# Empirical Research Methods

## t-test for independent samples

## (Or: What does beer have to do with statistics?)

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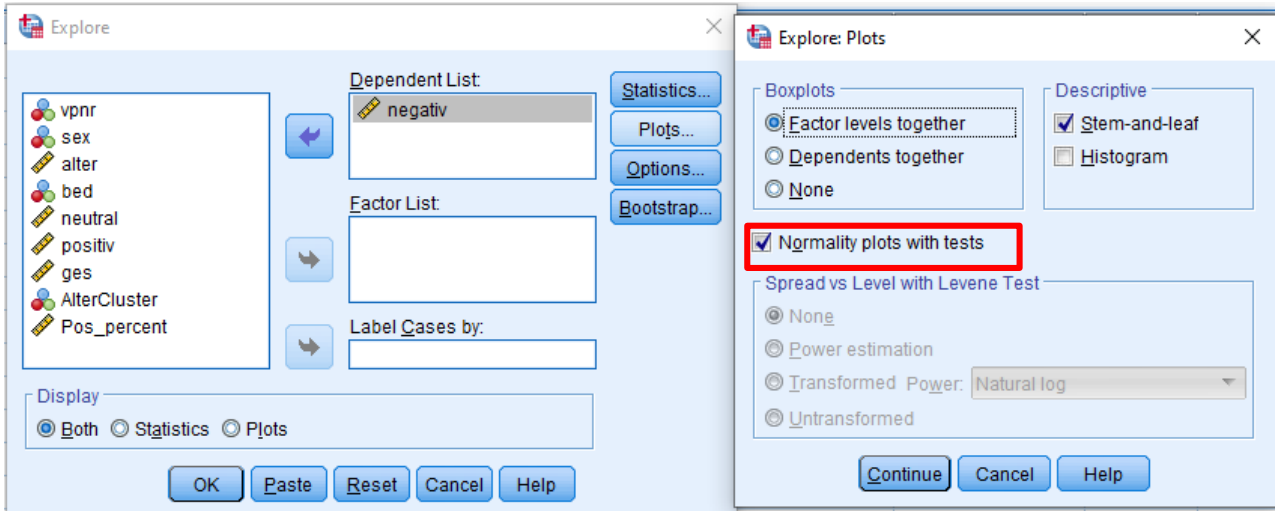
# From last week…

