How Statistics Can Lie

Are you impressed by remarkable claims in product ads? Here's why you might want to be skeptical.

BY JAMES H. BAIRD

"There are three kinds of lies: lies, damned lies, and statistics."
BENJAMIN DISRAELI (1804-1881)

If you start paying close attention to the use of statistics in everyday life, especially advertisements, then it becomes very easy to relate to the assertion made long ago by British Prime Minister Benjamin Disraeli. Valid or not, all of us use and rely upon statistics countless times each day — "Last night I slept about six hours. My office is approximately 2.5 miles from home. There's a 50% chance of rain today. My USGA Handicap Index is 6.2. On average, I run about four miles a day. The average golf course maintenance staff is comprised of 15 employees." In a nutshell, we need statistics to help us simplify and summarize our complex world.

Contrary to the implication of the title, statistics do not create themselves; people have to create them. There is no such thing as a perfect statistic, but some are less imperfect than others. Furthermore, we must realize that whether you're an activist, politician, salesperson, or a scientist, people use statistics to persuade. Confused? Must we all become statisticians to differentiate between good and bad or imperfect from less-than-perfect statistics? The purpose of this article is to identify some of the most common misuses of statistics and, in doing so, help you become a critical thinker, especially as it relates to those remarkable claims from salespeople and product advertisements.

"THE WELL-CHOSEN AVERAGE"

One of the most common statistics that you will encounter is the *average*. But what exactly is *average*? Most of the time the *average* represents the *mean*, which is defined as the arithmetic average of all samples from a population. However, the *average* also can represent the *median* — middle value in a ranked series, or *mode* — most frequent value in a series. If the distribution of a population or its sample is bell-shaped (i.e., normally distributed), then you need not be concerned about the source of the *average* because the *mean, median*, and *mode* will be approximately equal to one another. On the other hand, statistics such as average salary, maintenance budget, or green speed often skew from a normal distribution. In that case, if you want to be more compelling in your attempt to amaze or persuade, report the *mean*. Otherwise, reporting the *median* or *mode* would provide a more accurate assessment of the population.

THE NAKED STATISTIC

An average value without a measure of the variability in a distribution or the degree of significance is a naked statistic. Try comparing two or more of these statistics and you end up with totally useless information. Researchers collect data from an experiment or sampling study and subject it to statistical analysis in order to provide evaluation of treatment differences according to tests of significance that are based on measuring uncontrolled variability. One of the most widely used tests to determine significant differences between means is the Least Significant Difference (LSD), usually expressed at the 5% level of significance. Thus, if the difference between two treatment means is greater than the $LSD_{0.05}$, there is a 95% probability that the difference was due to treatment effects or a 5% probability that the difference was due to chance alone.

For example:

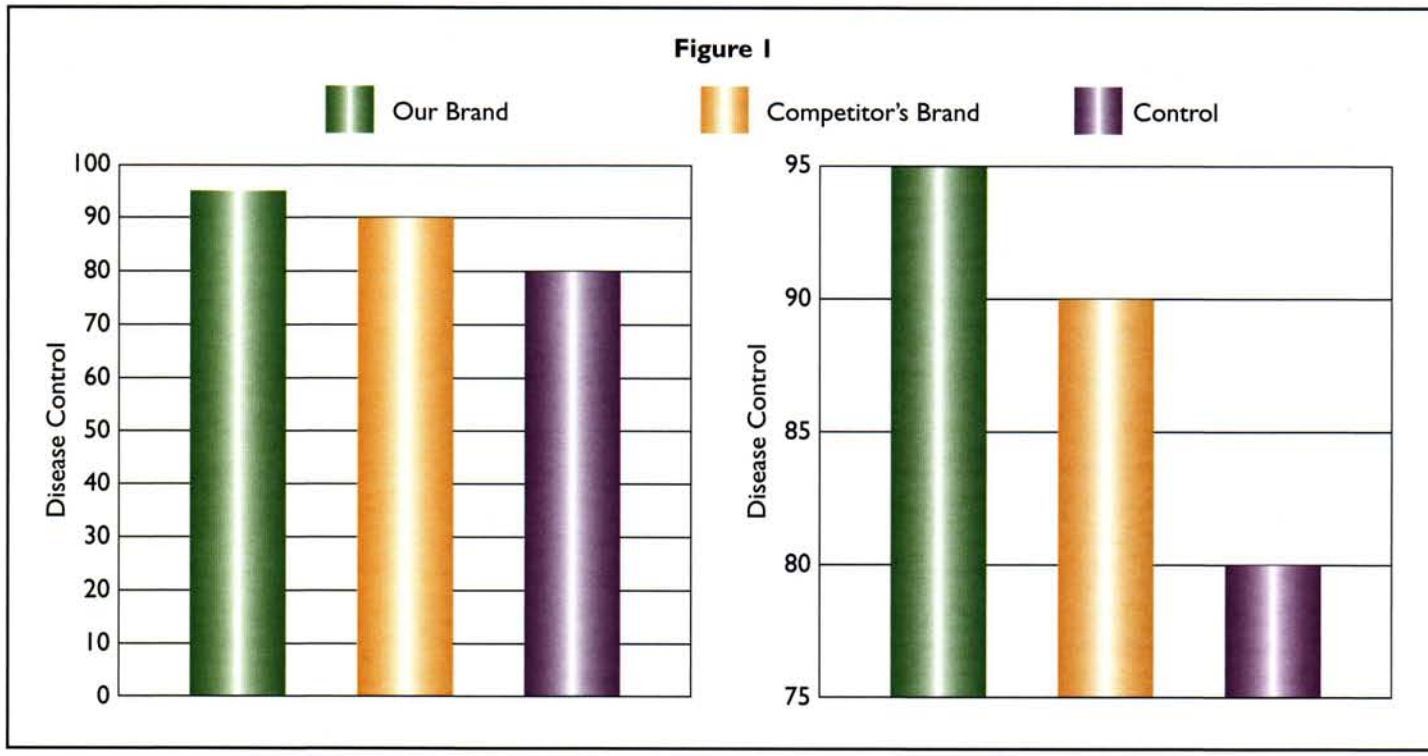
$LSD_{0.05} = 0.3$
Treatment A mean = 9.0
Treatment B mean = 8.6
$9.0 - 8.6 = 0.4$
$0.4 > 0.3$ ($LSD_{0.05}$)

