

simulation it achieves; it is rather the personal and quasi-intuitive awareness of what occurs psychologically in man's consciousness. The donation of grace depends (God willing it) upon man's free cooperative response. God's invitational love effects a passive immutation of the soul obscurely open to experience, in which the divine presence is discerned. It then appears possible within the obscurity of faith to know and love in some highly personal and more concrete way the Triune God. The soul thus moves beyond the abstract concepts of faith to a true experience involving interpersonal relationships. This experience is not direct and immediate, not an intuition, properly speaking; only the BEATIFIC VISION is such. Here there is only, at the most, a contact in knowledge and love, with God in His very presentiality, but only through the medium of experiencing His created effects within the soul. Saint Thomas characterizes this as quasi-experimental knowledge (*In sent.* 1.14.2.2 ad 3; *De virt. in comm.* 12 ad 11). In its more sublime instances this becomes infused contemplation elicited by the gift of WISDOM (cf. *Summa theologiae* 1a, q. 43, a. 5 ad 2), which may, but need not be, accompanied by MYSTICAL PHENOMENA.

The content of this experience is varied: a sense of sin, of the presence of God, of the victory of Christ, of freedom from the spirit of fear, of fellowship with Christ, of being begotten of God, of sonship, of the indwelling of the HOLY TRINITY, of entering upon relationships to the Father in the Spirit through the Son (Rom 6:4; Gal 2:20; 1 Jn 3:6; Rom 8:15; Col 1:2; Gal 4:6; Rom 5:5).

Faith is not only an intellectual assent to conceptually formulated truth; it is at the same time a loving surrender to a Person, and therefore an experience in itself. The believing act is an encounter with God, in Christ, and not merely as object but as subject. What is known obscurely is not merely that (or what), but who, God is. Such an encounter, moreover, cannot be unilateral. The sacramental act (above all, in the EUCHARIST) then, is first of all a symbolic expression of belief and free acceptance—the vital, conscious response of man to God's initiative in the dialogue of grace. This is undergone in a dark, but authentic, quasi-intuition of the Person and time-transcending presence of the GOD-MAN.

SEE ALSO NUMINOUS; RELIGION, PHILOSOPHY OF

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EXPERIMENT

The term *experiment* is derived from the Latin noun *experimentum*, meaning a proof, a trial, or a test. In the most common case of scientific experiment, an experimenter manipulates and observes extramental reality to test a scientific theory or hypothesis. Although experiments were conducted in ancient Greece and during the Middle Ages, they did not become a central feature of SCIENCE until the Scientific Revolution of the seventeenth century.

Two main kinds of experiment are used in the natural sciences. The first are called "real" (or physical or material) experiments, and they involve observation or

manipulation of extramental reality. The second are called “thought” (or “imaginary” or “nonmaterial”) experiments and are performed solely in the mind, usually to examine the logical implications of a theory. Real experiments dominate science, but THOUGHT EXPERIMENTS have been used by famous scientists such as Ernst Mach (1838–1916), Albert EINSTEIN (1879–1955), and Erwin Schrödinger (1887–1961). Mary S. Morgan has argued for a third kind of experiment, namely, hybrid experiments, which combine elements of both real and thought experiments. For example, she counts some kinds of computer simulations as hybrid experiments.

All experiments follow the same general procedure. The first stage is experimental design. Usually, the experimenter has a scientific theory or hypothesis in mind that he or she would like to test. An experiment is designed so that the results will either confirm or disconfirm a prediction of the theory or the hypothesis. Ian Hacking has argued that this is not always necessary, as experiments can be performed out of simple curiosity. He also discusses how some observations and experiments in the history of science preceded the formulation of theory. Nevertheless, Hacking admits that a scientist must have some idea about nature and how it works prior to conducting an experiment.

The second stage consists of performing the experiment, which can be fairly simple or extraordinarily complex in its execution. ARISTOTLE (384–322 BC) did manipulate nature, but he used no technology, except perhaps a knife, when he cracked open fertilized chicken eggs on different days during maturation to study the development of the embryo. In contrast, Sir Arthur Eddington (1882–1944) and his team used telescopes and photographic plates, but did not manipulate nature, when they observed the solar eclipse in 1919 to test Einstein’s theory of general relativity. However, most laboratory experiments involve both the manipulation of nature and the use of sophisticated technology. For example, the experiments designed to detect the presence of the Higgs boson (a proposed elementary particle in physics) require huge and technologically advanced particle accelerators.

The third stage consists of observing the results of the experiment and collecting the data. The fourth and final stage consists of interpreting the data and, if relevant, determining the relationship of the data to the theory or hypothesis that is being tested. These last two stages have been the cause of much discussion and disagreement among philosophers of science. The most important question concerns the extent to which the results of experiments can be used to decide between different scientific theories.

