

Introduction to the Within-Subjects T-test

All the following names might be used interchangeably with Within-Subjects: Matched-Samples, Paired-Samples, and Dependent-Samples. The point is that each participant completes both conditions, so you are comparing data *within* a participant. This is a sensitive test because it reduces error -- each participant serves as his/her own control.

NOTE: \bar{X}_D is the same as \bar{D} in Howell (Ch. 13); both represent the *mean of the difference scores*.

(1) In-Class Data: 9am

Participant	Interference	Control	D	$\bar{X}_D - D$	$(\bar{X}_D - D)^2$
1	51	56	-5	8.8	77.44
2	36	25	11	-7.2	51.84
3	28	21	7	-3.2	10.24
4	54	39	15	-11.2	125.44
5	52	66	-14	17.8	316.84
6	45	26	19	-15.2	231.04
7	25	21	4	-0.2	0.04
8	25	20	5	-1.2	1.44
9	52	16	36	-32.2	1036.84
10	41	48	-7	10.8	116.64
11	36	43	-7	10.8	116.64
12	21	21	0	3.8	14.44
13	43	47	-4	7.8	60.84
14	26	35	-9	12.8	163.84
15	26	24	2	1.8	3.24
16	32	27	5	-1.2	1.44
17	45	33	12	-8.2	67.24
18	23	25	-2	5.8	33.64

Mean of Diff: $\bar{X}_D=3.8$

SS = 2429.12

(2) Hypotheses

<u>One-tailed:</u> $H_0: \mu_D \leq 0$ $H_1: \mu_D > 0$	<u>Two-tailed:</u> $H_0: \mu_D = 0$ $H_1: \mu_D \neq 0$
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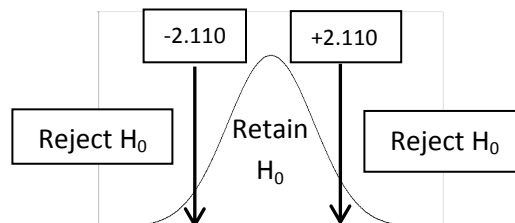
(3) Get T-critical Value & Define the Rejection Region

$$\alpha = .05$$

$$d.f. = N - 1 \quad 18 - 1 = 17$$

Two-tailed t-critical value: 2.110

One-tailed t-critical value: 1.740



(4) Calculate

(a) $S = \sqrt{\frac{SS}{N-1}}$

$$S = \sqrt{\frac{2429.12}{18-1}} = 11.954$$

(b) $SEM = \frac{S}{\sqrt{N}}$

$$SEM = \frac{11.95}{\sqrt{18}} = \frac{11.95}{4.24} = 2.817$$

(c) $t\text{-obtained} = \frac{\bar{x}_D - \mu_D}{SEM}$

$$t\text{-obtained} = \frac{3.8 - 0}{2.82} = +1.34$$

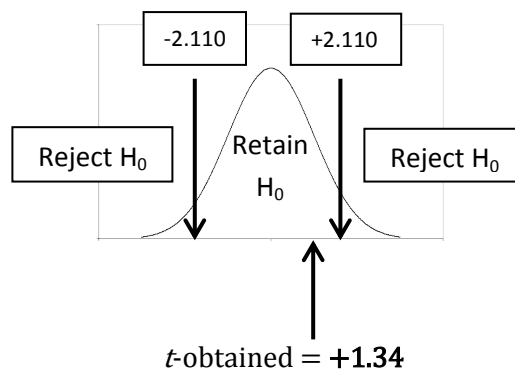
**NOTE: You can do this entire problem in SPSS in 30 seconds.
Place data in 2 columns. Make sure both variables are "Type: NUMERIC".
Analyze → Compare Means → Paired Samples Test**

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	Interference - Control	3.778	11.954	2.817	-2.167	9.722	1.341	17	.198

(5) Conclude

$t\text{-critical} = +/- 2.110$



Decision: Retain the null hypothesis: $H_0: \mu_D = 0$

Conclusion Sentence: There is no significant difference between the experimental (interference condition) and the control condition (upside down condition).

(1) In-Class Data: 3pm

Participant	Interference	Control	D	$\bar{X}_D - D$	$(\bar{X}_D - D)^2$
1	19	19	0	-1.6	2.56
2	35	33	2	0.4	0.16
3	43	34	9	7.4	54.76
4	32	26	6	4.4	19.36
5	38	38	0	-1.6	2.56
6	27	23	4	2.4	5.76
7	27	28	-1	-2.6	6.76
8	24	20	4	2.4	5.76
9	46	38	8	6.4	40.96
10	31	34	-3	-4.6	21.16
11	21	22	-1	-2.6	6.76
12	19	21	-2	-3.6	12.96
13	35	27	8	6.4	40.96
14	24	25	-1	-2.6	6.76
15	33	57	-24	-25.6	655.36
16	57	47	10	8.4	70.56
17	25	25	0	-1.6	2.56
18	48	39	9	7.4	54.76

Mean of Diffs: $\bar{X}_D = 3.8$ SS = 1010.48

(2) Hypotheses

<u>One-tailed:</u> $H_0: \mu_D \leq 0$ $H_1: \mu_D > 0$	<u>Two-tailed:</u> $H_0: \mu_D = 0$ $H_1: \mu_D \neq 0$
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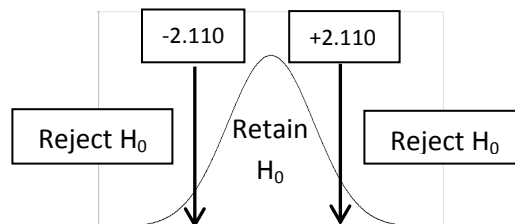
(3) Get T-critical Value & Define the Rejection Region

$\alpha = .05$

$d.f. = N - 1 \quad 18 - 1 = 17$

Two-tailed t-critical value: 2.110

One-tailed t-critical value: 1.740



(4) Calculate

(a) $S = \sqrt{\frac{SS}{N-1}}$

$S = \sqrt{\frac{1010.48}{18-1}} = 7.71$

(b) $SEM = \frac{S}{\sqrt{N}}$

$SEM = \frac{7.71}{\sqrt{18}} = \frac{7.71}{4.24} = 1.817$

(c) $t\text{-obtained} = \frac{\bar{X}_D - \mu_D}{SEM}$

$t\text{-obtained} = \frac{1.66 - 0}{1.86} = +0.856$

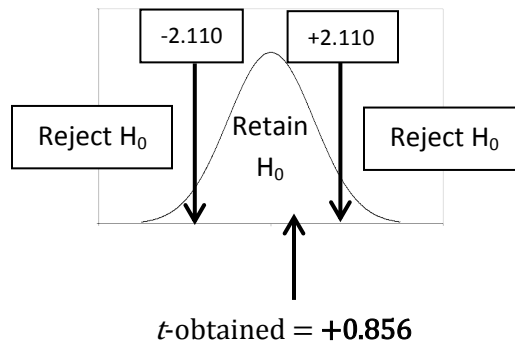
**NOTE: You can do this entire problem in SPSS in 30 seconds.
Place data in 2 columns. Make sure both variables are "Type: NUMERIC".
Analyze → Compare Means → Paired Samples Test:**

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	Interference - Control	1.55556	7.70960	1.81717	-2.27834	5.38945	.856	17	.404

(5) Conclude

$t\text{-critical} = +/- 2.110$



Decision: Retain the null hypothesis: $H_0: \mu_D = 0$

Conclusion Sentence: There is no significant difference between the experimental (interference condition) and the control condition (upside down condition).