## Determining normal distribution in SPSS

- Analyze > Descriptive Statistics > Explore > Plots

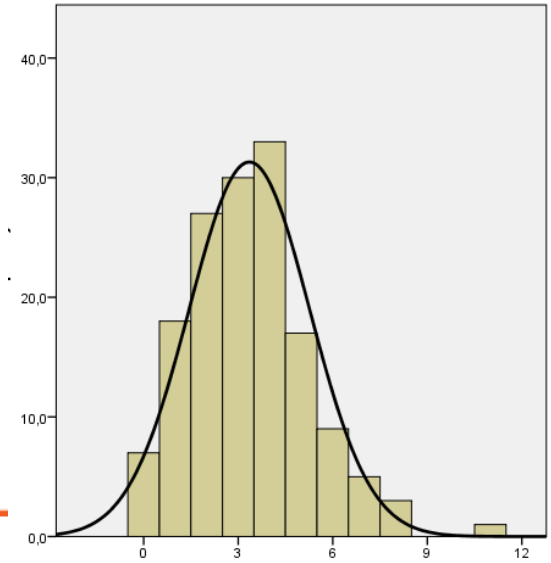


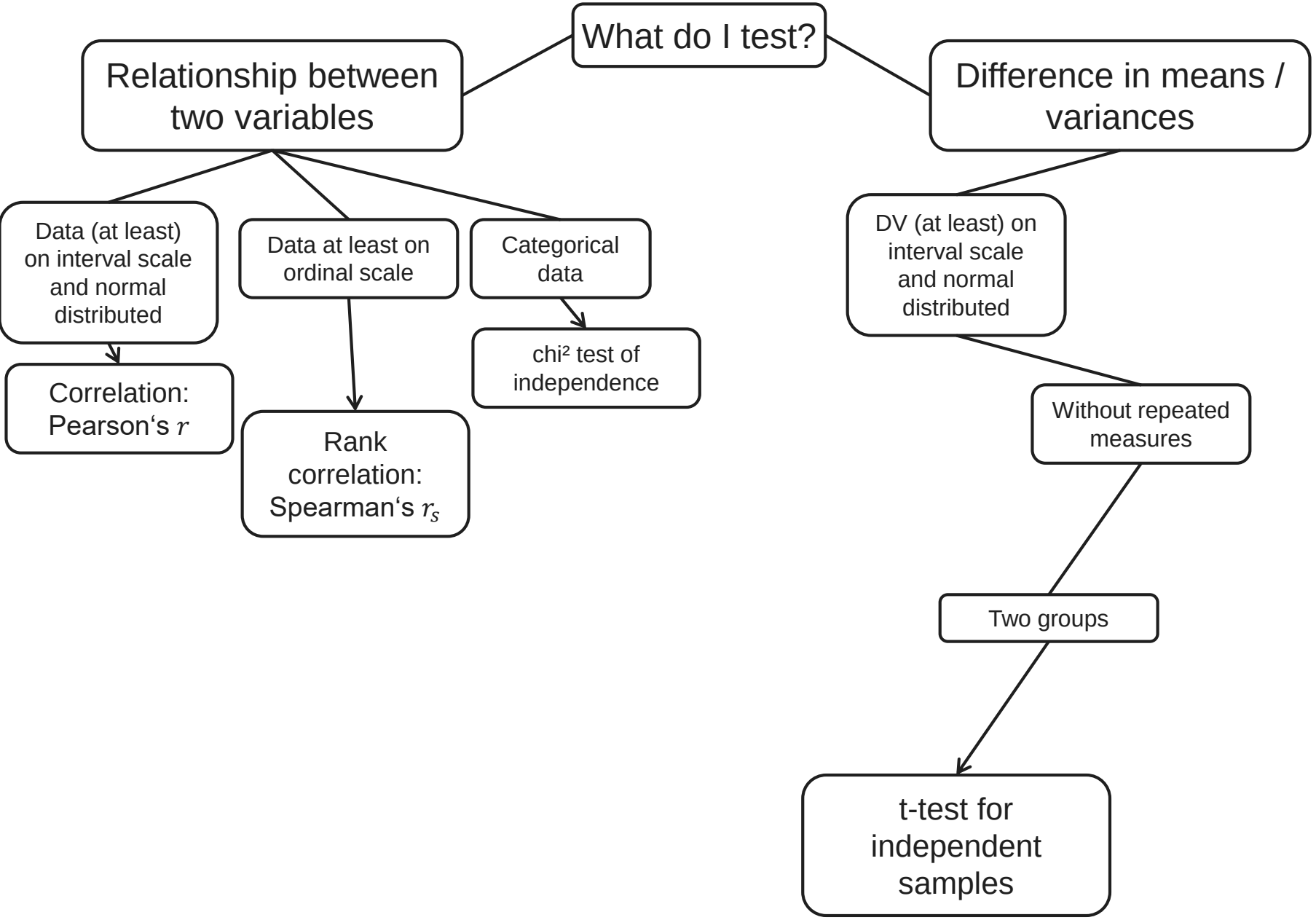

**Tests of Normality**

| | Kolmogorov-Smirnov[a] | | | Shapiro-Wilk | | |
|---|---|---|---|---|---|---|
| | Statistic | df | Sig. | Statistic | df | Sig. |
| negativ | ,134 | 150 | ,000 | ,951 | 150 | ,000 |

