T-TEST FOR INDEPENDENT SAMPLES

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What is a t-test?

A t-test is a statistical test which focuses on testing hypothesis if there are differences mean of samplers and populations.

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A t-test is used when mean and standard deviation of the whole population are unknown.

Types of t-test

1.One sample t-test

to test the mean of a single group

2.Independent t-test

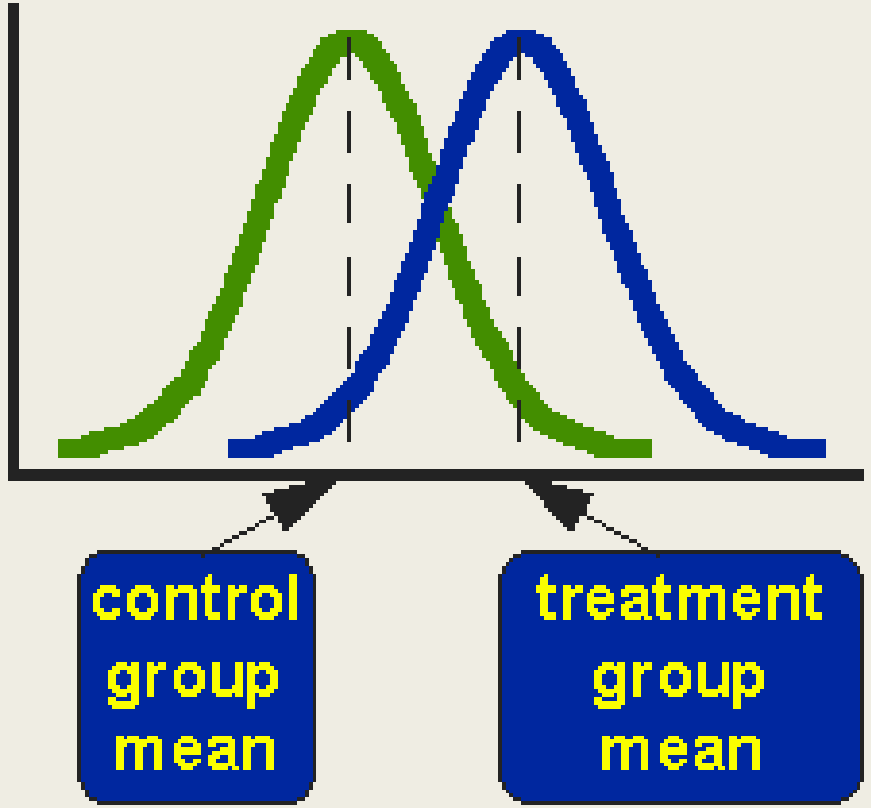
to compare the mean of two groups

3.Paired sample t-test

to compare the mean of the same group at different time

What is an independent t-test?

A t-test assessment is statistically used when we want to compare if the means of two groups are different.



http://www.socialresearchmethods.net/kb/stat_t.php

T-test six assumptions

- 1. Your dependent variables should be measured on interval or ratio scales.
- 2. Your independent variables should contain two definite, independent groups.

  - For example, groups of gender (male or female), behavior of drinking coffee (Yes/No).

- 3. You should make sure that there is no relation between each group.

  - For example, one participant must not be allowed to participate in more than one group of the experiment.

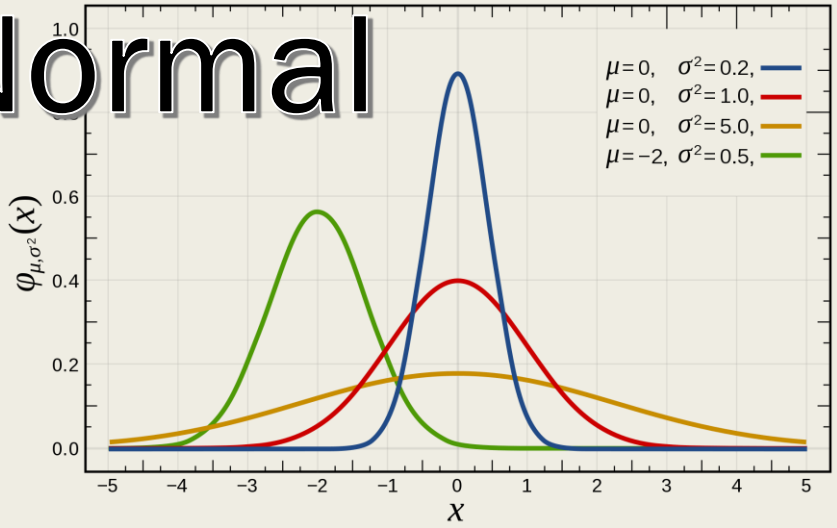
T-test six assumptions

- 4. Significant outliers are prohibited.

