# Tests of Significance:
## *Why and How*

Statistics is about more than calculating the probability of things or the proportions of things. It can be a powerful tool for making decisions, influencing people and proving or refuting claims. Good statistics can check new drugs for safety, sway voters, and re-allocate budgets. One of the simplest tools for using statistics to change the real world is the **test of significance**. A test of significance is used to help disprove a claim that someone else has made based on their own study's findings. Given that few people can tell the difference between bad statistics and valid statistics, this is a most useful tool.

Say that a cigarette company says that only 0.3% of its product's users get lung cancer, and therefore cigarettes aren't as dangerous as doctors say they are. They might present the data they used to draw this conclusion, but the data might be falsified, or their experiment might be biased. If you don't believe this claim, and you think the company is lying to the public, what can you do?

You could run your own statistical experiment. You could get test subjects who also use the company's cigarettes and see how many get lung cancer. But how do you use the results of your experiment to disprove the cigarette company's claim? How can you know, scientifically, that when you get a different result from their study — and you almost certainly will — that it's different enough not to be explained away by experimental variation?

A test of significance goes like this:

- We set up a null hypothesis and alternative hypothesis based on the original claim.
- We do a statistical experiment similar to the one that produced the claim.
- We assume that the claim accurately represents the mean of our experiment.
- We find the probability that our result could happen by chance, given the assumption.
- We decide about the validity of our assumption, thus possibly refuting the claim.

We'll look at an example to examine these steps.

*Example 1:* A medical study claims that an allergy medication does not increase blood pressure in users, stating that the mean systolic pressure is 118.1 with a $\sigma$ of 10.4. You survey 67 users of the medication. Your sample mean systolic blood pressure is 121.3, suggesting prehypertension. Determine whether this result is significant at the 0.05 level.

*Solution:* First we need to outline our test. We need a **null hypothesis**, a statement in statistical terms of what the original claim is. The null hypothesis always looks like this:

$$H_0: \mu = ?$$

It has an equal sign because the original claim will always be that the mean is a particular value. There may be an implication that the mean could have a value to one side of the stated value, and this would be fine. Obviously, our cigarette company would be happy if the mean were less than 0.3%. This implication will help us state our view.