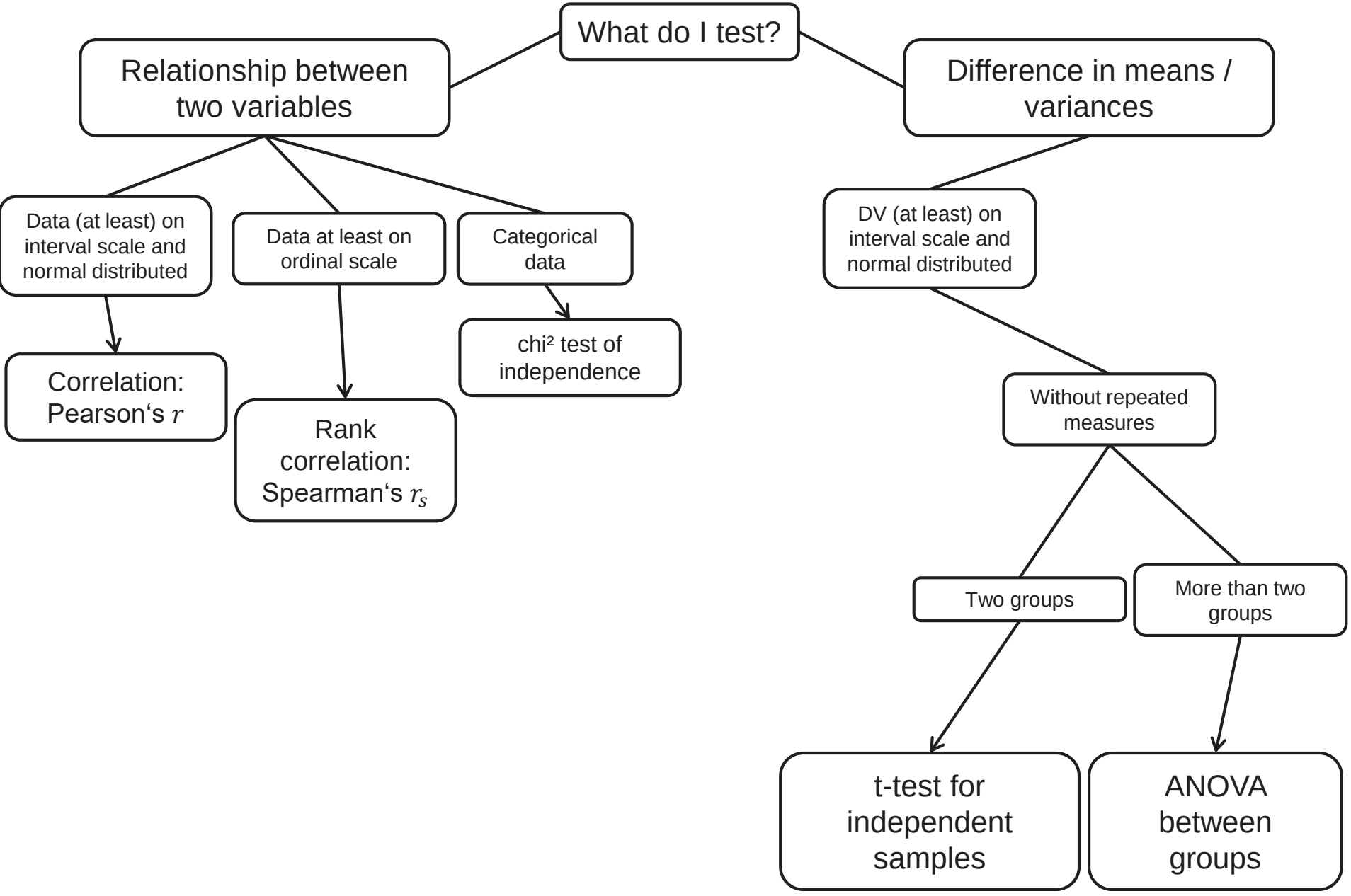
ANOVA between groups

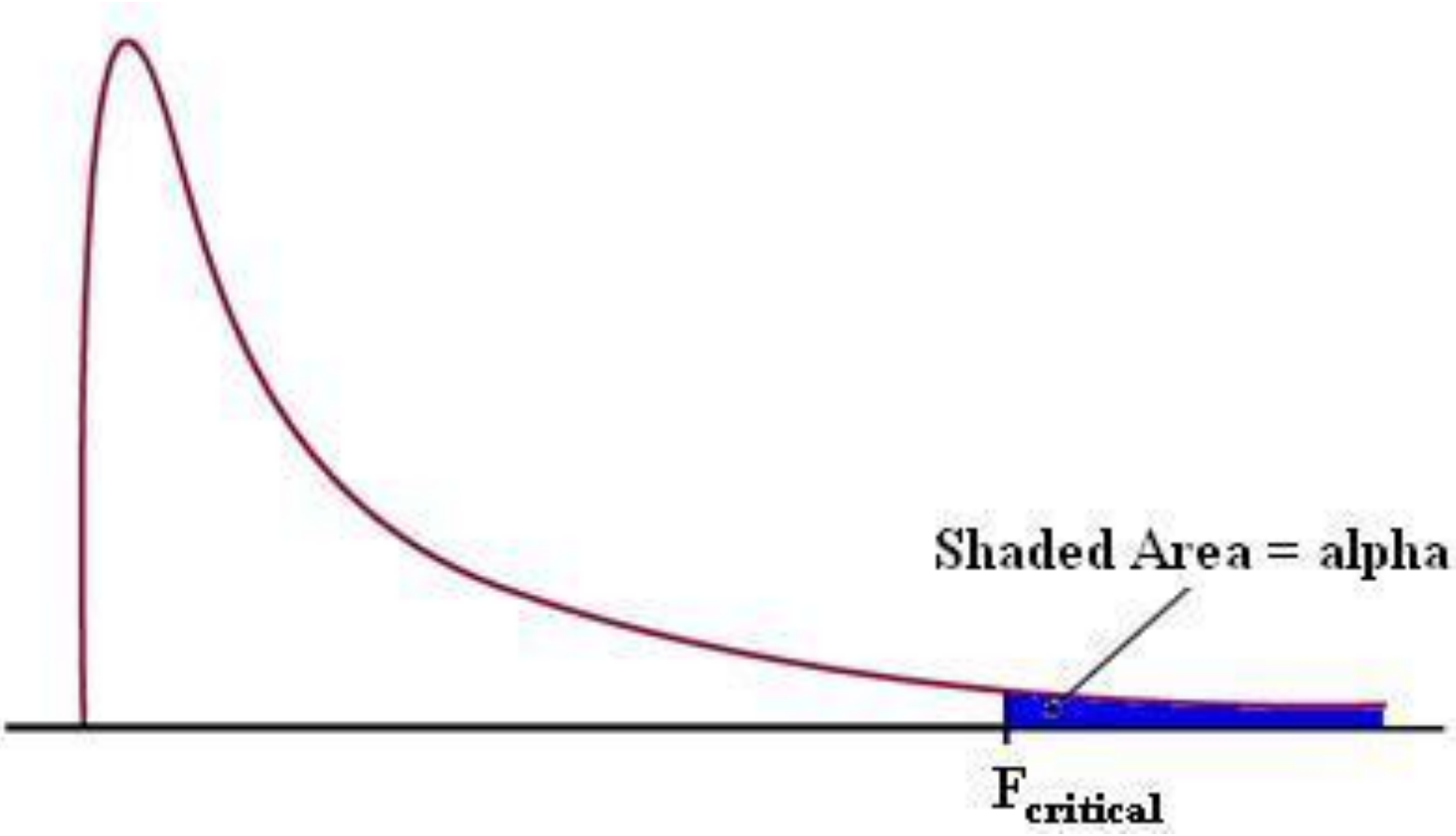
Lara Kataja

Room 1.13

l.kataja@edutech.uni-saarland.de


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
More than two groups
t-test for independent samples
ANOVA between groups

F distribution



http://www.statisticshowto.com/wp-content/uploads/2013/09/f-table.jpg

t-test vs. ANOVA

With two groups: both are applicable, but t-test is more common

Independent Samples Test

		Levene's Test for Equality of Variances				
		F	Sig.	t	df	Sig. (2-tailed)
alter	Equal variances assumed	,306	,581	1,937	148	,055
	Equal variances not assumed			2,125	133,057	,035

Tests of Between-Subjects Effects

Dependent Variable: alter

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	35,920[a]	1	35,920	3,751	,055
Intercept	65917,947	1	65917,947	6882,861	,000
sex	35,920	1	35,920	3,751	,055
Error	1417,413	148	9,577		
Total	73176,000	150			
Corrected Total	1453,333	149			

a. R Squared = ,025 (Adjusted R Squared = ,018)

t-test vs. ANOVA

- With more than two groups:
  - Alpha inflation: The probability of making an alpha error is increasing when you calculate many t-tests
  - → ANOVA: efficient procedure to compare several groups, avoids alpha inflation
- With more than one factor:
  - → ANOVA: ability to test multi-factorial designs
    - Main effects
    - Interaction effects

