CONCEPTUAL TOOLS FOR CAUSAL ANALYSIS IN THE SOCIAL (AND BIOMEDICAL) SCIENCES

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Introduction (1)

- Two philosophical projects (at least):

(1) Conceptual analysis

C causes E if and only if (conditions X_1, X_2, ..., X_n are satisfied) or (conditions Y_1, Y_2..., X_n are satisfied) or ... or (conditions Z_1, Z_2, ..., Z_n are satisfied)

Suzy and Billy have grown up, just in time to get involved in World War III. Suzy is piloting a bomber on a mission to blow up an enemy target, and Billy is piloting a fighter as her lone escort. Along comes an enemy fighter plane, piloted by Enemy. Sharp-eyed Billy spots Enemy, zooms in, pulls the trigger, and Enemy's plane goes down in flames. Suzy's mission is undisturbed, and the bombing takes place as planned. If Billy hadn't pulled the trigger, Enemy would have eluded him as shot down Suzy, and the bombing old not have happened. (Hall 2004, p. 241)

Introduction (2)

Events can stand in one kind of causal relation – dependence – for the explication of which the counterfactual analysis is perfectly suited ... . And they can stand in an entirely different kind of causal relation – production – which requires an entirely different kind of causal analysis ... .(Hall 2004, p. 226)

(2) Second task: develop an adequate set of causal concepts which helps scientists to achieve their aims.

Among the many factors that have prompted and sustained inquiry in the diverse fields of empirical science, two enduring human concerns have provided the principle stimulus for man's scientific efforts.

Introduction (3)

One of them is of a practical nature. Man wants not only to survive in the world, but also to improve his strategic position in it. This makes it important for him to find reliable ways of foreseeing changes in his environment and, if possible, controlling them to his advantage. The formulation of laws and theories that permit the prediction of future occurrences are among the proudest achievements of empirical science; and the extent to which they answer man's quest for foresight and control is indicated by the vast scope of their practical applications, which range from astronomic predictions to meteorological, demographic, and economic forecasts, and from physico-chemical and biological technology to psychological and social control.
The second motive for man's scientific quest is independent of such practical concerns; it lies in his sheer intellectual curiosity, in his deep and persistent desire to know and to understand himself and his world. So strong, indeed is this urge that in the absence of more reliable knowledge, myths are often invoked to fill the gap. But in time, many such myths give way to scientific conceptions of the what and why of empirical phenomena. (Hempel 1965, p. 333)

Introduction (4)

● Milton Friedman in *The Methodology of Positive Economics*: An obvious an not unimportant example is minimum-wage legislation. ... Proponents believe (predict) that legal minimum-wages diminish poverty by raising the wages of those receiving less than the minimum wage ..... (1995, p. 182)

● First type (section 2): *causal interaction* (Wesley Salmon in his book *Scientific Explanation and the Causal Structure of the World*)

● Section 3: a completely different kind of concept (a counterfactual concept at the population level) is needed to cover the second type of causation.

● Why "biomedical sciences" between brackets in the title of this paper?

Causal interactions (1)

- Definition:

At *t* there is a causal interaction between objects *x* and *y* if and only if
(1) there is an intersection between *x* and *y* at *t* (i.e. they are in adjacent or identical spatial regions at *t*),
(2) *x* exhibits a characteristic P in an interval immediately before *t*, but a modified characteristic P immediately after *t*,
(3) *y* exhibits a characteristic Q in an interval immediately before *t*, but a modified characteristic Q immediately after *t*,
(4) *x* would have had P immediately after *t* if the intersection would not have occurred, and
(5) *y* would have had Q immediately after *t* if the intersection would not have occurred.

Causal interaction (2)

● Salmon's concept is polyvalent: it can be applied in all areas of science, including the social sciences.

● Causal claim: "At *t* there was a causal interaction between *x* and *y*, in which *x* acquired characteristic P and lost characteristic P′, and in which *y* acquired characteristic Q and lost characteristic Q′."

● Presupposes a frame of reference: level of description, spatial scale and time scale.

