method of the theologians is enjoying something of a modest revival.

See also ***Philosophy, Moral; Scholasticism.***

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CAUSALITY. The causality debate has been centered on two issues, one metaphysical, the other epistemic. The metaphysical issue concerns the nature of the connection between cause and effect: How and in virtue of what does the cause bring about the effect? The epistemic issue concerns the possibility of causal knowledge: How, if at all, can causal knowledge be obtained?

Aristotle

Aristotle (384–322 B.C.E.) claimed a sharp distinction between understanding the fact and understanding the reason why (*dioti*; *aitia*). Though both types of understanding proceed via deductive syllogism, only the latter is characteristic of science because only the latter is tied to the knowledge of causes. In his *Posterior Analytics,* Aristotle contrasted the following two instances of deductive syllogism:

A. Planets do not twinkle; what does not twinkle is near; therefore, planets are near.

B. Planets are near; what is near does not twinkle; therefore, planets do not twinkle.

Syllogism A demonstrates the fact that planets are near but does not explain it because it does not state its causes. On the contrary, syllogism B is explanatory because it gives the reason why planets do not twinkle: because they are near. Explanatory syllogisms like B are formally similar to nonexplanatory syllogisms like A. Both are demonstrative arguments of the form: all Fs are Gs; all Gs are Hs; therefore, all Fs are Hs. The difference between them lies in the "middle term" G. In B, but not in A, the middle term states a cause. As Aristotle said: "The middle term is the cause, and in all cases it is the cause that is being sought" (90a5–10). To ask why F is H is to look for a causal link joining F and H. Aristotle's key observation was that, besides being demonstrative, explanatory arguments should also be asymmetric: the asymmetric relation between causes and effects should be reflected in an explanatory asymmetry between the premises and the conclusion of the explanatory arguments—the premises should explain the conclusion and not the other way around.

Aristotle took scientific knowledge to form a tight deductive-axiomatic system whose axioms are first principles, being "true and primary and immediate, and more known than and prior to and causes of the conclusion" (71b20–25). Being an empiricist, he thought that knowledge of causes has experience as its source. But experience on its own cannot lead, through induction, to the first principles: these are universal and necessary and state the ultimate causes. On pain of either circularity or infinite regress, the first principles cannot be demonstrated either. So, something besides experience and demonstration is necessary for the knowledge of first principles. This is a process of abstraction based on intuition, a process that reveals the essences of things—that is, the properties by virtue of which the thing is what it is. In the example B above, it is of the essence of something's being near that it does not twinkle. In the rich Aristotelian ontology, causes are essential properties of their subjects and necessitate their effects. He thought that the logical necessity by which the conclusion follows from the premises of an explanatory argument mirrors the physical necessity by which causes produce their effects.

In his *Physics,* Aristotle distinguishes between four types of causes. The material cause is "that out of which a thing comes to be"; the formal cause is "the definition of its essence"; the efficient cause is "the primary source of the change or rest"; and the final cause is "that for the sake of which a thing is done" (194b23–195a3). For instance, the material cause of a statue is its material; its formal cause is its form or shape; its efficient cause is its maker; and its final cause is the purpose for which the statue was made. Aristotle thought that a complete causal explanation has to cite all four causes: the efficient cause is the active agent that puts the form on matter for a purpose.

Aristotle's Legacy

Most of Aristotle's views were accepted by the Scholastics. Aristotle thought that the chains of efficient causes must stop at some "unmoved movers"—that is, things that are themselves unmoved but produce motion to other things. The Scholastics thought that the only proper efficient cause was God, being the ultimate unmoved mover. Later thinkers revolted against all but efficient causality. Efficient causality, what Aristotle called "the source of motion" (195a10), was taken to be the only type of causality by all those who advocated, in one form or another, the mechanical philosophy: in their hands, efficient causality became tantamount to pushings and pullings. Final causes, in particular, were cast to the winds. Where Aristotle saw goals and purposes in nature, mechanical philosophers either excised purpose from nature (Hobbes, Hume) or placed it firmly in the hands of God (Descartes, Leibniz). The moderns also revolted, to varying degrees, against the rich ontological landscape that Aristotle had painted: essences, substantial forms, activities, and so on. However, two key Aristotelian ideas, that there is necessity in nature and that this necessity is the same as the logical necessity of a demonstrative argument, were to become part of the mainstream philosophical thinking about causality until David Hume (1711–1776) subjected them to severe criticism and undermined them.