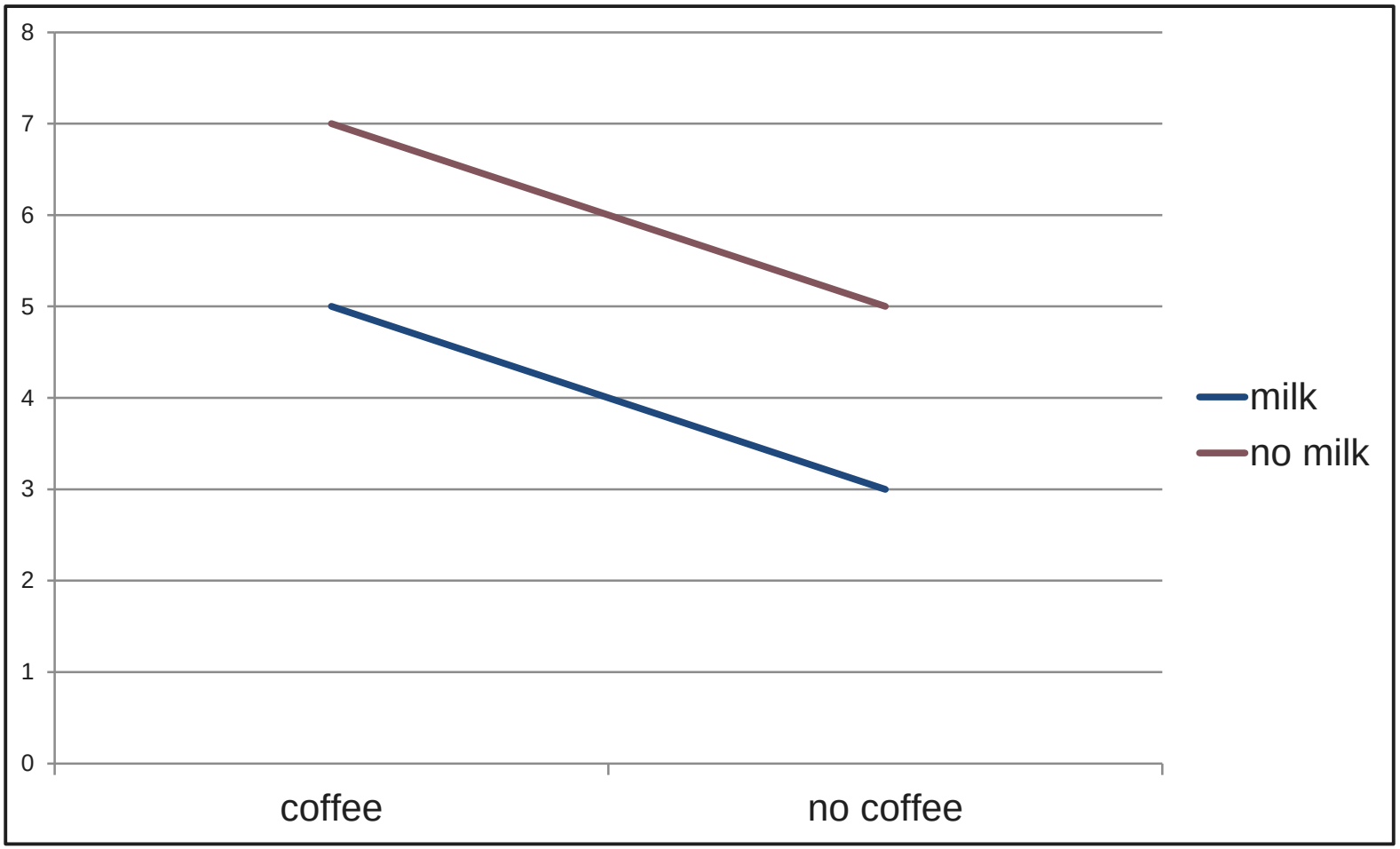
Multi-factorial design

ANOVA calculates:

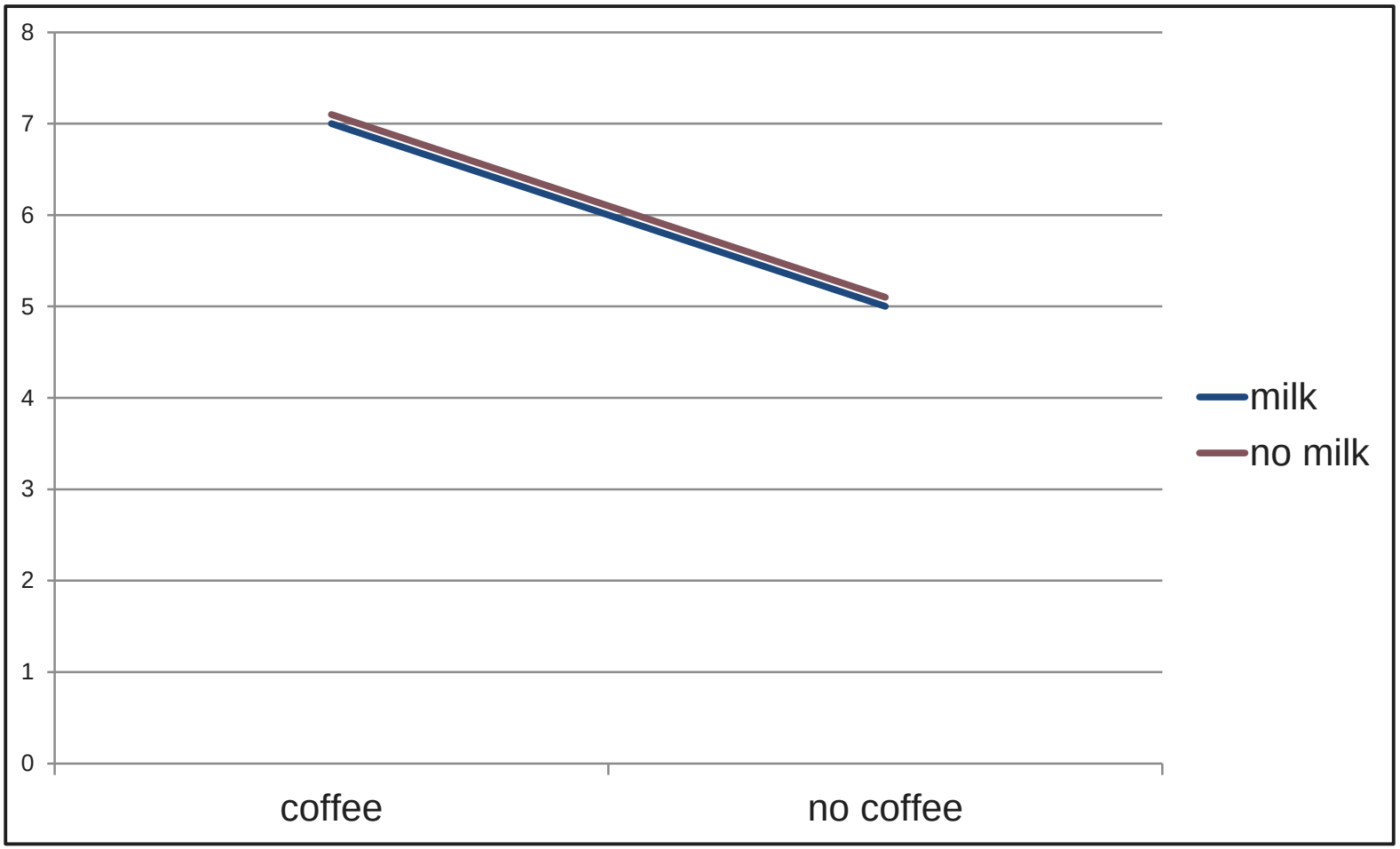
- Main effect for coffee
- Main effect for milk
- Interaction between coffee and milk

http://versuch.file2.wcms.tu-dresden.de/w/images/thumb/9/98/Mehrfaktoriell_Beispiel_Glas.jpg/391px-Mehrfaktoriell_Beispiel_Glas.jpg

