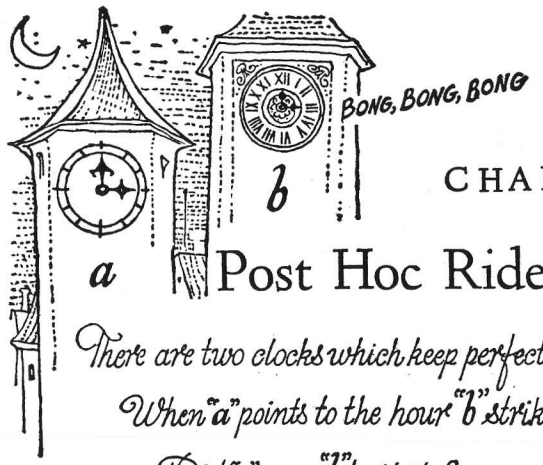
a hair rinse. By golly, she does look better afterwards at that. But most of the change, you note on careful inspection, has been wrought by persuading her to smile and throwing a back light on her hair. More credit belongs to the photographer than to the rinse.



CHAPTER 8

Post Hoc Rides Again

There are two clocks which keep perfect time.
When "a" points to the hour "b" strikes.
Did "a" cause "b" to strike?

SOMEBODY once went to a good deal of trouble to find out if cigarette smokers make lower college grades than non-smokers. It turned out that they did. This pleased a good many people and they have been making much of it ever since. The road to good grades, it would appear, lies in giving up smoking; and, to carry the conclusion one reasonable step further, smoking makes dull minds.

This particular study was, I believe, properly done: sample big enough and honestly and carefully chosen, correlation having a high significance, and so on.

The fallacy is an ancient one which, however, has a powerful tendency to crop up in statistical material, where it is disguised by a welter of impressive figures. It is the one that says that if B follows A, then A has caused B.

An unwarranted assumption is being made that since smoking and low grades go together, smoking causes low grades. Couldn't it just as well be the other way around? Perhaps low marks drive students not to drink but to tobacco. When it comes right down to it, this conclusion is about as likely as the other and just as well supported by the evidence. But it is not nearly so satisfactory to propagandists.

It seems a good deal more probable, however, that neither of these things has produced the other, but both are a product of some third factor. Can it be that the sociable sort of fellow who takes his books less than seriously is also likely to smoke more? Or is there a clue in the fact that somebody once established a correlation between extroversion and low grades—a closer relationship

apparently than the one between grades and intelligence? Maybe extroverts smoke more than introverts. The point is that when there are many reasonable explanations you are hardly entitled to pick one that suits your taste and insist on it. But many people do.

To avoid falling for the *post hoc* fallacy and thus wind up believing many things that are not so, you need to put any statement of relationship through a sharp inspection. The correlation, that convincingly precise figure that seems to prove that something is because of something, can actually be any of several types.

One is the correlation produced by chance. You may be able to get together a set of figures to prove some unlikely thing in this way, but if you try again, your next set may not prove it at all. As with the manufacturer of the tooth paste that appeared to reduce decay, you simply throw away the results you don't want and publish widely those you do. Given a small sample, you are likely to find some substantial correlation between any pair of characteristics or events that you can think of.

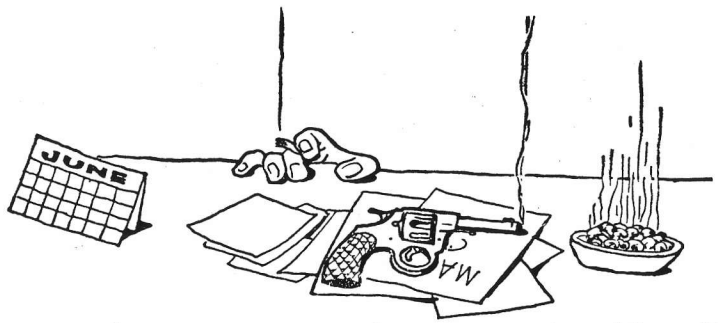
A common kind of co-variation is one in which the relationship is real but it is not possible to be sure which of the variables is the cause and which the effect. In some of these instances cause and effect may change places from time to time or indeed both may be cause and effect at the same time. A correlation between income and ownership of stocks might be of that kind. The more money you make, the more stock you buy, and the more stock you buy, the more income you get; it is not accurate

to say simply that one has produced the other.

Perhaps the trickiest of them all is the very common instance in which neither of the variables has any effect at all on the other, yet there is a real correlation. A good deal of dirty work has been done with this one. The poor grades among cigarette smokers is in this category, as are all too many medical statistics that are quoted without the qualification that although the relationship has been shown to be real, the cause-and-effect nature of it is only a matter of speculation. As an instance of the nonsense or spurious correlation that is a real statistical fact, someone has gleefully pointed to this: There is a close relationship between the salaries of Presbyterian ministers in Massachusetts and the price of rum in Havana.