a. Lilliefors Significance Correction

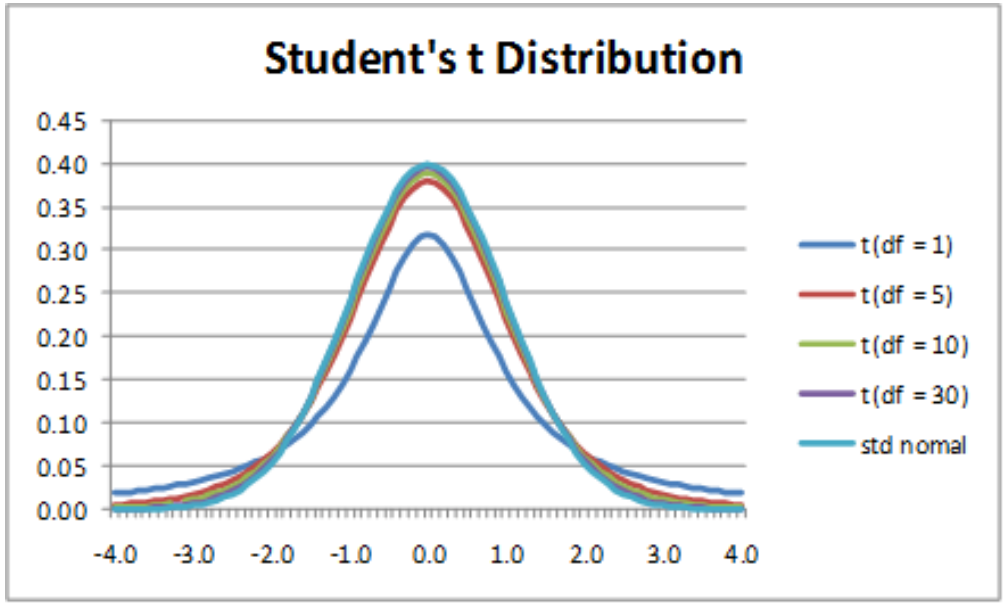
(Graphs > Chart Builder > Histogram)




What do I test?
Relationship between two variables
Difference in means / variances
Data (at least) on interval scale and normal distributed
Data at least on ordinal scale
Categorical data
DV (at least) on interval scale and normal distributed
Correlation: Pearson‘s $r$
Rank correlation: Spearman‘s $r_s$
chi² test of independence
Without repeated measures
Two groups
t-test for independent samples

# Degrees of Freedom and the t distribution

- df = degrees of freedom
  - How many values can I vary?
- t distribution:
  - Standardized normal distribution, influenced by df



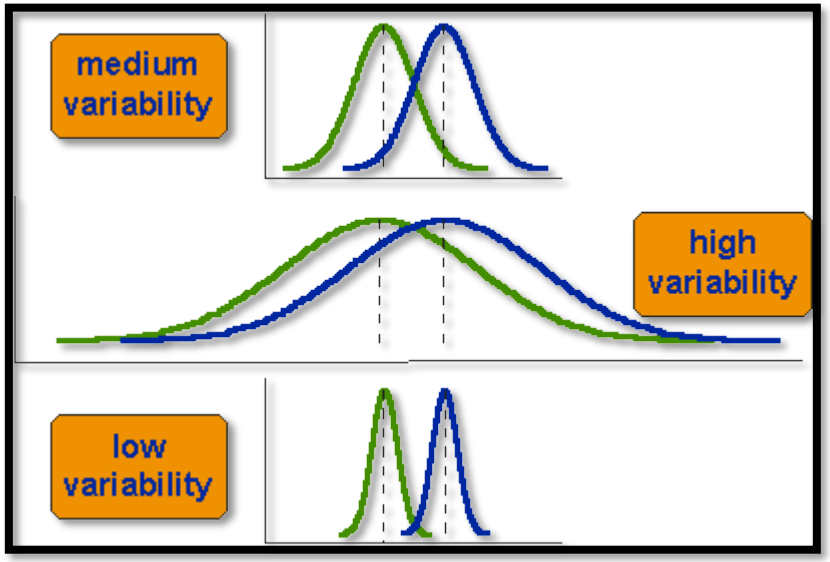

https://i2.wp.com/www.real-statistics.com/wp-content/uploads/2012/11/t-distribution-chart.png