Descartes

René Descartes (1596–1650) distinguished all substances into two sorts: thinking things (*res cogitans*) and extended things (*res extensa*). He took the essence of mind to be thought and that of matter extension. Unlike Aristotle, he thought that matter was inert (since its essence is that it occupies space). Yet, there are causal connections between bodies (bits of matter) and between minds and bodies (bits of different substances). So, two big questions emerge within Cartesianism. The first is: how is body-body interaction possible? The second is: how is mind-matter interaction possible? Descartes's answer to the first question is the so-called transference model of causality: when *x* causes *y,* a property of *x* is communicated to *y.* He thought that this view is an obvious consequence of the principle "Nothing comes from nothing." As he put it: "For if we admit that there is something in the effect that was not previously present in the cause, we shall also have to admit that this something was produced by nothing" (vol. 1, p. 97). But Descartes failed to explain how this communication is possible. Indeed, by taking matter to be an inert extended substance, he had to retreat to some external cause of motion and change. Descartes treated forces with suspicion since they did not quite fit within his tight scheme of the two distinct substances and their two essential attributes. So in his *Principles of Philosophy* (1644) he retreated to God, whom he took to be "the efficient cause of all things" (vol. 1, p. 202). But this retreat to God cannot save the transference model. Besides, the transference model of causality makes an answer to the second question above (how do mind and matter interact?) metaphysically impossible. Being distinct substances, they have nothing in common that can be communicated between them. Descartes was a rationalist. He thought that Reason alone can, by a priori reflection, discover the basic casual laws of nature, which, Descartes thought, stem directly from God.

Descartes's Successors

Descartes's successors were divided into two groups: the occasionalists and those who reintroduced activity into nature. Occasionalism is the view that the only real cause of everything is God and that all causal talk that refers to worldly substances is a sham. Nicolas Malebranche (1638–1715) drew a distinction between real causes and natural causes (or occasions). As he put it: "A true cause as I understand it is one such that the mind perceives a necessary connection between it and its effect. Now the mind perceives a necessary connection between the will of an infinite being and its effect. Therefore, it is only God who is the true cause and who truly has the power to move bodies" (1997, p. 450). Natural causes are then merely the occasions on which God causes something to happen. Malebranche pushed Cartesianism to its extremes: since a body's nature is exhausted by its extension, bodies cannot have the power to move anything, and hence to cause anything to happen. What Malebranche also added was that since causality involves a necessary connection between the cause and the effect (a view that Descartes accepted too), and since no such necessary connection is perceived in cases of alleged worldly causality (where, for instance, it is said that a billiard ball causes another one to move), there is no worldly causality: all there is in the world is regular sequences of events, which strictly speaking are not causal. Gottfried Wilhelm Leibniz (1646–1716), on the other hand, aimed to reintroduce forces and active powers into nature. As he said: "activity is the essence of substance" (1981, p. 65). Each substance is sustained by an internal "primitive active force," which causes its subsequent states. Yet, in a rather puzzling move, he also thought that there is no real causality in nature, since Leibnizian substances (what he called "the monads") do not interact. Rather, they are coordinated with each other by God's act of preestablished harmony, which confers on them the natural agreement of exact clocks.

There is an irony to be noted at this point. Most early modern philosophers tried to solve the metaphysical issue of causality. They devised elaborate theories to explain how the cause brings about the effect. But in the end, they excised causality from nature. More mildly put, insofar as there was causality in nature it was taken to be the product of divine impulse (Descartes) or of mysterious primitive forces (Leibniz).

Hume

In his ground-breaking *A Treatise of Human Nature* (1739–1740), David Hume made the scientific hunt for causes possible, by freeing the concept of causality from the metaphysical chains that his predecessors had used to pin it down. For Hume, causality, as it is in the world, is a regular succession of event-types: one thing invariably following another. His famous first definition of causality runs as follows: "We may define a CAUSE to be 'An object precedent and contiguous to another, and where all the objects resembling the former are plac'd in like relations of precedency and contiguity to those objects, that resemble the latter'" (1978 ed., p. 170).

Taking a cue from Malebranche, Hume argued that there was no perception of the supposed necessary connection between the cause and the effect. When a sequence of events that is considered causal is observed—for example, two billiard balls hitting each other and flying apart—there are impressions of the two balls, of their motions, of their collision, and of their flying apart, but there is no impression of any alleged necessity by which the cause brings about the effect. Hume went one step further. He found worthless his predecessors' appeals to the power of God to cause things to happen, since, as he said, such claims give us "no insight into the nature of this power or connection" (p. 249). So, Hume secularized completely the notion of causality. He also found inadequate, because circular, his predecessors' attempts to explain the link between causes and effects in terms of powers, active forces, and so on. As he put it: "[T]he terms *efficacy, agency, power, force, energy, necessity, connexion,* and *productive quality,* are all nearly synonymous; and therefore 'tis an absurdity to employ any of them in defining the rest" (p. 157).

