

A Beginner's Guide to Scientific Method

Third Edition

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QUICK REVIEW 3.1 Causation and Correlation**Causation**

Two things are causally linked if one proceeds and is responsible for the other. Suppose your car won't start because its battery is dead. The dead battery is the cause and your car's failure to start, the effect. Effects can have more than a single cause and there may be many causes for similar effects. Several causal factors are responsible for the behavior of the stock market and a market decline can be caused by a variety of factors. Causal relationships can hold between individual events or between large classes of events as in the claim that megadoses of vitamin C can reduce occurrences of the common cold. If events are causally linked, they will be correlated, but correlations do not necessarily indicate causal links.

Positive Correlation

In two populations, P and Q are positively correlated if a greater percentage of Ps than non-Ps have Q. Suppose that nationwide, people with cell phones have, on average, a higher income than people without cell phones. Cell-phone ownership and income are positively correlated. In a single population, if a regular increase in one trait, P, is accompanied by a regular increase in another, Q, then the two are positively correlated. Suppose worker productivity at a plant increases as pay increases though with some exceptions. Worker productivity is positively correlated with income.

Negative Correlation

In the two populations, P and Q are negatively correlated if a smaller percentage of Ps than non-Ps have Q. Suppose regular users of the local

public library (once or more a month) watch, on average, much less TV than sporadic or nonusers of the library. TV watching and library use are negatively correlated for the group in question. In a single population, P and Q are negatively correlated if a regular increase in P is accompanied by a regular decrease in Q. Suppose that the number of visits to the library per month increases as the average number of hours watching TV decreases. Library use and TV watching are negatively correlated.

No Correlation

In two populations, P and Q are not correlated if there is no difference in levels of Q in P and not-P. If equal percentages of males and females are left-handed, there is no correlation between left-handedness and gender. In a single population two traits are not correlated if there is no regular variance between the occurrence of the two. Suppose we were to record both the number of checks written and the number of soft drinks consumed per month by a randomly chosen group of people. We would probably find no evidence that variation in one trait is a predictor of a variation in the other. This suggests there is no correlation between the two.

Perfect Correlation

An invariant relation between two traits; for every change in one trait there is a consistent change in the other. In most species of trees, age in years is perfectly correlated with the number of rings in the tree's trunk; the older the tree the greater the number of rings, without exception.

QUICK REVIEW 3.2 Ways of Explaining**Causes**

To explain one thing or event by reference to another, antecedent thing or event. *Examples:* "Debris from last night's windstorm caused the power outage." "Excessive alcohol consumption can damage the liver."

Causal Mechanisms

To explain by citing intervening causal factors, factors that explain the effects of a more distant cause. *Examples:* "Debris from the storm severed several power lines thus causing last night's power outage."

Laws

To explain an event by referring to a general law or principle of which the event is an instance. *Example:* "The fuel efficiency of a vehicle is determined in part by size and weight. This is because acceleration is directly proportional to force but inversely proportional to mass. Thus, the larger the object you want to move, the greater the force you need

to apply, and so the more energy you need to expend."

Underlying Processes

To explain something by reference to the working of its component parts. *Example:* "The chest pain and breathing difficulty symptomatic of pneumonia results from an infection of the lung tissue. The tiny air sacs of which the lungs are composed—called alveoli—fill with inflammatory fluid caused by the infection. As a result, the flow of oxygen through the alveolar walls is greatly impaired."

Function

To explain something by reference to the role it fulfills in some larger enterprise. *Examples:* "Many species of birds build their nests in high places—trees, cliffs, etc.—to protect their young from predators." "The lungs serve as a means of both introducing oxygen into and removing carbon dioxide from the blood stream."

dominance of a trait within a species on the basis of the advantage it confers on those that have the trait—on, that is, the purpose it serves.

But in such cases, "purpose" need not be understood on the model of human purposes. Rather, "purpose," as it is used in biological explanations, means something more like "role in some larger enterprise." To give the purpose is to specify that role. So, for example, to wonder about the purpose served by the bright colors of many species of flowers is merely to consider how this trait is beneficial in the propagation of those species. Bees, it seems, are attracted to brightly colored flowers and thus bright coloration tends to enhance the chances of pollination. In a perfectly harmless sense then, the "purpose" of a bright coloration in some flower species is to attract potential pollinators. But in this sense, to explain by reference to the purpose served by a trait is not to suggest anything like the underlying intelligence we associate with human purposes.