How can we come to know such general truths? The causal relation is not purely logical or deductive; as David Hume emphasized, it cannot be discovered by any *a priori* reasoning.* Causal laws can be discovered only empirically, *a posteriori*, by an appeal to experience. But our experiences are always of *particular* circumstances, *particular* phenomena, and *particular* sequences of them. We may observe several instances of a circumstance (call it *C*), and every instance that we observe may be accompanied by an instance of a certain kind of phenomenon (call it *P*). But we will have experienced only some of the instances of *C* in the world, and our observations can therefore show us only that some cases of *C* are attended by *P.* Yet our aim is to establish a general, causal relation. How are we to get from the particulars we experience to the general proposition that *all* cases of *C* are attended by *P*—which is involved in saying that *C* causes *P*?

### 12.3 Induction by Simple Enumeration

When we assert that all cases of *C* are attended by *P*—that is, when we affirm a general causal relation—we have gone beyond analogy. The process of arriving at universal propositions from the particular facts of experience is called *inductive generalization*. Suppose we dip blue litmus paper into acid and it turns red. Suppose we do this three times, or ten times, always with the same result. What conclusion do we draw? By *analogy* we may draw a *particular* conclusion about what will happen to the color of the next piece of litmus paper we dip in acid—the fourth or the eleventh. Or we may draw a general conclusion about what will happen to *every* piece of blue litmus paper when it is dipped in acid. If we do the latter, it is an *inductive generalization* with which our argument concludes.

When the premises of an argument report a number of instances in which two attributes (or circumstances, or phenomena) occur together, we may infer

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*Hume wrote: “But to convince us that all the laws of nature, and all the operations of bodies without exception, are known only by experience, the following reflections may, perhaps, suffice. Were any object presented to us, and were we required to pronounce concerning the effect, which will result from it, without consulting past observation, after what manner, I beseech you, must the mind proceed in this operation? It must invent or imagine some event, which it ascribes to the object as its effect; and it is plain that this invention must be entirely arbitrary. The mind can never possibly find the effect in the supposed cause, by the most accurate scrutiny and examination. For the effect is totally different from the cause, and consequently can never be discovered in it. . . . A stone or piece of metal raised into the air, and left without any support, immediately falls; but to consider the matter *a priori*, is there anything we can discover in this situation which can beget the idea of a downward, rather than an upward, or any other motion, in the stone or metal? . . . In vain, therefore, should we pretend to determine any single event, or infer any cause or effect, without the assistance of observation and experience” (*An Enquiry Concerning Human Understanding*, 1748, sec. IV).
by analogy that some particular instance of one attribute will also exhibit the other attribute. By inductive generalization we might infer that every instance of the one attribute will also be an instance of the other. Inductive generalization of the form

- Instance 1 of phenomenon $E$ is accompanied by circumstance $C$.
- Instance 2 of phenomenon $E$ is accompanied by circumstance $C$.
- Instance 3 of phenomenon $E$ is accompanied by circumstance $C$.

Therefore every instance of phenomenon $E$ is accompanied by circumstance $C$.

is an **induction by simple enumeration**. An induction by simple enumeration is very similar to an argument by analogy, differing only in having a more general conclusion.

Simple enumeration is often used in establishing causal connections. Where a number of instances of a phenomenon are invariably accompanied by a certain type of circumstance, it is only natural to infer the existence of a causal relationship between them. Since the circumstance of dipping blue litmus paper in acid is accompanied in all observed instances by the phenomenon of the paper turning red, we infer by simple enumeration that dipping blue litmus paper in acid is the cause of its turning red. The analogical character of such an argument is quite apparent.

Because of the great similarity between argument by simple enumeration and argument by analogy, similar criteria for appraisal apply to both. Some arguments by simple enumeration may establish their conclusions with a higher degree of probability than others. The greater the number of instances appealed to, the greater is the probability of the conclusion. The various instances or cases of phenomenon $E$ accompanied by circumstance $C$ are often called *confirming instances* of the causal law asserting that $C$ causes $E$. The greater the number of confirming instances, the greater is the probability of the causal law—other things being equal. Thus the first criterion for analogical arguments also applies directly to arguments by simple enumeration.