Yet Hume faced a puzzle. According to his empiricist theory of ideas, there are no ideas in the mind unless there were prior impressions (perceptions). He did, however, recognize that the concept of causality involved the idea of necessary connection. Where does this idea come from, if there is no perception of necessity in causal sequences? Hume argued that the source of this idea is the perception of "a new relation

betwixt cause and effect": a "constant conjunction" such that "like objects have always been plac'd in like relations of contiguity and succession" (p. 88). The perception of this constant conjunction leads the mind to form a certain habit or custom: to make a "customary transition" from cause to effect. It is this felt determination of the mind that affords us the idea of necessity.

So instead of ascribing the idea of necessity to a feature of the natural world, Hume took it to arise from within the human mind, when the latter is conditioned by the observation of a regularity in nature to form an expectation of the effect, when the cause is present. Indeed, Hume offered a second definition of causality: "A CAUSE is an object precedent and contiguous to another, and so united with it, that the idea of the one determines the mind to form the idea of the other, and the impression of the one to form a more lively idea of the other" (p. 170). Hume thought that he had unpacked the "essence of necessity": it "is something that exists in the mind, not in the objects" (p. 165). He claimed that the supposed objective necessity in nature is spread by the mind onto the world. Hume can be seen as offering an objective theory of causality in the world (since causation amounts to regular succession), which was however accompanied by a mind-dependent view of necessity. This dual aspect of Hume's account of causality is reflected in his two definitions.

Being an empiricist, Hume argued that all causal knowledge stems from experience. He revolted against the traditional view that the necessity that links cause and effect is the same as the logical necessity of a demonstrative argument. He argued that there can be no a priori demonstration of any causal connection, since the cause can be conceived without its effect and conversely. His far-reaching observation was that the alleged necessity of causal connection cannot be proved empirically either. As he famously argued, any attempt to show, based on experience, that a regularity that has held in the past will or must continue to hold in the future will be circular and question-begging. It will presuppose a principle of uniformity of nature. But this principle is not a priori true. Nor can it be proved empirically without circularity. For any attempt to prove it empirically will have to assume what needs to be proved—namely, that since nature has been uniform in the past it will or must continue to be uniform in the future. This Humean challenge to any attempt to establish the necessity of causal connections on empirical grounds has become known as his skepticism about induction. But it should be noted that Hume never doubted that people think and reason inductively. He just took this to be a fundamental psychological fact about human beings that cannot be accommodated within the confines of the traditional conception of Reason. Indeed, Hume went on to describe in detail some basic "rules by which to judge of causes and effects" (p. 173).

Kant

It was Hume's critique of necessity in nature that awoke Immanuel Kant (1724–1804) from his "dogmatic slumber," as he himself famously stated. In his *Critique of Pure Reason* (1787), Kant tried to demonstrate that the principle of causality—namely, "everything that happens, that is, begins to be, presupposes something upon which it follows by rule," (1965 ed., p. 218)—is a precondition for the very possibility of objective experience. He took the principle of causality to be required for the mind to make sense of the temporal irreversibility that there is in certain sequences of impressions. So, whereas we can have the sequence of impressions that correspond to the sides of a house in any order we please, the sequence of impressions that correspond to a ship going downstream cannot be reversed: it exhibits a certain temporal order (or direction). This temporal order by which certain impressions appear can be taken to constitute an objective happening only if the later event is taken to be necessarily determined by the earlier one (i.e., to follow by rule from its cause). For Kant, objective events are not "given": they are constituted by the organizing activity of the mind and in particular by the imposition of the principle of causality on the phenomena. Consequently, the principle of causality is, for Kant, a synthetic a priori principle.

Ingenious though Kant's answer to Hume was, it was ironic in three respects. Firstly, Kant safeguarded the concept of causality but at the price of making it applicable only to the phenomena and not to the unknowable things-in-themselves (noumena). Secondly, recall that Hume argued that the supposed necessity of causal sequences cannot be observed in the sequences themselves, but is projected by the mind onto the world. Kant agreed with all this, but took this projection by the mind onto the world to be presupposed for the distinction between causal and noncausal sequences. Thirdly, Kant identified causality with the rule of natural law: causal sequences of events are lawful sequences of events. This became the main plank of the Humean philosophical tradition. Stripped from objective necessity, natural laws boil down to worldly regularities.