There is a 95% probability that the difference between treatment A and treatment B was due to the treatments themselves.

Now, imagine that I have a product to sell that I believe will improve the turf on your golf course. I give you, the superintendent (representing a small sample size), some of my product to test on your golf course. Chances are you won't replicate the application of the product, nor will you leave an untreated area of turf for comparison. Thus, how can anyone really be certain that my product was responsible for your results? Well, *chances are* something will happen, and if it is positive, then I'll be sure to include your picture and testimonial in my product advertisement. If not, I'll move on to the next golf course. What is the moral of this story? The smaller the sample size, the greater the probability that the results will be produced by chance (and not my product).

"THE GEE-WHIZ GRAPH"

Who has time to read these days, so why not show a picture, table, or graph to represent statistics? In Figure 1, the "Our Brand" product is only slightly better than the competitor's brand and a little more so than the control. In order to create the perception of large, significant differences (never mind the naked statistics), just change the magnitude of the scale on the vertical axis



Can you differentiate between the original and mutant statistics? Simply changing the magnitude of the vertical axis can turn a graph with no obvious significant differences (left) into a "gee-whiz" graph (right) that gives the impression there are significant differences between products.

and — *voila!* — the "Our Brand" product is now the best thing since sliced bread. Be cautious of "Gee-Whiz" graphs, tables, or pictographs.

POST-HOC RATIONALIZATION

"I just put down a magical biostimulant (hereafter referred to as "A") and you won't believe the tremendous improvement in turf shoot density and rooting ("B")!

Question: Have you done anything else recently?

"Well, sure, but nothing out of the ordinary. I aerated, topdressed, and bumped up the height of cut and nitrogen fertility. But it has to be that product!"

Post-hoc rationalization is "the fallacy of arguing from temporal sequence to a causal relation." More simply put, you can't always assume that if B follows A, then A caused B.

"HOW TO STATISTICULATE"

Misleading people with the use of statistics has been referred to as "statisticulation." Some of the more common ways to statisticulate include: 1) the use of means when medians are more appropriate; 2) misuse of significant figures — e.g., on average, I sleep 6.35 hours per night (who keeps track of sleep beyond the precision of about the nearest half-hour?); 3) improper use of percentages — e.g., "there's a 50% chance of rain on Saturday and the same on Sunday, so don't make any plans for this weekend because there's a 100% chance of rain"; and 4) mangling or changing the meaning of a good statistic through space and time, otherwise known as a "mutant statistic."

THE "SEMI-ATTACHED" STATISTIC

The last, but certainly the most important method of abusing or misusing statistics is the *semi*-attached statistic. Use of semi-attached statistics or information is perhaps the principal reason why bad statistics and snake oils have thrived since the life and times of Disraeli and Piper & Oakley (pioneers of the Green Section), and why they will probably continue to exist beyond our lifetime. Subscribers to this philosophy believe that "if you can't prove what you want to prove, demonstrate something else and pretend they are the same thing." Somewhere buried in the semi-attached statistic is usually a trace of truth or fact, but the rest is a whole lot of fluff. Thus, it is very difficult to pin a "lie" on a semi-attached statistic.

Wondering how you can learn to see through all of this? Read on to learn how to become a critical thinker.

SUMMARY

In his book titled *Damned Lies and Statistics*, author Joel Best describes four personalities in regard to how people cope with statistics. The "Awestruck" understand very little about statistics, but that's of no real concern to them because statistics have magical powers, just like the products they use.

The "Naïve" have a little more understanding of statistics, but are basically accepting of what they are told. If Dr. Turfgrass Expert or the famous golf course superintendent says

it's true, then it must be true. Besides, applying that product can't hurt anything, right?

The "Cynical" are very suspicious of statistics, in general, except when it comes to those that support their own beliefs. Overall, they don't trust in numbers and feel that "you can prove anything with statistics."

Finally, the "Critical" take a more thoughtful approach to statistics that avoids the extremes of naïve acceptance and cynical rejection. The Critical ask important questions such as who is the source and how do they know? How were the statistics produced? Where is the measure of variability or degree of significance? Is the statistic being properly interpreted? Most of all, they ask, "Does it make sense?"

Hopefully, this article has provided you with the tools to work toward becoming a critical thinker about statistics and the multitude of turf care products that are at your disposal.

"It ain't so much the things we don't know that get us into trouble. It's the things we know that ain't so."
ARTEMIS WARD

REFERENCES

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Huff, D. 1954. How to Lie With Statistics. W.W. Norton & Company, New York.

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Replicating treatments and including an untreated control provide a more reliable estimate of whether observed differences are due to the treatment or simply to chance.