SOURCEBOOK JASP ANNOTATED OUTPUT

Abstract: This chapter is intended to facilitate the connection between standard introductory statistics concepts and their implementation in JASP. It shows the output from various types of analyses, describes how to interpret the output, and shows the link between hand calculation formulas and JASP output. Results derive from the examples in the previous chapter of this project.

Keywords: JASP output, annotation, statistical interpretation

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This document is part of an online statistics sourcebook.

A browser-friendly viewing platform for the sourcebook is available: <u>https://cwendorf.github.io/Sourcebook</u>

> All data, syntax, and output files are available: https://github.com/cwendorf/Sourcebook

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Frequencies and Descriptives

(Note that some aspects of this output have been rearranged for the sake of presentation!)

(Note that some a	specis c	n this output have been rea	angeu for the
	data set. entries tl	des the sample size for the entire "Missing" refers to the number of nat are blank, whereas "Valid" is ber of entries that are not blank.	The "Mean", "St unbiased estima is determined as $\Sigma(fY)$ (2)
Descriptive Statistics		,	$M = \frac{\sum (fY)}{N} = \frac{(2)}{N}$
	score	/	IN
Valid	8		The "Variance" a
Missing	0		(not shown in th
Mean	4.000		`
Std. Deviation	3.117		$SS = \sum f(Y - $
Variance	9.714		$SS = \sum_{X \in Y} f(Y - SS) = 2(0 - 4)^{2}$
25 th percentile	2.250		55 - 2(0 +)
50 th percentile	4.000		
75 th percentile	5.500		Then, the "Varia
			$MMS = \frac{SS}{(N-1)}$
			(N-1)
			Finally, the "Std
			Finally, the "Std
		\frown	$SD = \sqrt{MS} = \sqrt{MS}$
Frequencies for Outcome			
Frequency	Percent	Valid Percent Cumulative Percent	"Percentiles" pro
0 2	25.000	25.000 25.000	For example, th
3 1	12.500	12.500 37.500	Position = PF
4 2	25.000	25.000 62.500	
5 1	12.500	12.500 75.000	Thus, the score
7 1	2.500	12.500 87.500	distribution – a s
9 1	12,500	12.500 100.00	
Missing 9	0.000		
Total 8	100.000		
†			
The first column lists al actual scores in the ent set. "Frequency" indica number of times that so exists. For example, the 4 was listed 2 times.	tire data tes the core	The "Percent" column provides the percentage of cases for each possible score. For example, of the 8 scores in the entire data set, the score of 4 was listed 2 times and 2/8 is 25.0%.	The "Valid Perc provides the per for each possib the total number there were no r the percent col

tandard Deviation", and "Variance" are all calculated as nates of the respective population parameter. Here, the mean as the average of the scores weighted by their frequencies:

$$M = \frac{\sum (fY)}{N} = \frac{(2 \times 0) + (1 \times 3) + (2 \times 4) + (1 \times 5) + (1 \times 7) + (1 \times 8)}{8} = 4$$

and "Std. Deviation" are both functions of the Sum of Squares the output) of the scores in the frequency distribution:

$$SS = \sum_{X} f(Y - M)$$

$$SS = 2(0 - 4)^{2} + 1(3 - 4)^{2} + 2(4 - 4)^{2} + 1(5 - 4)^{2} + 1(7 - 4)^{2} + 1(8 - 4)^{2} = 68$$

iance" (also known as Mean Squares) is calculated as:

$$MMS = \frac{SS}{(N-1)} = \frac{68}{7} = 9.714$$

d. Deviation" is determined by:

$$SD = \sqrt{MS} = \sqrt{9.71} = 3.117$$

rovide the scores associated with particular percentile ranks. the 50th percentile is the score in the following position:

PR(N + 1) = .50(8 + 1) = 4.5

e at the 50th percentile is the 4.5th score in the frequency score of 4.

rcent" column ercentage of cases ible score divided by per of cases. Here, missing scores, so olumns are equal.

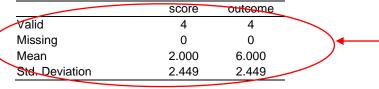
"Cumulative Percent" is the sum of all percentages up to and including the row in question. For example, 62.5% of scores were a 4 or smaller. Similarly, 37.5% were a 3 or smaller.

Correlations

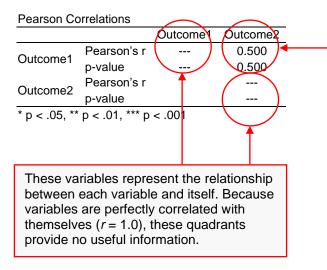
(Additional analyses have been added for the sake of completeness!)