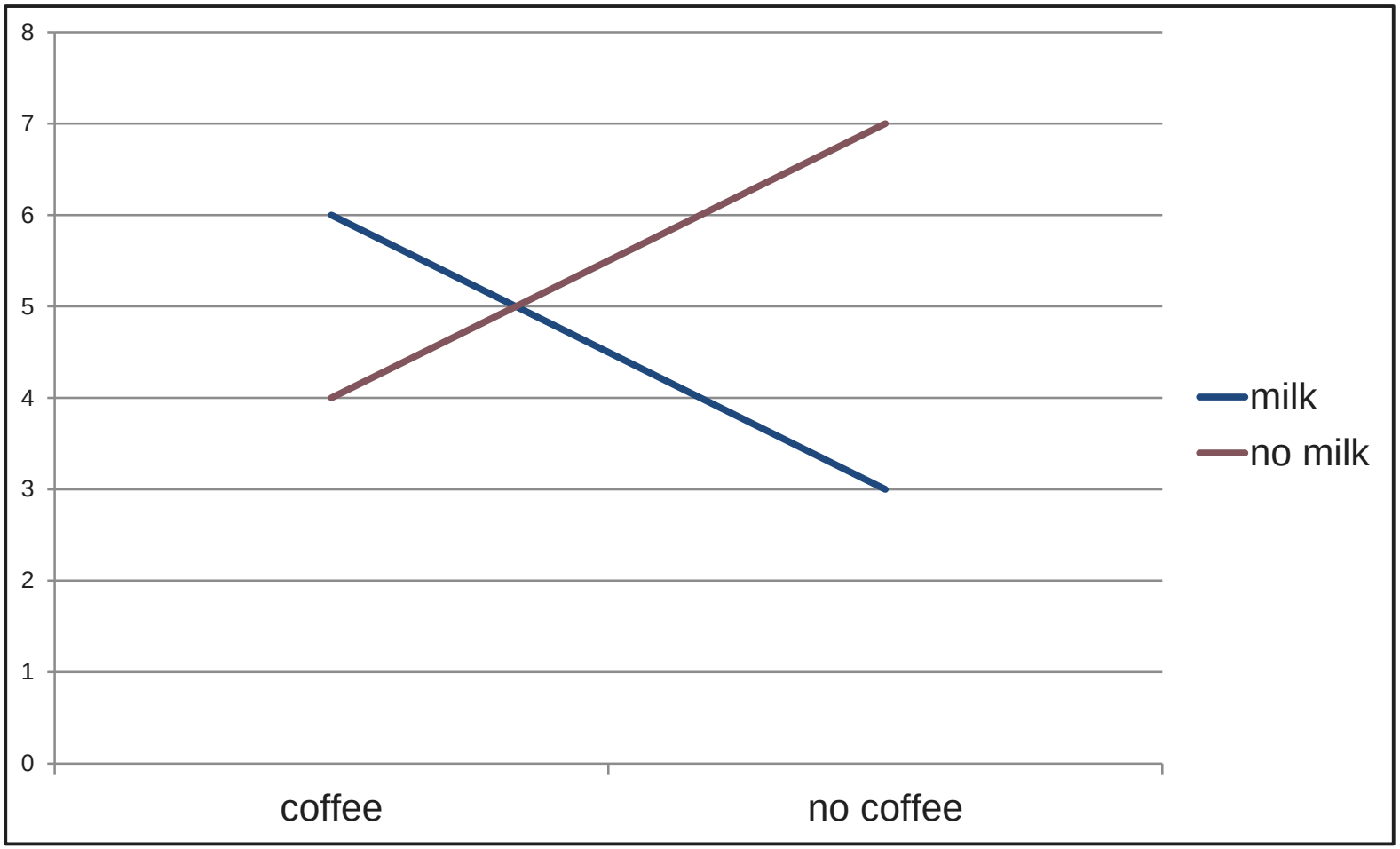
Main effects and interaction in ANOVA



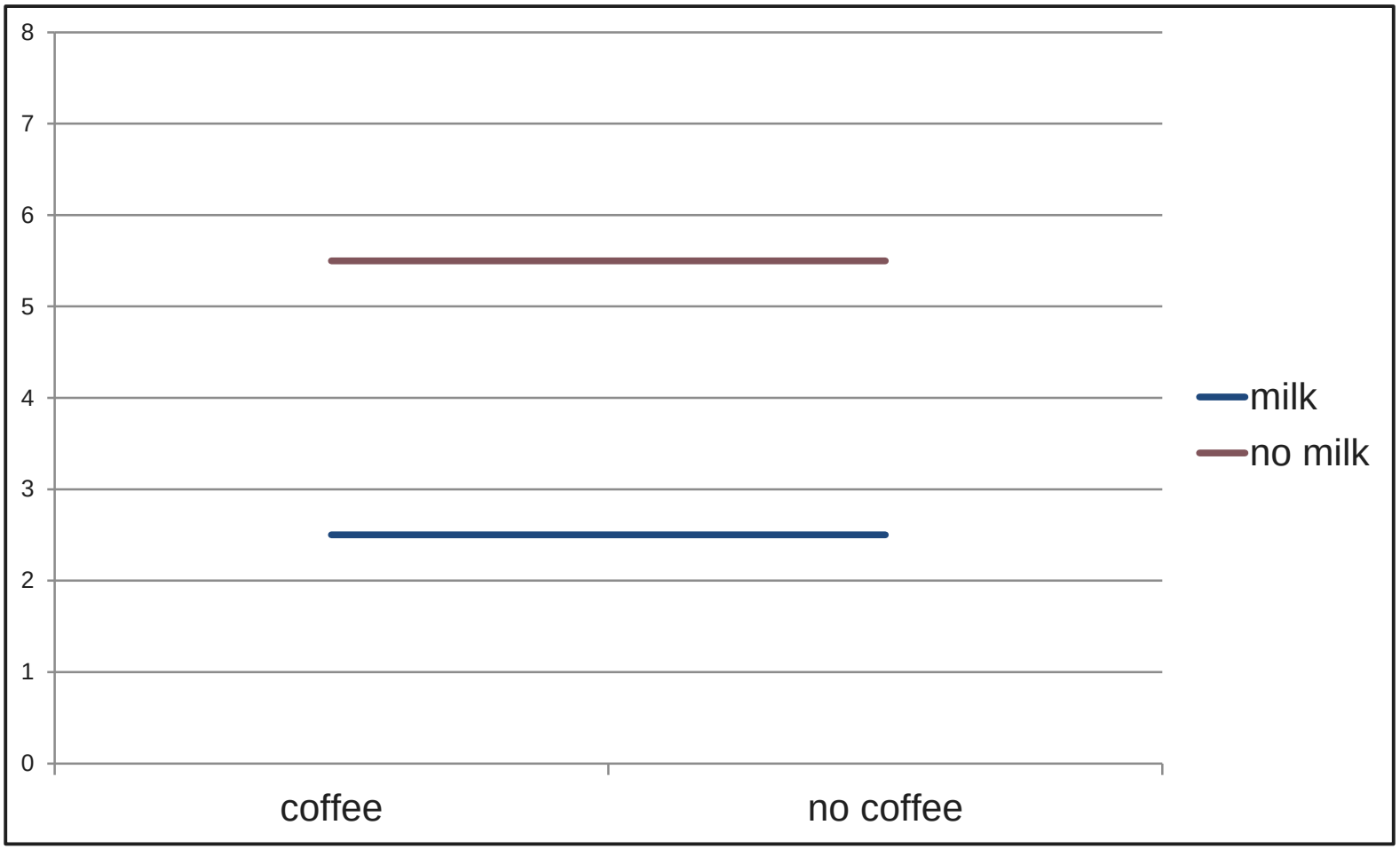
Main effects and interaction in ANOVA



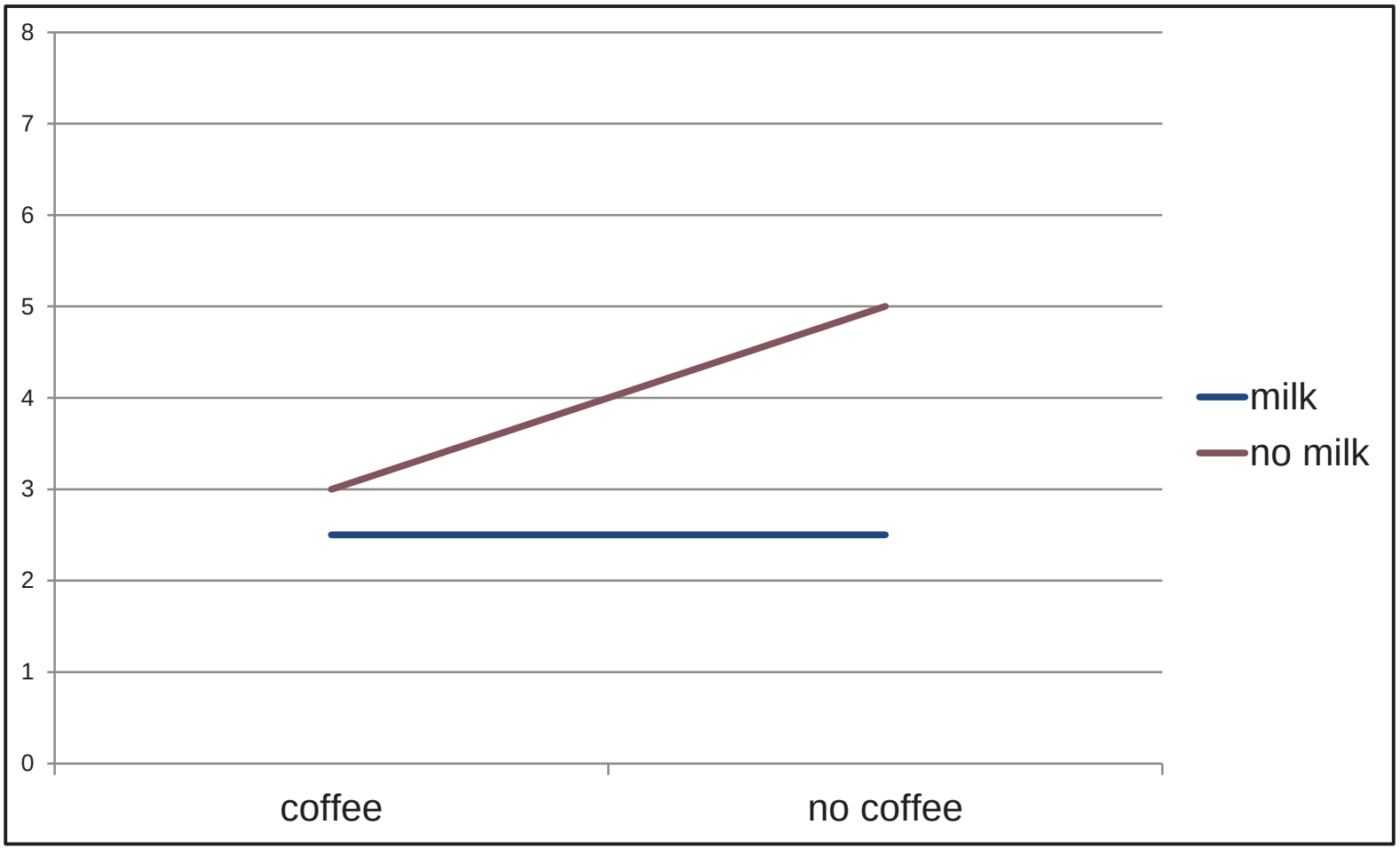
Main effects and interaction in ANOVA



Main effects and interaction in ANOVA



Main effects and interaction in ANOVA

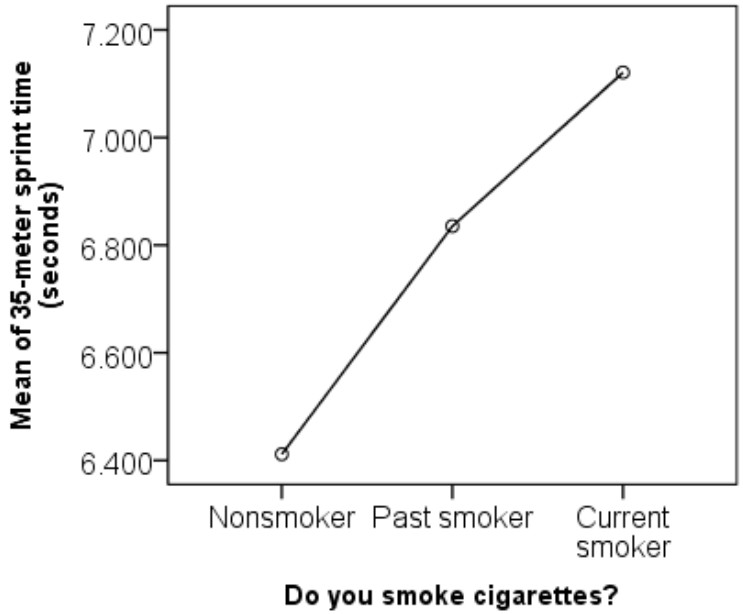


ANOVA = “Omnibus“ test

- “Significant“ means:
  - There is a difference, somewhere. At least two groups differ significantly from each other.
- What remains unclear:
  - Where exactly is the difference? Which groups differ significantly from each other?

… after the ANOVA

- A priori / planned contrasts
  - If you have specific hypotheses, you can check them with contrasts
- Post-Hoc
