Notes on Causal Arguments & Mill's Methods

Salmon (2013) *Intro to Logic and Critical Thinking*

1. Mill's Methods for Establishing Causes

Causal argument = An *inductive* argument in which the conclusion states a causal relationship.

John Stuart Mill (1806-1873)

Question: What are the criteria for a good causal argument? (How are causal statements justified?)

Mill's Methods: 5 types of causal argument (i.e., 5 methods of justifying a causal statement).

(i) Method of Agreement

- To determine the cause of an event e, look at antecedent circumstances for each occurrance *of* e.
- If there is a common antecendent circumstance, then it is *likely* (but not guaranteed) to be the cause of e.

Case	Antecedent Circumstances	Event for Which Cause is Sought
1	X, Y, Z	e
2	X, U, V, Y	e
3	X, W, S	e
4	X, T, Z, W	e
etc.	X, ...	e

Example: e = food poisoning

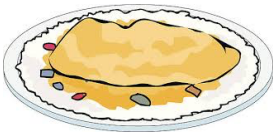
Case 1: Alice ate omelet, toast, orange juice.

Case 2: Bob ate omelet, rice, bacon, grapefruit juice.

Case 3: Eve ate omelet, muffin, coffee.

Case 4: Carlos ate omelet, waffles, orange juice, tea.

The Method of Agreement suggests the cause of the food poisoning was the omelet.



Limitations:

- Background information is typically required to narrow down *relevant* antecedent circumstances. (Alice, Bob, Eve, and Carlos may all own iPhones, but iPhone ownership is unrelated to food poisoning.)
- Does not guarantee that the common antecedent circumsrtance X is the cause of e, or just an effect of an underlying common cause.

(ii) Method of Difference

- To determine the cause of an event e, look at two cases, one in which e occurs and one in which e does not occur, and that are exactly similar in all but one antecedent circumstance.
- That antecedent circumstance that is present when e is present, and absent when e is absent, is most likely the cause of e.

Case	Antecedent Circumstances	Event for Which Cause is Sought
1	X, S, R, U, V, W	e occurs
2	S, R, U, V, W	e does not occur

Example: e = food poisoning

Case 1: Mr. Jones ate omelet, waffles, toast, muffin, orange juice, coffee.

Case 2: Mrs. Jones ate waffles, toast, muffin, orange juice, coffee.

The Method of Disagreement suggests the cause of Mr. Jones' food poisoning was the omelet.

Limitations:

- Background information is typically required to narrow down *relevant* antecedent circumstances.
- Does not guarantee that the different antecedent circumsrtance X is the cause of e, or just an effect of an underlying common cause.
- Requires a pair of cases that are exactly similar except for one characteristic.

(iii) Joint Method of Agreement and Difference

- To determine the cause of an event e, use Method of Agreement on all cases in which e occurs, and on all cases in which e does not occur.
- Use Method of Difference on the resulting two sets of cases.

Case	Antecedent Circumstances	Event for Which Cause is Sought
1	X, S, T, U	e occurs
2	X, S, T	e occurs
3	X, T	e occurs
4-i	X, S	e occurs
j	S, T, U, V	e does not occur
$j+1$	S, T	e does not occur
$j+2$	T, U	e does not occur
n	S, U, V	e does not occur

(iv) Method of Concomitant Variation

- To determine the cause of an effect e that varies, look for an antecedent condition that varies, either in direct or inverse proportion to variation in the suspected cause.
- That antecedent circumstance that is present when e is present, and absent when e is absent, is most likely the cause of e.

Cases or Groups	Antecedent Circumstances	Event or Condition for Which Cause is Sought
1	$X+$, Y, Z, ...	$e+$ (or e$-$)
2	$X-$, Y, Z, ...	$e-$ (or e$+$)

Example (1950s London): e = number of deaths from respiratory problems

Case 1: Nov 29-Dec 9, 1952: increase in air pollution ($X+$) coincides with increase in deaths from respiratory problems ($e+$).

Case 2: Dec 9-Dec 16, 1952: decrease in air pollution ($X-$) coincides with decrease in deaths from respiratory problems ($e-$).

The Method of Concomitant Variation suggests a cause of deaths from respiratory problems is air pollution.