The Regularity View of Causality

Arthur Schopenhauer (1788–1860) charged Kant with showing the absurd result that all sequence is consequence. As he noted, the tones of a musical composition follow each other in a certain objective order and yet it would be absurd to say that they follow each other according to the law of causality. This has also been a major objection to Hume's views. Hume left the metaphysics of causality behind, but like Kant, he ended up with a loose notion of causality. On the one hand, it seems that there can be causality without regularity. This is the case of the so-called singular causality, where one event causes another to happen without this particular (singular) sequence of events falling under a regularity. On the other hand, there can be regularity without causality. There are cases in which events regularly follow each other (like the night always follows the day) without being the cause of each other. Once more, the metaphysical and the epistemological issues of causality come to the fore. We might not be able to know that a sequence of events is causal unless we see it repeat itself many times. But this does not imply that, metaphysically speaking, causality consists in regular sequence. On the Humean view, whether or not a sequence of events is causal depends on things that happen elsewhere and elsewhen in the universe, and in particular on whether or not this particular sequence instantiates a regularity. The Humean

view may be entitled the Regularity View of Causality. But an opposite view that became prominent in the twentieth century, due mostly to the work of Curt John Ducasse (1881–1969), is that what makes a sequence of events causal is something that happens there and then: a local tie between the cause and the effect, or an intrinsic feature of the particular sequence. Ducasse's (1968) single-difference account, roughly that an event *c* causes an event *e* if and only if *c* was the last—or, the only—difference in *e*'s environment before *e* occurred, takes causality to link individual events independently of any regular association that there may or may not be between events like the cause and events like the effect. Causality, non-Humeans argue, is essentially singular: a matter of this causing that.

Most advocates of singular causation argue that, contra Hume, causality is observable. A central claim is that causal relations are embodied in language by causal verbs, such as "to bend," "to corrode," "to push," "to break," and so on. So, we are told, when one asserts that, for instance, the vase broke after being struck with a hammer, by the very use of the verb "to break," one makes a causal claim, and one has thereby directly perceived the vase being caused to break. Elizabeth Anscombe (b. 1919) argued that since our language is infested with causal verbs, there is no mystery in the claim that we directly perceive causings: when we learn to report such things as pushings, pullings, breakings, and the like from having observed them, we have thereby learned to report causings from having observed them.

Mill

In his monumental *A System of Logic Ratiocinative and Inductive* (1843), John Stuart Mill (1806–1873) defended the Regularity View of Causality, with the sophisticated addition that in claiming that an effect invariably follows from the cause, the cause should be taken to be the whole conjunction of the conditions that are sufficient and necessary for the effect. For Mill, regular association is not, on its own, enough for causality. A regular association of events is causal only if it is "unconditional"—that is, only if its occurrence does not depend on the presence of further factors which are such that, given their presence, the effect would occur even if its putative cause was not present. A clear case in which unconditionality fails is when the events that are invariably conjoined are effects of a common cause. Ultimately, Mill took to be causal those invariable successions that constitute laws of nature.

Mill is also famous for his methods by which causes can be discovered. These are known as the Method of Agreement and the Method of Difference. According to the first, the cause is the common factor in a number of otherwise different cases in which the effect occurs. According to the second, the cause is the factor that is different in two cases, which are similar except that in the one the effect occurs, while in the other it does not. In effect, Mill's methods encapsulate what is going on in controlled experiments: we find causes by creating circumstances in which the presence (or the absence) of a factor makes the only difference to the production (or the absence) of an effect. Mill, however, was adamant that his methods work only if certain metaphysical assumptions are in place. It must be the case that: (a) events have causes; (b) events have a limited number of possible causes; and (c) same causes have same effects, and conversely.

Logical Positivism

Bertrand Russell (1872–1970), in his "On the Notion of Cause" (1918), argued that the concept of causality was incoherent. But this was just as well for him, since, as he claimed, physics has stopped looking for causes: for "there are no such things." Here is his famous dictum: "The law of causality, I believe, like much that passes muster among philosophers, is a relic of a bygone age, surviving, like the monarchy, only because it is erroneously supposed to do no harm" (1918, p. 180). His suspicion of the concept of causality was inherited by the movement of logical positivism (the Vienna Circle), which set the agenda for most of the philosophy of science in the twentieth century. They took to heart Hume's critique of the supposed necessary connection between cause and effect. The twist they gave to this critique was based on their verificationist criterion of meaning. As the leader of the Circle, Moritz Schlick (1882–1936), stressed, positing a "linkage" between two events would be tantamount to "committing a kind of nonsense" since all attempts to verify it would be necessarily futile (1979, p. 245). Rudolf Carnap (1891–1970) thought that insofar as the concept of causality is useful to science, it should be understood by reference to the notion of laws of nature. He insisted that the only meaningful content that causal talk can have is when we call "cause" the event, or the physical magnitude, or the physical state, which temporally precedes another one nomologically dependent on the former. The logical positivists took the laws to be exceptionless regularities that are expressed by true universal statements of the form "all Fs are Gs" (e.g., all planets move in ellipses).

