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Patricia Curd (2005)

PASCAL, BLAISE (1623–1662)

Blaise Pascal was a French mathematician, physicist, inventor, philosopher, and theologian. He was born in Clermont in Auvergne, the son of a minor noble who was a government official. Pascal's mother died in 1626. In 1631 the family moved to Paris but fled in 1638 because of the father's opposition to the fiscal regulations of Richelieu. The next year Pascal's younger sister, Jacqueline, successfully acted in a children's play performed for Richelieu and thus gained a pardon for her father, who then became the royal tax commissioner at Rouen.

MATHEMATICS AND PHYSICS

Pascal was a prodigy, privately educated by his father, who was an excellent mathematician. His father wanted his son to have a good humanistic background before he learned mathematics and science, but at the age of twelve, Pascal discovered by himself the principles of geometry. When his father realized this, he abandoned his original plan for his son's education and encouraged his mathematical development. While still a teenager, Pascal published important mathematical and scientific papers and was a young prodigy in the Parisian intellectual circles. His father and he became members of a scientific discussion group organized by Father Marin Mersenne. There he would have met a wide range of people, probably

including Thomas Hobbes, Descartes, and others. At sixteen, Pascal wrote his first major work, *Essai pour les coniques* (published in 1640), which his sister reported was "considered so great an intellectual achievement that people said that they had seen nothing as mighty since the time of Archimedes." In 1642 Pascal invented the calculating machine, originally designed to help his father in his tax work. This machine was one of the first applied achievements of the "new science." Pascal's writings on the calculating machine from 1645 to 1652 indicate the inordinate difficulties of putting theory into practice, the wide divergence between the levels of metallurgical and mathematical skill, and the monumental importance of this early contribution to the industrial revolution.

For the rest of his life Pascal continued to make major mathematical contributions in probability theory, number theory, and geometry. Although he gave up serious concern with mathematical problems after his religious conversion in 1654, a notable analysis of the nature of the cycloid grew out of a night's insomnia in 1658. Pascal's important work in the philosophy of mathematics, *L'esprit géométrique*, was probably written in 1657 and 1658 as a preface to a textbook in geometry for the Jansenist school at Port-Royal.

THE VACUUM

In 1646 Pascal learned of Evangelista Torricelli's (1608–1647) experiment with a barometer, which involved placing a tube of mercury upside down in a bowl of mercury. Having successfully repeated the experiment, Pascal asked himself what kept some of the mercury suspended in the tube and what was in the space above the column of mercury in the tube. Many scientists believed that the pressure of the outside atmosphere was responsible for holding up the column of mercury, but they had no proof. All agreed that the space at the top of the tube contained some kind of rarefied and invisible matter; hence, no vacuum. In 1647 Pascal published *Expériences nouvelles touchant le vide*, a summary of a series of experiments with variously shaped and sized tubes and different liquids, in which he set forth the basic laws about how much water and how much mercury could be supported by air pressure and about how large a siphon had to be to function. He also sketched out the reasons why a genuine vacuum could and did exist above the column of mercury or other liquid supported in the barometer.

Father Estienne Noel, rector of the Collège de Clermont in Paris, challenged Pascal, insisting that nature abhors a vacuum and therefore would not allow one to exist; thus, the alleged empty space created in Pascal's

experiments actually contained a special kind of matter. Pascal's reply, in which he gave the conditions for judging a hypothesis, is one of the clearest statements on scientific method made during the seventeenth century. Pascal asserted that a hypothesis could be disproved if one could elicit either a contradiction or a conclusion counter to fact from the affirmation of the hypothesis. However, if all the facts fit the hypothesis or follow from it, this merely shows the hypothesis is probable or possible. "In order to show that a hypothesis is evident, it does not suffice that all the phenomena follow from it; instead, if it leads to something contrary to a single one of the phenomena, that suffices to establish its falsity." Pascal showed that Noel's and Aristotle's hypothesis that there is no vacuum is false because conclusions contrary to experimentally established facts follow from it, whereas his own theory of a genuine vacuum is a possible or probable explanation of the facts in question.