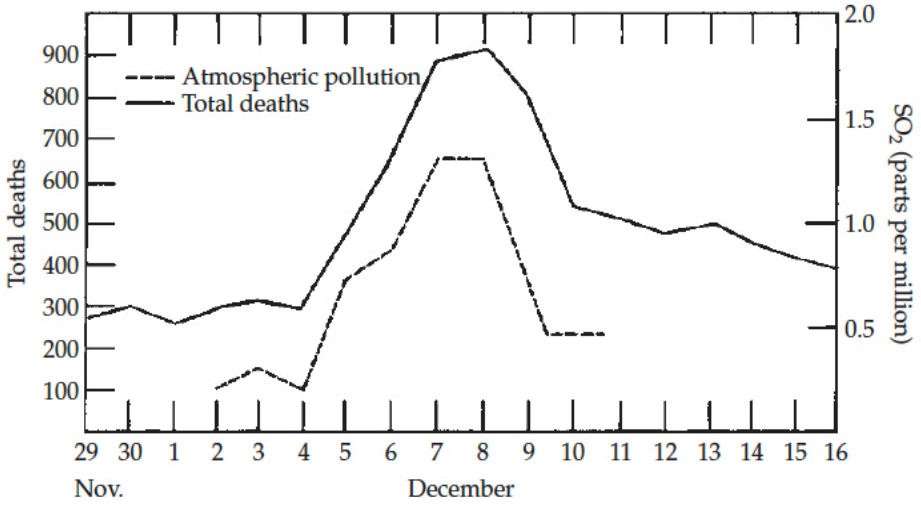


FIGURE 5.1
Atmospheric pollution (in parts per million of sulfur dioxide) and numbers of deaths per day in London, from November 29 to December 16, 1952. *Source:* B. MacMahon, T. Pugh, and J. Ipsen, Epidemiologic Methods (Boston: Little, Brown, 1960), p. 6. Copyright © Lippincott Williams & Wilkins. Reproduced by permission.

(v) Method of Residues

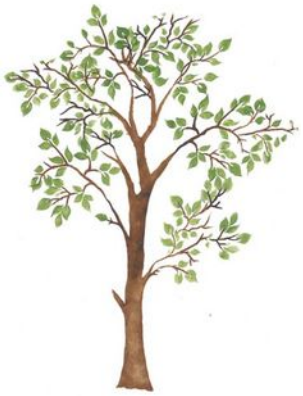
- To determine the cause of a complex effect e, account for as many of its components as possible.
- Invoke an additional cause to account for the remainder (the residue).

Components of Causal Complex	**Complex Effect**
X, Y, Z, ?	e_1 & e_2 & e_3 & e_4
X accounts for	e_1
Y accounts for	e_2
Z accounts for	e_3
? accounts for	e_4

Example: e = abnormally slow growth of a dogwood tree.

Possible components: not enough water, inappropriate amount of fertilizer, grass too close to trunk.

If you've watered it sufficiently, and have provided the right amount of fertilizer, it's most likely that you haven't sufficiently trimmed the grass around its trunk.



2. Controlled Experiments

- Typically take the form of Joint Method of Agreement and Difference, or Method of Concomitant Variations.
- Study two groups that are similar except for their exposure to the suspected cause:
  - *Experimental group* = group exposed to suspected cause.
  - *Control group* = group not exposed to suspected cause.
- Both groups must be *sufficiently large* and *sufficiently varied* in order to be representative of the relevant population being studied (recall criteria for inductive generalizations).

(i) Randomized Experimental Study

- Both experimental group and control group are selected *randomly* from the population they represent.
- Suspected cause is imposed on experimental group, but not on control group.

Example: Effects of a birth-control hormone on brain development in rats.
- Two groups of 100 rats selected randomly from a population.
- Experimental group gets food supplemented with doses of birth-control hormone.
- Control group gets same food, but not supplemented.
- If experimental group exhibits higher frequency of retarded brain development than control group, conclude that the birth-control hormone is most likely the cause of this difference.

(ii) Prospective Study

- Experimental group is "self-selected": suspected cause was exposed to them by choice, as opposed to being imposed by researchers.
- Control group is matched to characteristics of experimental group.
- "Forward-looking" study involving observations of both groups over a period of time.

Example: Prospective study of smokers.
- Identify a group of smokers and a group of similar (age, sex, occupation, place of residence, ethnic background, history of disease, *etc.*) non-smokers.
- Observe both groups over a given period of time to determine effects of smoking.

(iii) Retrospective Study

- Experimental group already exhibits effect for which a cause is sought.
- Control group is chosen so that it matches characteristics of experimental group except for the exhibition of the effect.
- "Backwards-looking" study that compares histories of both groups in an attempt to discover the cause.

> *Example*: Retrospective study of sleep disorder in newborn infants.
> - Experimental group of 28 newborns exhibiting more rapid-eye-movement sleep and less quiet sleep than control group of 30 newborns.
> - Mothers of both groups match with respect to age, nutrition, care during pregnancy, *etc.*
> - Comparison of past histories indicated that experimental group had all been exposed, while in the womb, to low doses of methadone (drug that treats heroin addiction).

(iv) Double-Blind Experiment

- Individuals are assigned to either the experimental group or the control group in a way that prevents both them and the researchers from knowing which group they belong to.
- *Goal*: To avoid biased judgments, both on the part of the group members (if they are human), and on the part of the researchers.

> *Example*: Typical drug test.
> - Experimental group is given drug to be tested.
> - Control group is given a *placebo* (an inert substance, like a sugar pill, that looks identical to drug being tested).
> - Distribution of drug and placebo is done in a way that researchers do not know who gets what.