  - For example, in a study of IQ scores of 100 participants, the mean score is 110, but there is one participant with 160 IQ which is too strange.

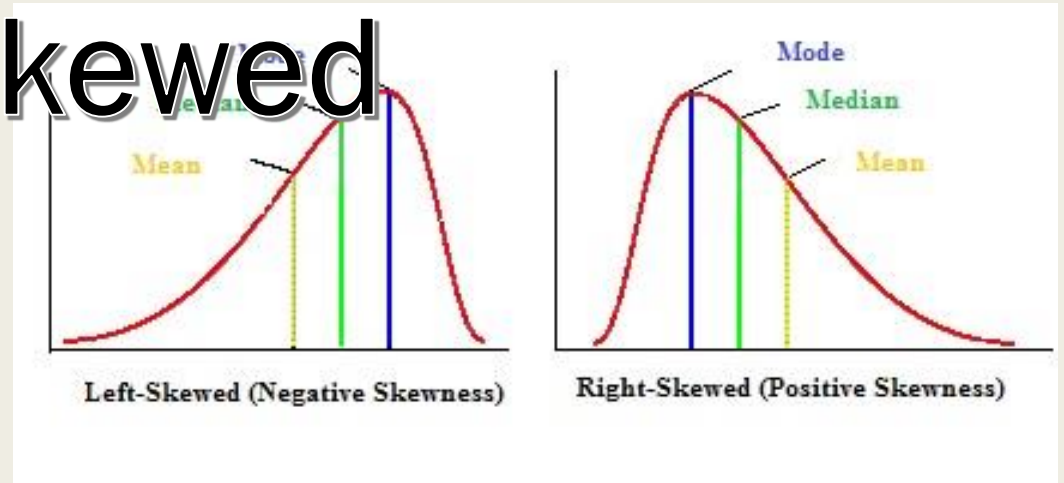
- 5. Your dependent variables should be a normal distribution.

Normal



https://en.wikipedia.org/wiki/Normal_distribution

Skewed

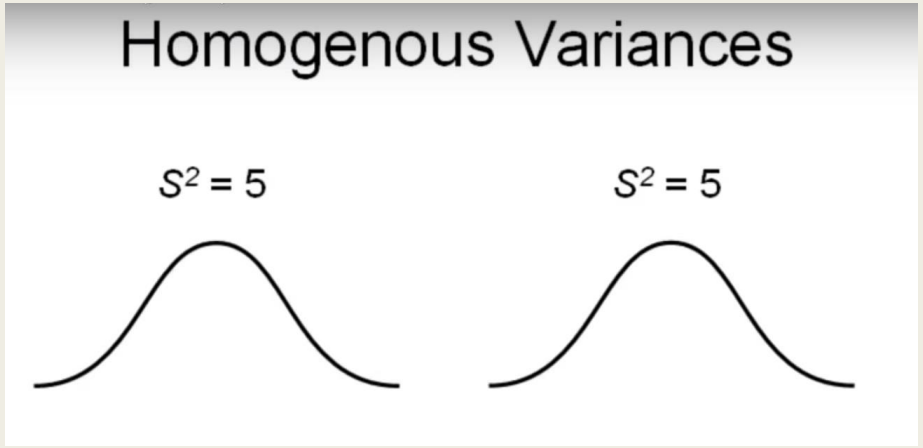


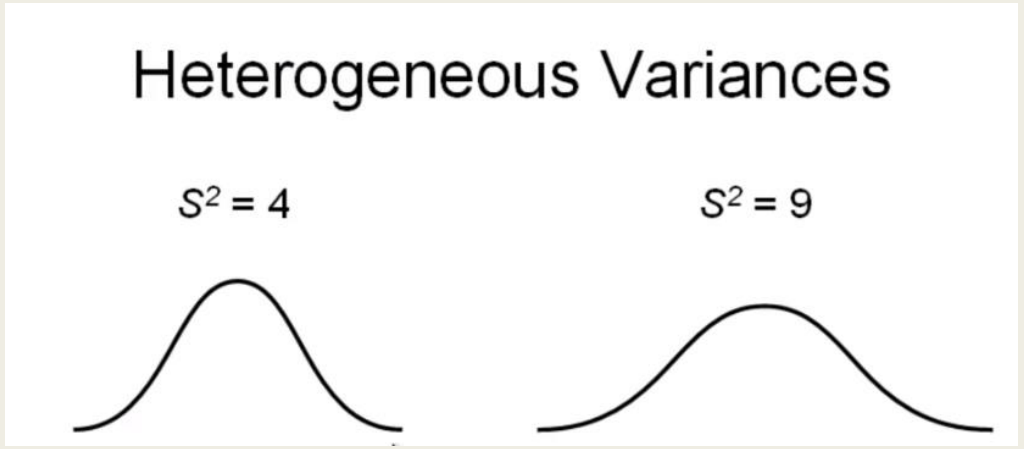
https://www.statisticshowto.datasciencecentral.com/probability-and-statistics/skewed-distribution/