Deductive-Nomological Explanation

A central element of the empiricist project was to legitimize—and demystify—the concept of causality by subsuming it under the concept of lawful explanation, which, in turn, was modeled on deductive arguments. This project culminated in Carl Hempel (1905–1977) and Paul Oppenheim's Deductive-Nomological model of explanation. According to this, to offer an explanation of an event *e* is to construct a valid deductive argument of the following form:

Antecedent/Initial Conditions

Statements of Laws

Therefore, *e* (event/fact to be explained)

So, when the claim is made that event *c* causes event *e* (e.g., that the sugar cube dissolved because it was immersed in water), it should be understood as follows: there are relevant laws in virtue of which the occurrence of the antecedent condition *c* (putting the sugar in water) is nomologically sufficient for the occurrence of the event *e* (the dissolving of the sugar). It has been a standard criticism of the Deductive-Nomological (DN) model that, insofar as it aims to offer sufficient and necessary conditions for an argument to count as a bona fide explanation, it fails. For, there are arguments that satisfy the

> There are some philosophers who assert that secondary causes act through their matter, figure, and motion . . . others assert that they do so through a substantial form; others through accidents or qualities, and some through matter and form; of these some through form and accidents, others through certain virtues or faculties different from the above. . . . Philosophers do not even agree about the action by which secondary causes produce their effects. Some of them claim that causality must not be produced, for it is what produces. Others would have them truly act through their action; but they find such great difficulty in explaining precisely what this action is, and there are so many different views on the matter that I cannot bring myself to relate to them.
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> SOURCE: Nicolas Malebranche, *The Search After Truth* (*Researche de la Vérité*) (1674–1675), trans. Thomas M. Lennon and Paul J. Olscamp. Cambridge, U.K., and New York: Cambridge University Press, 1997, p. 659.

structure of the DN-model, and yet fail to be bona fide explanations of a certain event. For instance, one can construct a deductive-nomological "explanation" of the height of a flagpole having as premises (a statement of) the length of its shadow and (statements of) relevant laws of optics, but this is not an explanation of why the flagpole has the height it does. In a sense, this counterexample repeats a point that we saw already made by Aristotle—namely, that good explanations are asymmetric: they explain effects in terms of causes and not conversely. Conversely, there are bona fide explanations that fail to instantiate the DN-model. For instance, one can construct an explanation of why there was a car crash (by telling a causal story of how it happened) without referring to any law at all. The joined message of these counterexamples is that the DN-model fails precisely because it ignores the role of causality in explanation. In other words, the moral of the counterexamples is there is more to the concept of causality than what can be captured by DN-explanations.

Laws of Nature

Be that as it may, the Deductive-Nomological model, as well as any attempt to tie causality to laws, faces a rather central conceptual difficulty: the problem of how to characterize the laws of nature. Most Humeans have come to adopt the Regularity View of Laws: laws of nature are regularities. Yet, they have a hurdle to jump: not all regularities are causal. Nor can all regularities be deemed laws of nature. The night always follows the day, but it is not caused by the day. And, though a regularity, it is not a law of nature that all coins in my pocket are euros. So, the Humeans have to draw a distinction between the good regularities (those that constitute the laws of nature) and the bad ones—that is, those that are, as Mill put it, "conjunctions in some sense accidental." Only the former can underpin causality and play a role in explanation. Among the many attempts to distinguish between laws and accidents, the most promising is what may be called the web of laws view. According to this, the regularities that constitute the laws of nature are those that are expressed by the axioms and theorems of an ideal deductive system of our knowledge of the world, which strikes the best balance between simplicity and strength. Whatever regularity is not part of this best system is merely accidental: it fails to be a genuine law of nature. The gist of this approach, which has been advocated by Mill, Frank Ramsey (1903–1930), and David Lewis (1941–2001), is that no regularity, taken in isolation, can be deemed a law of nature. The regularities that constitute laws of nature are determined in a kind of holistic fashion by being parts of a structure. But despite its many attractions, this view does not offer a purely objective account of laws of nature.

A contrary view that has been defended by David Armstrong (b. 1926) is that lawhood cannot be reduced to regularity. Lawhood is said to be a certain necessitating relation among natural properties. An attraction of this view is that it makes clear how laws can cause anything to happen: they do so because they embody causal relations among properties. But the central concept of nomic necessitation is still not sufficiently clear.

Inus Conditions

Among the more recent attempts to develop more defensible versions of the Regularity View of Causality, J. L. Mackie's (1917–1981) inus-conditions approach stands out. Mackie stressed that effects have, typically, a "plurality of causes" (p. 61). That is, a certain effect can be brought about by a number of distinct clusters of factors. Each cluster is sufficient to bring about the effect, but none of them is necessary. So, he takes the regularities in nature to have a complex form (A&B&C or D&E&F or G&H&I) ↔ E, which should be read as: all (A&B&C or D&E&F or G&H&I) are followed by E, and all E are preceded by (A&B&C or D&E&F or G&H&I). How do we pick out the cause of an event in this setting? Each single factor of A&B&C (e.g., A) is related to the effect E in an important way. It is an *insufficient* but *nonredundant* part of an *unnecessary* but *sufficient* condition for E. Using the first letters of the italicized words, Mackie has called

such a factor an inus condition. Causes, then, are inus conditions. So to say that short circuits cause house fires is to say that the short circuit is an inus condition for house fires. It is an insufficient part because it cannot cause the fire on its own (other conditions such as oxygen, inflammable material, etc. should be present). It is, nonetheless, a nonredundant part because, without it, the rest of the conditions are not sufficient for the fire. It is just a part, and not the whole, of a sufficient condition (which includes oxygen, the presence of inflammable material, etc.), but this whole sufficient condition is not necessary, since some other cluster of conditions, for example, an arsonist with gasoline, can produce the fire.

