AGAINST ALL ODDS
EPISODE 28 – "INFERENCE FOR PROPORTIONS"
TRANSCRIPT

FUNDER CREDITS

Funding for this program is provided by Annenberg Learner.

INTRO

Pardis Sabeti
Hello, I'm Pardis Sabeti and this is *Against All Odds*, where we make statistics count.

It's nearly impossible to collect data about an entire population; let's say all the salmon in one watershed. We can't exhaustively count the number of eggs laid by every single spawning salmon. But we can certainly count the eggs laid by a sample of some of these salmon. Then, thanks to statistical inference, we can use the mean number of eggs laid in our sample to draw conclusions about the egg laying of the population as a whole. The final step is to use probability to indicate how reliable our conclusions are.

We can also use statistical inference to figure out more than only the population mean though. We can estimate the population proportion. For instance, say we wanted to know how many of the eggs laid by our salmon friends were fertilized. We could investigate the fertilization rate in our sample and come up with a percent number. What we want to do is extrapolate from that sample proportion to the unknown population proportion. But how good of an estimate is it? That's the topic of this module.

Let's turn our attention to a completely different context: the workplace. Depending how close they are to entering the fulltime job market, students give varying amounts of thoughts to their future careers.

There's a lot to consider:
What do you have a natural talent for?
What do you like to do?
What'll pay the bills?

Employers have questions to mull over too; things like how to motivate their employees to do their best, most creative work.

Psychologist Teresa Amabile has studied creativity for years.

> **Teresa Amabile**
> One of the myths about creativity is that it's all in the person—it's all a function of your talent level, and your experience and your training. And of course that's very important. But one of the big discoveries from my earlier research is that creativity fluctuates even for a given individual; from year to year, even from day to day, as a function of the kind of work environment that you're in, as a function of what's actually happening at work.

Pardis Sabeti
Building on that foundation, Amabile designed a study around the question of worker motivation. She recruited 238 people with creative jobs who were willing to keep track of their activities, emotions and motivation levels every workday. Their electronic diaries had two components.

> **Teresa Amabile**
> One was numerical questions where they just, on a seven-point scale, told us how motivated they were, what their emotions were like that day and so on. What their subjective experience was like that day. We also had an open-ended question where we said briefly describe one event that occurred today that stands out in your mind. It can be anything at all as long as it's relevant to the work or the project. This gave us an absolute treasure trove of data.

Pardis Sabeti
After several years, Amabile had nearly 12,000 diary entries. They validated her earlier findings that people were able to solve problems creatively and come up with new ideas on days they felt most motivated and excited about their work. So obviously the next question was: what led to high levels of motivation? Dipping into the diaries, Amabile was able to see what one factor – far and away – made people feel they were having a great day at work.

> **Teresa Amabile**
> We found that there was one kind of event that stood out above all other events that happened on these great days. And it was simply making progress in meaningful work. Even if the progress looked kind of incremental. We call this the "Progress Principle."

Pardis Sabeti
76% of people's Best Days had a progress event, whereas only 25% of their Worst Days had a progress event. Progress was paramount for people to feel positive and highly motivated. Much more than other things like support from management and coworkers, feelings of doing important work, or collaboration.

> **Teresa Amabile**
> When we started telling managers about the Progress Principle that we'd discovered, a really surprising thing happened. Many of them would say to us, "Sure that's interesting, but it's kind of obvious that progress is motivating for people."
> We found this puzzling because when we studied our diaries, what people actually experienced every day, we did not see a lot of evidence that managers acted like they thought progress was that important. They didn't really pay attention to what they needed to do to support people in making progress every day.

Pardis Sabeti
So Amabile and her co-author decided to survey managers to see whether they were aware of how important this feeling of progress was in motivating workers. She asked them to rate five different items in order of how much they felt they affected motivation. If the managers just randomly chose which of the five options to rank number one, we would expect 20% of them to pick "Progress" as most important.

We can set up a test of hypothesis for population proportion. Our null hypothesis is that $p = .20$. That's the population proportion of managers we'd expect to select "Progress" if randomly choosing between the five motivational factors. Our alternative hypothesis is that p does not equal .20.

> **Teresa Amabile**
> Progress did not come out number one… even though we know it should be number one, by a lot! It didn't even turn out to be number two in the rankings that these managers made. In fact, it was ranked dead last—fifth out of the five employee motivators. So it's like they were actively saying they didn't think progress was that important.

Pardis Sabeti
As it turned out, only 35 out of 669 managers selected progress as the top motivational factor. That's a sample proportion of just .0523 or a mere 5.23%. 5.23% seems pretty low compared to the 20% proportion in our null hypothesis – but is it low enough to reject the null hypothesis?

To find out, we can turn to our test statistic z, using this equation. Plug in .0523 for our "p-hat," .20 for the population proportion as hypothesized under the null hypothesis, and 669 for the number of mangers surveyed in our sample, and you wind up with -9.55. That's a pretty extreme z-statistic. If you compare it to a standard normal distribution, being more than 9.55 standard deviations from the mean is highly unlikely. The area under the curve that far out isn't even really visible! In fact the p-value is .000. So we have our answer: reject the null hypothesis and accept the alternative. The population proportion of all managers in the world at large who would select "Support for Making Progress" as the most important motivator is not 20%.

Now that we've rejected the null hypothesis, let's calculate a confidence interval for the true population proportion. We know the sample proportion of managers who selected "Progress" was .0523, but we don't know how close that is to the true population proportion. Just like in the module about Inference for One Mean, we can figure out a standard error to go with our point estimate. Here's the formula…

Choosing a 95% confidence interval means z^* equals 1.96. We have our sample proportion as our point estimate: .0523. And again n is the 669 managers surveyed.

Plug it all in and we get $.0523 \pm .0169$. So our estimate is that only between 3.5% and 6.9% of managers in the overall population would rate "Progress" as the number one motivational factor. How could they be so unaware of what really counted to their employees?

> **Teresa Amabile**
> What they've said is, "That's just people's job. They're supposed to make progress, that's just them doing their job." Managers don't typically see progress as something they need to worry about. But they need to worry about it a lot! Because we saw in the diaries that there were small hassles happening in the work-lives of most of our participants many days that we followed them. And these were things that managers with not a lot of effort could have cleared away for them if they had been paying attention. But they weren't.

Pardis Sabeti
On some level, the workers themselves might have recognized that their best days often went hand in hand with progress events. But the managers basically had no clue. It's the kind of finding that makes perfect sense once you know about it. Sometimes you just need to ask the right questions… and know how to analyze the data!

For *Against All Odds*, I'm Pardis Sabeti. See you next time!

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Special Thanks:
IDEO Boston

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