T-test six assumptions

- 6. Homogeneity of variances is needed.

  If variances of two groups are different, it will affect type I error rate.





https://www.youtube.com/watch?v=3BApSAESfxI

Calculating an independent T-test without using SPSS

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We need two t-values: calculated and critical t-value.

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After calculating if the t-value is more than the critical t-value, we will reject the null hypothesis. When the t-value is lower than the critical t-value, we fail to reject the null hypothesis.

How to calculate an independent t-test?

Step 1: Calculate mean and variance from each group.

Step 2: After getting calculated t-value, compare it to the critical t-value from the t-table.

Step 3: Determine if

T-value > Critical value: Reject H0.

T-value < Critical value: Accept H0.

Example

Brody et al. (2004) wanted to see if smokers and non-smokers have equal brain size.

Brain volume data is collected from 17 non-smokers and 19 smokers.

In this case, independent variables are smoker & non-smoker. Dependent variable is brain volume.

Level of measurement: Ratio

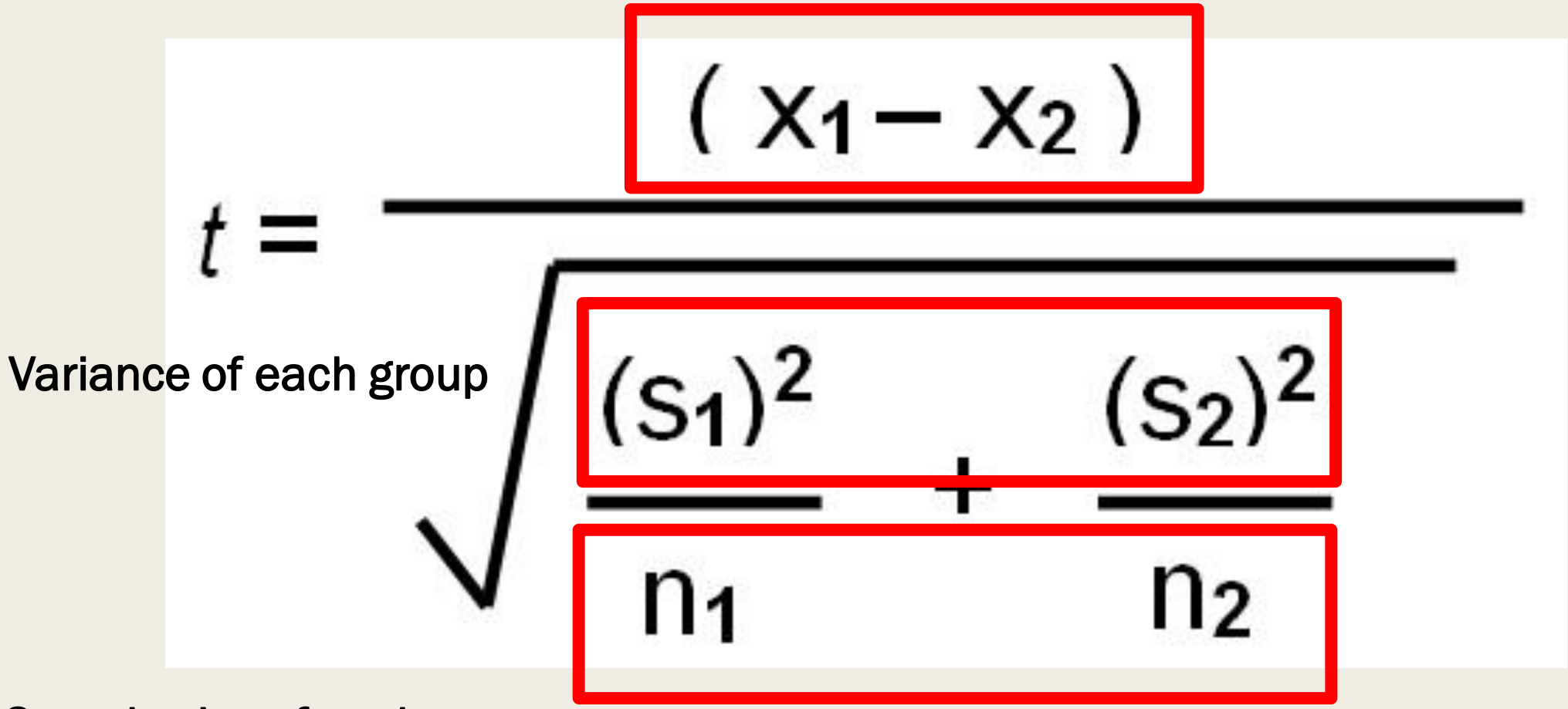
Hypotheses

Null hypothesis (H0): Smokers and non-smokers have equal brain size.

