

## Pascal, Blaise (1623-62)

Blaise Pascal was a mathematical prodigy who numbered among his early achievements an essay on conic sections and the invention of a calculating machine. In his early twenties he engaged in the vigorous European debate about the vacuum, undertaking, or causing to be undertaken, a series of experiments which helped to refute the traditional view that nature abhors a vacuum and setting out clearly the methodology of the new science. In 1646 he came under the influence of Jansenism; this he seems to have rejected for a short time in the early 1650s, but he then underwent a profound spiritual experience which transformed his life and drew him into close association with leading Jansenists, with whom he collaborated in producing the polemical *Lettres provinciales* (1656-7). At the same time he planned to write an apology for the Christian religion, but ill-health so affected his final years that this only survives in the fragmentary form of the *Pensées* (1670). He made significant contributions to mathematics, especially in the fields of geometry, number theory and probability theory, and he also helped to describe the 'esprit géométrique' which characterized the new science of the 1650s. He argued that geometry was superior to logic in that it could provide not only demonstrative procedures but also axioms from which to work; and he set down appropriate rules of argument. His religious writings were published shortly after his death; many attempts have been made to reconstruct the apology which they encapsulate. It seems most likely that this would have fallen into two parts, the first setting out the wretchedness of humans without God, the second demonstrating the truth of Christianity and the felicity of the religious life. Humans are portrayed in Augustinian terms as corrupt, vapid creatures, prey to their passions and the delusions of imagination; but they are also shown to possess greatness through their reason and self-awareness, which can bring them to recognize that Christianity alone has represented their predicament accurately, and that they should turn to religion, even if initially they lack the instinctive faith which is the hallmark of the saved. In the 'wager' fragment, Pascal employs his mathematical insights to revivify an old apologetic argument (that it is wiser to bet on God existing rather than on his not existing) and to link it to an existential imperative (that we all are obliged to choose between these alternatives). The adroit interplay between scepticism, rationalism and faith of the first part is succeeded by a second part which argues the veracity of Christianity from Biblical interpretation, prophecies and miracles. Pascal concedes that this cannot carry absolute conviction; but he insists that the rejection of such arguments is caused not by man's rational powers but by his corrupt passions. Pascal's *Pensées* are written for the most part in terse aphoristic form; he aspired to a style that was so accessible that the reader would believe he was experiencing as his own the thoughts that he read. Although Pascal said at the end of his life that he considered his mathematical pursuits a quite separate enterprise from his religious writings, a common epistemology can be found in both, together with a scientific outlook which Pascal saw as superior to the philosophical alternatives of his day.

### 1 Early life and mathematical works

Blaise Pascal was born in Clermont in Auvergne, the son of a government official who was also an enthusiast for the new mathematical learning. With his family, he moved to Paris in 1631, and stayed there until 1638, when his father was forced to flee because of his public opposition to an aspect of Richelieu's fiscal policy. Blaise was educated privately by his father, who wanted him to be fully conversant with Greek and Latin before introducing him to mathematics: but his prodigy son worked out for himself the principles of geometry as far as the thirty-second proposition of Book I of Euclid at the age of twelve. It was also during this Parisian period that he was able to attend the mathematical academy of Father Marin *Mersenne* who was actively engaged both in European scientific and philosophical circles and in the religious controversy surrounding the new scientific ideas, as Pascal himself was also to become engaged. It is unclear how well-grounded Pascal was in the classics and in traditional Aristotelian logic and physics, and whether his unconventional education contributed to the originality that he showed in his later career.

After his father had been pardoned by Cardinal de Richelieu for his dissent and given the office of royal tax commissioner for the province of Haute Normandie, Pascal went with him to Rouen in 1640; in the same year his first mathematical publication, the *Essai pour les Coniques* (Essay on conical sections), appeared. Two years later he invented a calculating machine, which he had originally conceived to help his father with his tax work; this remarkable achievement was far in advance of the industrial skills required to produce it, although various versions were made and demonstrated to scientific colleagues, prominent politicians and members of the aristocracy.