● Series of examples:
Objects = common sense macro objects
Space = rooms and multiples of them (floors, buildings)
Time = 1 hour and multiples (days, weeks, ...)

Causal interaction (3)

Objects = common sense macro objects
Space = 1 *mm* distance and multiples
Time = 5 seconds and multiples

Time = 0.5 seconds and multiples

- I think we can draw three lessons from these examples:

(1) Salmon's concept of causal interaction is a "skeleton concept": it cannot be applied to empirical phenomena until we supplement it with a frame of reference as outlined above.
(2) Scientists in a given discipline should find the appropriate frame of reference for their domain a frame of reference that "makes a difference"
(3) There are no causal interactions in the world: if something is a causal interaction given a frame of reference, refining the frame of reference is sufficient to ensure that the phenomenon fails to satisfy the conditions.

- Dowe

Spontaneous evolutions (1)

● Ronald Giere:
C is a *positive causal factor* for E in the population U whenever $\mathbf{P}_X(E)$ *is greater than* $\mathbf{P}_K(E)$.
C is a *negative causal factor* for E in the population U whenever $\mathbf{P}_X(E)$ *is less than* $\mathbf{P}_K(E)$.
C is *causally irrelevant* for **E** in the population U whenever $\mathbf{P}_X(E)$ *is equal to* $\mathbf{P}_K(E)$. (p. 204)

● Link with experimental designs: the relative frequency of E in the experimental group of a randomised experiment is a reliable estimate of $\mathbf{P}_X(E)$, and the relative frequency of E in the control group a reliable estimate of $\mathbf{P}_K(E)$.
● Standard experimental practice has a presupposition: the alleged cause variable (independent variable) can somehow be manipulated.

Spontaneous evolutions (2)

- The possibility of manipulation is often taken for granted:

Experiments involve comparison between treated material and appropriate controls. Their purpose is to see what consequence follows the treatment; it is essential to know also what happens if the treatment not applied, so that events which occur even if treatment is not given are not wrongly attributed to the treatment. At first sight it is not difficult to arrange control observations, and if the system under study is sufficiently stable this is true. For example, solutions of barium chloride and sodium sulphate can be left in stoppered test-tubes for hours or days without visible changes. If the solutions are mixed, a heavy white precipitate of barium sulphate appears at once, undoubtedly because the two solutions have been mixed and not because of some other unrecognized source of change. The stability of each solution in ordinary laboratory conditions is so well known that further controls are unnecessary. However, a meticulous experimenter confronted with an exacting critic might lay aside half of each solution before mixing the other halves, and observe that the unmixed portions did not change, so controlling that no unsuspected outside influence was operating. (p. 130)

Conclusion

- I have argued that social scientists need two causal concepts, and I have tried to explicate them.
- There are huge differences between the concepts: the first involves two systems (objects, whatever they may be; they can be regarded as atoms), the second an evolution within a system (a population of any kind; a system in isolation, but with elements).
- The first presupposes counterfactuals (two counterfactual claims needed in order to make a causal claim), the second implies counterfactual claims (their meaning is counterfactual), while the evidence is factual (data in the experimental and control group).

"Provides current models, tools, and examples for the formulation and evaluation of scientific hypotheses in causal terms. Introduces a new method of model parametritization. Illustrates structural equations and graphical elements for complex causal systems."Â As a practicing biostatistician I am all too aware of the degree to which causation is not used in the biomedical sciences, and I am reasonably sure that we will progress more rapidly if we overcome our Humean phobia that causation may not be real. I will admit that there is some mathematics here (mostly a new variant of algebra), but I contend that it is simple, and like most useful mathematics, gives back more in understanding than it extracts in mental sweat. Causal analysis is the field of experimental design and statistics pertaining to establishing cause and effect. Typically it involves establishing four elements: correlation, sequence in time (that is, causes must occur before their proposed effect), a plausible physical or information-theoretical mechanism for an observed effect to follow from a possible cause, and eliminating the possibility of common and alternative ("special") causes. Such analysis usually involves one or more artificial or