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# SMELLING PARKINSON'S DISEASE

## INTRODUCTION

As reported by the Washington Post (<http://tinyurl.com/SmellPark>), Joy Milne of Perth, UK, smelled a "subtle musky odor" on her husband Les that she had never smelled before. At first, Joy thought maybe it was just from the sweat after long hours of work. But when Les was diagnosed with Parkinson's 6 years later, Joy suspected the odor might be a result of the disease.

Scientists were intrigued by Joy's claim and designed an experiment to test her ability to "smell Parkinson's." Joy was presented with 12 different shirts, each worn by a different person, some of whom had Parkinson's and some of whom did not. The shirts were given to Joy in a random order and she had to decide whether each shirt was worn by a Parkinson's patient or not.

1. Why would it be important to know that someone can smell Parkinson's disease?
2. How many correct decisions (out of 12) would you expect Joy make if she couldn't really smell Parkinson's and was just guessing?
3. How many correct decisions (out of 12) would it take to *convince* you that Joy really could smell Parkinson's?

## A FORMAL TEST OF SIGNIFICANCE

Although the researchers wanted to believe Joy, there was a chance that she may not really be able to tell Parkinson's by smell. It's logical to be skeptical of claims that are very different than our experiences. If Joy couldn't really distinguish Parkinson's by smell, then she would just have been guessing which shirt was which. The researchers were not willing to commit time and resources to a larger investigation unless they could be convinced to that Joy's wasn't just guessing.

4. What are the null and alternative hypotheses for this test of Joy's ability? (*Hint: think proportions!*)
  
  
  
  
  
  
  
  
  
  
5. Use technology to test the claim you stated above. Report the test statistic and the  $p$ -value and give a conclusion in context.
  
  
  
  
  
  
  
  
  
  
6. Why should you not have performed the test above?

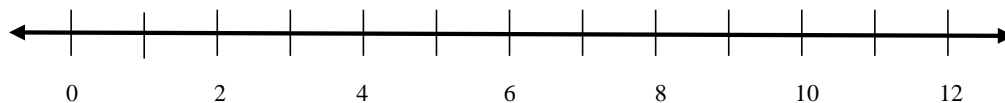
## SIMULATING THE EXPERIMENT

Although a 1-sample  $z$  test is not appropriate for this situation, we can still test the hypotheses by running a simulation, assuming that the null hypothesis is true.

- Mr. Tyson will hand you 12 cards (shirts) that have been shuffled into a random order. Don't turn them over yet! On the back of some of them is "Parkinson's" and on the back of others is "No Parkinson's." For each card, guess Parkinson's or No Parkinson's. Once you have made your guess, turn the card over and see if you were correct. Repeat this for each card and record the number of correct identifications (out of 12) below.

Tally of correct identifications	Number of correct identifications	Proportion of correct identifications

- Create a dotplot of the number of correct identifications with the rest of the class. Record the results below.



- In the actual experiment, Joy identified 11 of the 12 shirts correctly. Based on the very small-scale simulation by you and your classmates, what proportion of the simulations resulted in 11 or more shirts correctly identified, assuming that the person was guessing? This is the simulated (estimated)  $p$ -value for our test.
- How might we improve our estimate of the true probability?

## STATISTICAL INFERENCE FROM THE SIMULATION

11. Use the SPA Applet for One Categorical Variable at <https://tinyurl.com/SPAapplets> to run this simulation 10000 times. Then use that simulation to get a (likely) better estimate of the  $p$ -value for 11 or more shirts correctly identified, assuming that this person was just guessing. Is it *possible* that Joy correctly identified 11 shirts just by random chance (guessing)? Is it *likely*?
  
12. An interesting side note is that Joy's one "mistake" really wasn't a mistake. The shirt was worn by a person who supposedly didn't have Parkinson's even though Joy claimed that she could smell the telltale smell on that shirt. That person called the experimenters 8 months after the experiment and reported that he had just been diagnosed with Parkinson's disease. That meant that Joy correctly identified 12 out of 12 shirts. What is the approximate  $p$ -value for 12 shirts correctly identified, assuming that this person was just guessing?

## DEEPER AP STATS CONNECTIONS

13. The true theoretical probability can't be well-approximated by a Normal distribution as we have seen. However, the count of successes in 12 decisions assuming that Joy is just guessing is really and truly a binomial random variable, which you learned about earlier in the course. Find the exact theoretical probability to get 11 or more successes in 12 trials when the true probability of success is 0.5.