Alternative hypothesis (H1): Smokers and non-smokers have unequal brain size.

T-test formula

Mean of each group



Variance of each group

Sample size of each group

https://www.biologyforlife.com/t-test.html

Step 1.1: Calculate mean and variance from each group

Non-smokers	X – 5.33	(X – 5.33)^2	Smokers	X – 4.29	(X – 4.29)^2
7.3	1.97	3.88	4.2	- 0.09	0.01
6.5	1.17	1.37	4.0	- 0.29	0.08
5.2	- 0.13	0.2	2.6	- 1.69	2.86
6.3	0.97	0.94	4.9	0.61	0.37
4.6	- 0.73	0.53	4.3	0.01	0.00
4.8	- 0.53	0.28	4.8	0.51	0.26
3.8	- 1.53	2.34	2.4	- 1.89	3.57
4.6	- 0.73	0.53	5.5	1.21	1.46
		Sum = 18.04	5.5	1.21	1.46
		S^2 = 1.13	3.7	- 0.59	0.35
Mean = 5.33			Mean = 4.29	Sum = 16.13	S^2 = 0.90

$$S^2 = \frac{\sum (x - \overline{x})^2}{n - 1}$$

https://www.tutorialexample.com/what-is-sample-variance-and-how-to-compute-it-in-numpy-numpy-tutorial/

Step 1.2: Calculate t-value

- Mean of non-smokers' brain volume = 5.33
- Mean of smokers' brain volume = 4.30
- Variance of non-smokers group = 1.13
- Variance of smokers group = 0.90
- Sample size of non-smokers group = 17
- Sample size of smokers group = 19

$$t = \frac{(x_1 - x_2)}{\sqrt{\frac{(s_1)^2}{n_1} + \frac{(s_2)^2}{n_2}}}$$

https://www.biologyforlife.com/t-test.html

$$t = \frac{5.33 - 4.30}{\sqrt{\frac{1.13}{17} + \frac{.90}{19}}} \qquad t = \frac{1.03}{\sqrt{.066 + .047}} \qquad t = \frac{1.03}{.336} \qquad t = 3.07$$