Descriptives

Descriptive Statistics



Correlation Matrix



These statistics were obtained using the "Descriptives" command described on the previous page of this guide. Note that they are calculated separately for each variable.

This quadrant represents the relationship between the two variables.

The calculations are dependent on the "Covariance" (COV), which is not determinable from the summary statistics provided, but rather the data. Therefore, the calculations for it are not shown here.

"Pearson's r" is a function of the covariance and the standard deviations of both variables:

$$r = \frac{COV}{(SD_X)(SD_Y)} = \frac{3.000}{(2.45)(2.45)} = .500$$

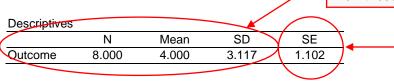
Though the statistic is not shown, *t* provides the standardized statistic for testing whether the correlation differs from zero:

$$t = \frac{r}{\sqrt{(1 - r^2)/(N - 2)}} = \frac{.500}{\sqrt{(1 - .500^2)/(4 - 2)}} = .816$$

The *t* statistic follows a non-normal (studentized or *t*) distribution that depends on degrees of freedom. Here, df = N - 2 = 4 - 2 = 2. A *t* with 4 *df* that equals .816 has a two-tailed probability (*p*) of .500, which is not a statistically significant finding.

Confidence Intervals

(Note that some aspects of this output have been rearranged for the sake of presentation!)



These values of the one-sample statistics are identical to the values that would be provided by the "Descriptives" commands. See the earlier annotated output for details of how these are computed from frequency distributions.

> The "Standard Error of the Mean" provides an estimate of how spread out the distribution of all possible random sample means would be. Here it's calculated as:

$$SE_M = \frac{SD}{\sqrt{N}} = \frac{3.117}{\sqrt{8}} = 1.102$$

One Samp	le T-Test				
				95% Confider	nce Interval
	t	df	р	Lower	Upper
Outcome	3.360	7	0.008	1.394	6.606
Note All tests hypethesis is population mean is different from 6					

population mean is different from 6 *Note.* All tests, hypothes

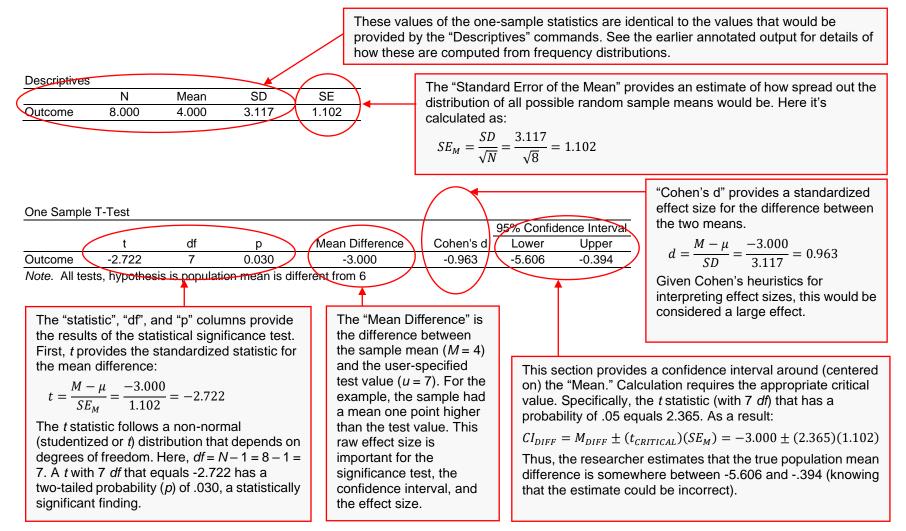
This material provides a statistical significance test. It is important for the next topic, but not immediately relevant to the confidence interval.

This section provides a confidence interval around (centered on) the "Mean." Calculation requires the appropriate critical value. Specifically, the t statistic (with 7 df) that has a probability of .05 equals 2.365. As a result:

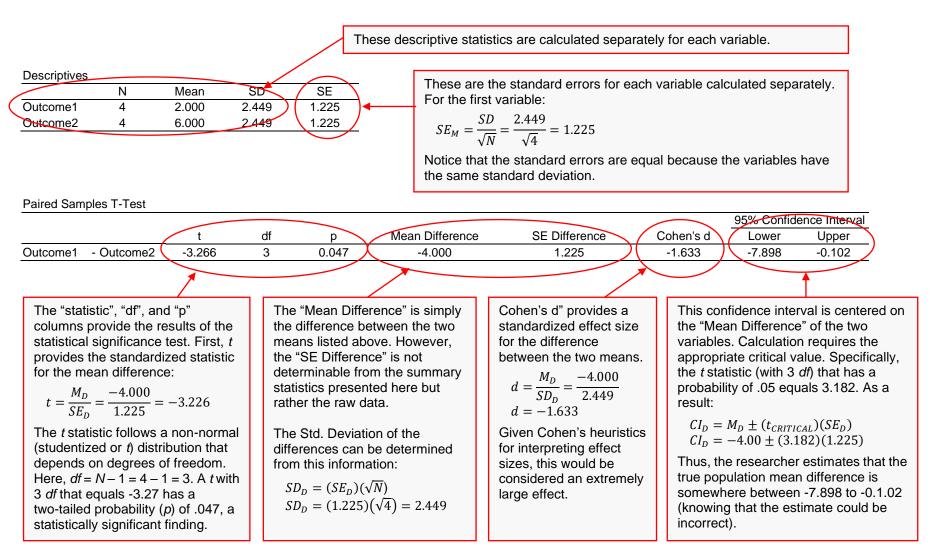
 $CI_M = M \pm (t_{CRITICAL})(SE_M) = 4.000 \pm (2.365)(1.102)$

Thus, the researcher estimates that the true population mean is somewhere between 1.394 and 6.606 (knowing that the estimate could be incorrect).

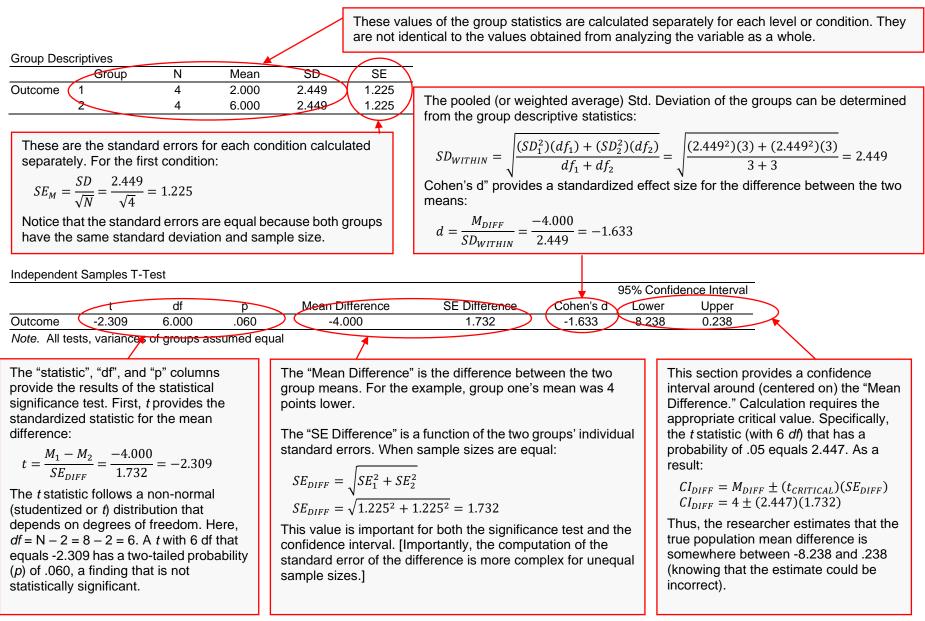
One Sample t Test



Paired Samples t Test



Independent Samples t Test



OneWay ANOVA

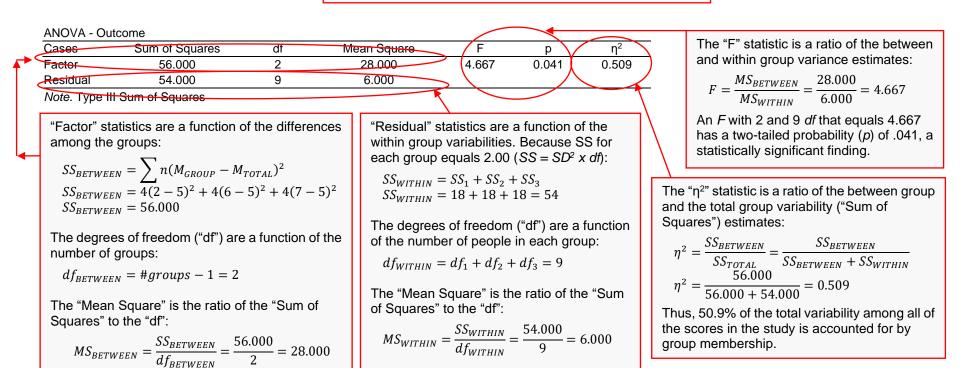
(Note that some aspects of this output have been rearranged for the sake of presentation!)

