Example 13
t-test (Two-sample)
Comparing sample means
Setup

An animal care technician needs to determine if different types of rat food generate different mass gains in rats. He fed 20 rats two different diets and measured their increase in mass (g). The data are attached.

Diet	MassGain
A	4.5
A	5.6
A	8.2
A	4.5
A	2.3
A	9.7
A	4.4
A	4.4
A	1.9
A	2.4
B	7.7
B	5.4
B	4.9
B	9.9
B	11.6
B	8.8
B	8.3
B	9.6
B	9.9
B	10.4

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Solution

1. State your question: Do the different diets produce different mass gains in rats?
   a. Is it a good scientific question? Definable, measurable, controllable
   b. Identify your population: Mass gains in rats
   c. Identify your dependent variable: Mass gains
   d. Identify your independent variable: Diet
2. State your hypothesis set
   a. Verbal hypothesis: The diets differ in the weight gain generated in rats.
   b. Statistical hypothesis (H_O, H_A).
      H_O: $x_A = x_B$ The two different diets do not produce significantly different weight gains in rats.
      H_A: $x_A \neq x_B$ The two different diets produce significantly different weight gains in rats
   c. Is your hypothesis set exhaustive? Yes
   d. Is your hypothesis set exclusive? Yes
3. State your significance level: $\alpha=0.05$
4. Select the appropriate test
   a. Variable scales
      i. Dependent variable: Interval scale (Why?)
         - Converted or transformed? No
      ii. Independent variable: Nominal
         - Converted or transformed? No
   b. What information is given or available?
      i. Sample data
   c. Number of samples: 2
   d. Are the data paired or unpaired? Unpaired
   e. What aspect of the variable do you want to compare?
      i. Central tendency -- means
   f. State the test to be used: t-test – two sample
      i. Are the assumptions of the test met? Yes
         - Random samples – Assumed
         - Independent samples – Assumed
         - Normally distributed populations – Tested
         - Equal variances – Tested

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        Shapiro-Wilk normality test

data:  RatsA$MassGain
W = 0.8869, p-value = 0.1564
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Shapiro-Wilk normality test

data: RatsB$MassGain
W = 0.9237, p-value = 0.389

F test to compare two variances

data: Rats$MassGain by Rats$Diet
F = 1.3778, num df = 9, denom df = 9, p-value = 0.6408
alternative hypothesis: true ratio of variances is not equal to 1
95 percent confidence interval:
 0.3422172 5.5468713
sample estimates:
ratio of variances
 1.377764

5. Conduct your sampling
   We obtain random samples of rats that have been feed the different diets

6. Graph the data

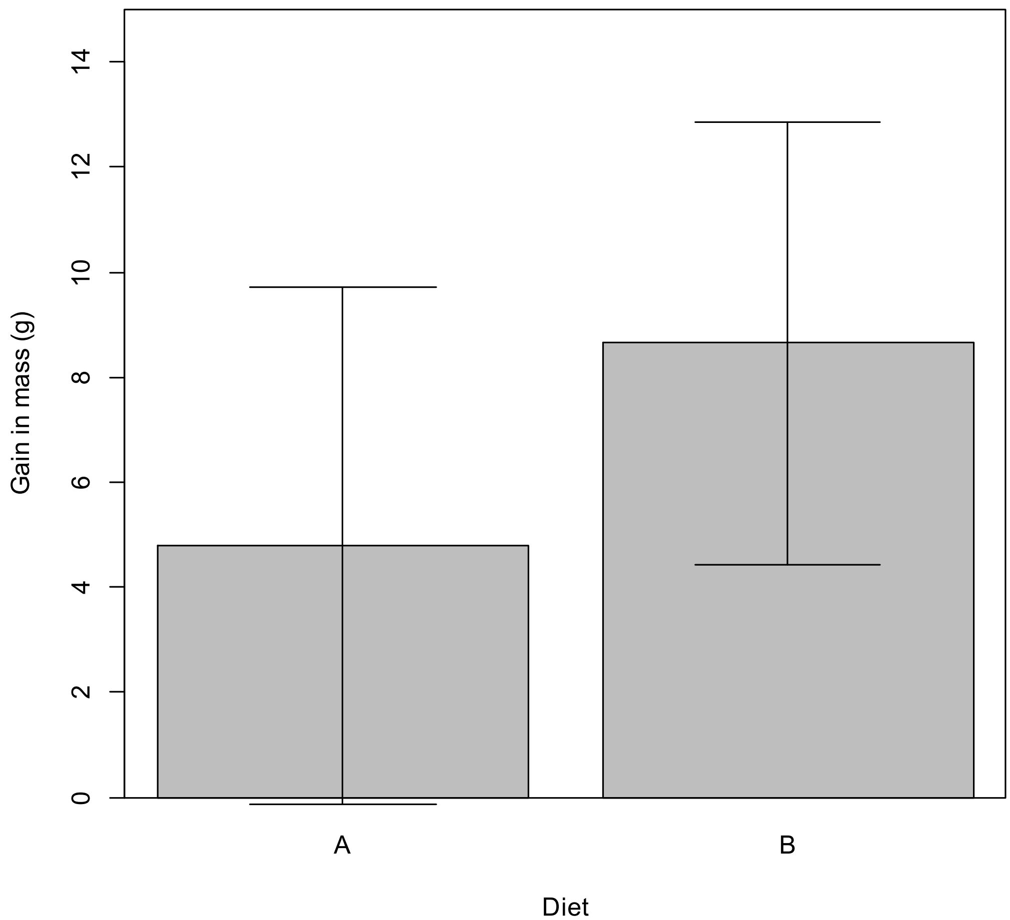

Figure 1. Mass gains in rats feed diet A and diet B

7. Summarize the data.

Weight gains for diet A

$n = 10$ $\nu = 9$

$x_A = 4.79$ g

$s_A = 2.52$ g

Weight gains for diet B

$n=10$ $\nu=9$

$x_B = 8.65$ g

$s_B = 2.15$ g

8. Calculate your test statistic.

    Two Sample t-test

data: Rats$MassGain by Rats$Diet
t = -3.6879, df = 18, p-value = 0.001683
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -6.058943 -1.661057
sample estimates:
mean in group A mean in group B
    4.79   8.65

9. Retain or reject your null hypothesis based on your test statistic.
   The calculated p-value (0.002) is less than the significance level (0.05), therefore we would reject our null hypothesis and retain our alternate hypothesis.
10. Interpret the results in biological terms.
   The diets produce significantly different mass gains (t=3.69, df=18, p=0.002).