## 2 The debate over the vacuum

Between 1646 and 1648, Pascal became embroiled in the fierce European debate concerning the existence of the vacuum. Torricelli's experiment with a barometer, which involved placing a tube of mercury upside down in a bowl of mercury, had been made public in France by Mersenne in 1644, and had given rise to many competing interpretations. Nearly all of these had recourse to the notion of atmospheric pressure as an explanation, and there was general agreement that the space at the top of the tube contained some kind of rarefied and invisible matter, which was consistent with the Aristotelian adage *natura abhorret vacuum*. In 1647, Pascal published his *Expériences nouvelles touchant le vide* (*Experiments on the vacuum*); this was the summary of a series of experiments he conducted with Pierre Petit, using variously sized and shaped tubes and different liquids. Through them he was able to determine the quantity of water and mercury that could be supported by air pressure and the size a siphon had to be in order to function. He also set out in this summary the reasons why there was no rarefied and invisible matter occupying the space above the column of liquid supported in the barometer, but did not feel able yet to affirm the existence of a vacuum. He was challenged in his conclusions by Father Étienne Noël, the Jesuit Rector of the Collège de Clermont in Paris and a proponent of traditional Aristotelian physics; Pascal set out in his reply what are now taken to be the basic principles governing the application of scientific judgment and method. At the same time, he wrote to his brother-in-law Florin Périer to ask him to undertake the experiment of carrying a barometer up a mountain (the Puy-de-Dôme), the results of which showed that the level in the column of mercury varied with height. Pascal confirmed this himself on a church tower in Paris, and published the findings in 1648 in his *Récit de la grande expérience de l'équilibre des liqueurs* (*Account of the great experiment on equilibrium in liquids*); he concluded that experiment, not authority, governed physics, that his experiments had shown that nature has no horror of a vacuum, and that air pressure accounts for all the effects associated with said imaginary horror. These experimental writings played an important role in discrediting Aristotelian and scholastic scientific ideas (see [Aristotle](#); [Aristotelianism, medieval](#); [Aristotelianism, Renaissance](#)).

## 3 Pascal and Jansenism

Pascal's father suffered an accident in 1646, which brought him into contact with a priest sympathetic to the ideas of Cornelis Jansen (1585-1638), the bishop of Ypres. Pascal also encountered Jansenist ideas on grace and piety, and was deeply affected by them, as were other members of his family. After her father's death in 1651, Blaise's sister Jacqueline became a nun at the convent at Port-Royal, which was the centre of Jansenist doctrine and religious practice in France (see [Port-Royal](#)). Pascal opposed her vocation strongly, and indeed for two years thereafter led a life very different from hers, consorting with free-thinkers, gamblers and libertines of fashionable Parisian society; but on the night of 23 November 1654 he underwent a profound spiritual experience which altered his life irrevocably.

This 'nuit de feu' was such that Pascal sewed the record that he made of it at the time of the event itself as a permanent memento into his clothes, where it was found at his death. The document records an experience of conversion; not an intellectual experience, but one which persuaded Pascal of the superiority of instinctive belief. (This conviction was strengthened two years later, when his niece was cured miraculously at Port-Royal of an apparently incurable fistula.) As a result of his experience, Pascal went to Port-Royal-des-Champs for a two-week retreat in 1655. There he met Isaac Le Maistre de Saci, a Jansenist theologian, with whom he had a debate, an account of which was published in 1720 as *Entretien avec M. de Saci* (*A conversation with M. de Saci*). This debate indicates not only that Pascal had conceived of an apology of the Christian religion in terms which would speak most powerfully to the very libertines and gamblers of the Parisian society which he had just forsaken, but also that he felt that one of the most powerful voices with which he had to contend was that of Michel de [Montaigne](#), the gentleman philosopher who had championed the cause of scepticism in the later sixteenth century. It is also clear that he felt the need to reassure those who had been shaken in their faith by new scientific developments, especially those in astronomy. Among Pascal's immediate sources of inspiration was Antoine [Arnauld](#), the leading Jansenist theologian and philosopher, who was at that time on the point of being condemned by the Sorbonne for his religious views. Together with Arnauld and Pierre Nicole, another prominent Jansenist, Pascal composed the *Lettres provinciales* (*Provincial letters*), a series of eighteen letters published in 1656-7. These constitute a scathing attack on the moral and theological views of the Jesuits, who were the most vociferous opponents of both Arnauld and Jansenism. In this debate the Jesuits were somewhat unfairly represented as a religious faction which engaged in deliberate deception for political ends and sacrificed doctrine to morals, and the