  - You find something interesting in your data and want to analyze it in more detail afterwards



(You don‘t need to select and apply a priori or post-hoc test in the exam, but you need to be aware that they exist and when you would need one.)

Reporting ANOVA

"Comparing post-test means, we found a small negative significant main effect of individual preparation on knowledge outcomes, ***F*(1;124) = 5.121; *p* = .025; η_p^2 = .04**."

- *F* = 5.121 → F-value, result from the ANOVA
- (1;124) → df (n of groups minus 1; n of observations minus n of groups)
- *p* = .025 → result from the significance test
- η_p^2 = .04 → Effect size (next week)

Tsovaltzi, D., Judele, R., Puhl, T., Weinberger, A. (2015). Individual preparation and argumentation scripts in social networking sites. In O. Lindwall, P. Häkkinen, T. Koschman, P. Tchounikine & S. Ludvigsen (Eds.). *Exploring the Material Conditions of Learning: The Computer Supported Collaborative Learning (CSCL) Conference 2015, Volume 2.* Gothenburg, Sweden: The International Society of the Learning Sciences, pp. 667-668.

Question

What is the difference between one-factorial (one-way) and two-factorial (two-way) ANOVA?

ANOVA exercise 1

Using Beispieldatensatz, test the following hypotheses:

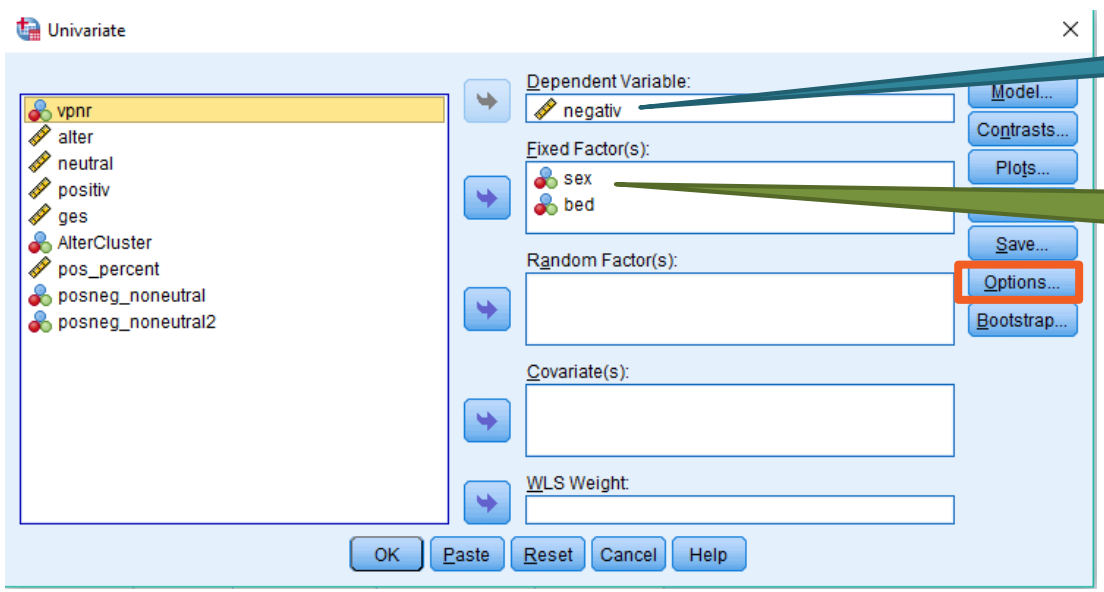
a) There is a main effect of gender on the number of remembered negative adjectives.

b) There is a main effect of condition on the number of remembered negative adjectives.

c) There is an interaction effect between gender and condition on the number of remembered negative adjectives.

