

CAUSATION

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Causation

Primary Disciplinary Field(s): Philosophy (Metaphysics), Science (Epidemiology, Physics), Law, Psychology, Statistics.

1. Core Definition

Causation is the fundamental empirical and metaphysical relationship that describes how one event, state, or object (the cause) contributes to the production of another event, state, or object (the effect). This relationship is characterized by the concept that the cause possesses the **potential capacity** to bring about the effect, establishing a necessary or highly probable link between the antecedent and the consequent. In its simplest form, causation is often summed up by the principle that nothing happens without a cause, meaning that every event in the universe is the result of some preceding action or condition.

The establishment of a causal link requires more than mere temporal sequence or correlation. While the cause must always precede the effect chronologically, the relationship must be non-spurious, meaning that the observed connection cannot be entirely explained by a third, confounding variable. The concept is central to virtually all forms of human inquiry, from the natural sciences seeking to model physical laws to the judicial system determining responsibility and liability. Without a robust understanding of causation, prediction, control, and explanation of phenomena become impossible, rendering scientific progress and rational decision-making inert.

In analytical philosophy and statistics, the definition often distinguishes between **deterministic causation**, where the cause invariably produces the effect, and **probabilistic causation**, where the cause raises the probability of the effect's occurrence, which is particularly relevant in social sciences, medicine, and quantum mechanics where absolute certainty is often elusive. The ongoing debate centers on what exactly constitutes the "bringing about" mechanism--whether it is a transfer of energy, a counterfactual dependence, or simply a regularity of observed events.

2. Philosophical Foundations and Historical Development

The systematic study of causation originates in ancient Greek philosophy, most notably with **Aristotle**, who outlined his famous doctrine of the four causes: Material, Formal, Final, and, most pertinent to the modern understanding, the **Efficient Cause**. The Efficient Cause is defined as that which immediately triggers the effect--the primary source of the change or motion. In the Aristotelian tradition, as noted in the original source content, the existence of the cause was often viewed as a **sufficient basis** for the existence of the effect, implying a strong, inherent necessity in the causal chain. This classical viewpoint dominated Western thought for over a millennium, underpinning much of early theology and physics.

A radical shift occurred during the Enlightenment, primarily through the skepticism of David Hume. Hume challenged the assumption of necessary connection, arguing that while we observe the constant conjunction of events (Event A always followed by Event B), we never actually perceive the necessary force or power linking them. For Hume, causation is not an objective fact of the world but a psychological expectation or habit formed by repeated experience. This Humean analysis separated the metaphysical necessity previously ascribed to causes from the mere observed regularity, fundamentally changing the course of epistemology and scientific methodology by emphasizing observation and induction over inherent rational necessity.

Following Hume, figures like Immanuel Kant attempted to restore a degree of objective necessity to causation by positing it as an *a priori* condition of human experience--a necessary category of the understanding that allows us to structure the world rationally. In the 20th century, causation became deeply intertwined with logic and semantics, leading to the development of sophisticated models such as counterfactual theories (e.g., those developed by David Lewis), which define causation by asking: If the cause had not occurred, would the effect still have happened? If the answer is no, a causal link is established.

3. Key Characteristics of Causal Relationships

Temporal Priority (Antecedence): The cause must always precede the effect in time. While this seems self-evident, it is a crucial characteristic that distinguishes causal chains from mere correlation or circular relationships. The strict adherence to temporal order is a cornerstone of scientific methodology, although discussions regarding backwards causation exist primarily in theoretical physics.

Contiguity and Mechanism: Traditionally, causes and effects were thought to be contiguous, meaning they interact physically or temporally close to one another. While modern physics allows for non-local correlations (e.g., quantum entanglement), the classical notion requires some intervening mechanism or process--a physical means by which the energy or influence is transferred from the cause to the effect.

Necessary Connection (The Problem of Induction): This refers to the persistent philosophical problem of verifying that the connection between the cause and the effect is truly necessary, rather than accidental. As per Hume, this connection is not empirically verifiable, requiring scientists to rely on the principle of induction--the assumption that future instances will resemble past ones.

Non-Spuriousness: A causal relationship must be genuine and not the result of a confounding variable (C) that influences both the observed Cause (A) and the observed Effect (B). Establishing non-spuriousness is the primary goal of experimental design, often achieved through randomization or statistical control, ensuring that the effect is solely attributable to the manipulation of the cause.