Jansenists were for their part depicted as crypto-Calvinists whose interpretation of St Augustine was both erroneous and heretical. Pascal and his co-authors tried vigorously to rebut the charge of heresy levelled at Jansen's writings while still acknowledging the authority of the Church that as Roman Catholics they were bound to accept. As it transpired, the debate was won *de facto* by the Jesuits; the *Lettres provinciales* were placed on the Index of Forbidden Books in 1657, and the Jansenist movement itself was condemned by the Pope shortly after. But the wit of the letters and their dazzling display of satire and irony have ensured that the judgment of posterity has been accorded to Pascal's side, at least in literary terms. For all that, the school at Port-Royal was closed in 1661, and the remaining *solitaires* and nuns were forced to sign a document to mark their submission to the Roman Catholic Church; this prompted Pascal to write the *Écrit sur la signature du formulaire* (*Tract on the signing of the formulary*), urging Port-Royalists not to sign. In it he reiterated the defence of Jansenism which is found in the *Lettres provinciales*, distinguishing between fact and faith or law in matters of religion. Councils, Fathers of the Church and popes are infallible on matters of faith, but not on matters of fact, and Pascal contends that the identification of Jansenism with heresy is a matter of fact, not law. The *Écrit* was never published because Nicole and Arnauld contradicted Pascal's advice. After a stormy altercation with them, Pascal renounced all further engagement in religious controversy. Instead he devoted his final months of life to the poor of the part of Paris in which he lived, not only making over all his worldly goods to them, but also organizing what was in effect the world's first omnibus service, which carried passengers from one part of Paris to another for a fixed fare. Throughout his short life, he had never enjoyed long periods of good health; he died on 19 August 1662 after a protracted and painful illness, and his final days were marked by his own deep piety and his desire to fulfil his religious duties to the last.

#### 4 Works posthumously published

Although Pascal was well known to the European scientific community in his lifetime, few of his works were published. His last foray into the world of mathematics - the solution to a set of problems concerning the nature of the cycloid - was in fact circulated anonymously as a competition in 1658, although its author was sufficiently well-known for the Dutch mathematician and physicist Christiaan Huyghens (1629-95) to write to Pascal about it in the following year. After Pascal's death some mathematicians (including Leibniz) had access to his scientific papers, but these did not all appear in print until much later. Pascal's religious writings, however, were posthumously edited by his family and friends; the *Pensées* and other short works appeared in 1670, and the *Entretien avec M. de Saci* in 1728. The original edition of the *Pensées* was both an abridgment and a reworking of Pascal's papers, only part of which had been put in order by him; since the mid-nineteenth century various attempts have been made to reconstruct the manuscript as it was left by Pascal, culminating in Louis Lafuma's edition of 1952 which is now taken to be standard. More recently still Pol Ernst has been able not only to reconstruct the pages which were cut up by Pascal himself when he decided to arrange the fragments into thematic groups, but also to establish the date of composition of the major part of the project (1656-8). This recent scholarship has permitted a (somewhat conjectural) chronological ordering of the *Pensées* to be published and has opened up new possibilities for their interpretation.

#### 5 Mathematical philosophy

Pascal himself said in a letter to Pierre Fermat written in 1660 that he felt that his religious writings had little connection with his scientific and mathematical work. His outlook, however, was deeply influenced by what he conceived to be a new way of looking at the world inspired by geometry, and most commentators would agree that all his writings are impregnated with it. He himself made strictly mathematical contributions to number theory, geometry and probability theory, but he also involved himself in the wider polemic about the status of science in his day. In his letter to Father Noel, he set out the prerequisites of sound scientific methodology, laid down the rules for making affirmative or negative scientific judgments (through axioms and apodictic demonstration), and for establishing or disproving hypotheses about the physical world, which in his view could never be more than provisional. In the same letter, Pascal referred to the rival claims of authority (in this case, the authority of Aristotle) and scientific demonstration; this topic is more fully developed in the *Préface sur le traité du vide* (*Preface to a treatise on the vacuum*) (1651?), in which Pascal shows that experiment and correct reasoning should govern the sciences, and that authority and historical example have no place in them. His view of science is very much a progressive one; as more and more experiments are undertaken with more sophisticated instruments, previously accepted hypotheses are supplanted by newer ones. Thus the hypothesis of occult qualities or powers,

