**Marijuana Users Executive Functioning**

Fontes, Bolla, Cunha, Almeida, Jungerman, Laranjeira, Bressan, and Lacerda[[1]](#footnote-1) studied marijuana users who started using before the age of 15. Volunteers for the study included marijuana users (n = 49) and non-marijuana users (n = 44). They were compared to each other using a neuropsychological task (the Stroop Test).

There are many versions of the Stroop Test. This study used 3 different versions. The first test showed the participant’s blocks of colors and they had to name the colors as fast as they could. The second listed multiple nouns written in different colors and again the participants had to name the colors as fast as they could. The last test listed multiple colors (in word form) that were shown in different colors. The participant would have to say the color that the word was written in. For example, the participant would see the word “red” but it was written in blue. The participant would have name the color blue.

To demonstrate this last test, your instructor will now show a test on the projector and you will name the color of the words as quickly as you can with the class.

For this study, each of the volunteers took each of the 3 Stroop Tests. For each test they were given a score. Those 3 scores were then added to create a single measure, the total response time spent on the 3 Stroop Tests. The data file for this activity is *Marijuana-Users.csv.*

**Discuss the Following Questions**

1. Was the study conducted an observational study or experiment?
2. What would be an appropriate research question for this study?
3. What is the statistic that is of interest in the research question?
4. What statistical method might you use to help answer this research question?
5. What would be the null and alternative hypothesis statements that would be used to answer the research question? Write out the hypothesis statements in both words and symbols.

H0:

Ha:

1. Did you choose to make a one-tailed or two-tailed hypothesis test? Why?
2. Describe how you would conduct a randomization test simulation to answer your research question. Make sure to include whether or not you should use with or without replacement. Recall your answer to question 1 to make this decision.

* Open a web browser and go to <http://lock5stat.com/statkey>.
* Click on the appropriate link to conduct your simulation.
* Open the file *15-Randomization-Test-Marijuana-Users.csv*.
* In *StatKey*, click on the button that says *Edit Data*.
* Highlight all of the data in the window and press Delete.
* Copy the data and paste it into the *Edit Data* window. Click Ok.
* Select whether you want to use with replacement or without replacement by clicking on the drop down menu for *Randomization method*. Note that *Reallocate Groups* means without replacement and *Combine Groups* means with replacement.

1. What is the value of the statistic for this data set?

* Simulate at least 10,000 randomization samples.

1. Sketch a plot of the randomization distribution below.
2. Describe what the plot of the randomization distribution represents.
3. Where is the plot centered? Why does this make sense?
4. Where does the location of the sample statistic fall in the plot?
5. Based on your answer to the previous question, would you expect to see a small or large *p*-value?
6. Find the *p*-value.
7. Provide an answer to the research question.
8. Can you generalize these results to all marijuana users and non-marijuana users? Why or why not?
9. Can you make any cause-and-effect conclusions? Why or why not?

**EXTENSIONS**

1. Would there be a benefit in calculating a bootstrap interval in addition to the hypothesis test? Why or why not?
2. If you were to compute a bootstrap interval for this example, would the interval include 0?
3. Create a bootstrap interval to check your answer in the previous question.
4. When conducting a randomization test, the sample data is sampled with replacement. Explain why.

1. Fontes, M. A., Bolla, K. I., Cunha, P. J., Almeida, P. P., Jungerman, F., Laranjeira, R. R., Bressan, R. A., & Lacerda, A. L. T. (2011). Cannabis use before age 15 and subsequent executive functioning. *The British Journal of Psychiatry, 198*, pp. 442-447. doi: 10.1192/bjp.bp.110.077479 [↑](#footnote-ref-1)