

Course : Research statistics

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Level : Master

Lecture : 10

Independent-samples t-test

Lecture objectives : Introducing the independent-samples t-test and how to compute it.

Introduction

After having seen for what kind of research design the dependent-test is used , this lecture introduces the independent t-test, most of the time used in research. The **independent-samples t-test**, also called the **unpaired-samples t-test**, is for research design where we are comparing the results of groups that are independent of each other (for example, class 1 and class 2, or **control and experimental groups**).

After the collection of data, summarizing and describing them, the next phase is to test the hypothesis using the appropriate t-test. Before computing the test,

First, we choose the **level of statistical significance** $\alpha = 0.05$

Degree of freedom for two samples $\longrightarrow df = (N_1 + N_2) - 2$

Critical value for df at the level 0.05 (refer to the critical table in the appendix). We should also know **whether the hypothesis one one-tailed or two-tailed**.

The following formula can be used to compute the independent-samples t-test.

Computation of the t-test for independent samples

The following stages will be followed to calculate the independent test for this experiment (Miller, 1984, p. 80):

I. Calculate the two samples means \bar{X}_1, \bar{X}_2 using the formula

$$\bar{x} = \frac{\sum X}{N}$$

II. Calculate the two samples variances S_1^2 and S_2^2 using the formula;

$$s^2 = \frac{\sum X^2}{N} - \bar{X}^2$$

III. Substitute the values of: $\bar{X}_1, \bar{X}_2, S_1^2, S_2^2, N_1, N_2$ in the computational formula for t :

$$t_{N_1 + N_2 - 2} = \frac{(\bar{X}_1 - \bar{X}_2)\sqrt{(N_1 + N_2 - 2)N_1 N_2}}{\sqrt{(N_1 S_1^2 + N_2 S_2^2)(N_1 + N_2)}}$$

IV Find the number of degrees of freedom using the formula: $df=N_1+N_2-2$.

V Find the value of t needed for your chosen level of significance using the table in the appendix. This critical value will depend on (1) the number of degrees

of freedom, and (2) whether the prediction is directional or not.

VI If the observed value of t is *equal* to or *greater* than the critical value of t , reject the null hypothesis in favour of the alternate hypothesis, i.e. conclude that the independent variable had an effect on behaviour.

Example

Effects of two drugs on a perceptual-motor skill.

Experimenter predicts that Drug 1 will produce higher scores than Drug Two (One tailed) (Miller, 184,p. 68).

In our situation, this can be two groups who were taught by two different methods.

$N_1=5$

$N_2=7$

$Df= (N_1+N_2)- 2= (5+7) -2= 10$

$\alpha= 0.05$

Group receiving Drug 1 ($N_1=5$)		Group receiving Drug 2 ($N_2=7$)	
X_1	X_1^2	X_2	X_2^2
6	36	4	16
8	64	7	49
7	49	5	25
9	81	4	16
8	64	5	25
		6	36
		4	16
<hr/>		<hr/>	
$\Sigma X_1 = 38$	$\Sigma X_1^2 = 294$	$\Sigma X_2 = 35$	$\Sigma X_2^2 = 183$
I $\bar{X}_1 = \frac{\Sigma X_1}{N_1} = \frac{38}{5} = 7.6$		$\bar{X}_2 = \frac{\Sigma X_2}{N_2} = \frac{35}{7} = 5.0$	
II $S_1^2 = \frac{\Sigma X_1^2}{N_1} - \bar{X}_1^2$		$S_2^2 = \frac{\Sigma X_2^2}{N_2} - \bar{X}_2^2$	
$= \frac{294}{5} - 7.6^2$		$= \frac{183}{7} - 5^2$	
$= 1.04$		$= 1.143$	
III $t_{N_1+N_2-2} = \frac{(\bar{X}_1 - \bar{X}_2)\sqrt{(N_1 + N_2 - 2)N_1 N_2}}{\sqrt{(N_1 S_1^2 + N_2 S_2^2)(N_1 + N_2)}}$			
$= \frac{(7.6 - 5.0)\sqrt{(5 + 7 - 2)5 \times 7}}{\sqrt{(5 \times 1.04 + 7 \times 1.143)(5 + 7)}}$			
$= \frac{2.6\sqrt{10 \times 5 \times 7}}{\sqrt{13.201 \times 12}} = 3.86$			

Conclusion. As the observed t is greater than the critical value 1.812 $t = 3.86 > 1.812$ (refer to the critical value in the appendix). It is unlikely that our results could have arisen by chance.

We may therefore accept the alternate hypothesis that Drug 1 produces higher performance than Drug 2.

Appendix : The *t* distribution critical values of *t* for a one -tailed test

The critical values of *t* distribution are calculated according to the probabilities of two alpha values and the degrees of freedom. The Alpha(α) values 0.05 one tailed to be compared with the degrees of freedom in the row of the table.

α (1 tailed)	0.05	α (1 tailed)	0.05
df		df	
1	6.3138	16	1.7459
2	2.9200	17	1.7396
3	2.3534	18	1.7341
4	2.1319	19	1.7291
5	2.0150	20	1.7247
6	1.9432	21	1.7207
7	1.8946	22	1.7172
8	1.8595	23	1.7139
9	1.8331	24	1.7109
10	1.8124	25	1.7081
11	1.7959	26	1.7056
12	1.7823	27	1.7033
13	1.7709	28	1.7011
14	1.7613	29	1.6991
15	1.7530	30	1.6973

References

Miller, S. (1984). Experimental design and statistics (2nd ed.). London and New York: Routledge

References for further reading

Greasley, P. (2008). Quantitative data analysis using SPSS. Mc Grill Hill : Open Univeristy.

MUIjs , D. Doing quantitative research in education with SPSS. London : Sage Publications