In 1648 Pascal's brother-in-law performed the experiment of carrying a barometer up a mountain. This established the change in the level of the column of mercury. Pascal checked the results at various heights on a church tower in Paris. He then declared that these results established

that Nature has no abhorrence of a vacuum, that she makes no effort to avoid it; that all the effects that are ascribed to this horror are due to the weight and pressure of air; ... and that, due to not knowing this, people have deliberately invented that imaginary horror of a vacuum, in order to account for them.

Combining his ingeniously derived experimental data with a clear analysis of the possible explanatory hypotheses, Pascal arrived at one of the major achievements of seventeenth-century science. His theory of the vacuum and air pressure played an important role in the development of the mechanical theory of nature and the elimination of some of nature's alleged occult qualities and personal characteristics. The preface to the *Traité du vide* (which is all that has survived of the *Traité*) contains a defense of the new science and a discussion of the nature of scientific progress. In the study of nature, Pascal insisted that respect for authority should not take precedence over reasoning or experience (in theology, however, he maintained that it should). The secrets of nature, he said, are hidden from us, and although it is always active, we do not always discover its effects. In the course of time, through experience and understanding, we come to learn more about the natural world. Hence, as more data are accumulated, we should expect to find previously

accepted hypotheses replaced by newer ones. Our conclusions about nature are always limited by the amount of experience gathered up to now. In time we seek for truths in terms of our experience and comprehension. What is sought for may be unchanging, but the results of the quest are the variable developments that constitute the history of science. Thus, there is no reason for preferring the ancient scientific views of Aristotle or anyone else to the latest achievements of scientific reasoning, based on the most recent data.

PASCAL AND JANSENISM

Pascal's mathematical and scientific accomplishments are among the most important of his time, but his religious and philosophical views have overshadowed them. His writings in religion and philosophy grew out of his involvement with the Jansenist movement. In 1646, after his father was injured, two Jansenists came to take care of him. The whole family, including Blaise, became interested in and involved with this Catholic reform movement, with his sister Jacqueline, becoming a nun at Port-Royal de Paris. From 1652 to 1654, Pascal turned away from religious interests, spending his time mainly with libertine friends who were gamblers, womanizers, and probably freethinkers. Pascal often visited his sister at Port-Royal, indicating to her that he had a great contempt for the world and people but that he did not feel drawn to God. However, after a traumatic experience crossing the Pont Neuf in Paris during a storm, Pascal had a religious conversion. He recorded this religious experience in *Le Mémorial* as "certitude, certitude, feeling, joy, peace." A year later, in 1655, with the encouragement of his sister, he made his first retreat at Port-Royal-des-Champs. Thereafter, Pascal objected vehemently to the philosophy of Descartes, unfavorably contrasting the God of the philosophers—namely, Descartes's God—with the God of Abraham, Isaac, and Jacob.

In January 1655 Pascal went to Port-Royal-des-Champs, the order of the two Port-Royal convents, for a two-week retreat. There a famous discussion with the Jansenist theologian, Isaac Le Maistre de Saci, took place, published in the *Entretien avec M. de Saci*. This text indicates that Pascal had already formulated many of the views later developed in the *Pensées*. During the next several months, Pascal often visited the two Port-Royal convents. On one of these visits Pascal met Antoine Arnauld, the leading Jansenist philosopher and theologian, who was about to be condemned by the Sorbonne for his views. In *Lettres provinciales*, a series of eighteen letters published in 1656 and 1657, Pascal defended Arnauld and

satirized his Jesuit opponents and their theological and moral view. These letters, published under the pseudonym Louis de Montalte, were probably the cooperative work of Pascal, Arnauld, and Pierre Nicole, though they were principally by Pascal. One of the great French literary masterpieces, the *Lettres provinciales* mercilessly ridicules the casuistry of various Jesuit moralists for what Pascal considered their lax, inconsistent, and unchristian views and defends Jansenism against charges of heresy. The arguments of various sixteenth-century and seventeenth-century scholastics are torn apart, and the charges against the Jansenists rebutted in a dazzling display of wit, irony, abuse, argument, and literary brilliance. Nevertheless, the *Lettres provinciales* was placed on the Index in 1657, and shortly thereafter the Jansenist movement was condemned by the pope. In 1661 the schools at Port-Royal were closed, and the nuns and solitaires had to sign a submission to the church.