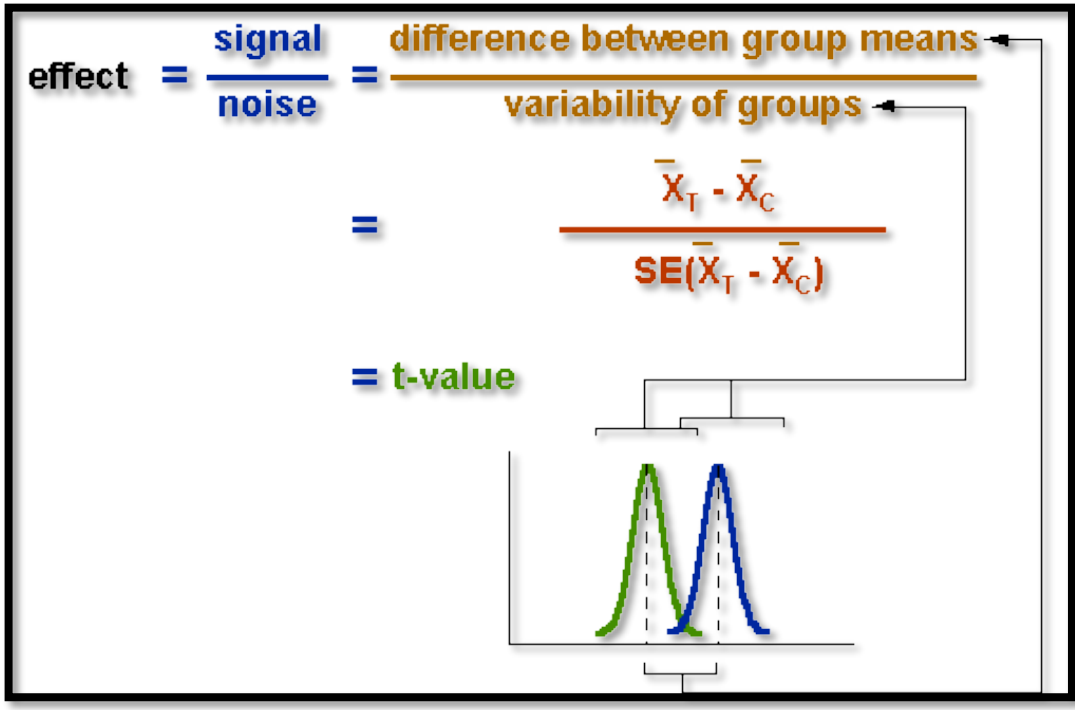
# Student‘s t?


- The t distribution is named after William Gosset who used the pseudonym “Student” for publishing
- Gosset worked for the Guiness brewery and was interested in applying statistics to develop better beers
- The t-test we use nowadays builds on his (and others’) work

# t-value

Calculating a t-value from a data set (t empirical):

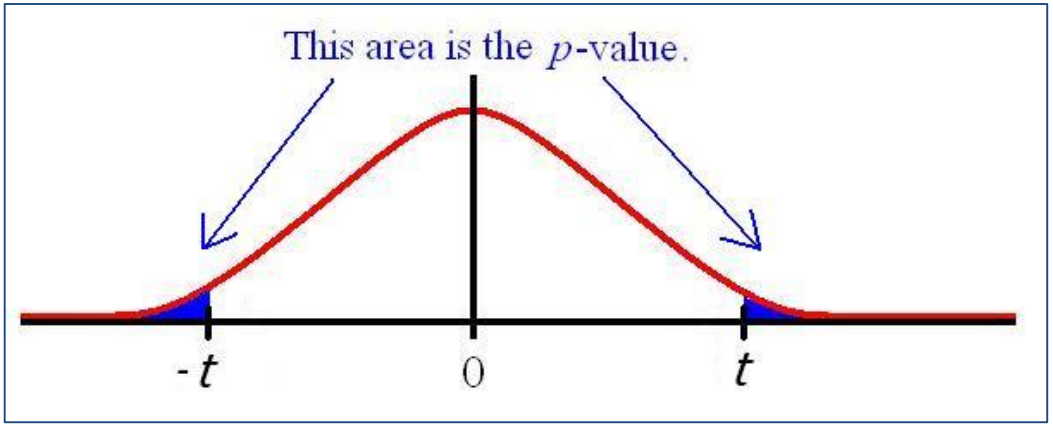



$t_{emp}$ = empirical t-value (result from our calculation); difference of means of our two samples taking into account the variability inside the data set

