)

The phenomenalist phase of post-Humean empiricism ended by the 1940s, for by that time it had become obvious that statements about physical things could not be translated into statements about actual and possible sense data.[[27]](http://en.wikipedia.org/wiki/Empiricism#cite_note-27) If a physical object statement is to be translatable into a sense-data statement, the former must be at least deducible from the latter. But it came to be realized that there is no finite set of statements about actual and possible sense-data from which we can deduce even a single physical-object statement. Remember that the translating or paraphrasing statement must be couched in terms of normal observers in normal conditions of observation. There is, however, no *finite*set of statements that are couched in purely sensory terms and can express the satisfaction of the condition of the presence of a normal observer. According to phenomenalism, to say that a normal observer is present is to make the hypothetical statement that were a doctor to inspect the observer, the observer would appear to the doctor to be normal. But, of course, the doctor himself must be a normal observer. If we are to specify this doctor's normality in sensory terms, we must make reference to a second doctor who, when inspecting the sense organs of the first doctor, would himself have to have the sense data a normal observer has when inspecting the sense organs of a subject who is a normal observer. And if we are to specify in sensory terms that the second doctor is a normal observer, we must refer to a third doctor, and so on (also see the [third man](http://en.wikipedia.org/wiki/Third_Man_Argument)).[[28]](http://en.wikipedia.org/wiki/Empiricism#cite_note-28)[[29]](http://en.wikipedia.org/wiki/Empiricism#cite_note-29)

### Logical empiricism

Logical empiricism (aka *logical positivism* or *neopositivism*) was an early 20th-century attempt to synthesize the essential ideas of British empiricism (e.g. a strong emphasis on sensory experience as the basis for knowledge) with certain insights from [mathematical logic](http://en.wikipedia.org/wiki/Mathematical_logic) that had been developed by [Gottlob Frege](http://en.wikipedia.org/wiki/Gottlob_Frege) and [Ludwig Wittgenstein](http://en.wikipedia.org/wiki/Ludwig_Wittgenstein). Some of the key figures in this movement were [Otto Neurath](http://en.wikipedia.org/wiki/Otto_Neurath), [Moritz Schlick](http://en.wikipedia.org/wiki/Moritz_Schlick) and the rest of the [Vienna Circle](http://en.wikipedia.org/wiki/Vienna_Circle), along with [A.J. Ayer](http://en.wikipedia.org/wiki/A.J._Ayer), [Rudolf Carnap](http://en.wikipedia.org/wiki/Rudolf_Carnap) and [Hans Reichenbach](http://en.wikipedia.org/wiki/Hans_Reichenbach). The neopositivists subscribed to a notion of philosophy as the conceptual clarification of the methods, insights and discoveries of the sciences. They saw in the logical symbolism elaborated by Frege (d. 1925) and [Bertrand Russell](http://en.wikipedia.org/wiki/Bertrand_Russell) (1872–1970) a powerful instrument that could rationally reconstruct all scientific discourse into an ideal, logically perfect, language that would be free of the ambiguities and deformations of natural language. This gave rise to what they saw as metaphysical pseudoproblems and other conceptual confusions. By combining Frege's thesis that all mathematical truths are logical with the early Wittgenstein's idea that all [logical truths](http://en.wikipedia.org/wiki/Logical_truth)are mere linguistic [tautologies](http://en.wikipedia.org/wiki/Tautology_(logic)), they arrived at a twofold classification of all propositions: the *analytic* (a priori) and the *synthetic* (a posteriori).[[30]](http://en.wikipedia.org/wiki/Empiricism#cite_note-30) On this basis, they formulated a strong principle of demarcation between sentences that have sense and those that do not: the so-called [verification principle](http://en.wikipedia.org/wiki/Verification_principle). Any sentence that is not purely logical, or is unverifiable is devoid of meaning. As a result, most metaphysical, ethical, aesthetic and other traditional philosophical problems came to be considered pseudoproblems.[[31]](http://en.wikipedia.org/wiki/Empiricism#cite_note-31)