Descriptive	s – Outcome		
Factor	Mean	SD	N
1	2.000	2.449	4
2	6.000	2.449	4
3	7.000	2.449	4

These values of the group statistics are calculated separately for each group. They are not identical to the values obtained from analyzing the variable as a whole.

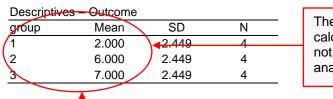
A grand mean can be determined by taking the weighted average of all of the group means:

$$M_{TOTAL} = \frac{\sum n(M_{GROUP})}{N} = \frac{4(2) + 4(6) + 4(7)}{4 + 4 + 4} = 5.000$$



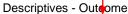
Post Hoc Comparisons

(Note that some aspects of this output have been rearranged/deleted for the sake of presentation!)



These values of the group statistics are calculated separately for each group. They are not identical to the values obtained from analyzing the variable as a whole.

"Mean Difference" is the difference between the means for the two listed groups.



Becchiptivee	Outcome			
	Mean Difference	SE	t	Ptukey
2	-4.000	1.732	-2.309	0.106
3	-5.000	1.732	-2.887	0.043
2 3	-1.000	1.732	-0.577	0.835

These "Standard Errors" are for the difference between the two group means. The values are a function of the MS_{WITHIN} (from the ANOVA) and the sample sizes:

$$SE_{DIFF} = \sqrt{\left(\frac{MS_{WITHIN}}{n_{GROUP}}\right) + \left(\frac{MS_{WITHIN}}{n_{GROUP}}\right)}$$
$$SE_{DIFF} = \sqrt{\left(\frac{6}{4}\right) + \left(\frac{6}{4}\right)} = 1.732$$

In this case, because all groups are of the same size, the standard error for each comparison is the same.

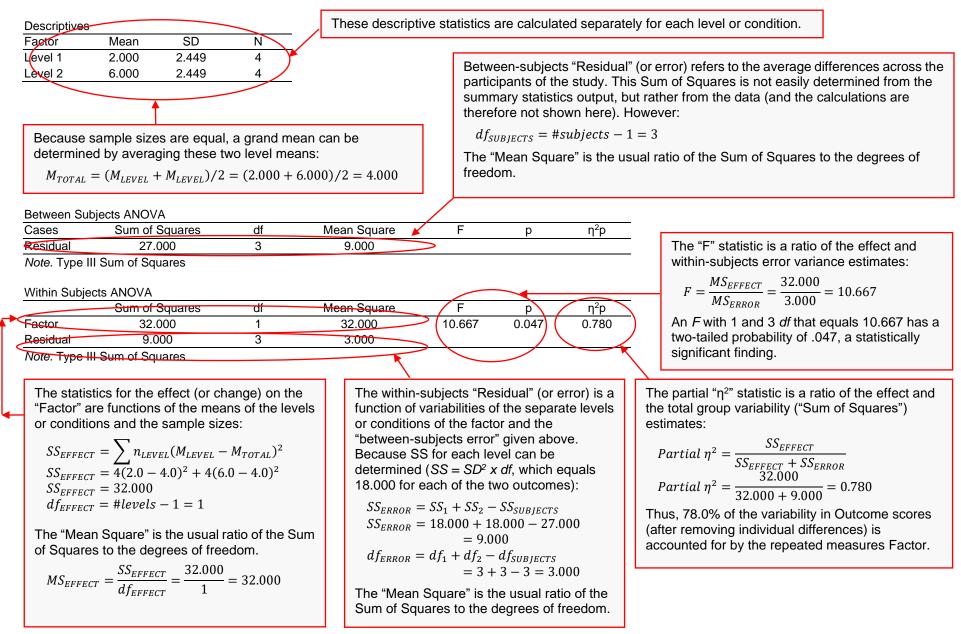
Tukey's HSD procedure is appropriate for all possible post-hoc pairwise comparisons between groups. The output lists all possible pairwise comparisons, excluding those that are redundant.

The "t" column provides an HSD value that is conceptually similar to a *t* statistic in that it is a function of the "Mean Difference" and the "Std. Error". For the first comparison in the example:

$$HSD = \frac{M_1 - M_2}{SE_{DIFF}} = \frac{-4.000}{1.732} = -2.309$$

The " p_{tukey} " column provides the probability of the HSD statistic. An HSD of -2.309 (with 2 $df_{BETWEEN}$ and 9 df_{WITHIN} like in the ANOVA source table) has a two-tailed probability (p) of .106, a finding that is not statistically significant.

