

From Evidence to a p -value.

Barry the Statypus-in-Training says:

Wait, I'm looking at Figure 9.7 in the *Statypus* textbook and it only shades **one** side of the curve! But in our *Order in the Court* drawing, we shaded **both** tails. Which one is right?

Sally the Statypus says: They are both right, Barry! It entirely depends on the specific **claim** (the Alternative Hypothesis, H_a) brought by the prosecution.

Bill the Statypus says: Your claim was just that the “machine was broken.” That means it could be biased towards white candies *or* blue candies. That is a **two-sided** test ($p \neq p_0$). But if the charge is specific, we only look at one side!

Task 1: The Specific Charges

If the alternative hypothesis (H_a) is not the two-sided $p \neq p_0$, what are the two other possible mathematical forms for H_a ?

Task 2: Reframing the Courtroom

Imagine the prosecution specifically claimed that the candy bag was biased **towards White candies** (meaning the proportion of White candies is greater than 0.50). Re-write your null and alternative hypotheses for this specific charge.

Task 3: Resketching the Evidence

Based on your new 1-sided H_a , resketch the Normal curve from your *Order in the Court* workspace. Plot our assumed center ($p_0 = 0.50$), the standard deviation of the null ($\sigma_{\hat{p}} \approx 0.071$), and our observed sample ($\hat{p} = 0.596$). **Only shade the area that represents this specific claim.**

The p -Value Definition

Task 4: The Formal Definition

Open your textbook to Section 9.3.2. Locate the formal definition of a **p-value** and copy it **verbatim** on the lines below. Do not paraphrase.

Sally the Statypus says: The formal definition is a mouthful, but we can give you an easier way of understanding it. Look for the Big Idea in the textbook above Definition 9.13.

Reflection: Understanding a p -Value

Based on the Big Idea you just read, explain in your own words how your belief in H_0 changes based on running a hypothesis test.

Sally the Statypus says: This nicely illustrates one of the golden rules for calculating areas using a Normal curve: Find the area in one tail, and then **multiply by the number of tails** (1 or 2) specified in your H_a !

Barry the Statypus-in-Training says:

So $p \neq p_0$ means 2 tails and both $<$ and $>$ mean 1 tail.

Bill the Statypus says: Precisely.

The Code for Hypothesis Tests

Sally the Statypus says: We understand the logic, the setup, and the geometry. Now we need an engine to do the heavy lifting of calculating the standard deviation of the null, z-scores, and the final p-value.

Task 5: Labeling the Engine

Below is the standard R Code Template for a Hypothesis Test for a Population Proportion. **Your task is to draw an arrow to every single line of code inside the box and annotate exactly what that line is doing, calculating, or asking you to provide.**

Coding Corner: Hypothesis Test for a Population Proportion

```
#Number of "Good" cases
x =

#Sample Size
n =

#Value of p in null hypothesis
p0 =

#The number of tails: Either 1 or 2
Tails =

#Do not change anything below this line
pHat0 <- x / n      #Sample proportion

SD <- sqrt( p0 * ( 1 - p0 ) / n )

zStat <- ( pHat0 - p0 ) / SD

pValue <- Tails * pnorm( - abs( zStat ) )

pValue              #Outputs the p-value
```

Bill the Statypus says: You do not have to understand all of the exact syntax here or worry about ever typing it out by hand, but you should be able to follow what is going on based on the math in your textbook.

Putting the Engine to Work

Sally the Statypus says: Now that we have investigated our code engine line-by-line, it is time to deploy it on a real biological problem. Let's see if we can transition completely from raw parameters down to a clear weight of empirical evidence.

The Field Log: The Sanctuary Audit

A proposed conservation referendum requires a supermajority of 75% of all votes to be in favor of it to secure funding. You survey 100 local residents and find that 67 support the measure. You claim to your boss that this evidence shows that the referendum will not pass and that you need to spend more money on advertising.

Task 6: Identifying the Claim

Underline the line in the paragraph above that is the claim that the researcher wants to test. Then, write it down in simple terms below involving a population proportion.

Task 7: Writing the Formal Hypotheses

Write out the formal statistical hypotheses using correct parameter notation.

H_0 : _____

H_a : _____

Task 8: Running The Test

Use the Code Template in section 9.3.3 to run this test. What is the p -value?

Write out what this p -value means as a full sentence based on your Reflection on page 2 of this worksheet.

Barry the Statypus-in-Training says:

Whoa, wait up! I ran our inputs through the template and got a p -value right around 0.03. That means if true support is exactly 75%, there's only about a 3% chance we'd get a sample this low purely from random sampling luck. That seems super rare... but it's not totally impossible, right? Where is the exact boundary line?

Bill the Statypus says: Barry, keep your fedora on, we will get to that very soon!