Manipulation/Intervention: In many scientific and psychological contexts, a true causal relationship is confirmed by the ability to manipulate the cause and observe a corresponding

change in the effect. This characteristic is formalized in the concept of **interventional causality**, central to fields like experimental psychology and econometrics.

4. Causation in Scientific Methodology and Models

In scientific practice, particularly in epidemiology and social sciences, establishing causation requires rigorous methodology because true deterministic causes are rare and often obscured by complexity. Scientists rely heavily on models, such as the **Bradford Hill Criteria** (developed by Sir Austin Bradford Hill and Sir Richard Doll), which provide guidelines for inferring causation from observational data, particularly in public health. These criteria include strength of association, consistency, specificity, temporality, biological gradient (dose-response), plausibility, coherence, experimental evidence, and analogy.

The **Counterfactual Model** remains one of the most powerful analytical tools. In this approach, typically associated with the Rubin Causal Model (RCM), the causal effect of a treatment (cause) is defined as the difference between the observed outcome when the treatment is applied and the hypothetical (counterfactual) outcome had the treatment not been applied. Since the counterfactual outcome can never be directly measured, scientists use statistical techniques, such as randomized controlled trials (RCTs), to estimate this difference accurately by ensuring that the two groups (treated and untreated) are comparable in all relevant aspects.

Furthermore, contemporary scientific understanding often relies on **system causation** or **network causality**, recognizing that effects are rarely due to a single, isolated cause but rather emerge from a complex web of interacting variables and feedback loops. This is particularly true in fields like ecology, climate science, and behavioral neuroscience, where linear, one-to-one causal links are insufficient to explain observed phenomena.

5. Legal and Moral Causation

The concept of causation plays a critical, dual role within legal systems, especially in tort law and criminal law, where it determines responsibility and liability. Legal causation is typically divided into two necessary components that must both be satisfied for a defendant to be held responsible for an injury or crime.

The first component is **Causation-in-Fact** (or actual cause), which employs the "but-for" test: But for the defendant's actions, would the harm or injury have occurred? If the answer is no, factual causation is established. This test can sometimes lead to overly broad liability, especially in cases involving multiple contributing factors, necessitating the second component.

The second, and more restrictive, component is **Proximate Cause** (or legal cause). This test limits liability to consequences that are reasonably foreseeable or directly resulting from the

defendant's actions. Proximate cause ensures that a person is not held legally responsible for remote, bizarre, or highly attenuated consequences of their behavior, thus incorporating elements of public policy and fairness into the determination of responsibility. The interplay between factual and proximate cause demonstrates how law must adapt the purely empirical concept of causation to practical, moral, and social imperatives.

6. Debates and Criticisms

Despite its essential nature, causation is fraught with theoretical difficulties, leading to continuous philosophical debate. The enduring ****Problem of Induction****--Hume's challenge--remains central: how can past regularities justify a belief in future necessary connections? Positivists have attempted to eliminate the metaphysical notion of necessity altogether, reducing causation solely to observed empirical regularities.

Modern physics introduces further complications. ****Quantum mechanics**** suggests that certain events, such as radioactive decay, are fundamentally indeterminate or stochastic, meaning they occur without a deterministic, external cause in the classical sense. This has forced philosophers to refine models of causation to accommodate intrinsic randomness, moving away from purely deterministic models prevalent since Newton.

A persistent practical criticism, especially in statistics and data science, is the pervasive risk of ****mistaking correlation for causation****. The increasing availability of large datasets can reveal strong statistical correlations (e.g., between ice cream sales and drowning incidents), yet these correlations are often driven by a third variable (e.g., warm weather). Successfully navigating this distinction requires sophisticated experimental design, model specification, and a deep understanding of the underlying domain--a challenge that continues to drive methodological innovation across all empirical fields.

Further Reading

[Causation](#) (Stanford Encyclopedia of Philosophy)

[David Hume](#) (Stanford Encyclopedia of Philosophy)

[Aristotle's Metaphysics: Causality](#) (Stanford Encyclopedia of Philosophy)

[The Bradford Hill Criteria for Causality](#) (Centers for Disease Control and Prevention)

[Counterfactual Theories of Causation](#) (Stanford Encyclopedia of Philosophy)