Which is the cause and which the effect? In other words, are the ministers benefiting from the rum trade or supporting it? All right. That's so farfetched that it is ridiculous at a glance. But watch out for other applications of *post hoc* logic that differ from this one only in being more subtle. In the case of the ministers and the rum it is easy to see that both figures are growing because of the influence of a third factor: the historic and world-wide rise in the price level of practically everything.

And take the figures that show the suicide rate to be at its maximum in June. Do suicides produce June brides —or do June weddings precipitate suicides of the jilted? A somewhat more convincing (though equally unproved) explanation is that the fellow who licks his depression all through the winter with the thought that things will look



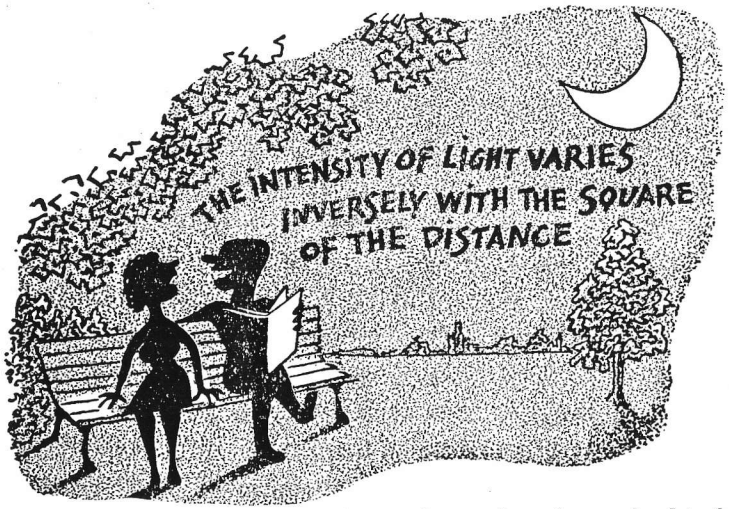
rosier in the spring gives up when June comes and he still feels terrible.

Another thing to watch out for is a conclusion in which a correlation has been inferred to continue beyond the data with which it has been demonstrated. It is easy to show that the more it rains in an area, the taller the corn grows or even the greater the crop. Rain, it seems, is a blessing. But a season of very heavy rainfall may damage or even ruin the crop. The positive correlation holds up to a point and then quickly becomes a negative one. Above so-many inches, the more it rains the less corn you get.

We're going to pay a little attention to the evidence on the money value of education in a minute. But for now let's assume it has been proved that high-school graduates make more money than those who drop out, that each year of undergraduate work in college adds some more income. Watch out for the general conclusion that the more you go to school the more money you'll make. Note that this has not been shown to be true for the years beyond an undergraduate degree, and it may very well not apply to them either. People with Ph.D.s quite often become

college teachers and so do not become members of the highest income groups.

A correlation of course shows a tendency which is not often the ideal relationship described as one-to-one. Tall boys weigh more than short boys on the average, so this is a positive correlation. But you can easily find a six-footer who weighs less than some five-footers, so the correlation is less than 1. A negative correlation is simply a statement that as one variable increases the other tends to decrease. In physics this becomes an inverse ratio: The further you get from a light bulb the less light there is on your book; as distance increases light intensity de-



creases. These physical relationships often have the kindness to produce perfect correlations, but figures from business or sociology or medicine seldom work out so neatly. Even if education generally increases incomes it

may easily turn out to be the financial ruination of Joe over there. Keep in mind that a correlation may be real and based on real cause and effect—and still be almost worthless in determining action in any single case.

Reams of pages of figures have been collected to show the value in dollars of a college education, and stacks of pamphlets have been published to bring these figures—and conclusions more or less based on them—to the attention of potential students. I am not quarreling with the intention. I am in favor of education myself, particularly if it includes a course in elementary statistics. Now these figures have pretty conclusively demonstrated that people who have gone to college make more money than people who have not. The exceptions are numerous, of course, but the tendency is strong and clear.

The only thing wrong is that along with the figures and facts goes a totally unwarranted conclusion. This is the *post hoc* fallacy at its best. It says that these figures show that if *you* (your son, your daughter) attend college you will probably earn more money than if you decide to spend the next four years in some other manner. This unwarranted conclusion has for its basis the equally unwarranted assumption that since college-trained folks make more money, they make it because they went to college. Actually we don't know but that these are the people who would have made more money even if they had not gone to college. There are a couple of things that indicate rather strongly that this is so. Colleges get a disproportionate number of two groups of kids: the bright and the

rich. The bright might show good earning power without college knowledge. And as for the rich ones . . . well, money breeds money in several obvious ways. Few sons of rich men are found in low-income brackets whether they go to college or not.

