

Dependent (paired) Sample t-tests

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Dependent Samples t -test

Used when we have dependent samples – matched, paired or tied somehow

- Repeated measures
- Brother & sister, husband & wife
- Left hand, right hand, etc.

Useful to control individual differences. Can result in more powerful test than independent samples t -test.



Dependent Samples t

Formulas:

$$t_{\bar{X}_D} = \frac{\bar{D}}{SE_{diff}}$$

t is the difference in means over a standard error.

$$SE_{diff} = \frac{SD_D}{\sqrt{n_{pairs}}}$$

The standard error is found by finding the difference between each pair of observations. The standard deviation of these difference is SD_D . Divide SD_D by sqrt (number of pairs) to get SE_{diff} .



Another way to write the formula

$$t_{\bar{X}_D} = \frac{\bar{D}}{SD_D / \sqrt{n_{pairs}}}$$



Dependent Samples t example

Person	Painfree (time in sec)	Placebo	Difference
1	60	55	5
2	35	20	15
3	70	60	10
4	50	45	5
5	60	60	0
M	55	48	7
SD	13.23	16.81	5.70



Dependent Samples t Example (2)

1. Set alpha = .05
2. Null hypothesis: $H_0: \mu_1 = \mu_2$.
Alternative is $H_1: \mu_1 \neq \mu_2$.
3. Calculate the test statistic:

$$SE_{diff} = \frac{SD}{\sqrt{n_{pairs}}} = \frac{5.70}{\sqrt{5}} = 2.55$$

$$t = \frac{\bar{D}}{SE_{diff}} = \frac{55 - 48}{2.55} = \frac{7}{2.55} = 2.75$$

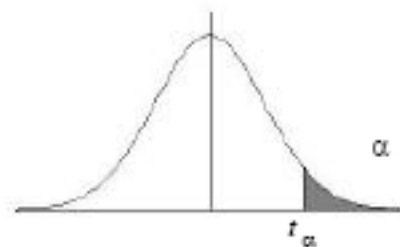


Dependent Samples t Example (3)

4. Determine the critical value of t.
Alpha = .05, tails=2
df = N(pairs)-1 = 5-1=4.
Critical value is 2.776
5. Decision rule: is absolute value of sample value larger than critical value?
6. Conclusion. Not (quite) significant. Painfree does not have an effect.



Table 4: Percentage Points of the t distribution



df	α					
	0.250	0.100	0.050	0.025	0.010	0.005
1	1.000	3.078	6.314	12.706	31.821	63.657
2	0.816	1.886	2.920	4.303	6.965	9.925
3	0.765	1.638	2.353	3.182	4.541	5.841
4	0.741	1.533	2.132	2.776	3.747	4.604
5	0.727	1.476	2.015	2.571	3.365	4.032
6	0.718	1.440	1.943	2.447	3.143	3.707
7	0.711	1.415	1.895	2.365	2.998	3.499
8	0.706	1.397	1.860	2.306	2.896	3.355
9	0.703	1.383	1.833	2.262	2.821	3.250
10	0.700	1.372	1.812	2.228	2.764	3.169
11	0.697	1.363	1.796	2.201	2.718	3.106
29	0.683	1.311	1.699	2.045	2.462	2.756
30	0.683	1.310	1.697	2.042	2.457	2.750
40	0.681	1.303	1.684	2.021	2.423	2.704
60	0.679	1.296	1.671	2.000	2.390	2.660
120	0.677	1.289	1.658	1.980	2.358	2.617
∞	0.674	1.282	1.645	1.960	2.326	2.576



