

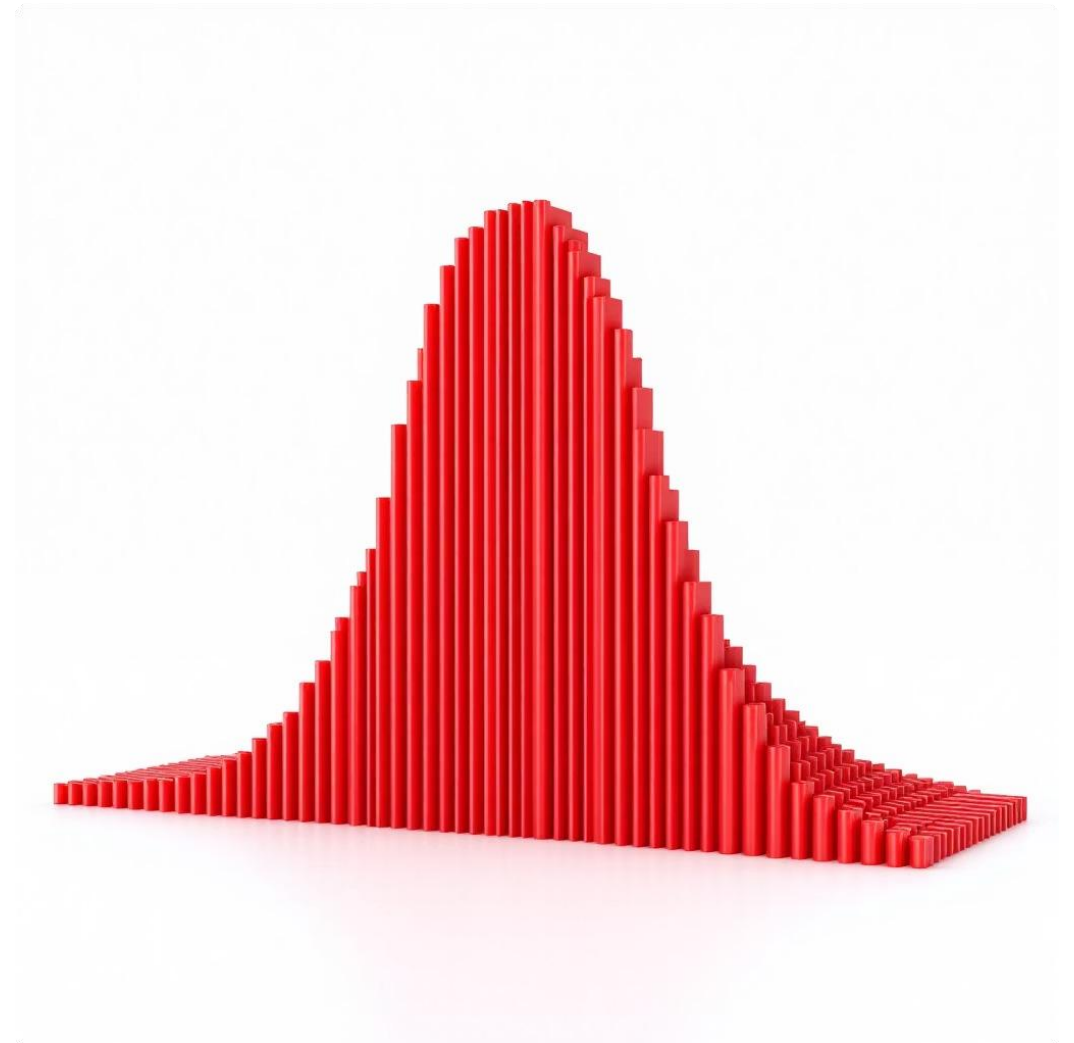
# What is a t-Test?

A t-test is a powerful statistical method that allows researchers to determine whether the differences they observe between groups are meaningful or simply the result of random chance.

In psychology, we constantly ask questions like: "Does this therapy work?" or "Do men and women differ in cognitive abilities?" The t-test provides us with objective, quantitative answers to these questions by comparing means<sup>4</sup>the average scores of different groups or conditions.

T-test lies in its ability to account for variability in data. Not everyone responds the same way to treatments, and individual differences are the norm in psychology.

The t-test considers this natural variation and tells us whether group differences are large enough to be considered statistically significant.