Until 1659 Pascal worked on a wide variety of subjects defending Jansenism, composing his *Écrits sur la grâce*, *De l'esprit géométrique*, *De l'art de persuader*, and the works on the cycloid and preparing his *Apologie de la religion chrétienne*, the unfinished work posthumously published as the *Pensées*. In 1659, seriously ill, Pascal practically stopped writing. In 1660 he was somewhat better and wrote his *Trois discours sur la condition des grands*. The next year, after the suppression of Jansenism and the death of Jacqueline, Pascal wrote his final work on Jansenism, *Écrit sur la signature du formulaire*, urging the Port-Royalists not to give in. He then withdrew from all further controversy. His last achievement, illustrating another side of his genius, was the invention of a large carriage with many seats and the inauguration of what was in effect the first bus line, carrying passengers from one part of Paris to another for a fixed fare. One of his motives was to gain money to give to the poor, because he had already disposed of almost all his worldly possessions. Much of his will is devoted to bequeathing portions of his bus revenues to various hospitals.

PHILOSOPHY OF MATHEMATICS AND SCIENCE

Pascal left unpublished his two most important philosophical works, the *Pensées* and *De l'esprit géométrique*. *De l'esprit géométrique* was first published in the eighteenth century. In it Pascal dealt with the problem of the method for discovering truths. The ideal method, he declared, would be one which defined all of the terms employed and demonstrated all propositions from already established truths, but this is impossible, because

the basic terms to be defined presuppose others to explain their meaning, and the fundamental propositions to be proved presuppose still others. Thus, it is impossible to reach first terms and principles. Instead, we find primitive terms that admit of no further definitions that clarify them and principles that are so clear that nothing clearer can be found to aid in proving them. "From which it seems that men are naturally and unalterably powerless to deal with any science whatsoever in an absolutely perfected manner."

Given this state of affairs, geometrical procedure is the most perfect known to humankind—a balanced one in which those things that are clear and known to everyone are not defined and everything else is defined, and in which those propositions known by all are assumed and other propositions are derived from them. Pascal insisted that this did not mean either that human beings could know by natural means that the premises of geometry were really true or that the fundamental concepts were thoroughly understood. Rather, the geometrical method provided the greatest certitude attainable by use of our limited capacities. Essentially, it developed an axiomatic system in which, from primitive terms and axioms, a set of propositions could be logically derived. Such a set would be true if the axioms were true.

In the companion piece to *L'esprit géométrique*, *De l'art de persuader*, Pascal explained how we come to be convinced of first principles and of conclusions from them. Conclusions are explained via the geometrical method. The problem of first principles raises a basic point for Pascal's theory of knowledge that is developed in the *Pensées*. Our reason and understanding can only work out axiom systems. Because we cannot prove the first principles, we can always cast skeptical doubts upon their truths, no matter how certain they may appear to us at various times. We can overcome this constant tendency toward skepticism (which also occurs in scientific research, because we can never know the secrets of nature but only plausible and as yet unrefuted hypotheses about the world) only by recognizing that principles are gained through instinct and revelation. This recognition requires admitting the importance of feelings and of submission to God in the quest for truth.

RELIGION

Pascal left the *Pensées* unfinished, with many notes of varying sizes pinned together. The first editors copied all the materials exactly as Pascal left them but published only those portions that they felt were completed, organizing them as they saw fit. Later editors assumed that the

Pensées was a collection of fragments, left in a disordered state by their author, and that each editor could arrange the fragments as he wished. Victor Cousin in 1842 pointed out that only selections of the *Pensées*, often somewhat embellished by the various editors, existed in print, and he urged a definitive edition based on the manuscripts in the Bibliothèque Nationale. One of these, the *Recueil original*, consists of the fragments in Pascal's own handwriting, pasted on large sheets of paper. For the next century editors used this manuscript for varying presentations of the text. In the 1930s and 1940s Zacharie Tourneur and Louis Lafuma established that the *Recueil* was pasted together after Pascal's death and that another manuscript, a copy by one of Pascal's relatives, represented the actual state of the work as organized and partially completed by the author. This led to Lafuma's definitive edition in 1952, which radically changed the order of the fragments, finally presenting the development of the themes in the *Pensées* as Pascal had intended them to be read.

