Activity: Kissing Right?

Most people are right-handed, and even the right eye is dominant for most people. Developmental biologists have suggested that late-stage human embryos tend to turn their heads to the right. In a study reported in *Nature* (2003), German bio-psychologist Onur Güntürkün conjectured that this tendency to turn to the right manifests itself in other ways as well, so he studied kissing couples to see which side they leaned their heads while kissing.

Step 1: Ask a research question

1. State the research question for this study.

Step 2: Design a study and collect data

The researchers observed kissing couples in public places such as airports, train stations, beaches, and parks. They were careful not to include couples who were holding objects such as luggage that might have affected which direction they turned. For each kissing couple observed, the researchers noted whether the couple leaned their heads to the right or to the left. They observed 124 couples, age 13-70 years.

2. What are the observational units in this study?
3. What is the variable measured on each observational unit & what type of variable is it?

Step 3: Explore the data

Researchers found that 80 of the 124 couples leaned right.

4. Calculate the observed statistic.
5. What symbol could we use to represent this value?

Step 4: Draw inferences

6. What *parameter* are we trying to estimate from these data?

7. What symbol can we use to represent this unknown value?

8. Do these data provide some evidence that a majority of kissing couples lean right?

9. State null and alternative hypotheses.

10. Use the one proportion applet to estimate the p-value

11. Based on other right sided tendencies (handedness, eye dominance, embryos), Dr. Güntürkün actually conjectured that 2/3 of kissing couples would lean right in the long run. State appropriate null and alternative hypotheses for his conjecture. What p-value

do you estimate from the applet? Will you reject the null hypothesis? Why or why not? Have you *proven* that π equals 2/3? Why or why not?

Discussion: Your simulation analysis should convince you that the sample data provide very strong evidence to believe that kissing couples lean their heads to the right more than half the time in the long run. That leads to a natural follow-up question: How much more than half the time? In other words, we have strong evidence that the long-run probability of leaning to the right is greater than one-half, but can we now estimate the value for that probability? We will do this by testing many different (null) values for the probability that a couple leans to the right when kissing. Because we don't really have a good idea whether the probability is larger or smaller than other values, we will use two-sided p-values for this exploration. We will also use 0.05 as our "level of significance" for deciding our p-value is small enough to reject the null hypothesis is favor of the alternative hypothesis.

12. Use the one proportion applet to test the probability values given in the following table.

- Each time, change the **Probability of success** to match the value that you are testing (keeping the observed sample proportion that you count beyond the same).
- Everything else should stay the same; press **Draw Samples** and then **Count** to see the new two-sided p-value (with the **Two-sided** box checked).
- Option: Check the Show sliders box…

Probability under H_0	**0.52**	**0.53**	**0.54**	**0.55**	**0.56**	**0.57**	**0.58**	**0.59**	**0.60**	**0.61**	**0.62**	**0.63**
(Two-sided) p-value												
Reject or plausible?												

Probability under H_0	**0.64**	**0.65**	**0.67**	**0.68**	**0.69**	**0.70**	**0.71**	**0.72**	**0.73**	**0.74**	**0.75**	**0.76**
(Two-sided) p-value												
Reject or plausible?												

13. Using a 0.05 significance level and your results from #12, provide a range of plausible values for π, the long-run probability that a kissing couple leans their heads to the right.

This range of values represents an interval containing all values between two *endpoints*.

Key idea: The interval of *plausible* values that you wrote down in #13 is also called a ***95% confidence interval for*** $\pi\pi$
π , the long-run probability that a kissing couple leans their heads to the right. Why is this called *95% confidence*? This corresponds to the 5% (0.05) significance level that was used to decide whether there was enough evidence against a hypothesized value. Notice that 95% and 5% add up to give 100%. The 95% is called the ***confidence level***, and is a measure of how confident we are about our interval estimate of the parameter, in this case, we are 95% confident that the population proportion of all couples who lean their heads to the right while kissing is in the interval that you found.

14. Does your 95% confidence interval from #13 include the value of 0.50? Does it include the value 2/3? Explain how your answers relate to the significance test and p-value that you calculated in #10 and #11.

In fact, confidence intervals and 2-sided tests of significance generally give complementary information. Values that are not considered plausible by the (two-sided) test of significance should not be contained in the corresponding confidence interval (confidence level = 100% – level of significance). Because 0.50 is not inside the confidence interval, this matches the test. It is not "further evidence against the null" but confirms our calculations agree. The confidence interval then gives us additional information on how large this majority is.

Step 5: Formulate Conclusions

15. Write a one-sentence interpretation of your confidence interval in context. Be sure to clarify the parameter and population of interest.

Step 6: Look back and ahead

16. Critique the design and conclusion of this study. Were there any limitations, such as how the subjects were selected or how the measurements were recorded? Was the sample size large enough? Did you observe a result of practical value? Discuss how you might address a few of these limitations. Suggest how you might design a follow-up study.

Extensions

- Calculate 2SD approximate 95% confidence interval
- Compare the calculated interval to a “theory-based approach”, e.g., $\hat{p} \pm 1/\sqrt{n}$
- Explore other confidence levels. How do they impact the confidence interval?