In the extreme empiricism of the neopositivists—at least before the 1930s—any genuinely synthetic assertion must be reducible to an ultimate assertion (or set of ultimate assertions) that expresses direct observations or perceptions. In later years, Carnap and Neurath abandoned this sort of *phenomenalism* in favor of a rational reconstruction of knowledge into the language of an objective spatio-temporal physics. That is, instead of translating sentences about physical objects into sense-data, such sentences were to be translated into so-called *protocol sentences*, for example, "*X* at location *Y* and at time *T* observes such and such."[[32]](http://en.wikipedia.org/wiki/Empiricism#cite_note-32) The central theses of logical positivism (verificationism, the analytic-synthetic distinction, reductionism, etc.) came under sharp attack after World War 2 by thinkers such as [Nelson Goodman](http://en.wikipedia.org/wiki/Nelson_Goodman), [W.V. Quine](http://en.wikipedia.org/wiki/W.V._Quine), [Hilary Putnam](http://en.wikipedia.org/wiki/Hilary_Putnam), [Karl Popper](http://en.wikipedia.org/wiki/Karl_Popper), and [Richard Rorty](http://en.wikipedia.org/wiki/Richard_Rorty). By the late 1960s, it had become evident to most philosophers that the movement had pretty much run its course, though its influence is still significant among contemporary [analytic philosophers](http://en.wikipedia.org/wiki/Analytic_philosophy) such as [Michael Dummett](http://en.wikipedia.org/wiki/Michael_Dummett) and other [anti-realists](http://en.wikipedia.org/wiki/Anti-realism).

### Pragmatism

In the late 19th and early 20th century several forms of [pragmatic philosophy](http://en.wikipedia.org/wiki/Pragmatism) arose. The ideas of pragmatism, in its various forms, developed mainly from discussions that took place while [Charles Sanders Peirce](http://en.wikipedia.org/wiki/Charles_Sanders_Peirce) and [William James](http://en.wikipedia.org/wiki/William_James) were both at Harvard in the 1870s. James popularized the term "pragmatism", giving Peirce full credit for its patrimony, but Peirce later demurred from the tangents that the movement was taking, and redubbed what he regarded as the original idea with the name of "pragmaticism". Along with its [*pragmatic theory of truth*](http://en.wikipedia.org/wiki/Pragmatic_theory_of_truth), this perspective integrates the basic insights of empirical (experience-based) and [rational](http://en.wikipedia.org/wiki/Rationalism) (concept-based) thinking.

Charles Peirce (1839–1914) was highly influential in laying the groundwork for today's empirical [scientific method](http://en.wikipedia.org/wiki/Scientific_method).[[*citation needed*](http://en.wikipedia.org/wiki/Wikipedia:Citation_needed)] Although Peirce severely criticized many elements of Descartes' peculiar brand of rationalism, he did not reject rationalism outright. Indeed, he concurred with the main ideas of rationalism, most importantly the idea that rational concepts can be meaningful and the idea that rational concepts necessarily go beyond the data given by empirical observation. In later years he even emphasized the concept-driven side of the then ongoing debate between strict empiricism and strict rationalism, in part to counterbalance the excesses to which some of his cohorts had taken pragmatism under the "data-driven" strict-empiricist view. Among Peirce's major contributions was to place [inductive reasoning](http://en.wikipedia.org/wiki/Inductive_reasoning) and [deductive reasoning](http://en.wikipedia.org/wiki/Deductive_reasoning) in a complementary rather than competitive mode, the latter of which had been the primary trend among the educated since David Hume wrote a century before. To this, Peirce added the concept of [abductive reasoning](http://en.wikipedia.org/wiki/Abductive_reasoning). The combined three forms of reasoning serve as a primary conceptual foundation for the empirically based scientific method today. Peirce's approach "presupposes that (1) the objects of knowledge are real things, (2) the characters (properties) of real things do not depend on our perceptions of them, and (3) everyone who has sufficient experience of real things will agree on the truth about them. According to Peirce's doctrine of [fallibilism](http://en.wikipedia.org/wiki/Fallibilism), the conclusions of science are always tentative. The rationality of the scientific method does not depend on the certainty of its conclusions, but on its self-corrective character: by continued application of the method science can detect and correct its own mistakes, and thus eventually lead to the discovery of truth".[[33]](http://en.wikipedia.org/wiki/Empiricism#cite_note-33)