THE HUMAN CONDITION. In the Lafuma edition the initial sections, "Order," "Vanity," "Misery," "Boredom," and "Causes of Effects," all portray the human condition by showing humankind's ways of dealing with and reacting to the ordinary world. The sixth and seventh sections turn to the core of humankind's philosophical problem—how to find truth and happiness. If humans are miserable, vain creatures, unable by their own resources to find first truths from which to derive others, they have to realize that "we know truth not only by reason but more so by the heart. It is in this latter way that we know first principles, and it is in vain that reason, which plays no part in this, tries to combat them" (Lafuma 1952, p. 110; Brunschvicg, p. 292). The principles of geometry are known instinctively by the heart, and reason employs these principles to establish theorems. Both heart and reason yield results that are certain, but by different routes, and it would be ridiculous to require proofs of the heart's instincts and intuitions or intuitive knowledge of what is proved. The inability of reason to establish first principles serves to humiliate reason but not to undermine our certainty. The realization of the limitations of reason helps us, Pascal declared, to recognize our wretchedness, and the greatness of humankind is that people alone are capable of such a recognition.

The climax of this attempt to show the ultimate non-rational foundation of our knowledge of first principles comes in the next section, "Contradictions." In a famous passage on skepticism (131 and 434) Pascal began by pointing out that the strongest contention of the

Pyrrhonists was that we have no assurance of the truth of any first principles apart from faith and revelation except that we feel them within us. This natural feeling is no convincing proof of their truth, because apart from faith we cannot tell whether humans were created by a good God, an evil demon, or by chance. The truth-value of the principles depends upon their source. Pascal then explored the depths of complete skepticism and showed that if one had no assurance or any principles, one could be certain of nothing; but at the same time one could not even become a complete skeptic.

What then will man do in this state? Will he doubt everything? Will he doubt whether he is awake? Whether he is being pinched, whether he is being burned, will he doubt that he doubts, will he doubt that he exists?

We cannot go so far as that; and I set it forth as a fact that there has never been a complete perfect Pyrrhonist. Nature sustains our feeble reason and prevents it from raving to that extent. ...

What kind of a chimera then is man? What novelty, what monster, what chaos, what subject of contradictions, what prodigy? Judge of all things, imbecile worm of the earth, depository of truth, sink of uncertainty and error, glory and scum of the world.

Who will unravel this tangle? Certainly it surpasses dogmatism and Pyrrhonism; and all human philosophy. ...

Nature confounds the Pyrrhonists and reason confounds the dogmatists. ...

Know then, proud man, what a paradox you are to yourself. Humble yourself, weak reason. Silence yourself, foolish nature, learn that man infinitely surpasses man, and hear from your master your real state which you do not know.

Hear God.

The problem of knowledge thus becomes, for Pascal, a religious one. Only through submission to God and through acceptance of his revelation can we gain completely certain knowledge. The greatest achievements in science and mathematics rest on a fundamental uncertainty, because the basic principles employed, known through instinct and intuition, are open to question. Skeptical probing can only reveal the human predicament in its fullest and prepare us to submit and accept a religious foundation of knowledge.

The *Pensées* then proceeds to show how humans try to avoid recognizing their situation through diversion and philosophy. Philosophy can only lead us continually to skepticism, from which we are saved by our own intuitive knowledge of truth. We seek for happiness but cannot find it apart from religion. Pascal then tried to show in the famous wager argument (418 and 233) that it is not unreasonable to believe in God. God, he argued, is infinitely incomprehensible to us. But either God exists or he does not exist, and we are unable to tell which alternative is true. However, both our present lives and our possible future lives may well be greatly affected by the alternative we accept. Hence, Pascal contended, because eternal life and happiness is a possible result of one choice (if God does exist) and because nothing is lost if we are wrong about the other choice (if God does not exist and we choose to believe that he does), then the reasonable gamble, given what may be at stake, is to choose the theistic alternative. The person who remains an unbeliever is taking an infinitely unreasonable risk just because he or she does not know which alternative is true. Pascal's dialectic in his religious apologetics prods people to realize that there is not enough evidence to confirm the religious hypothesis and not enough to reject it. So, a person in his or her fallen state chooses on moral characters rather than philosophical ones.