Counterfactual Dependence

In his *Enquiry Concerning Human Understanding* (1748) Hume stated briefly another way to view causality. He said that an object is the cause of another when "if the first object had not been, the second never had existed" (1975 ed., p. 146). This view has been articulated into a theory of causality by David Lewis. Lewis (1986) defined causality in terms of the counterfactual dependence of the effect on the cause: the cause is rendered counterfactually necessary for the effect. For instance, to say that the short-circuit caused the fire is to say that if the short-circuit had not happened, the fire would not have ensued. To be more precise, Lewis defined causality by reference to a *causal chain* of counterfactually dependent events, where a sequence of events (*C, E, E′, . . .*) is a chain of counterfactual dependence if and only if *E* counterfactually depends on *C, E′* counterfactually depends on *E,* and so on. This move is meant to enforce that causation is a transitive relation among events (that is, if *C* causes *E* and *E* causes *E′,* then *C* causes *E′*). As Lewis put it: "one event is a cause of another if and only if there exists a causal chain leading from the first to second" (p. 167). Statements such as "if *C* had happened, then *E* would have happened" are called counterfactual conditionals (another example, "if this sugar cube had been in water, it would have dissolved") for they state what could or could not have happened, under certain circumstances. But it has been notoriously difficult to specify the conditions under which counterfactual conditionals are true or false. Lewis articulated a rather complicated logic of counterfactual conditionals, which was based on the idea that, besides the actual world, there are also other possible worlds, which can be deemed more or less similar to the actual. A chief but not inviolable criterion for judging the similarity among worlds was taken to be whether the same laws of nature govern the worlds under comparison.

Though it is still one of the main contestants, this view of causality faces important difficulties. A chief among them comes from cases of causal overdetermination, where there are two factors each of which is sufficient to bring about the effect, but none of them is necessary, since even if the one was not present, the other factor would ensure the occurrence of the effect. For instance, two rocks are simultaneously thrown at a bottle and they shatter it. They both caused the shattering, but the effect is not counterfactually dependent on either of them, since if the first rock had missed the bottle, the other would have still shattered it. So there is causality without the cause being counterfactually dependent on the effect.

> Here is a billiard-ball lying on the table, and another ball moving towards it with rapidity. They strike; and the ball, which was formerly at rest, now acquires a motion. This is as perfect an instance of the relation of cause and effect as any which we know, either by sensation or by reflection. Let us therefore examine it. 'Tis evident, that the two balls touched one another before the motion was communicated, and that there was no interval betwixt the shock and the motion. *Contiguity* in time and place is therefore a requisite circumstance to the operation of all causes. 'Tis evident likewise, that the motion, which was the cause, is prior to the motion, which was the effect. *Priority* in time, is therefore another requisite circumstance in every cause. But this is not all. Let us try any other balls of the same kind in a like situation, and we shall always find, that the impulse of the one produces motion in the other. Here therefore is a *third* circumstance, viz., that is a constant conjunction betwixt the cause and effect. Every object like the cause, produces always some object like the effect. Beyond these three circumstances of contiguity, priority, and *constant conjunction,* I can discover nothing in this cause. The first ball is in motion; touches the second; immediately the second is in motion: and when I try the experiment with the same or like balls, in the same or like circumstances, I find that upon the motion and touch of the one ball, motion always follows in the other. In whatever shape I turn this matter, and however I examine it, I can find nothing farther.(pp. 649–650)
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> SOURCE: David Hume, *Abstract to A Treatise of Human Nature.* Published by Hume anonymously in 1739.