Using SPSS for dependent t-test

Open SPSS

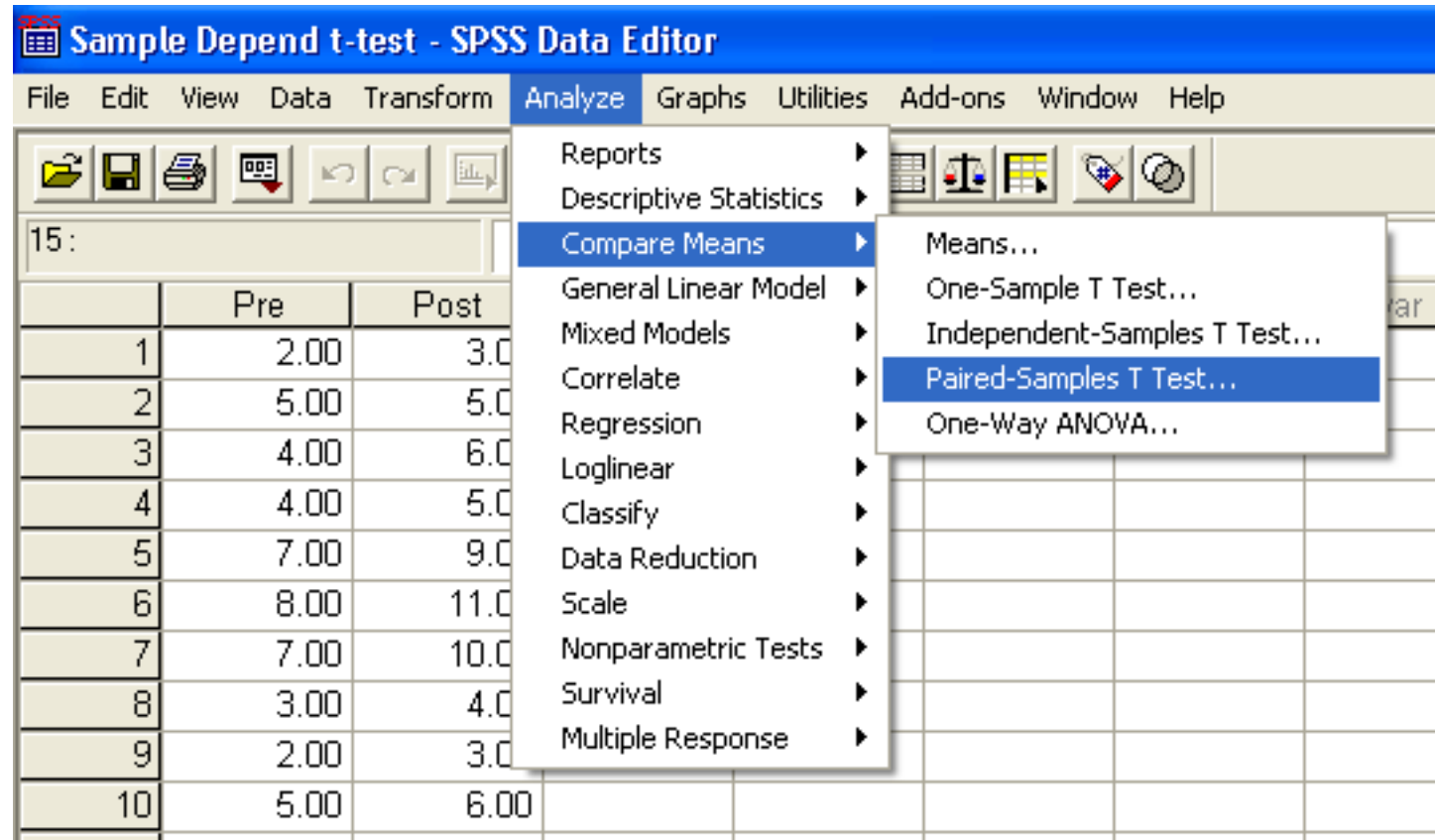
Open file “SPSS Examples” (same as before)

Go to:

- “Analyze” then “Compare Means”
- Choose “Paired samples t-test”
- Choose the two IV conditions you are comparing. Put in “paired variables box.”



Dependent or Paired t-Test: Select Paired-Samples



The screenshot shows the SPSS Data Editor window titled "Sample Depend t-test - SPSS Data Editor". The "Analyze" menu is open, and the "Compare Means" option is selected, which has opened a sub-menu. In this sub-menu, the "Paired-Samples T Test..." option is highlighted. The background shows a data grid with two columns, "Pre" and "Post", and ten rows of data.

	Pre	Post
1	2.00	3.00
2	5.00	5.00
3	4.00	6.00
4	4.00	5.00
5	7.00	9.00
6	8.00	11.00
7	7.00	10.00
8	3.00	4.00
9	2.00	3.00
10	5.00	6.00



Dependent or Paired t-Test: Select Variables

The screenshot shows the SPSS Data Editor window titled "Sample Depend t-test - SPSS Data Editor". The data table has columns "Pre" and "Post" with 12 rows of data. A "Paired-Samples T Test" dialog box is open, showing "Pre" and "Post" in the "Current Selections" list. The "Paired Variables:" list contains "Pre -- Post". The dialog box includes buttons for "OK", "Paste", "Reset", "Cancel", "Help", and "Options...".

	Pre	Post
1	2.00	3.00
2	5.00	5.00
3	4.00	6.00
4	4.00	5.00
5	7.00	9.00
6	8.00	11.00
7	7.00	10.00
8	3.00	4.00
9	2.00	3.00
10	5.00	6.00
11		
12		



Dependent or Paired t-Test: Options

The screenshot shows the SPSS Data Editor window titled "Sample Depend t-test - SPSS Data Editor". The main window displays a data table with columns "Pre" and "Post" and rows 1 through 12. The "Paired-Samples T Test" dialog box is open, showing "Pre" and "Post" as the paired variables. The "Paired-Samples T Test: Options" sub-dialog is also open, showing a confidence interval of 95% and the option "Exclude cases analysis by analysis" selected.

	Pre	Post
1	2.00	3.00
2	5.00	5.00
3	4.00	6.00
4	4.00	5.00
5	7.00	9.00
6	8.00	11.00
7	7.00	10.00
8	3.00	4.00
9	2.00	3.00
10	5.00	6.00
11		
12		

Paired-Samples T Test

Paired Variables:
Pre -- Post

Paired-Samples T Test: Options

Confidence Interval: 95 %

Missing Values

- Exclude cases analysis by analysis
- Exclude cases listwise

Buttons: OK, Paste, Reset, Cancel, Help, Options...



Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Pre	4.7000	10	2.11082	.66750
	Post	6.2000	10	2.85968	.90431

Dependent or Paired t-Test:
Output

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	Pre & Post	10	.968	.000

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Pre - Post	-1.50000	.97183	.30732	-2.19520	-.80480	-4.881	9	.001

Is there a difference between pre & post?

$$t(9) = -4.881, p = .001$$

Yes, 4.7 is significantly different from 6.2