In a historical report, simple enumeration can provide persuasive grounds for inferring a causal relationship. To illustrate, legislative acts designed to savage some individual or group temporarily out of favor, called bills of attainder, are known to endanger their advocates when the pendulum of political power swings. The accuser today becomes the victim tomorrow. Condemning such a bill of attainder (aimed at Thomas Osborne, Earl of Danbury) in the British House of Lords, the Earl of Carnarvon drove the point home in 1678 with the following enumeration:

> My Lords, I understand . . . not a little of our English history, from which I have learnt the mischiefs of prosecutions such as these, and the ill fate of the prosecutors.
I shall go no further back than the latter end of Queen Elizabeth’s reign, at
which time the Earl of Essex was run down by Sir Walter Raleigh, and your
Lordships well know what became of Sir Walter Raleigh. My Lord Bacon, he ran
down Sir Walter Raleigh, and your Lordships know what became of my Lord
Bacon. The Duke of Buckingham, he ran down my Lord Bacon, and your
Lordships know what happened to the Duke of Buckingham. Sir Thomas
Wentworth, afterwards Earl of Strafford, ran down the Duke of Buckingham,
and you all know what became of him. Sir Harry Vane, he ran down the Earl of
Strafford, and your Lordships know what became of Sir Harry Vane. Chancellor
Hyde, he ran down Sir Harry Vane, and your Lordships know what became of the
Chancellor. Sir Thomas Osborne, now Earl of Danby, ran down Chancellor Hyde.
What will now become of the Earl of Danby, your Lordships best can tell. But
let me see that man that dare run the Earl of Danby down, and we shall soon see
what will become of him.  

Rhetorically effective though this recounting of instances may be, it does not
provide a trustworthy argument. The conclusion, that there is a causal connec-
tion between malicious accusation and subsequent destruction, appeals to six
confirming instances—but the very nature of those instances prevents them
from distinguishing between confirming instances of a genuine causal law
and mere historical accidents.

The heart of the difficulty is this: The method of simple enumeration takes
no account—can take no account—of exceptions to the causal law being sug-
gested. Any alleged causal law may be overthrown by a single negative case,
for any one disconfirming instance shows that what had been proposed as a
“law” was not truly general. Exceptions disprove the rule—for an exception
(or “negative instance”) is either one in which the alleged cause is found and
is not followed by the alleged effect (in this historical case, a bill of attainder
whose author did not suffer a like fate), or one in which the effect is encoun-
tered while the alleged cause is absent—where (using our earlier schema) C is
present without E, or E is present without C. In an argument by simple
enumeration there is no place for either of these; the only legitimate premises
in such an argument are reports of instances in which both the alleged cause
and the alleged effect are present.

Four hundred years ago Sir Francis Bacon, in The Advancement of Learning
(1605), clearly identified the shortcomings of induction by simple enumera-
tion. He wrote: “The induction that proceeds by simple enumeration is
childish;* its conclusions are precarious, and exposed to peril from a contra-
dictory instance; and it generally reaches decision on too small a number of
facts, and on those only that are on hand.”

It is thus a grave weakness of simple enumeration arguments that, if
we confine ourselves to them exclusively, we will not look for, and are
therefore unlikely even to notice, the negative or disconfirming instances that might otherwise be found. For this reason, despite their fruitfulness and value in suggesting causal laws, inductions by simple enumeration are not at all suitable for testing causal laws. Yet such testing is essential; to accomplish it we must rely upon other types of inductive arguments—and to these we turn now.

12.4 Methods of Causal Analysis

The classic formulation of the methods central to all induction were given in the nineteenth century by John Stuart Mill (in *A System of Logic*, 1843). His systematic account of these methods has led logicians to refer to them as Mill’s methods of inductive inference. The techniques themselves—five are commonly distinguished—were certainly not invented by him, nor should they be thought of as merely a product of nineteenth-century thought. On the contrary, these are universal tools of scientific investigation. The names Mill gave to them are still in use, as are Mill’s precise formulations of what he called the “canons of induction.” These techniques of investigation are permanently useful. Present-day accounts of discoveries in the biological, social, and physical sciences commonly report the methodology used as one or another variant (or combination) of these five techniques of inductive inference called Mill’s methods: They are

1. The method of agreement
2. The method of difference
3. The joint method of agreement and difference

*Induction by simple enumeration can mislead even the learned. The author of an account of the creation of the Oxford English Dictionary [*The Professor and the Madman*] reported his faithful belief in a curious causal claim: “Ever since I was 4 years old, I have said “White Rabbits” at the very first moment of waking on every single first day of every single month that has passed. My mother, tucking me into bed one night, told me to do it, to bring good fortune; and since I have enjoyed fair good fortune for all of my subsequent days I have assumed that the acceptance of this moderate and harmless habit has had something to do with it, and so has reinforced my need to keep up the practice . . . No fewer than 696 times I have maintained what has been a quite unvarying routine . . . when my eyes have snapped open with the first streaks of daylight, I have always uttered “White Rabbits.”

—Simon Winchester, “Oh Dear, Too Late for the White Rabbits,”