Probabilistic Causality

No matter how one thinks about causality, there are certain platitudes that this concept should satisfy. One of them may be called the difference platitude: causes make a difference—namely, things would be different if the causes of some effects were absent. This platitude is normally cast in two ways. We

> [W]e derived the principle that everything that happens has a cause from the condition under which alone a concept of happening in general is objectively possible—namely, by showing that the determination of an event in time, and therefore the event as belonging to experience, would be impossible save as standing under such a dynamical rule.
>
> SOURCE: Immanuel Kant, *Critique of Pure Reason* (1787), trans. Norman Kemp Smith. New York: St. Martin's Press, 1965, p. 624.

have already seen the first, the counterfactual way: if the cause had not been, the effect would not have been either. The other is a probabilistic way: causes raise the chances of their effects—namely, the probability that a certain event happens is higher if we take into account its cause than if we do not. This thought has led to the development of theories of probabilistic causality. We do rightly claim that smoking causes lung cancer, even though there is no regular association (or deterministic connection) between smoking and lung cancer. Some philosophers, most notably Patrick Suppes (1984) and Nancy Cartwright (1983), think that this is already a good argument against the view that causality is connected with invariable sequences or regularities. They then analyze causal claims in terms of probabilistic relations among magnitudes, capitalizing on the intuition that causes (mostly, but not invariably) raise the probabilities of their effects. Some think that there are good empirical reasons to jettison determinism (roughly, that each and every event has a fully sufficient set of causes) in favor of indeterminism (roughly, that there are genuinely chancy events). They then try to show that indeterminism and causality mix well, given the thought that a certain event can be caused to happen even though its cause made only a difference to its chance to happen. Interestingly, these ideas are extended to deterministic causality as well, with the prime thought being that an effect is deterministically caused to happen if its probability, given its cause, is unity.

Causes as Recipes

Another central platitude of the concept of causality may be called the recipe platitude: causes are recipes for producing or preventing their effects. This platitude is normally cast in terms of manipulability: causes can be manipulated to bring about certain effects. G. H. von Wright (1906–2003) developed this thought into a full-blown theory of causality. He took it that what confers on a sequence of events the character of causal connection is "the possibility of subjecting cause-factors to experimental test by interfering with the 'natural' course of events" (1993, p. 117). Since manipulation is a distinctively human action, he concluded that the causal relation is dependent upon the concept of human action. But his views were taken to be too anthropomorphic. For, do we not think that there would be causal relations, even if there would not be any humans around capable of manipulating anything? Yet, recently, there have been important attempts to give a more objective gloss to the idea of manipulation. James Woodward (2003) introduces a notion of intervention that is not restricted to human action and argues that a relationship among some magnitudes X and Y is causal if, were one to intervene to change the value of X appropriately, the relationship between X and Y would remain invariant but the value of Y would change, as a result of the intervention on X. This interventionist account has been developed by Judea Pearl (2001) into a rather powerful mathematical tool, known as Bayesian probabilistic networks, for discovering and establishing causal relations from relations of probabilistic dependence among variables. An attraction of the interventionist approach is that it is not so much concerned with the metaphysics of causality as with the epistemological and methodological circumstances under which causal facts can be ascertained.

Physical Causality

Lately, there have been a number of attempts to show that there is more to causality than regular succession by positing a physical mechanism that links cause and effect. In his *Scientific Explanation and the Causal Structure of the World* (1984), Wesley Salmon (1925–2001) advanced a mechanistic approach, roughly that an event *c* causes an event *e* if and only if there is a causal process that connects *c* and *e*. Borrowing an idea of Hans Reichenbach's (1956), Salmon characterized "causal" those processes that are capable of transmitting a mark, where a mark is a modification of the structure of a process. Later on, Salmon (1997) and Phil Dowe (2000) took causality to consist in the exchange or transfer of some conserved quantity, such as energy-momentum or charge. Such accounts may be called transference models because they claim that causality consists in the transfer of something (some physical quantity) between the cause and its effect. They claim that causality need not involve regularities or laws. Rather, it consists in a local physical tie between cause and effect. But there is a drawback. Even if it is granted that these models offer neat accounts of causality at the level of physical events or processes, they can be generalized as accounts of causality *simpliciter* only if they are married to strong reductionistic views that all worldly phenomena (be they social or psychological or biological) are, ultimately, reducible to physical phenomena. We saw earlier that Descartes, too, advanced a transference model of causality and that he stumbled on the issue of mental causality: how can the mental cause anything physical to happen, as it manifestly does? The irony is that the very same hurdle might have to be jumped by the advocates of the modern transference models.

Neo-Aristotelianism

Hume found any appeal to causal powers suspect, since he thought there were no impressions of them. Hume's views were dominant until the last quarter of the twentieth century, when there was a resurgence of Aristotelianism. A few contemporary philosophers think that causation should be best understood in terms of causal powers—that is, powers, dispositions, and

capacities things have to cause other things to happen. These powers are supposed to stem from the nature or essence of a thing and they determine what a thing is and what it can do. The causal laws that govern the world are supposed to stem from these causal powers. According to Brian Ellis (2001), a chief defender of this view, causal laws state necessary truths about how things are intrinsically disposed to behave. But many philosophers find these views unappealing, not least because they fail to explain the fundamental notion of causal power.