❏ **Key Concept:** Statistical significance means the probability that our observed difference occurred by chance alone is very low<sup>4</sup>typically less than 5%.

# Assumptions of the t-Test

Before conducting any t-test, we must verify that our data meets certain conditions. These assumptions are not arbitrary rules—they're mathematical requirements that ensure our results are valid and interpretable.



## Continuous T Normal Data

Your dependent variable must be measured on a continuous scale (like depression scores or reaction times) and should follow an approximately normal distribution—the famous bell curve shape.



## Random Sampling

Participants should be randomly selected from the population to ensure your sample represents the broader group you want to study. This reduces bias and increases generalizability.



## Independence of Groups

For independent samples t-tests specifically, the groups being compared must be truly separate—one person's score in Group A shouldn't influence another person's score in Group B.

# One-Sample t-Test

The one-sample t-test is the simplest form of t-test, used when you want to compare your sample's mean to a known or hypothesized population value. This is particularly useful when established norms or benchmarks exist in the literature.

## Research Example: Test Anxiety Study

Imagine previous research has established that the average test anxiety score in the general student population is 50. You collect data from your psychology class and want to know if your students differ from this norm.

### Hypothesis Formation

- **Null Hypothesis ( $H_0$ ):**  $\mu = 50$  (The mean anxiety score of our students equals the population mean of 50)
- **Alternative Hypothesis ( $H_1$ ):**  $\mu \neq 50$  (The mean anxiety score of our students is different from 50)

This is a two-tailed test because we're simply asking if our students are "different"4 they could be either more or less anxious than the population average.

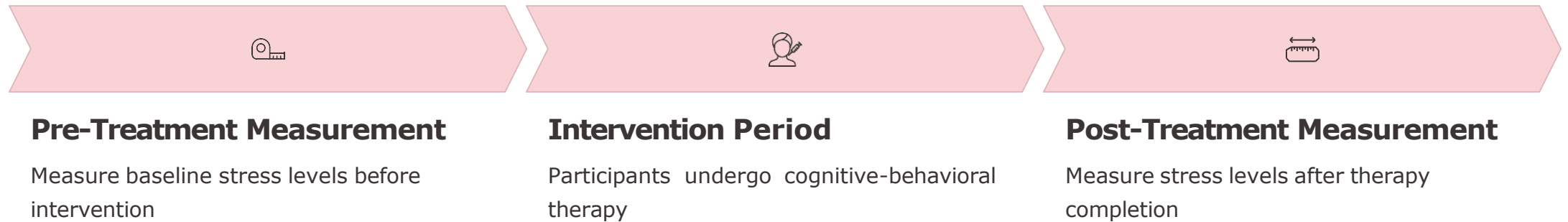
### When to Use It

Use a one-sample t-test whenever you have a single group and want to compare it against a known standard, such as clinical cutoff scores, published norms, or theoretical values.

📌 **Clinical Application:** One-sample t-tests are frequently used to determine if patient groups score differently from established clinical thresholds on standardized psychological assessments.

# Paired Sample t-Test (Dependent Samples)

The paired sample t-test, also called a dependent samples or repeated measures t-test, is used when you measure the same participants twice. This design is incredibly powerful because each person serves as their own control, reducing variability caused by individual differences.



## Research Example: Therapy Effectiveness

You want to evaluate whether a 6-week cognitive-behavioral therapy program reduces stress levels in university students. You measure each student's stress score before starting therapy and again after completing the program.

### Hypothesis Formation

- **Null Hypothesis ( $H_0$ ):**  $\mu_{\text{difference}} = 0$  (The mean difference in stress levels before and after therapy equals zero4therapy has no effect)
- **Alternative Hypothesis ( $H_1$ ):**  $\mu_{\text{difference}} \neq 0$  (There is a significant difference in stress levels4therapy has an effect)

### Advantages of Paired Design

- Greater statistical power4individual differences are controlled
- Requires fewer participants than independent designs
- Perfect for pre-post intervention studies
- Ideal for studying learning, development, or treatment effects

# Independent Samples t-Test

The independent samples t-test compares means between two separate, unrelated groups. This is perhaps the most commonly used t-test in psychology because many research questions involve comparing distinct groups of people.

