Determining Significance Based on Probability

by Sophia

WHAT'S COVERED

This lesson discusses determining significance based on probability. By the end of this lesson, you should be able to understand the relationship between the level of significance and the probability that an event occurs. This lesson covers:

1. Hypotheses and Probability

In the experimental method, the null hypothesis states that there is not a cause-and-effect relationship between the two variables, whereas the alternative hypothesis states that there might be such a relationship. The results of an experiment are considered significant if they are unlikely to occur when the null hypothesis is true.

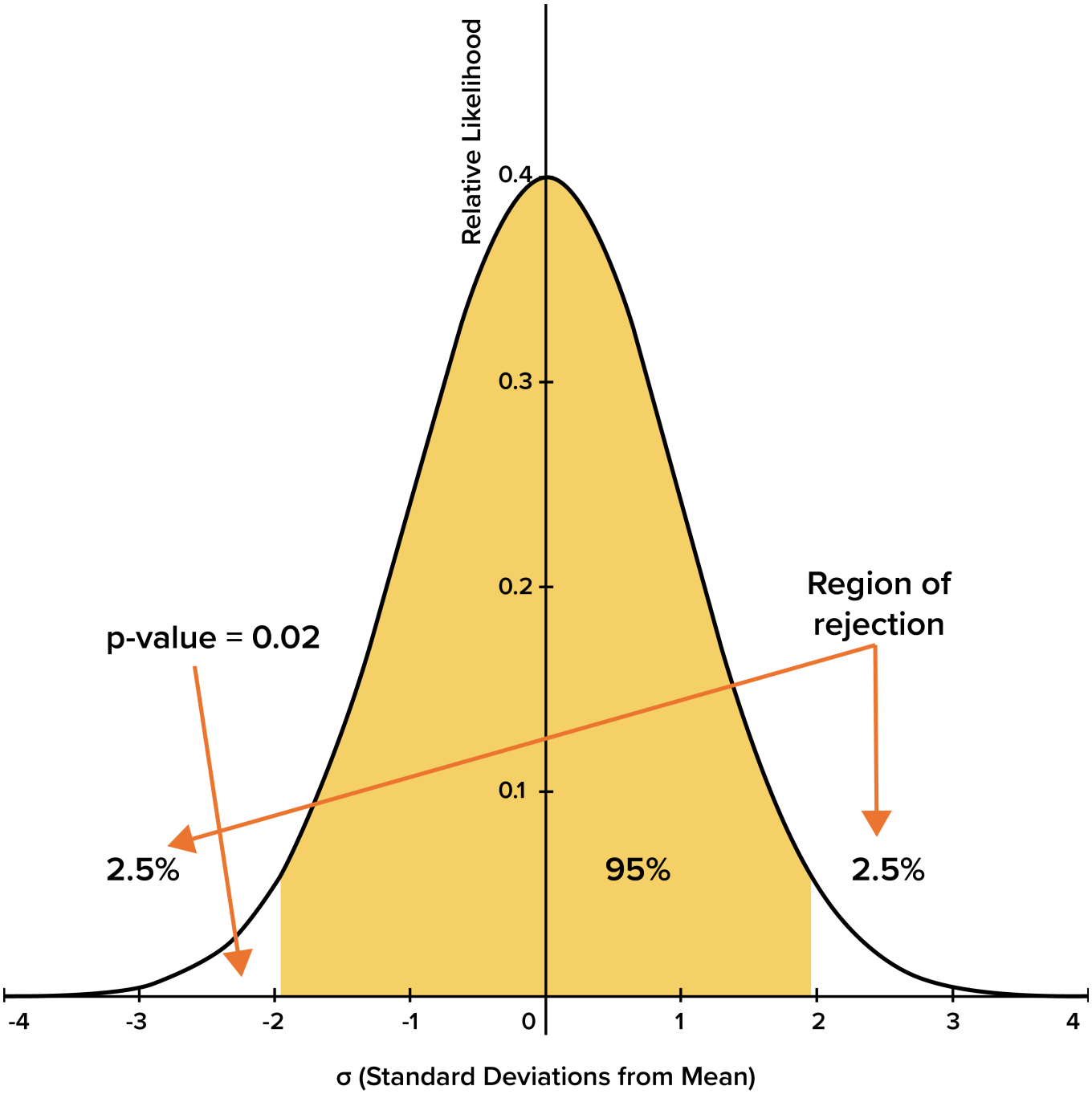
Probability is a means of establishing how likely an event or result of an experiment is. A p-value is the probability that a result occurs in the event that the null hypothesis is actually true. The results of an experiment are considered significant if they are unlikely to occur in the event that the null hypothesis is true. Similarly, you could say that the results of an experiment lie in the region of rejection with an area of 5%, and such a result is significant when its p-value is less than the significance level of 5%.

2. Examples

2a. Resting Heart Rate and Exercise

Consider the relationship between how often a person engages in cardiovascular exercise and his or her resting heart rate. The null hypothesis for such an experiment would be that regardless of how often a person exercises, it would have no impact on resting heart rate. However, since there is a cause-and-effect relationship between the frequency of cardio exercise and resting heart rate, you would expect the results of such an experiment to be significant.

Suppose in this case, mean resting heart rate for exercisers is 2.2 standard deviations less than the population mean. This difference corresponds to a p-value of 0.02, or 2%. As you can see on the graph below, the combination of the two-tailed region works out to be 5% of the entire region under the normal distribution curve. For a sample mean located at the point shown, the p-value is 0.02, or 2%, which lies on the region of rejection since it is less than our 5% level of significance.



In this experiment, the group who exercised had lower mean resting heart rates with an associated p-value of 0.02. This p-value is within the left tail region (2.5%) where we reject the null hypothesis at the 5% significance level (2.5% + 2.5%).

2b. Texts and Pets

Now consider the relationship between how many text messages a person sends per day and the number of pets that they have. Let's use the most common level of significance of 5%. In a case such as this, you might expect to fail to reject the null hypothesis, and as such, would not be surprised to arrive at a p-value of 0.35, or 35%. Such a value would indicate that we would expect a result this different than the population mean about

35% of the time. This result is not significant because it is greater than 5.0% and does not allow us to reasonably reject the null hypothesis.

2c. Travel and Gas Prices

What about the case of the average price of gasoline and the average annual number of car miles traveled by car for vacation by Americans? Suppose that having conducted two experiments on these variables, we arrived at results that yielded a p-value of 0.015, or 1.5%. This is expected given that high gas prices might deter Americans from taking long road trips. In this case, the results are significant because 1.5% is less than our chosen significance level of 5%.

HINT

Significant results have a p-value of less than 0.05 (5%). A value less than 0.05 (5%) means that we would expect to get a result at least this extreme only 5% of the time if the null hypothesis were true.

SUMMARY

In this lesson, you looked at the relationship between **hypotheses and probability**. Probability can be used to support or invalidate a null hypothesis. It is important to understand the relationship between the level of significance and the probability that an event occurs. To illustrate these relationships, you looked at several **examples** involving **resting heart rate and exercise**, **texts and pets**, and **travel and gas prices**.

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