Independent Samples t Test

Data

The following data set reflects a between-subjects design with one factor (that has two levels). The data are presented in a format suitable for entry into statistical software.

	Factor	Outcome
1	1.00	.00
2	1.00	.00
3	1.00	3.00
4	1.00	5.00
5	2.00	4.00
6	2.00	7.00
7	2.00	4.00
8	2.00	9.00

Computer Output

The following tables represent typical output from statistical software. Options, labels, and layout vary from program to program.

The table of descriptive statistics can be used to determine the inferential statistics.

	Group	N	Mean	Std. Deviation	Std. Error Mean
Outcome	Level 1	4	2.000	2.445	1.225
	Level 2	4	6.000	2.445	1.225

The table of inferential statistics shows the key elements to be calculated.

	t	df	p	Mean Difference	SE Difference	Lower CI	Upper CI	Cohen's d
Outcome	-2.309	6.000	0.060	-4.000	1.732	-8.238	0.238	-1.633

Calculations

Mean Difference (Raw Effect): The mean difference is the difference between the two sample means (raw effect).

$$M_1 - M_2 = 2.000 - 6.000 = -4.000$$

Within Groups Statistics: When multiple groups are used, it is necessary to get an estimate of the pooled (combined) within group variabilities.

$$SS_1 = (SD_1^2)(df_1) = (2.44949^2)(3) = 18.000$$
$$SS_2 = (SD_2^2)(df_2) = (2.44949^2)(3) = 18.000$$

$$SS_{WITHIN} = SS_1 + SS_2 = 18.000 + 18.000 = 36.000$$
$$df_{WITHIN} = df_1 + df_2 = 3 + 3 = 6$$

$$MS_{WITHIN} = \frac{SS_{WITHIN}}{df_{WITHIN}} = \frac{36.000}{6} = 6.000$$

$$SD_{WITHIN} = \sqrt{MS_{WITHIN}} = \sqrt{6.000} = 2.449$$

Standard Error of the Difference: The standard error of the difference is a function of the two groups' individual standard errors.

When the two sample sizes are equal:

$$SE_{DIFF} = \sqrt{SE_1^2 + SE_2^2} = \sqrt{1.225^2 + 1.225^2} = 1.732$$

When the two sample sizes are unequal:

$$SE_{DIFF} = \sqrt{\frac{MS_{WITHIN}}{n_1} + \frac{MS_{WITHIN}}{n_2}} = \sqrt{\frac{6.000}{4} + \frac{6.000}{4}} = 1.732$$

Statistical Significance: The t statistic is the ratio of the mean difference (raw effect) to the standard error of the difference.

$$t = \frac{M_1 - M_2}{SE_{DIFF}} = \frac{-4.000}{1.732} = -2.309$$

$df = (n_1 - 1) + (n_2 - 1) = N - 2 = 8 - 2 = 6$
With df = 6, $t_{CRITICAL}$ = 2.447
Because $t < t_{CRITICAL}$, $p > .05$

Effect Size: Cohen's d Statistic provides a standardized effect size for the difference between the two means.

$$d = \frac{M_1 - M_2}{SD_{WITHIN}} = \frac{-4.000}{2.449} = -1.630$$

Confidence Interval: For this test, the appropriate confidence interval is around (centered on) the mean difference (raw effect).

$$CI_{DIFF} = (M_1 - M_2) \pm (t_{CRITICAL})(SE_{DIFF})$$
$$CI_{DIFF} = -4.000 \pm (2.447)(1.732) = [-8.238, 0.238]$$

APA Style

For this analysis, the emphasis is on comparing the means from two groups. Here again the summary and the inferential statistics focus on the difference. The first example focuses on statistical significance testing, whereas the second version includes and emphasizes interpretation of the confidence interval and effect size.

> An independent samples *t* test showed that the difference in Outcome scores between the first group (*n* = 4, *M* = 4.00, *SD* = 2.45) and the second group (*n* = 3, *M* = 6.00, *SD* = 2.45) was not statistically significant, *t*(6) = -2.31, *p* = .060.

> Analyses revealed potentially large, yet inconclusive, differences in Outcome scores between the first group (*n* = 4, *M* = 4.00, *SD* = 2.45) and the second group (*n* = 3, *M* = 6.00, *SD* = 2.45), 95% CI [-8.24, 0.24], *d* = -1.63, *t*(6) = -2.31, *p* = .060.

Alternatively, the means, standard deviations, and confidence intervals could be presented in a table or figure associated with this text.