## Research Example: Gender and Depression

Depression is a major focus in clinical psychology, and researchers often investigate whether certain demographic variables are associated with depression severity. In this example, we examine potential gender differences in depression scores.

### Hypothesis Formation

- **Null Hypothesis ( $H_0$ ):**  $\mu_{\text{males}} = \mu_{\text{females}}$  (There is no difference in mean depression scores between males and females)
- **Alternative Hypothesis ( $H_1$ ):**  $\mu_{\text{males}} \neq \mu_{\text{females}}$  (Mean depression scores differ between males and females)

This two-tailed hypothesis doesn't predict which group will score higher; it simply tests whether any difference exists.

The independent samples t-test requires that the two groups are truly independent; no participant can be in both groups simultaneously. This is different from the paired samples design where the same people are measured twice.

## Other Psychology Examples

- Testing whether patients diagnosed with anxiety disorder score higher on worry questionnaires than healthy controls
- Examining differences in reaction times between participants who consumed caffeine versus a placebo
- Investigating whether extraverts report higher life satisfaction than introverts

# Visualizing the Three t-Test Types

Visual representation helps clarify the fundamental differences between these three t-test variants. Each addresses a distinct research design and answers different types of questions.

## **One-Sample t-Test**

A single sample mean is compared against a fixed, known population value. The visualization shows one distribution being tested against a reference line representing the hypothesized mean.

## **Paired Sample t-Test**

Two measurements from the same individuals are compared by examining the differences within subjects. The visualization emphasizes the paired nature of the data with connecting lines showing change over time or conditions.

## **Independent Samples t-Test**

Two separate distributions representing different groups are positioned side by side. The visualization highlights that these are distinct groups with no overlap in membership.

# How to Interpret t-Test Results

## The Statistical Decision Process

Understanding how to interpret t-test output is crucial for making valid scientific conclusions. The process involves examining several key pieces of information that statistical software provides.

### Key Statistics to Report

- 1. t-value:** The test statistic that indicates how many standard errors your sample mean is from the hypothesized value or comparison group
- 2. Degrees of freedom (df):** Related to sample size and affects the shape of the t-distribution
- 3. p-value:** The probability of obtaining your results (or more extreme) if the null hypothesis were true
- 4. Effect size (Cohen's d):** Indicates the magnitude of the difference in standardized units
- 5. Confidence interval:** A range of plausible values for the true population difference

**NOTE:** Statistical significance ( $p < 0.05$ ) tells you that an effect probably exists, but effect size tells you whether that effect matters in the real world. Always report both!

Example reporting: "An independent samples t-test revealed that males ( $M = 25.3$ ,  $SD = 4.2$ ) reported significantly lower depression scores than females ( $M = 28.7$ ,  $SD = 4.8$ ),  $t(98) = 3.45$ ,  $p = .001$ ,  $d = 0.75$ , 95% CI [1.5, 5.3]. This represents a medium-to-large effect size."

01

---

### Calculate Statistics

Run the t-test in your statistical software (SPSS, R, Python, etc.) and obtain the t-value and p-value

02

---

### Compare p-value to <sup>3</sup>

If  $p < 0.05$  (your alpha level), reject  $H_0$  and conclude a significant difference exists

03

---

### Assess Effect Size

Determine practical significance using Cohen's d (small: 0.2, medium: 0.5, large: 0.8)

04

---

### Report Results

Write up findings in APA format including all relevant statistics and confidence intervals

# Summary of t-Test Types

## One-Sample t-Test

### Design Structure

Single group compared against a known population mean or theoretical value

### Research Question

"Does our sample differ from the established norm?"

### Example Studies

- Testing if therapy patients' scores differ from clinical cutoffs
- Comparing student IQ scores to population mean of 100
- Evaluating if response times differ from a standard benchmark

## Paired Sample t-Test

### Design Structure

Same group measured twice under different conditions or time points

### Research Question

"Does the intervention cause a change within participants?"

### Example Studies

- Pre-test and post-test after training or treatment
- Comparing performance under two experimental conditions
- Measuring change over developmental periods

## Independent Samples t-Test

### Design Structure

Two separate, unrelated groups compared on the same variable

### Research Question

"Do these two groups differ from each other?"

### Example Studies

- Comparing experimental and control groups
- Testing gender differences in psychological traits
- Examining clinical vs. non-clinical populations