# t-value

- $t_{crit}$ = critical t-value (depending on α and df)
- If $|t_{emp}| > t_{crit}$, then the t-value is “unlikely enough” and we reject H0



# t-test exercise 1

Find examples for hypotheses that require a t-test

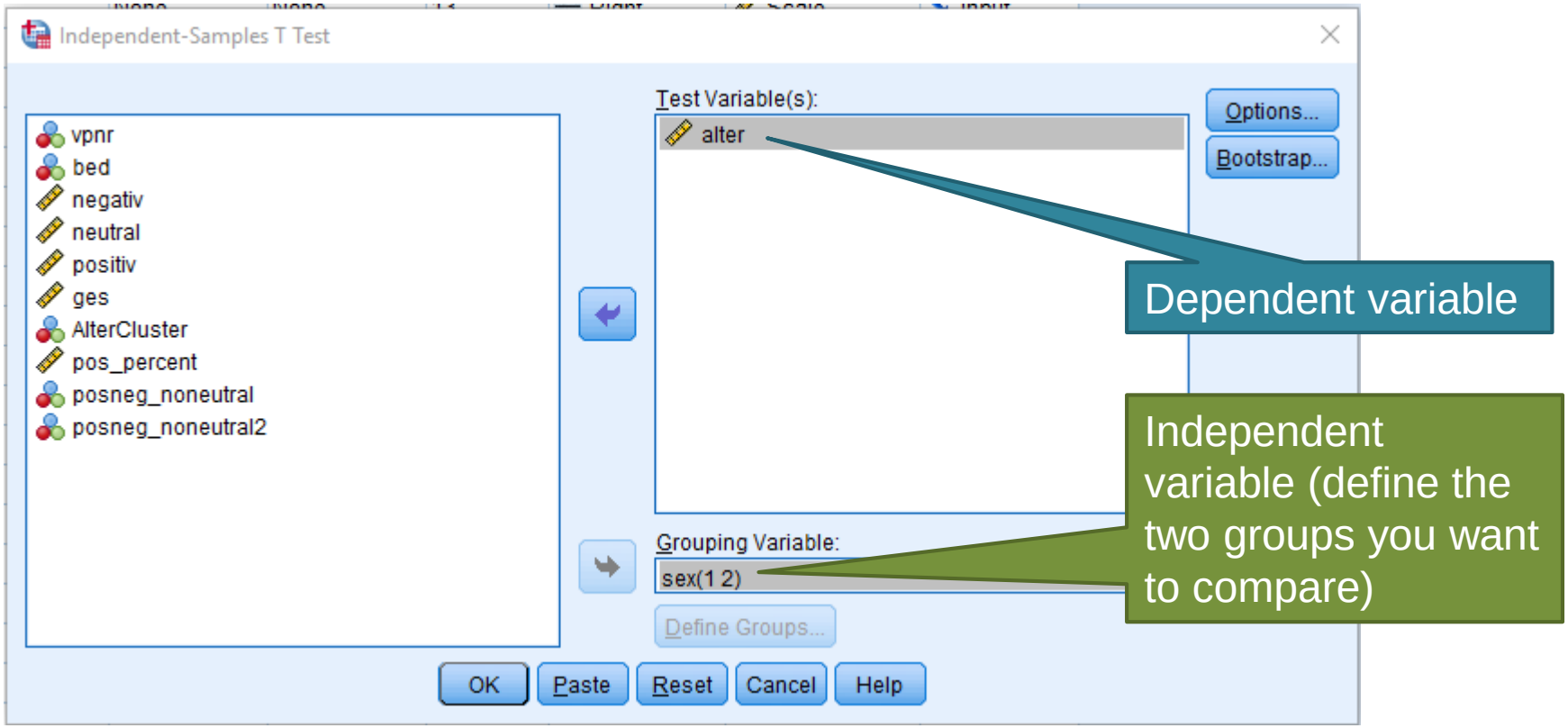
# t-test exercise 2

Using Beispieldatensatz, test the following hypothesis:

There is a difference in age depending on the gender.