Pascal is not just presenting the problem of human knowledge in philosophical terms. As he once explained to his fellow members at Port-Royal, what he was working on as the culminating statement of his views was "an apology for the Christian religion." The *Pensées* are either this apology or reflect a good deal of its content or design. The skeptical problems and the skeptical attitude are part of the apologetic project. But Pascal does not see skepticism as leading to religious knowledge or religious truth, but more as neutralizing man's rational impulses. Pascal was not following the route of Michel Eyquem De Montaigne, Pierre Charron, and Francois de La Mothe Le Vayer. He was using their skeptical weapons to combat the dogmatists and to make the skeptics aware of the religious dimension. Pascal did not see skepticism as leading to the relaxed, tranquil view of the ancient Pyrrhonists, but rather to a sharpened and heightened desperation. The desire to know could not be satisfied by human rational faculties but there was a necessity to know.

What Pascal contributes to the skeptical discussion is what José Maia Neto (1995) has called the "Christianization of Pyrrhonism." The Christianization of Pyrrhonism is seen in Pascal's description of people's state without God. This state, theologically, is what has happened to

humankind in the Fall. Humans in this condition can find no security through reasoning or the use of their faculties, *and* they can unfortunately realize the desperation of their situation. They still have a glimmer or afterglow of the prelapsarian state of affairs but are unable to reach it. Pascal tried to show how belief can be achieved by curbing the passions, submitting to God, and using reason as a means of realizing that true religion is beyond reason and is known only through Jesus. We are suspended between two infinities, the infinitely small (the void) and the infinitely great (the Divine). Reason exposes our plight to us. Our desire for truth and happiness makes us see the futility of science, mathematics, and human philosophy as ways of finding the answers humans seeks.

THE CHRISTIAN RELIGION. The later sections of the *Pensées* are devoted to apologetics, arguing that the Christian religion is the true religion. From historical data, moral precepts, miracles, and the fulfillment of prophecies, Pascal argued that the Bible is the source of true religious knowledge. He contended that the Old Testament foretold Christ's coming and the Jewish rejection of him. Using the recently rediscovered Spanish anti-Semitic classic by Raymundus Martinus, *Pugio Fidei*, Pascal took material from many Jewish sources to claim that "God used the blindness of the Jewish people for the benefit of the elect" (469 and 577) and that "if the Jews had been completely converted by Jesus Christ, we would not have had any but suspect witnesses. And if they had been exterminated, we would not have had any at all" (592 and 750). The apologetic argument, Pascal admitted, was not logically decisive but only persuasive. The real problem was to *be* a Christian, and here reason could not help. Humans could submit, but they still desperately required God's Grace.

The prophecies, the miracles themselves, and the proofs of our religion are not of such a nature that it could be said they are absolutely convincing, but they are also of such a kind that it cannot be said that it would be unreasonable to believe them. Thus there is evidence and obscurity to enlighten some and confuse others, but the evidence is such that it surpasses or at least equals the evidence to the contrary, so that it is not reason that can determine men not to follow it, and thus this can only be as a result of lust or malice of heart...[so] that it appears that in those who follow it [religion], it is grace and not reason which makes them follow it, and that in

those who shun it, it is lust and not reason that makes them shun it. (835 and 564)

Pascal's views hardly constitute an organized system. Most of his works are fragmentary, and he apparently made no effort to put the fragments together. His career first as a mathematical prodigy, then as a student of physics and finally as a religious thinker made continuous intellectual development difficult. From the vantage point of his fideistic religious views his mathematical and scientific efforts appeared to him as of small significance. Throughout the *Pensées* Pascal tried to characterize the role and limits of mathematical and scientific achievements, in keeping with what he himself had accomplished. But his religious views were essentially antiphilosophical. Among philosophical views he found skepticism the most congenial insofar as it revealed most clearly "the misery of man without God" and prepared men for faith and grace.