which was postulated to explain what lies beyond sensory perception, and the Aristotelian distinction between act and potency, should be replaced if experimentation can show that they are inadequate according to Pascal's rules. Natural causation and phenomena are unchanging; human attempts to understand them are relative to the historical moment at which the attempts are made. In a striking image, Pascal refers to the successive generations of scientists as a single person in a perpetual state of existence and development. Thus, when we disagree with scientists of the past, we are not contradicting them, since by applying the principle of charity we would have to agree that we would have understood the world in their way had we lived in their times with their resources; and it follows also that they would have agreed with us today for the same reasons. (It is worth noting that Pascal is willing to believe that past scientists acted and wrote in good faith, whereas he refused to concede that his Jesuit opponents did so.)

*De l'Esprit géométrique et de l'art de persuader (On the spirit of geometry and the art of persuasion)* (1657-8?) is a yet more sophisticated presentation of the new scientific outlook. Pascal begins by conceding that definitions in geometry are nominal and not real, and that what are taken for axioms are intuitive perceptions which can neither be demonstrated nor reasonably be doubted. The four terms which he identifies in this way are number, space, movement and time. All share the property of being infinitely divisible and infinitely extensible. This insight is counter-intuitive to those who conceive knowledge as finite but, unless it can be grasped, then the geometric spirit itself cannot be comprehended. Pascal is not claiming that man's capacity for knowledge is unlimited; merely that the immediate information of his senses and his reason have to be transcended if scientific advances are to be made. Geometry emerges from this as superior to logic, in that it can both provide axioms and engage in demonstration, whereas logic can only do the latter.

The second part of the work is devoted to the thorny problem of persuasion; here the will comes into question as the path through which human assent to a given argument is to be obtained. Even here, however, a method or a set of rules are supplied for the correct conduct of an argument. Terms must be given clear definitions, axioms must be incontrovertible and must all be explicit, and conclusions should be checked by substituting definitions for the terms used. Pascal's discussion of scientific method is therefore distinct from Bacon's negative use of induction although, like Bacon, he conceives of science in evolutionary terms; nor does it evince Descartes' greater reliance on the resources of human reason; it harnesses the arguments of the sceptics, but escapes from their epistemological dilemma by positing intuitive truths which do not come to us from the exercise of our intellect (see [Bacon, F. §§2-6](#); [Descartes, R. §§2-3](#)).

## 6 Theology and the human condition

In 1658, Pascal gave an account of his planned apology for the Christian religion to his friends at Port-Royal, which is probably the reason for his cutting up his sheets of reflections and notes and arranging them into bundles. It is far from certain, however, that all the fragments which survive were written as part of this one project, or that the project was anything like complete and fixed in Pascal's mind. Not only are sections of the text in dialogue, with none of the voices clearly identified, it also seems likely that the grammatical first person who appears in a number of other fragments does not refer in all cases to Pascal himself. Such interpretative problems have not deterred past editors from partial or total reconstructions of the apology. The Lafuma edition, which is less interventionist, begins with a section devoted to the proposed organization of the work, which makes its general character clear. In the first part, the human condition was to be described, and shown to be wretched; in the second, human felicity with God and the truth of the Christian religion were to be demonstrated. In a series of sections entitled 'vanity', 'misery', 'ennui', 'causes of effects', 'greatness', 'contradictions', 'distraction', 'philosophers', Pascal sets out a description in implicitly Augustinian terms of human experience of the world. The arbitrariness and injustice of human political institutions, the vapidness of human pastimes, the false notions of social hierarchy, and the wilful flight of humans from confronting the primordial questions of their existence are all memorably expressed, often in terse aphoristic form. Notable is the very low assessment of the moral nature of humanity, whose self is said to be hateful. Pascal then turns to the paradox that in the human's very wretchedness there lie the seeds of greatness. Although the passions and imagination pervert and oppress them, humans also possess reason and self-awareness, and even can attain to certain knowledge about their environment through their intuitive grasp of geometric axioms. Such intuition, which Pascal sites in the heart, is also where true faith in God is to be found; the function of his apology is to persuade his reader rationally that the Christian religion is true because its description of the human condition is accurate, but it cannot do more than predispose the reader to



receive the gratuitous divine gift of faith. In this sense it is a superfluous enterprise; and although in his *Écrits sur la Grâce (Writings on grace)* (1657-8?) he tries to come to terms with the Tridentine proposition that the just are able of themselves to obey the Commandments, Pascal seems to concede the inefficacy of instilling rational conviction alone at various points in the *Pensées*.