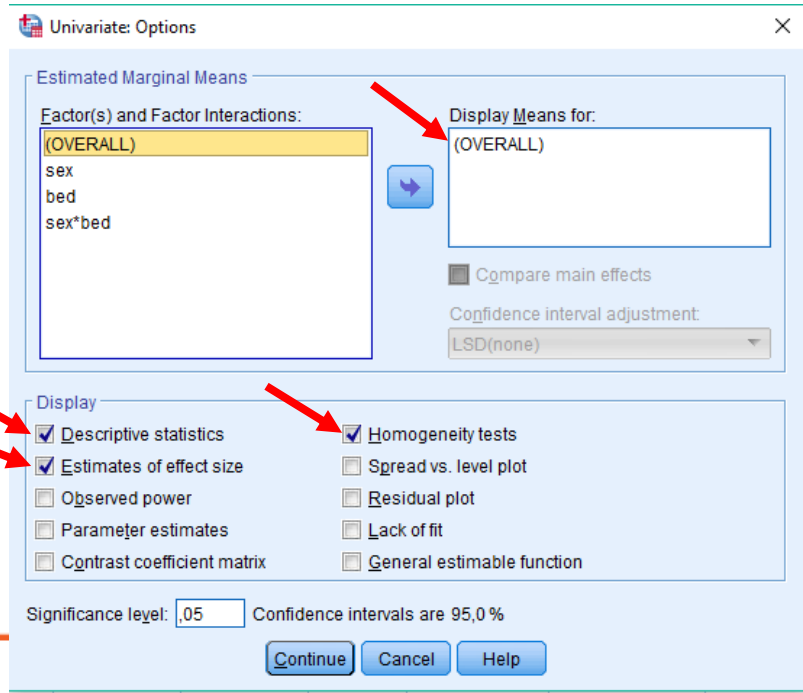
ANOVA exercise 1

Analyze > General linear model > Univariate



Dependent variable

Independent variables / factors



ANOVA exercise 1

Tests of Between-Subjects Effects

Dependent Variable: negativ

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	41,917[a]	5	8,383	2,403	,040	,077
Intercept	1478,115	1	1478,115	423,700	,000	,746
sex	2,021	1	2,021	,579	,448	,004
bed	31,352	2	15,676	4,494	,013	,059
sex * bed	1,449	2	,725	,208	,813	,003
Error	502,357	144	3,489			
Total	2231,000	150				
Corrected Total	544,273	149				

a. R Squared = ,077 (Adjusted R Squared = ,045)

A

B

A X B

No sign. main effect of gender (sex): $F(1;144) = .579$, $p = .448$, $\eta_p^2 = .004$

Sign. main effect of condition (bed): $F(2;144) = 4.494$, $p = .013$, $\eta_p^2 = .059$

No sign. interaction between sex and bed: $F(2;144) = .208$, $p = .813$, $\eta_p^2 = .003$

…on the DV “negativ”

ANOVA exercise 2

Report the results:

Tests of Between-Subjects Effects

Dependent Variable: neutral

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	23,215[a]	3	7,738	2,028	,113	,040
Intercept	50,743	1	50,743	13,300	,000	,083
AlterCluster	23,215	3	7,738	2,028	,113	,040
Error	557,025	146	3,815			
Total	2194,000	150				
Corrected Total	580,240	149				

a. R Squared = ,040 (Adjusted R Squared = ,020)

There is no sign. main effect of AlterCluster on the DV “neutral”:
$F(3, 146) = 2.028$, $p = .113$, $\eta_p^2 = .040$

ANOVA exercise 2

Report the results:

Tests of Between-Subjects Effects

Dependent Variable: Post_Qu_6

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	7,448[a]	3	2,483	2,562	,062	,098
Intercept	254,763	1	254,763	262,916	,000	,787
hand_N	,158	1	,158	,163	,687	,002
Own_MT	2,318	1	2,318	2,392	,126	,033
hand_N * Own_MT	5,609	1	5,609	5,788	,019	,075
Error	68,798	71	,969			
Total	1382,500	75				
Corrected Total	76,247	74				

a. R Squared = ,098 (Adjusted R Squared = ,060)

- There is no sign. main effect of hand_N on the DV “Post_Qu_6”: F (1, 71) = .163, p = .687, η_p^2 = .002
- There is no sign. main effect of Own_MT on the DV “Post_Qu_6”: F (1, 71) = 2.392, p = .126, η_p^2 = .033
- There is no sign. interaction between hand_N and Own_MT on the DV “Post_Qu_6”: F(1, 71) = 5.788, p = .019, η_p^2 = .075