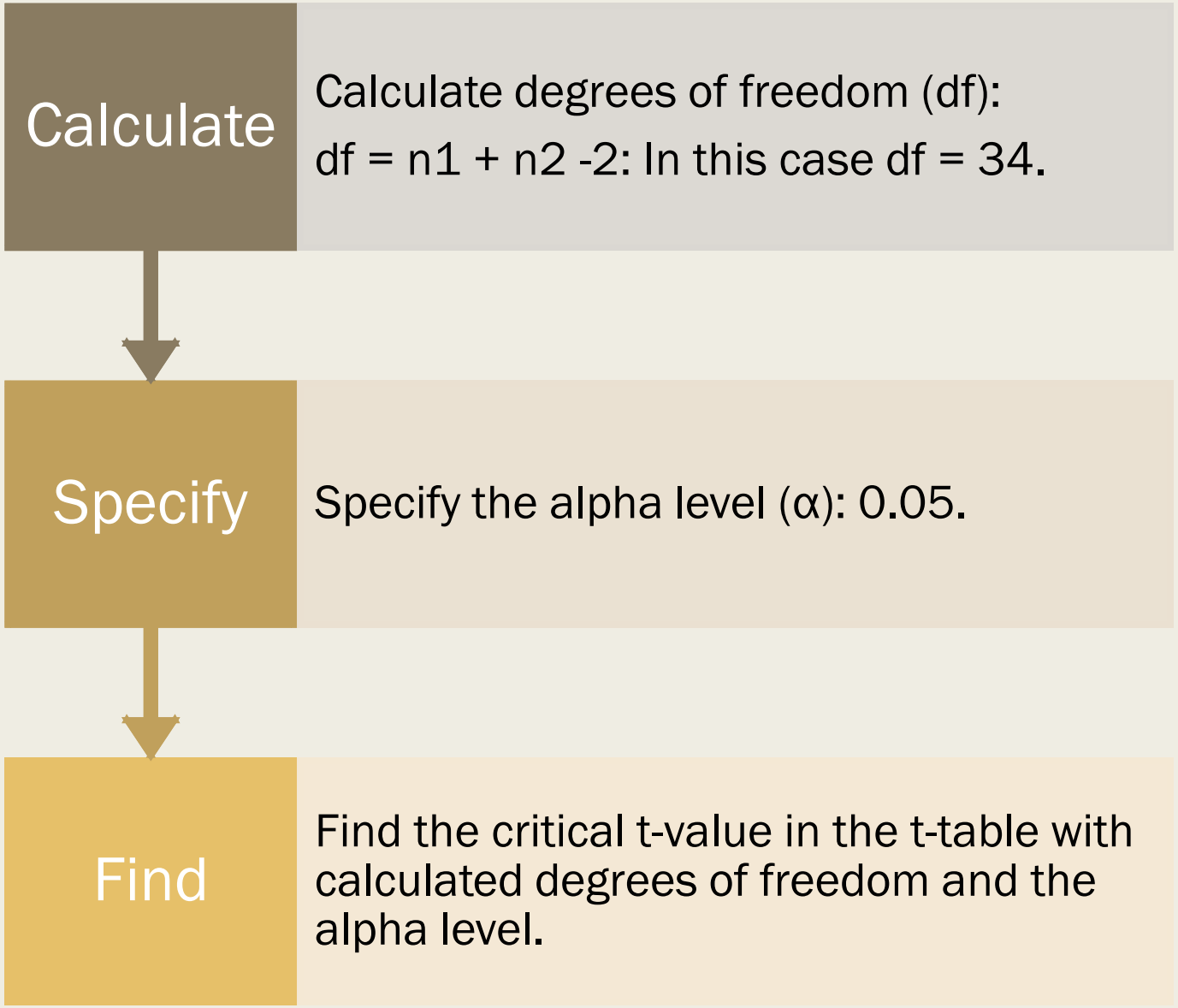
https://www.youtube.com/watch?v=IQgeSeRKkVY

Alphas and a p-value

The alpha level: The probability of rejecting H0 when H0 is true. Normally, we use the alpha level of 0.05.

A p-value: If a p-value is less than an alpha = Reject H0, for example, the p-value = 0.02 and the alpha = 0.05, then we reject the H0.

Step 1.3: Find the critical t-value



http://sites.edtech.haifa.ac.il/stats/00-important-concepts/00-t-table

The t-table

In this case:

df = 34

α = .05

Critical t-value = 1.697

TABLE D *t* distribution critical values

	Upper tail probability *p*											
df	.25	.20	.15	.10	.05	.025	.02	.01	.005	.0025	.001	.0005
1	1.000	1.376	1.963	3.078	6.314	12.71	15.89	31.82	63.66	127.3	318.3	636.6
2	0.816	1.061	1.386	1.886	2.920	4.303	4.849	6.965	9.925	14.09	22.33	31.60
3	0.765	0.978	1.250	1.638	2.353	3.182	3.482	4.541	5.841	7.453	10.21	12.92
4	0.741	0.941	1.190	1.533	2.132	2.776	2.999	3.747	4.604	5.598	7.173	8.610
5	0.727	0.920	1.156	1.476	2.015	2.571	2.757	3.365	4.032	4.773	5.893	6.869
6	0.718	0.906	1.134	1.440	1.943	2.447	2.612	3.143	3.707	4.317	5.208	5.959
7	0.711	0.896	1.119	1.415	1.895	2.365	2.517	2.998	3.499	4.029	4.785	5.408
8	0.706	0.889	1.108	1.397	1.860	2.306	2.449	2.896	3.355	3.833	4.501	5.041
9	0.703	0.883	1.100	1.383	1.833	2.262	2.398	2.821	3.250	3.690	4.297	4.781
10	0.700	0.879	1.093	1.372	1.812	2.228	2.359	2.764	3.169	3.581	4.144	4.587
11	0.697	0.876	1.088	1.363	1.796	2.201	2.328	2.718	3.106	3.497	4.025	4.437
12	0.695	0.873	1.083	1.356	1.782	2.179	2.303	2.681	3.055	3.428	3.930	4.318
13	0.694	0.870	1.079	1.350	1.771	2.160	2.282	2.650	3.012	3.372	3.852	4.221
14	0.692	0.868	1.076	1.345	1.761	2.145	2.264	2.624	2.977	3.326	3.787	4.140
15	0.691	0.866	1.074	1.341	1.753	2.131	2.249	2.602	2.947	3.286	3.733	4.073
16	0.690	0.865	1.071	1.337	1.746	2.120	2.235	2.583	2.921	3.252	3.686	4.015
17	0.689	0.863	1.069	1.333	1.740	2.110	2.224	2.567	2.898	3.222	3.646	3.965
18	0.688	0.862	1.067	1.330	1.734	2.101	2.214	2.552	2.878	3.197	3.611	3.922
19	0.688	0.861	1.066	1.328	1.729	2.093	2.205	2.539	2.861	3.174	3.579	3.883
20	0.687	0.860	1.064	1.325	1.725	2.086	2.197	2.528	2.845	3.153	3.552	3.850
21	0.686	0.859	1.063	1.323	1.721	2.080	2.189	2.518	2.831	3.135	3.527	3.819
22	0.686	0.858	1.061	1.321	1.717	2.074	2.183	2.508	2.819	3.119	3.505	3.792
23	0.685	0.858	1.060	1.319	1.714	2.069	2.177	2.500	2.807	3.104	3.485	3.768
24	0.685	0.857	1.059	1.318	1.711	2.064	2.172	2.492	2.797	3.091	3.467	3.745
25	0.684	0.856	1.058	1.316	1.708	2.060	2.167	2.485	2.787	3.078	3.450	3.725
26	0.684	0.856	1.058	1.315	1.706	2.056	2.162	2.479	2.779	3.067	3.435	3.707
27	0.684	0.855	1.057	1.314	1.703	2.052	2.158	2.473	2.771	3.057	3.421	3.690
28	0.683	0.855	1.056	1.313	1.701	2.048	2.154	2.467	2.763	3.047	3.408	3.674
29	0.683	0.854	1.055	1.311	1.699	2.045	2.150	2.462	2.756	3.038	3.396	3.659
30	0.683	0.854	1.055	1.310	1.697	2.042	2.147	2.457	2.750	3.030	3.385	3.646
40	0.681	0.851	1.050	1.303	1.684	2.021	2.123	2.423	2.704	2.971	3.307	3.551
50	0.679	0.849	1.047	1.299	1.676	2.009	2.109	2.403	2.678	2.937	3.261	3.496
60	0.679	0.848	1.045	1.296	1.671	2.000	2.099	2.390	2.660	2.915	3.232	3.460
80	0.678	0.846	1.043	1.292	1.664	1.990	2.088	2.374	2.639	2.887	3.195	3.416
100	0.677	0.845	1.042	1.290	1.660	1.984	2.081	2.364	2.626	2.871	3.174	3.390
000	0.675	0.842	1.037	1.282	1.646	1.962	2.056	2.330	2.581	2.813	3.098	3.300
z^*	0.674	0.841	1.036	1.282	1.645	1.960	2.054	2.326	2.576	2.807	3.091	3.291
	50%	60%	70%	80%	90%	95%	96%	98%	99%	99.5%	99.8%	99.9%
	Confidence level *C*											

Step 2 & 3: Compare t-value with critical t-value

In this case, calculated t-value > critical t-value.