As he does elsewhere, Pascal here sets up powerful binary oppositions between philosophies and exploits their reciprocal failings and strengths. Scepticism is modest in its claims, yet impotent and negative; dogmatism (roughly, rationalistic neo-Stoicism) is presumptuous and yet has some purchase on the real world. Philosophy is therefore incapable both of knowing humanity and of taking action. Pascal finds a way beyond this impasse by exploiting his insight about the infinitely great and the infinitely small in a novel manner: humans are everything with respect to nothing, and nothing with respect to everything (God and the cosmos). They are also imbued with a desperate desire for certainty, and cannot suspend their judgment indefinitely, because they are subject to an existential imperative: 'you must take on the bet, for you are in the game' (Pascal 1670: 550 [L418]). This is the context of the famous wager argument, which had been used before Pascal by other apologists. Either God exists, or he does not: if human life is vain and wretched (as Pascal believes he has demonstrated), humans have nothing to lose by betting on the next life (that is submitting to the Christian religion), for they have lost nothing in the case of God's nonexistence, and gained everything if he does exist. Some have seen this argument as purely rhetorical; others have accused it of being a case of *petitio principii* (the worthlessness of life is presupposed in the conclusion that we have nothing to lose in sacrificing the allegedly vain pleasures of this world); yet others see in it an ingenious example of decision theory *avant la lettre*. Whatever interpretation is given to it, it can be seen to be particularly apposite to the potential constituency of libertines and gamblers whom Pascal was intending to address.

Pascal's apology is therefore not simply fideistic, postulating the two truths of faith and reason; it employs both faith and reason, as well as doubt, to achieve certainty. As one *pensée* has it 'one must doubt in the right way, assert in the right way, and submit in the right way' (1670: 523 [L170]). Descartes tried to demonstrate too much, and relied on his *cogito* to gain knowledge of an infinite and hence incomprehensible God; Montaigne doubted too much, and did not agonize enough about his passive acceptance of ignorance and hedonism; only Pascal (and his mentor St Augustine) used reason to affirm, to negate and to recognize its own limitations appropriately. In the second part of his apology, Pascal planned to use arguments from Biblical history, prophecies, miracles, and above all else the interpretation of Holy Writ to present the case for the truth of Christianity; but he conceded that such proofs were not absolutely convincing, although they were sufficient to secure the consent of those who read them free from the perverting effects of their own corrupt passions.

In the *Pensées*, as in the *Esprit géométrique*, Pascal is at pains to stress the importance of style. The great art, which he identified in Epictetus, in Montaigne's essays as well as in his own writings, was to write in such a way that those reading would think that they could have written the text themselves. As he shrewdly put it: 'it is not in Montaigne, but in me that I find all that I find in his text' (1670: 591 [L689]). Knowledge has to be made desirable, and also to be made accessible; the writer is its undetectable mediator; truth, as he had asseverated in the letter to Father Noel, is itself not a historical or personal phenomenon. The fortunes of his own writings do not seem to bear this out. In the late seventeenth century, he was the champion of those who embraced Augustine's gloomy vision of corrupt human nature; in the eighteenth century, he was reviled for the same reason by moralists of a more optimistic bent; in the twentieth century he was caused to doubt the existence of God in the early part, a Kierkegaardian existentialist in the middle, and is now appreciated as a rhetorician and precursor of probability theory. The sustained interest shown in his work is a testament to its linguistic brilliance, its brevity and its clear vision of an epistemology embracing both the seen and the unseen, the intuited and the perceived, and the natural and the supernatural, all grounded in an impressively coherent outlook derived from his particular conception of geometry.

See also: [Decision and game theory](#)

IAN MacLEAN

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