

# MOT 2312

## Research Methods

### Hypothesis Testing, $z$ -Test, and $t$ -Test

### \_\_\_\_\_ JASP Examples \_\_\_\_\_

**Laurens Rook (Delft University of Technology)**

**NHST**

**1.**

# $H_0$ and $H_a$ : two forms

- ❖ **One-tailed:** Your  $H_a$  is formulated in terms of “higher / lower” (thus **directional**); same follows for the  $H_0$
- ❖ **Two-tailed:** Your  $H_a$  is formulated in terms of “differences that exist between groups” (**nondirectional**); the  $H_0$  then states that no differences exist

# In JASP

Chatbot Data\*

Descriptives T-Tests ANOVA Regression Frequencies Factor Network Machine Learning SEM

## One Sample T-Test

Variables

Tests

- ☒ Student
- ☐ Wilcoxon signed-rank
- ☐ Z Test

Test value: 0

Std. deviation: 1

Alt. Hypothesis

- ☒  $\neq$  Test value
- ☐  $>$  Test value
- ☐  $<$  Test value

Assumption checks

- ☐ Normality

Additional Statistics

- ☐ Location parameter
- ☐ Effect Size
- ☐ Descriptives
- ☐ Descriptives plots
- ☐ Vovk-Sellke maximum p-ratio

Missing Values

- ☒ Exclude cases analysis by analysis
- ☐ Exclude cases listwise

## Results

### One Sample T-Test

One Sample T-Test

Statistic	df	p
.	.	.

### One Sample T-Test

One Sample T-Test

t	df	p
.	.	.

Note. Student's t-test.

**Two-tailed**

**One-tailed (two directions)**

# The (single sample) $z$ -test and $t$ -test

2.

# Interpretation of a *z*-test vs. *t*-test

- ❖ What are the different assumptions underlying the two tests of variable “CPerson” in the JASP output?

## One Sample T-Test

One Sample T-Test ▼

		Test	Statistic	df	p
CPerson	Student		37.51	119	< .001
	Z		36.83		< .001

# Answer

- ❖ **Assumptions z-test:** (1) we have a known CPerson population variance elsewhere; (2) CPerson is normally distributed, (3) the sample size is bigger than 30 (but the output for the z-test itself does not tell us)
- ❖ **Assumptions (Student) t-test:** (1) we do NOT know the CPerson population variance, (2) Cperson must be an interval/ratio measure, (3) Cperson is symmetrical in distribution but not normally distributed

# Interpretation of a *z*-test vs. *t*-test

- ❖ Do you have any idea about the sample size of the Cperson dataset?

## One Sample T-Test

One Sample T-Test ▼

		Test	Statistic	df	p
CPerson	Student		37.51	119	< .001
	Z		36.83		< .001



# Answer

❖ 120 (degrees of freedom + 1)

# Interpretation t-test (two-tailed)

- ❖ I ran a single-sample t-test on CPerson, NPS and Gender. The p-values for all three variables are  $< .05$ . They clearly fall in the region of rejection for the  $H_0$ . Should I be happy, now?

The screenshot shows the SPSS One Sample T-Test dialog box on the left and the Results output on the right. In the dialog, the 'Variables' list contains CPerson, NPS, and Gender. The 'Tests' section has 'Student' checked. The 'Results' output shows a table with t, df, and p values for each variable, all with p-values less than .001.

**One Sample T-Test**

Variables: CPerson, NPS, Gender

Tests: ☒ Student

Additional Statistics: ☐ Location parameter

**Results**

**One Sample T-Test**

	t	df	p
CPerson	37.505	119	< .001
NPS	52.249	119	< .001
Gender	7.859	119	< .001

Note. Student's t-test.

# Answer

- ❖ **Yes** for Cperson: that variable is at interval/ratio scale, and suits this type of t-test. Congrats!
- ❖ **No** for NPS: that variable is at ordinal scale, which does not fit this type of t-test. You should have run a nonparametric test, instead. Alas!
- ❖ **No** for Gender: that variable is at nominal scale, which does not fit this type of t-test. You should have run a nonparametric test, instead. Alas!

# Follow-up question

- ❖ Let's assume the previous single-sample t-test output on CPerson was based on the following hypotheses:

$H_0$ : The sample mean for CPerson is not significantly different from the CPerson population mean

$H_a$ : The sample mean for CPerson is significantly different from the CPerson population mean

- ❖ Did we conduct a one-tailed t-test or a two-tailed t-test, and what makes you say so?

# Answer

- ❖ **Two-tailed:** the  $H_0$  and  $H_a$  were formulated in nondirectional manner. All they predicted was significant vs. nonsignificant differences between sample and population means.

# Final follow-up question

- ❖ So, the t-test output on CPerson was based on the following hypotheses:

$H_0$ : The sample mean for CPerson is not significantly different from the CPerson population mean

$H_a$ : The sample mean for CPerson is significantly different from the CPerson population mean

- ❖ Do we accept or reject the null hypothesis, and what makes you say so?

# Answer

- ❖ The result was:  $t(119) = 37.51, p < .001$ . This result is lower than probability value .05, where we had set our critical value. Our result thus falls within the rejection region for  $H_0$ . **We reject  $H_0$  and accept  $H_a$ .**