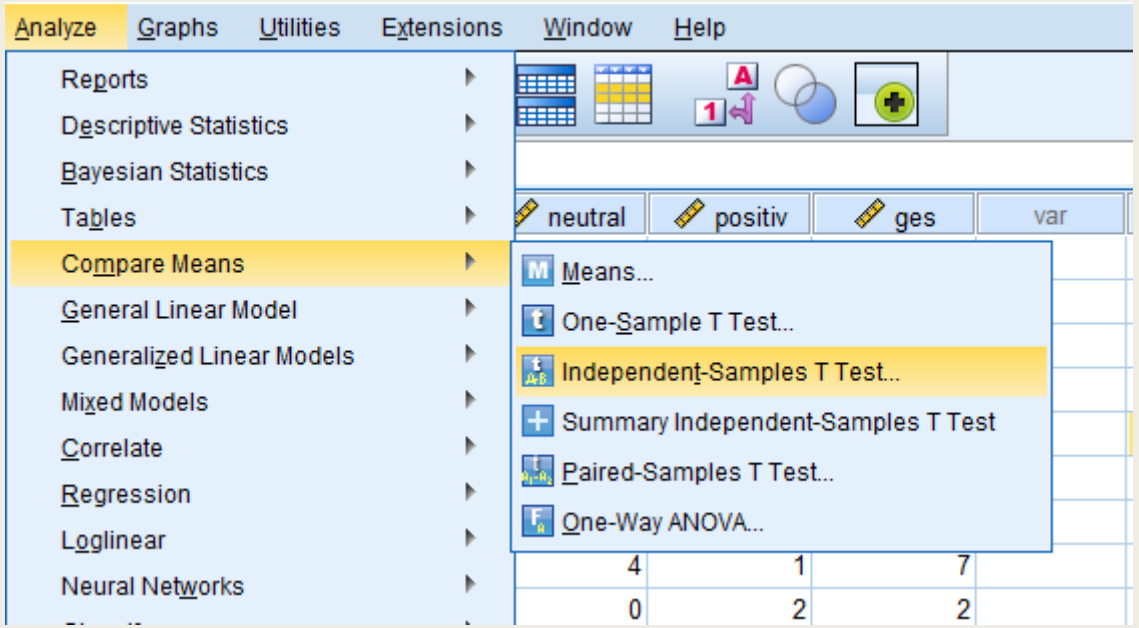
Calculated t-value = 3.07

Critical t-value = 1.697

We reject null hypothesis (H0) and accept alternative hypothesis (H1) : Non-smokers and smokers have unequal brain size $t = 3.07$ $p < .05$.

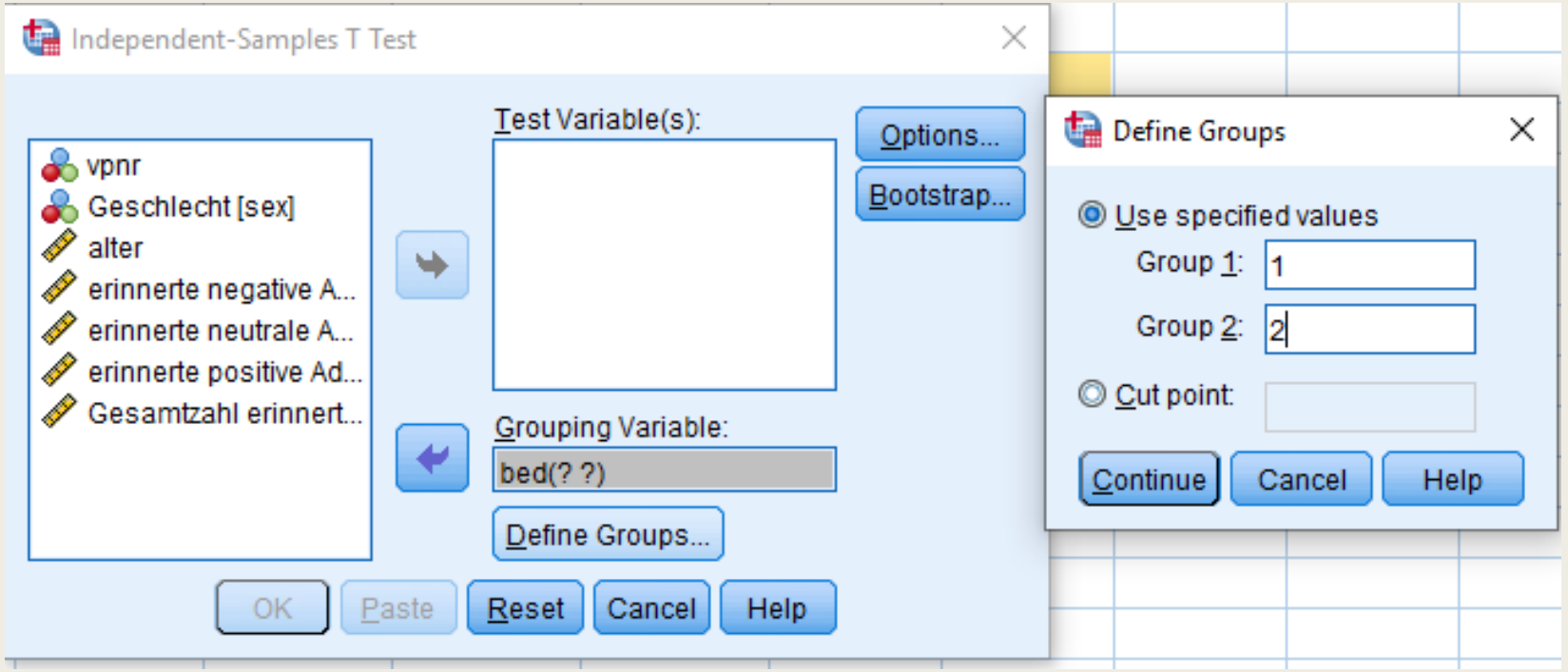
Calculating a t-test with SPSS

- Step 1: Choose Analyze on the menu bar -> Compare Means -> Independent Samples t-test.



