Screening Off and the Barometer

1. The Problem

The following argument apparently conforms to the requirements of the D-N account of explanation:

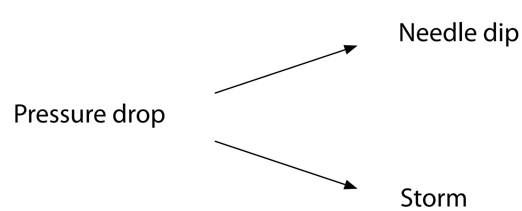
1. The needle on the barometer dipped
2. Whenever the needle dips there is a storm, therefore
3. A storm occurred.

But it is surely a bad explanation: the storm is not explained by the barometer needle's dipping.

Solution: add a new clause to the D-N account to rule out events like the needle dip as explainers. This will be the *screening off* constraint.

2. Causal Forks

Before stating the screening off constraint, consider for a moment the situation as we are inclined to describe it causally. The dip of the barometer's needle and the storm are both effects of a single cause, namely, a drop in atmospheric pressure. In pictures,



Whenever you have a "causal fork" such as this, Reichenbach noted in *The Direction of Time* (1956), the following is true:

1. Remove the needle dip but not the pressure drop, and you still get a storm.
2. Remove the pressure drop but not the needle dip (so you have the needle dip for some other reason, such as a malfunction) and you no longer get a storm.

Our aim is to use this observation as a reason to favor the pressure drop over the needle dip as an explainer of the storm, without at any stage mentioning causation.

3. Formalization

We add to the D-N account the following *screening off constraint*:

> A fact, event, or set of initial conditions *N* cannot appear in an explanation of an event *S* if there is another fact, event, or set of initial conditions *P* that *screens off N* from *S*.

An event *P* screens off *N* from *S* just in case, if *P* is already present, then adding *N* does not increase the probability of *S*'s occurrence. To put it another way, the presence of *P* renders *N* probabilistically irrelevant to *S*. In symbols:

$$\Pr(S|NP) = \Pr(S|P)$$

Typically, in such a case, *P* is not screened off from *E* by *N*, so that

$$\Pr(S|NP) > \Pr(S|N)$$

In the empiricist tradition, all these probabilities are interpreted as statistics, so that, for example, the probability $\Pr(S|P)$ is just the proportion of those cases where *P* is present in which *S* also occurs.

4. Solution

We want to show that the drop in pressure screens off the needle dip from the occurrence of the storm. The screening off constraint will then disallow the needle dip as an explainer of the storm.

The question we must ask is: in the case where there is already a pressure drop, will a needle dip raise the probability of a storm? This can be true only if there are cases where there is a needle dip and a storm, but no pressure drop. On the assumption that a pressure drop is a necessary condition for a storm, there are no such cases, therefore, the needle dip is screened off from the storm by the pressure drop.

(Exercise: what are the values of the relevant probabilities in a case like this? Answer: both $\Pr(S|P)$ and $\Pr(S|NP)$ are equal to one.)

5. More on Screening Off

Warning: Read on only once you understand all of the above!

So far, we have assumed that whenever there is a storm there is a pressure drop, and whenever there is a pressure drop there is a storm. But neither of these assumptions is necessary for the needle dip to be screened off by the pressure drop. It is because of this that the screening off criterion is more powerful than the criterion used by Hempel in his treatment of the Koplik spots (*Aspects of Scientific Explanation* 374–5).

To see that, even if there could be storms without pressure drops, the needle dip can still be screened off: Suppose that storms occur in two kinds of circumstances, pressure drops and attacks by the evil superfiend Weatherman. Then it is still the case that $\Pr(S|NP) = \Pr(S|P)$ (and indeed, $\Pr(S|P)$ is already equal to one, so could hardly be increased by the addition of N), so provided that a pressure drop actually occurs, it screens off the needle dip from the storm.

To see that, even if there could be pressure drops without storms, the needle dip might still be screened off: Suppose that pressure drops are followed by storms only in circumstances Z. Suppose also that needle dips are not correlated with the presence of circumstances Z. Then the probability of a storm given a pressure drop is equal to the probability that conditions Z obtain. That is, $\Pr(S|P) = \Pr(Z)$.* For the same reason, the probability $\Pr(S|NP)$ is equal to $\Pr(Z|N)$. By assumption, Z and N are not correlated, so $\Pr(Z|N)$ is equal to $\Pr(Z)$. Hence, $\Pr(S|P) = \Pr(S|NP)$.

Problem: what if N is positively correlated with Z, so that a needle dip serves as some kind of indication that conditions Z obtain? Then $\Pr(Z|N)$ is greater than $\Pr(Z)$, and so $\Pr(S|NP)$ is greater than $\Pr(S|P)$. The pressure drop therefore does not screen off the needle dip from the storm. But no matter how good barometers are at detecting conditions Z, we would not want to say that they explain storms. How can the screening off constraint deal with this case?

Hint: to rule out the needle dip as a storm explainer, you do not need to show that the pressure drop screens off the needle dip from the storm. You just need to show that *something* screens off the needle dip from the storm.

Note

* To help keep things simple, I have made an additional assumption, that P and Z are not correlated.