# t-test exercise 2

Analyze > Compare means > Independent-samples t test



# t-test exercise 2

DV

IV

**Group Statistics**

| | sex | N | Mean | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|---|
| alter | maennlich | 52 | 22,54 | 2,477 | ,344 |
| | weiblich | 98 | 21,51 | 3,374 | ,341 |

**Independent Samples Test**

| | | Levene's Test for Equality of Variances | | t-test for Equality of Means | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | 95% Confidence Interval of the Difference | |
| | | F | Sig. | t | df | Sig. (2-tailed) | Mean Difference | Std. Error Difference | Lower | Upper |
| alter | Equal variances assumed | ,306 | ,581 | 1,937 | 148 | ,055 | 1,028 | ,531 | -,021 | 2,077 |
| | Equal variances not assumed | | | 2,125 | 133,057 | ,035 | 1,028 | ,484 | ,071 | 1,985 |

Homogeneity of variances is given*

t-value / df / significance (p)

There was no sign. difference regarding age depending on participants‘ sex: $t$ (148) = 1.937, $p$ = .055

*If the Levene test becomes significant, the homogeneity is not given and you need to read the results from the row “equal variances not assumed“

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# t-test exercise 3

Report the results:

**Group Statistics**

| | AlterCluster | N | Mean | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|---|
| pos_percent | up to 19 years | 25 | 34,6838 | 9,23946 | 1,84789 |
| | 20-29 years | 123 | 33,4802 | 16,90847 | 1,52459 |

**Independent Samples Test**

| | | Levene's Test for Equality of Variances | | t-test for Equality of Means | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | 95% Confidence Interval of the Difference | |
| | | F | Sig. | t | df | Sig. (2-tailed) | Mean Difference | Std. Error Difference | Lower | Upper |
| pos_percent | Equal variances assumed | 6,964 | ,009 | ,345 | 146 | ,731 | 1,20362 | 3,48908 | -5,69201 | 8,09924 |
| | Equal variances not assumed | | | ,502 | 62,130 | ,617 | 1,20362 | 2,39563 | -3,58499 | 5,99222 |

There was no sign. difference regarding “pos_percent” depending on participants‘ age cluster: $t$ (62) = .502, $p$ = .617

# t-test exercise 4

Report the results:

**Group Statistics**

| | bed | N | Mean | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|---|
| ges | strukturell | 50 | 7,20 | 3,162 | ,447 |
| | emotional | 50 | 12,02 | 4,206 | ,595 |

**Independent Samples Test**

| | | Levene's Test for Equality of Variances | | t-test for Equality of Means | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | 95% Confidence Interval of the Difference | |
| | | F | Sig. | t | df | Sig. (2-tailed) | Mean Difference | Std. Error Difference | Lower | Upper |
| ges | Equal variances assumed | 4,273 | ,041 | -6,477 | 98 | ,000 | -4,820 | ,744 | -6,297 | -3,343 |
| | Equal variances not assumed | | | -6,477 | 90,979 | ,000 | -4,820 | ,744 | -6,298 | -3,342 |

There was a sign. difference regarding “ges” depending on the experimental condition (strukturell vs. emotional): t (91) = -6.477, p = .000

# t-test exercise 5

Report the results:

**Group Statistics**

| | bed | N | Mean | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|---|
| pos_percent | strukturell | 50 | 36,0633 | 20,33905 | 2,87638 |
| | emotional | 50 | 35,4023 | 12,30672 | 1,74043 |

**Independent Samples Test**

| | | Levene's Test for Equality of Variances | | t-test for Equality of Means | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | 95% Confidence Interval of the Difference | |
| | | F | Sig. | t | df | Sig. (2-tailed) | Mean Difference | Std. Error Difference | Lower | Upper |
| pos_percent | Equal variances assumed | 8,148 | ,005 | ,197 | 98 | ,845 | ,66106 | 3,36194 | -6,01060 | 7,33273 |
| | Equal variances not assumed | | | ,197 | 80,639 | ,845 | ,66106 | 3,36194 | -6,02860 | 7,35073 |

There was no sign. difference regarding “pos_percent” depending on the experimental condition (strukturell vs. emotional): $t$ (81) = .197, $p$ = .845