See also ***Aristotelianism; Cartesianism; Determinism; Dualism; Empiricism; Neoplatonism; Probability.***

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Stathis Psillos

CAUSATION. Philosophers have theorized about causation since well before Aristotle, who distinguished several types of causation: efficient, material, final, and formal. For example, a wood carving is made by an artist (the efficient cause) by chiseling a piece of wood (the material cause) for the purpose of creating a beautiful object (the final cause), arriving at something that has the properties of a wood carving (the formal cause).

Although Aristotle's typology framed discussions of causation until the scientific revolution and in some circles even until David Hume, the focus settled onto analyzing efficient causation and in particular on understanding the kinds of substances that might interact causally. René Descartes, for example, separated material and mental substances and wrote extensively on how cross-substance causation might happen. Discussions of causation thus became entangled with the metaphysics of substance, and positions ranged all the way from Baruch Spinoza, who claimed there is only one type of substance, to Gottfried Wilhelm Leibniz, who claimed there was an infinity of unique substances, one per monad. Everyone wanted to understand causation as involving some "power" to produce change, and different substances possess different sorts of powers over their own and other substances. For example, the empiricist Bishop George Berkeley argued that our ideas (sensations) cannot be caused by other ideas or matter, because ideas and matter are "inert" and do not have the sort of causal "power" necessary for efficient causation. Only an agent like God or a willful person possesses such power. John Locke, in *An Essay concerning Human Understanding,* wrote voluminously trying to explicate the idea of causal power in empiricist terms. David Hume, the brilliant eighteenth-century Scottish philosopher, finally rejected the notion of causal power as being beyond direct observation, and he recast the problem of understanding the connection between a cause and its effect as another version of the problem of induction. Although causes always seem to be followed by their effects, the bond between them might well be nothing more than a psychological habit we develop as a result of regularly perceiving the idea of one type of object or event (e.g., thunder) just after the idea of another (e.g., lightning). Hume's challenge was to find compelling reasons for believing that when an object similar to one we have seen previously occurs, then the effect must necessarily occur. No one has succeeded in answering Hume's challenge, but his effect on the debate was as powerful as Aristotle's. All modern theories of causation begin with something like Hume's story: there are objects or events that we can group as similar, like the events of walking in the rain with no coat and developing a cold. They all ask what does it mean to assert that the relation between these events is causal.

Modern Theories of Causation

Practically, causation matters. Juries must decide, for example, whether a pregnant mother's refusal to give birth by cesarean section was the cause of the death of one of her twins. Policy makers must decide whether violence on TV causes violence in life. Neither question can be coherently debated without some theory of causation. Fortunately (or not, depending on where one sits), a virtual plethora of theories of causation have been championed in the third of a century between 1970 and 2004.

Before the sketch of a few of the major theories, however, consider what one might want out of a theory of causation. First, although one can agree that causation is a relation, what are the relata? Are causes and effects *objects,* like moving billiard balls? Are they *particular events,* like the *Titanic* hitting an iceberg in 1912? Or are they *kinds of events,* like smoking cigarettes and getting lung cancer? As it turns out, trying to understand causation as a relation between particular objects or events is quite a different task than trying to understand it as relation between *kinds* of occurrences or events.

Second, one wants a theory to clarify, explain, or illuminate those properties of causation that one can agree are central. For example, whatever causation is, it has a direction. Warm weather causes people to wear lighter clothing, but wearing lighter clothing does not cause warm weather. A theory that fails to capture the *asymmetry of causation* will be unsatisfying.

Third, one knows that in many cases one thing can occur regularly *before* another, and thus appear to be related as cause and effect, but is in fact the effect of a common cause, a phenomenon called *spurious causation.* For example, flashes of lightning appear just before and seem to cause the thunderclaps that follow them, but in reality both are effects of a common cause: the superheating of air molecules from the massive static electric discharge between the earth and the atmosphere. A good theory of causation ought to successfully separate cases of real from spurious causation.

The history of thinking on causation from 1970 to 2004 can be organized in many ways, but the one that separates matters best, both temporally and conceptually, is captured eloquently by Clark Glymour:

> Philosophical theories come chiefly in two flavors, Socratic and Euclidean. Socratic philosophical theories, whose paradigm is *The Meno,* advance an analysis (sometimes called an "explication"), a set of purportedly necessary and sufficient conditions for some concept, giving its meaning; in justification they consider examples, putative counterexamples, alternative analyses and relations to other concepts. Euclidean philosophical theories, whose paradigm is *The Elements,* advance assumptions, considerations taken to warrant them, and investigate the consequences of the assumptions. Socratic theories have the form of definitions. Analyses of "virtue," "cause," "knowledge," "confirmation," "explanation," are ancient and recent examples. Euclidian theories have the form of formal or informal axiomatic systems and are often essentially mathematical: Euclid's geometry, Frege's