Ruling Out Chance

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Three activities that illustrate the connections between probability and statistical inference:

Activity 1: The Cookie Game
Activity 2: Inappropriate Dress
Activity 3: Duct Tape to Remove Warts?

Activity 2: Inappropriate Dress

A CareerBuilders (www.careerbuilders.com) press release dated June 17, 2008 claims more than one third of employers have sent an employee home for inappropriate attire. Suppose that in a random sample of 40 employers, 15 report that they have sent an employee home to change clothes. Do the data provide convincing evidence that the CareerBuilders claim is correct?

Sample proportion = $\frac{15}{40}$ = .38

Is chance variation from sample to sample (sampling variability) a plausible explanation for why the sample proportion is greater than 1/3 ?

To be convinced, we must see not just a sample proportion greater than 1/3, but one that is enough greater than 1/3 that it is not likely to have occurred just by chance due to sampling variability.

Ruling Out Chance: What kind of sample proportions would not be convincing? What kind of sample proportions would we expect to see just due to chance when the population proportion is 1/3 ?

Investigate using simulation.

1. Create a population with proportion of successes = 1/3. We will use a hypothetical population of random digits. We will ignore 0's and designate 1, 2, and 3 as successes and 4, 5, 6, 7, 8, and 9 as failures.
2. Take a sample of size 40 using a random number table. Pick an arbitrary starting point and then follow along the rows until you have 40 non-zero digits. Record your digits here:

3. Compute the number of successes and the proportion of successes for your sample of 40.

4. Now record the sample proportions for the entire class here:

5. Construct a dotplot of the simulated sample proportions:

6. Locate the sample proportion of .38 on the dot plot. What proportion of the simulated sample proportions are .38 or greater?

7. Is a sample proportion of .38 for a random sample of size 40 convincing evidence that more than 1/3 of employers have sent an employee home for inappropriate dress? Justify your answer.

Activity 3: Duct Tape to Remove Warts (adapted from Peck, Olsen, Devore Example 11.9)

Some people seem to believe that you can fix anything with duct tape. Even so, many were skeptical when researchers announced that duct tape may be a more effective and less painful alternative to liquid nitrogen, which doctors routinely use to freeze warts. The article "What a Fix-It: Duct Tape Can Remove Warts" (*San Luis Obispo Tribune*, October 15, 2002) described a study conducted at Madigan Army Medical Center. Patients with warts were randomly assigned to either the duct tape treatment or the more traditional freezing treatment. Those in the duct tape group wore duct tape over the wart for 6 days, then removed the tape, soaked the area in water, and used an emery board to scrape the area. This process was repeated for a maximum of 2 months or until the wart was gone.

Data consistent with summary values in the paper (but sample sizes here are smaller) are given.

	Wart Successfully Removed	**Wart Not Successfully Removed**	**Total**
Liquid Nitrogen Freezing	15	10	**25**
Duct Tape	21	4	**25**
Total	**36**	**14**	

Duct tape was more successful (84% successes) than liquid nitrogen (60% successes), but is this convincing evidence that the duct tape treatment is superior? Could this have happened by chance just due to the random assignment?

Ruling Out Chance: Suppose that there is no difference between the treatments and that these 36 people would have had successful removal no matter which treatment was applied. If this is the case, the difference between the 15 successes for the liquid nitrogen group and the 21 successes for the duct tape group is just due to the "luck of the draw" when the random assignment to groups was done.

We investigate this by simulating the random assignment to groups.

1. Start by creating a group of 50 subjects where 36 are successes and 14 are failures. We will use a bag containing 50 beads, 36 of which are red (the successes) and 14 of which are white.

2. Mix the beads in the bag and draw out 25 beads to represent the liquid nitrogen group. Count the number of successes and record it here:

3. Repeat this process 2 more times, recording the observed number of successes here:

4. Use the observed numbers of successes in the liquid nitrogen group for the entire class to construct a frequency distribution of these values.

   Number of successes:
   Frequency:

5. What proportion of the time was the number of successes for the liquid nitrogen group 15 or smaller, just by chance?

6. Is chance variation resulting just from random assignment a plausible explanation for why we would see as few as 15 successes in the liquid nitrogen group and as many as 21 successes in the duct tape group? Explain.

7. Is it reasonable to conclude based on the given data that duct tape is more effective in removing warts? Explain.