Repeated Measures ANOVA



Factorial ANOVA

(Note that some aspects of this output have been rearranged for the sake of presentation!)

Descriptives - score FactorA FactorB 1 1 2 1 2 1 2 1 2 These descriptive s for each group or c	Mean SD 2.000 2.449 7.000 2.449 6.000 2.449 5.000 2.449 5.000 2.449 5.000 2.449 5.000 2.449 5.000 2.449 6.000 2.449 5.000 2.449 6.000	N 4 4 4 4 separately	(marginal) me means. For e $M_{LEVEL} = \sum$ A grand mean	ean can be determined by the matrix $\frac{n(M_{GROUP})}{n_{LEVEL}} = \frac{4}{n_{LEVEL}}$	ermined by tal arginal mean f $\frac{4(2) + 4(7)}{8} =$ mined by takin	king the we for Level 1 4.500 ng the weig	hted average of all of the group means:
and Factor B" are f (marginal) means a "Factor B": $SS_{FACTORB} = \sum r$ $SS_{FACTORB} = 8(4.1)$ $SS_{FACTORB} = 4.00$	e effects of "Factor A" functions of the level and sample sizes. For $m(M_{LEVEL} - M_{TOTAL})^2$ $(5-5)^2 + 8(5.5-5)^2$	betwee SS_{INT} SS_{INT} df_{INT} "Residual" (e variabilities. $(SS = SD^2 x)$ $SS_{ERROR} =$ $SS_{ERROR} =$	Mean-Square 4.000 16.000 36.000 6.000 actor A * Factor on- group variable $ERACTION = SS_{MC}$ $ERACTION = 56.0$ $ERACTION = df_A >$ perror) statistics a Because SS for df_1 : $SS_1 + SS_2 + SS_3$ $18.000 + 18.000$ $df_1 + df_2 + df_3$	ility not account $g_{DEL} - SS_{FACTOR}$, 00 - 4.000 - 10 $\times df_B = 1$ are a function of r each group ca $+ SS_4$ 0 + 18.000 + 18	ted for by the f $A - SS_{FACTORB}$ $6.000 = 36.00^{\circ}$ of the within ground the determined an be determined	factors: 0 oup ned	"Mean Squares" are estimates of the variances associated with each source For "Factor B": $MS_{FACTORB} = \frac{SS_{FACTORB}}{df_{FACTORB}} = 16.000$ The "F" statistic is a ratio of the effect and within group (error) variance estimates. For "Factor B": $F_{FACTORB} = \frac{MS_{FACTORB}}{MS_{ERROR}} = \frac{16.0}{6.0} = 2.660$ An <i>F</i> with 1 and 12 <i>df</i> that equals 2.66 has a two-tailed probability of .128, which is not statistically significant. The "q ² p" statistic is a ratio of the effect at the effect plus residual variability. For "Factor B": $\eta^2 p = \frac{SS_{FACTOR}}{SS_{FACTOR}} = \frac{SS_{FACTOR}}{SS_{FACTOR}}$
Overall, all of the b	etween-group variability	is a function of	the group mear	ns and sample	sizes:		$\eta^2 p = \frac{SS_{FACTOR}}{SS_{FACTOR} + SS_{ERROR}}$ $\eta^2 p = \frac{16.000}{16.000 + 72.000} = 0.182$

 $SS_{MODEL} = \sum_{max} n(M_{GROUP} - M_{TOTAL})^2 = 4(2-5)^2 + 4(7-5)^2 + 4(6-5)^2 + 4(5-5)^2 = 56.000$ $df_{MODEL} = \#groups - 1 = 3$

res" are estimates of the ssociated with each source. B":

$$MS_{FACTORB} = \frac{SS_{FACTORB}}{df_{FACTORB}} = 16.000$$

$$F_{FACTORB} = \frac{MS_{FACTORB}}{MS_{ERROR}} = \frac{16.0}{6.0} = 2.667$$

and 12 df that equals 2.667 ailed probability of .128, statistically significant.

ic is a ratio of the effect and esidual variability. For

$$\eta^2 p = \frac{SS_{FACTOR}}{SS_{FACTOR} + SS_{ERROR}}$$
$$\eta^2 p = \frac{16.000}{16.000 + 72.000} = 0.182$$

Thus, 18.2% of the variability among the scores is accounted for by Factor B.