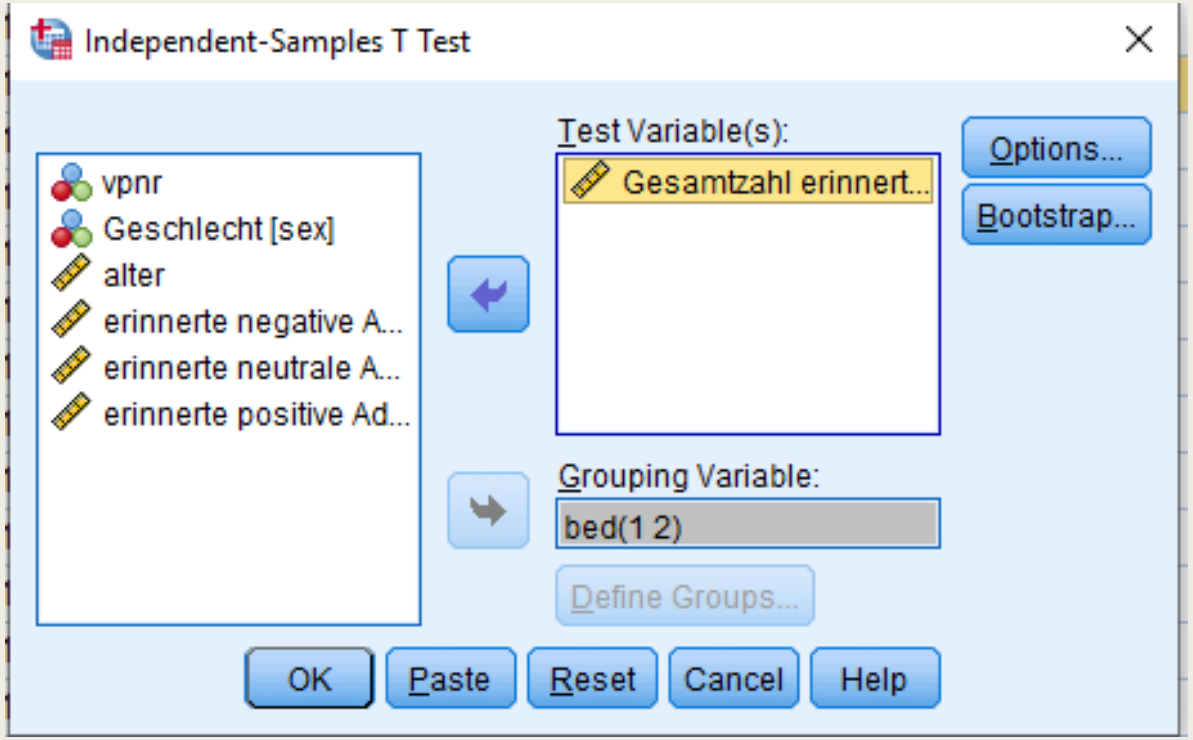
Calculating a t-test with SPSS

- Step 2: Choose your independent variable to be in the label “Grouping variable”. Then, click define groups. Type the number that code to each group.



Calculating a t-test with SPSS

- Step 3: Choose your dependent variable to be in the label “Test variable(s)”.



Interpreting a t-test data from SPSS

T-Test

Group Statistics

	Verarbeitungsbedingung	N	Mean	Std. Deviation	Std. Error Mean
Gesamtzahl erinnerter Adjektive	strukturell	50	7.20	3.162	.447
	bildhaft	50	11.00	4.140	.586

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means				
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
Gesamtzahl erinnerter Adjektive	Equal variances assumed	3.764	.055	-5.158	98	.000	-3.800	.737
	Equal variances not assumed			-5.158	91.653	.000	-3.800	.737

Levene's test for equality of variances

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F (A)	Sig. (A)	t (B)	df (B)	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower (C)	Upper (C)
Mile time	Equal variances assumed	102.98	.000	13.475	390	.000	0:02:14	0:00:10	0:01:55	0:02:34
	Equal variances not assumed			15.047	315.846	.000	0:02:14	0:00:08	0:01:57	0:02:32

https://libguides.library.kent.edu/SPSS/IndependentTTest

ANY QUESTIONS ?

References

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THANK YOU FOR YOUR KIND ATTENTION