The following passage is taken from an article in question-and-answer form that appeared in *This Week* magazine, a Sunday supplement of enormous circulation. Maybe you will find it amusing, as I do, that the same writer once produced a piece called "Popular Notions: True or False?"

Q: What effect does going to college have on your chances of remaining unmarried?

A: If you're a woman, it skyrockets your chances of becoming an old maid. But if you're a man, it has the opposite effect —it minimizes your chances of staying a bachelor.

Cornell University made a study of 1,500 typical middle-aged college graduates. Of the men, 93 per cent were married (compared to 83 per cent for the general population).

But of the middle-aged women graduates only 65 per cent were married. Spinsters were relatively three times as numerous among college graduates as among women of the general population.

When Susie Brown, age seventeen, reads this she learns that if she goes to college she will be less likely to get a man than if she doesn't. That is what the article says, and there are statistics from a reputable source to go with it. They go with it, but they don't back it up; and note also that while the statistics are Cornell's the conclusions are

not, although a hasty reader may come away with the idea that they are.

Here again a real correlation has been used to bolster up an unproved cause-and-effect relationship. Perhaps it all works the other way around and those women would have remained unmarried even if they had not gone to college. Possibly even more would have failed to marry. If these possibilities are no better than the one the writer insists upon, they are perhaps just as valid conclusions: that is, guesses.

Indeed there is one piece of evidence suggesting that a propensity for old-maidhood may lead to going to college. Dr. Kinsey seems to have found some correlation between sexuality and education, with traits perhaps being fixed at pre-college age. That makes it all the more questionable to say that going to college gets in the way of marrying.

Note to Susie Brown: It ain't necessarily so.

A medical article once pointed with great alarm to an increase in cancer among milk drinkers. Cancer, it seems, was becoming increasingly frequent in New England, Minnesota, Wisconsin, and Switzerland, where a lot of milk is produced and consumed, while remaining rare in Ceylon, where milk is scarce. For further evidence it was pointed out that cancer was less frequent in some Southern states where less milk was consumed. Also, it was pointed out, milk-drinking English women get some kinds of cancer eighteen times as frequently as Japanese women who seldom drink milk.

A little digging might uncover quite a number of ways to account for these figures, but one factor is enough by itself to show them up. Cancer is predominantly a disease that strikes in middle life or after. Switzerland and the states mentioned first are alike in having populations with relatively long spans of life. English women at the time the study was made were living an average of twelve years longer than Japanese women.

Professor Helen M. Walker has worked out an amusing illustration of the folly in assuming there must be cause and effect whenever two things vary together. In investi-

gating the relationship between age and some physical characteristics of women, begin by measuring the angle of the feet in walking. You will find that the angle tends to be greater among older women. You might first consider whether this indicates that women grow older because they toe out, and you can see immediately that this is ridiculous. So it appears that age increases the angle between the feet, and most women must come to toe out more as they grow older.

Any such conclusion is probably false and certainly unwarranted. You could only reach it legitimately by studying the same women—or possibly equivalent groups—over a period of time. That would eliminate the factor responsible here. Which is that the older women grew up at a time when a young lady was taught to toe out in walking, while the members of the younger group were learning posture in a day when that was discouraged.

When you find somebody—usually an interested party—making a fuss about a correlation, look first of all to see if it is not one of this type, produced by the stream of events, the trend of the times. In our time it is easy to show a positive correlation between any pair of things like these: number of students in college, number of inmates in mental institutions, consumption of cigarettes, incidence of heart disease, use of X-ray machines, production of false teeth, salaries of California school teachers, profits of Nevada gambling halls. To call some one of these the cause of some other is manifestly silly. But it is done every day.

Permitting statistical treatment and the hypnotic presence of numbers and decimal points to befog causal relationships is little better than superstition. And it is often more seriously misleading. It is rather like the conviction among the people of the New Hebrides that body lice produce good health. Observation over the centuries had taught them that people in good health usually had lice and sick people very often did not. The observation itself was accurate and sound, as observations made informally over the years surprisingly often are. Not so much can be said for the conclusion to which these primitive people came from their evidence: Lice make a man healthy. Everybody should have them.

As we have already noted, scantier evidence than this—treated in the statistical mill until common sense could no longer penetrate to it—has made many a medical fortune and many a medical article in magazines, including professional ones. More sophisticated observers finally got things straightened out in the New Hebrides. As it turned out, almost everybody in those circles had lice most of the time. It was, you might say, the normal condition of man. When, however, anyone took a fever (quite possibly carried to him by those same lice) and his body became too hot for comfortable habitation, the lice left. There you have cause and effect altogether confusingly distorted, reversed, and intermingled.