In his Harvard "Lectures on Pragmatism" (1903), Peirce enumerated what he called the "three cotary propositions of pragmatism" ([L:](http://en.wikipedia.org/wiki/Latin) *cos, cotis* whetstone), saying that they "put the edge on the [maxim of pragmatism](http://en.wikipedia.org/wiki/Pragmatic_maxim)". First among these he listed the peripatetic-thomist observation mentioned above, but he further observed that this link between sensory perception and intellectual conception is a two-way street. That is, it can be taken to say that whatever we find in the intellect is also incipiently in the senses. Hence, if theories are theory-laden then so are the senses, and perception itself can be seen as a species of [abductive inference](http://en.wikipedia.org/wiki/Abductive_reasoning), its difference being that it is beyond control and hence beyond critique – in a word, incorrigible. This in no way conflicts with the fallibility and revisability of scientific concepts, since it is only the immediate percept in its unique individuality or "thisness" – what the [Scholastics](http://en.wikipedia.org/wiki/Scholastics) called its [*haecceity*](http://en.wikipedia.org/wiki/Haecceity) – that stands beyond control and correction. Scientific concepts, on the other hand, are general in nature, and transient sensations do in another sense find correction within them. This notion of perception as abduction has received periodic revivals in [artificial intelligence](http://en.wikipedia.org/wiki/Artificial_intelligence) and [cognitive science](http://en.wikipedia.org/wiki/Cognitive_science)research, most recently for instance with the work of [Irvin Rock](http://en.wikipedia.org/wiki/Irvin_Rock) on [*indirect perception*](http://en.wikipedia.org/wiki/Indirect_perception).[[34]](http://en.wikipedia.org/wiki/Empiricism#cite_note-34)[[35]](http://en.wikipedia.org/wiki/Empiricism#cite_note-35)

Around the beginning of the 20th century, William James (1842–1910) coined the term "radical empiricism" to describe an offshoot of his form of pragmatism, which he argued could be dealt with separately from his pragmatism – though in fact the two concepts are intertwined in James's published lectures. James maintained that the empirically observed "directly apprehended universe needs ... no extraneous trans-empirical connective support",[[36]](http://en.wikipedia.org/wiki/Empiricism#cite_note-36) by which he meant to rule out the perception that there can be any [value added](http://en.wikipedia.org/wiki/Value_added) by seeking [supernatural](http://en.wikipedia.org/wiki/Supernatural) explanations for [natural](http://en.wikipedia.org/wiki/Nature) [phenomena](http://en.wikipedia.org/wiki/Phenomena). James's "radical empiricism" is thus *not* radical in the context of the term "empiricism", but is instead fairly consistent with the modern use of the term "[empirical](http://en.wikipedia.org/wiki/Empirical)". (His method of argument in arriving at this view, however, still readily encounters debate within philosophy even today.)

[John Dewey](http://en.wikipedia.org/wiki/John_Dewey) (1859–1952) modified James' pragmatism to form a theory known as [instrumentalism](http://en.wikipedia.org/wiki/Instrumentalism). The role of sense experience in Dewey's theory is crucial, in that he saw experience as unified totality of things through which everything else is interrelated. Dewey's basic thought, in accordance with empiricism was that [reality](http://en.wikipedia.org/wiki/Reality) is determined by past experience. Therefore, humans adapt their past experiences of things to perform experiments upon and test the pragmatic values of such experience. The value of such experience is measured experientially and scientifically, and the results of such tests generate ideas that serve as instruments for future experimentation,[[37]](http://en.wikipedia.org/wiki/Empiricism#cite_note-37) in physical sciences as in ethics.[[38]](http://en.wikipedia.org/wiki/Empiricism#cite_note-38) Thus, ideas in Dewey's system retain their empiricist flavour in that they are only known *a posteriori*.