Karl R. Popper (1902–1994) argued, and it is generally agreed, that the use of experiments and inductive

reasoning can never definitively prove a theory true. Instead, he argued that science uses hypothetico-deductive reasoning, which can falsify a theory but cannot prove it true. In contrast, Thomas S. Kuhn (1922–1996) argued that the history of science shows that scientists will not give up on a theory simply because some experiments did not give the expected results. He also argued that observation is not a purely neutral process, but is affected by the theories experimenters hold.

Prior to Popper and Kuhn, Pierre Duhem (1861–1916) argued that falsification in physics is impossible. The reason is that one cannot test a theory without also holding some background assumptions about how the world works. If an experiment does not confirm a scientist’s predictions, the scientist is not sure if the error lies in the theory or in one of the background assumptions. A more general version of Duhem’s point, applicable to all of science, was raised by Willard Van Orman Quine (1908–2000), and it has come to be known as the Duhem-Quine thesis. While generally accepted, some philosophers of science have argued against it or around it.

For example, by discussing several examples in the history of science, Allan Franklin has argued that the Duhem-Quine thesis is not always applicable. Imre Lakatos (1922–1974) took a different approach. After conceding that an individual hypothesis or theory cannot be proven false from a few experiments, he argued that an entire scientific research program (such as Newtonian physics) can be falsified if it is degenerating. A degenerating research program is one that either does not predict new facts, or, if it does, none of those new predictions get confirmed by observation and experimentation. In practice, however, scientists often do consider experiments capable of falsifying hypotheses or theories, and most hold that the best theories approximate the truth precisely because they are so well confirmed by experiment.

SEE ALSO INDUCTION; PHILOSOPHY AND SCIENCE; SCIENCE, PHILOSOPHY OF

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EXPLANATION

Explanation is the act of the mind by which support, justification, or reasons are given for an opinion, judgment, or conclusion. In other words, to explain something is usually to give the cause of that thing, to manifest in speech or thought the principle of the being or becoming of a thing, or (most generally) to give an account of something. (For example, why is the moon eclipsed? It is because the Earth is interposed between the sun and the moon, casting a shadow on the latter.)

Explanations dissolve puzzlement or satisfy wonder. Because the philosopher pursues wisdom as a goal, he pursues explanations as means. PLATO (429–347 BC) teaches that only when one knows what something is can one explain its properties (see *Rep.* 354c). ARISTOTLE (384–322 BC) says: "All men begin . . . by wondering that the matter is so . . . but we must end in the contrary and, according to the proverb, the better state, as is the case . . . when men learn the cause." (*Meta.* 983a15, 18–20). Although explanations arise in all parts of philosophy, they originate in common experience and everyday discourse. It is from such dialogues that SOCRATES (469–399 BC) initiated the philosophic turn, investigating the truth in conversation, conducting an

examination of others, and questioning the explanations that people gave for their opinions and actions (*Apology* 20c–30b).

Practical and Speculative Philosophy. Explanation differs in practical and speculative philosophy. This is because explanations are limited by the matter of the subject in question. Moral explanations do not admit of a mathematical degree of certitude because action is always in the particular, attended by an indeterminate number of circumstances (*Eth. Nic.*, 1094b12–28; this does not entail that right and wrong are subjective or situational, but only that they must be situated in specific circumstances). Further, because practical philosophy is ordered to action and requires a good upbringing, *that* a kind of action is good or bad is taken as a starting point—*why* it is so, the explanation, is the goal of ethical inquiry (*Eth. Nic.*, 1095a30–b13). In virtue ethics, the schema of such explanations is measured by the intrinsic excellences available to HUMAN NATURE.

This overall schema of explanation differs in modern ethical theories such as deontology, which seek to find a normative justification in terms of moral absolutes based upon their consistency with formal universal principles, for example, the CATEGORICAL IMPERATIVE of Immanuel KANT (1724–1804). Similarly, the UTILITARIANISM of John Stuart MILL (1806–1873) explains moral maxims in terms of a common goal of humanity, the greatest happiness of the greatest number. Modern ethical theories distinguish between reasons for an action that are normative or justificatory (reasons that reveal the rectitude of an action) and those that are merely explanatory (reasons that reveal the motives of an AGENT). These theories hold that justifications can be either subjective or objective, and philosophers debate whether they are all internal (having reference only to the agent's motivations—a position that cannot explain moral absolutes) or also external (without reference to the agent's motivations).

In speculative philosophy, the truth is sought for its own sake. Theoretical explanations require more precision and adequacy because the knowledge sought concerns the thing as it is and is not limited by the indeterminacy of an action or product. Traditionally, logic is the part of philosophy that considers explanation as such. Developments in the twentieth-century philosophy of science also thematize explanation.

Questions seeking why something is the case are seeking an explanation, that is, the cause. The cause will be one of the four causes: END, FORM, agent, or matter (*Po. An.* 94a20–23). Thus, the structures involved in explanation are dependent upon those of CAUSALITY.

Generally, the subject and predicate of a judgment are either connected by DEFINITION (essentially) or not.