Pascal's religious concerns have overshadowed his other contributions and as a result his impact has been mainly on thinkers concerned with religious subjects. In recent years Pascal has been studied seriously by existentialists because of his brilliant portrayal of the human condition, and he has often been compared with Kierkegaard, especially in terms of his antiphilosophical and fideistic statement of Christianity. Pascal's works on scientific method and the philosophy of mathematics have tended to be neglected, but in these areas he was one of the clearest and most advanced thinkers of his age. His many-sided genius and his unequalled command of the French language make him one of the most inspiring and thought-provoking of writers. Pascal fills a major place in the history of ideas both for his work in mathematics, physics, and philosophy of science and for his insights into human nature and his analysis of Christianity.

See also Epistemology; Jansenism; Philosophy of Religion; Philosophy of Science, History of.

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Richard Popkin (1967, 2005)

PASTORE, VALENTINO ANNIBALE

(1868–1956)

Valentino Annibale Pastore, an Italian philosopher and logician, was born at Orbassano (Teramo), Italy. He educated himself in literary studies, and then obtained a degree in letters from the University of Turin, under Arturo Graf, with a thesis on *La vita delle forme letterarie* (The life of literary forms), which was published at Turin in 1892. Pastore then turned to philosophy and was influenced by Hegelianism through the teachings of Pasquale d'Ercole. At the same time he was influenced by such scientists as Friedrich Kiesow, A. Garbasso, and Giuseppe Peano. In 1903 he published in Turin his thesis in philosophy, *Sopra le teorie della scienza: logica, matematica, fisica* (On the theories of science: logic, mathematics, physics). In 1911 he began teaching theoretical philosophy at Turin, where he was full professor from 1921 until 1939 and where he instituted a laboratory of experimental logic.

Pastore's thesis was published in the same year in which Benedetto Croce's *La critica* appeared and in which irrationalism burst out in Italy in diverse forms—as a revolt against positivism, as a rebirth of idealism, as an expression of the “bankruptcy of science.” Having been educated in an environment in which Hegelianism was not ignored but was linked with the point of view of classical positivism, Pastore became aware of the impossibility of separating the sciences (mathematical and natural) from philosophy, or of substituting the sciences for philosophy. In the first case, if philosophy were severed from the conditions that render it possible and nourish it, it

would become empty and would wither; in the second case, the sciences themselves would eventually lose consciousness of their relationships, their fundamental rationale, and their methods and goals. Pastore therefore sought to assess the meaning of scientific knowledge and of its logical procedures.

Turning his attention to logical problems in particular, Pastore was at first drawn toward Bertrand Russell's thesis of the identity of logic and mathematics, as is shown in *Logica formale e dedotta dalla considerazione dei modelli meccanici* (Formal logic deduced by the consideration of mechanical models; Turin, 1906) and *Sillogismo e proporzione* (Syllogism and proportion; Turin, 1910). His principal work of this period, *Il problema della causalità, con particolare riguardo alla teoria del metodo sperimentale* (The problem of causality, with particular attention to the theory of experimental method; 2 vols., Turin, 1921), which deals with causality, shows his systematic effort to single out the mutual relationship between scientific investigation and philosophical research. Pastore examined three aspects of causality—experience, science, and philosophy—and distinguished and analyzed the idea of cause, the concept of the causal relation, and the principle of causality.

After 1922, Pastore's interests were still focused on scientific knowledge, but he clarified his conception of philosophy as the study of “pure thought,” as “not of that which is common to all particular systems, by being inherent in each one, but of that which results from all the particular systems, even though not being inherent in each one.” From this conception he evolved his idea of a “general logic” whose basis lies “outside of particular logical systems.” Around 1936, assisted by Ludovico Geymonat, he investigated the “logic of strengthening” as a “theory of primal systems,” that is, as a search for “the process of construction of the most elementary forms of thinking and of their relationships,” by means of a distinction between logic as logicity (general presystematic logic) and logic as a particular system, joining, as he himself said, “the deduction of the discourse (*D*) with the logical intuition of the universe (*U*).” Pastore did not seek to reach a demonstration of intuitive principles, nor to propose an ontological intuition, but rather to establish the laws of the relationship between *D* and *U*, between the analysis of the discourse and a synthetic vision of the universe.

In the final phase of his work Pastore's concern with the sense of mystery became marked (“logic has always two allies at its side: sadness and mystery”). In the light of this concern he examined and discussed both the existen-