7.3: The Research Hypothesis and the Null Hypothesis

Hypotheses

Hypotheses are predictions of expected findings.

The Research Hypothesis

A research hypothesis is a mathematical way of stating a research question. A research hypothesis names the groups (we'll start with a sample and a population), what was measured, and which we think will have a higher mean. The last one gives the research hypothesis a direction. In other words, a research hypothesis should include:

1. The name of the groups being compared. This is sometimes considered the IV.
2. What was measured. This is the DV.
3. Which group are we predicting will have the higher mean.

There are two types of research hypotheses related to sample means and population means: Directional Research Hypotheses and Non-Directional Research Hypotheses

Directional Research Hypothesis

If we expect our obtained sample mean to be above or below the other group's mean (the population mean, for example), we have a directional hypothesis. There are two options:

- "The sample mean is expected to be *bigger* than the population mean."
  - Symbol: $\bar{X} > \mu$
  - (The mean of the sample is greater than than the mean of the population.)
- "The sample mean is expected to be *smaller* than the population mean."
  - Symbol: $\bar{X} < \mu$
  - (The mean of the sample is less than than mean of the population.)

Example 7.3.1

A study by Blackwell, Trzesniewski, and Dweck (2007) measured growth mindset and how long the junior high student participants spent on their math homework. What's a *directional* hypothesis for how scoring higher on growth mindset (compared to the population of junior high students) would be related to how long students spent on their homework? Write this out in words and symbols.

Solution

Answer in Words: Students who scored high on growth mindset would spend more time on their homework than the population of junior high students.

Answer in Symbols: $\bar{X} > \mu$

Non-Directional Research Hypothesis

A non-directional hypothesis states that the means will be different, but does not specify which will be higher. In reality, there is rarely a situation in which we actually don't want one group to be higher than the other, so we will focus on directional research hypotheses. There is only one option for a non-directional research hypothesis: "The sample mean *differs* from the population mean." These types of research hypotheses don't give a direction, the hypothesis doesn't say which will be higher or lower.

A non-directional research hypothesis in symbols should look like this: $\bar{X} \neq \mu$ (The mean of the sample is not equal to the mean of the population).

Exercise 7.3.1

What's a *non-directional* hypothesis for how scoring higher on growth mindset higher on growth mindset (compared to the population of junior high students) would be related to how long students spent on their homework (Blackwell, Trzesniewski, & Dweck, 2007)? Write this out in words and symbols.

Answer

Answer in Words: Students who scored high on growth mindset would spend a different amount of time on their homework than the population of junior high students.

Answer in Symbols: $\bar{X} \neq \mu$

See how a non-directional research hypothesis doesn't really make sense? The big issue is not if the two groups differ, but if one group seems to improve what was measured (if having a growth mindset leads to more time spent on math homework). This textbook will only use *directional* research hypotheses because researchers almost always have a predicted direction (meaning that we almost always know which group we think will score higher).

The Null Hypothesis

The hypothesis that an apparent effect is due to chance is called the null hypothesis, written H_0 ("H-naught"). We usually test this through comparing an experimental group to a comparison (control) group. This null hypothesis can be written as:

$$\mathrm{H}_0 : \bar{X} = \mu$$

For most of this textbook, the null hypothesis is that the means of the two groups are similar. Much later, the null hypothesis will be that there is no relationship between the two groups. Either way, remember that a null hypothesis is always saying that nothing is different.

This is where descriptive statistics diverge from inferential statistics. We know what the value of $\overline{\mathrm{X}}$ is – it's not a mystery or a question, it is what we observed from the sample. What we are using inferential statistics to do is infer whether this sample's descriptive statistics probably represents the population's descriptive statistics. This is the null hypothesis, that the two groups are similar.

Keep in mind that the null hypothesis is typically the opposite of the research hypothesis. A research hypothesis for the ESP example is that those in my sample who say that they have ESP would get more correct answers than the population would get correct, while the null hypothesis is that the average number correct for the two groups will be similar.

In general, the null hypothesis is the idea that nothing is going on: there is no effect of our treatment, no relation between our variables, and no difference in our sample mean from what we expected about the population mean. This is always our baseline starting assumption, and it is what we seek to reject. If we are trying to treat depression, we want to find a difference in average symptoms between our treatment and control groups. If we are trying to predict job performance, we want to find a relation between conscientiousness and evaluation scores. However, until we have evidence against it, we must use the null hypothesis as our starting point.

> *In sum, the null hypothesis is always:*
>
> *There is* ***no difference between the groups' means***
>
> *OR*
>
> *There is* ***no relationship between the variables****.*

In the next chapter, the null hypothesis is that there's no difference between the *sample mean*_and **population mean.** In other words:

- There is no mean difference between the sample and population.
- The mean of the sample is the same as the mean of a specific population.
- $\mathrm{H}_0 : \bar{X} = \mu$
- We expect our sample's mean to be same as the population mean.

? Exercise 7.3.2

A study by Blackwell, Trzesniewski, and Dweck (2007) measured growth mindset and how long the junior high student participants spent on their math homework. What's the *null hypothesis* for scoring higher on growth mindset (compared to the population of junior high students) and how long students spent on their homework? Write this out in words and symbols.

Answer

Answer in Words: Students who scored high on growth mindset would spend a similar amount of time on their homework as the population of junior high students.

Answer in Symbols: $\bar{X} = \mu$
