

## P-value and $\alpha$ level

### How to calculate the example of the presentation in SPSS

#### Problem Statement

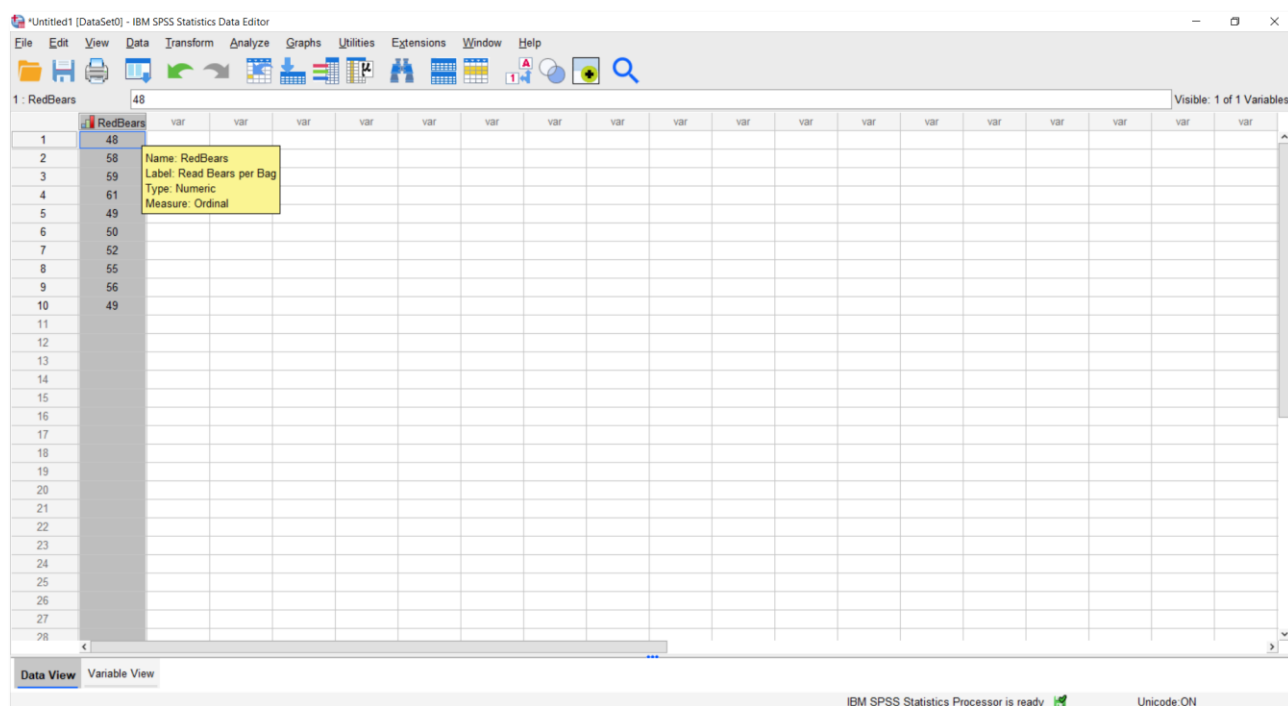
The manufacturer says their gummy bear bags with 100 gummy bears in each have an average of 50 red bears in them. We, as critical scientists, formulate the following hypotheses:

H0: The average of red bears in each bag is 50.  
in other words: H0:  $\mu = 50$

H1: The average of red bears in each bag is different from 50.  
in other words: H1:  $\mu \neq 50$

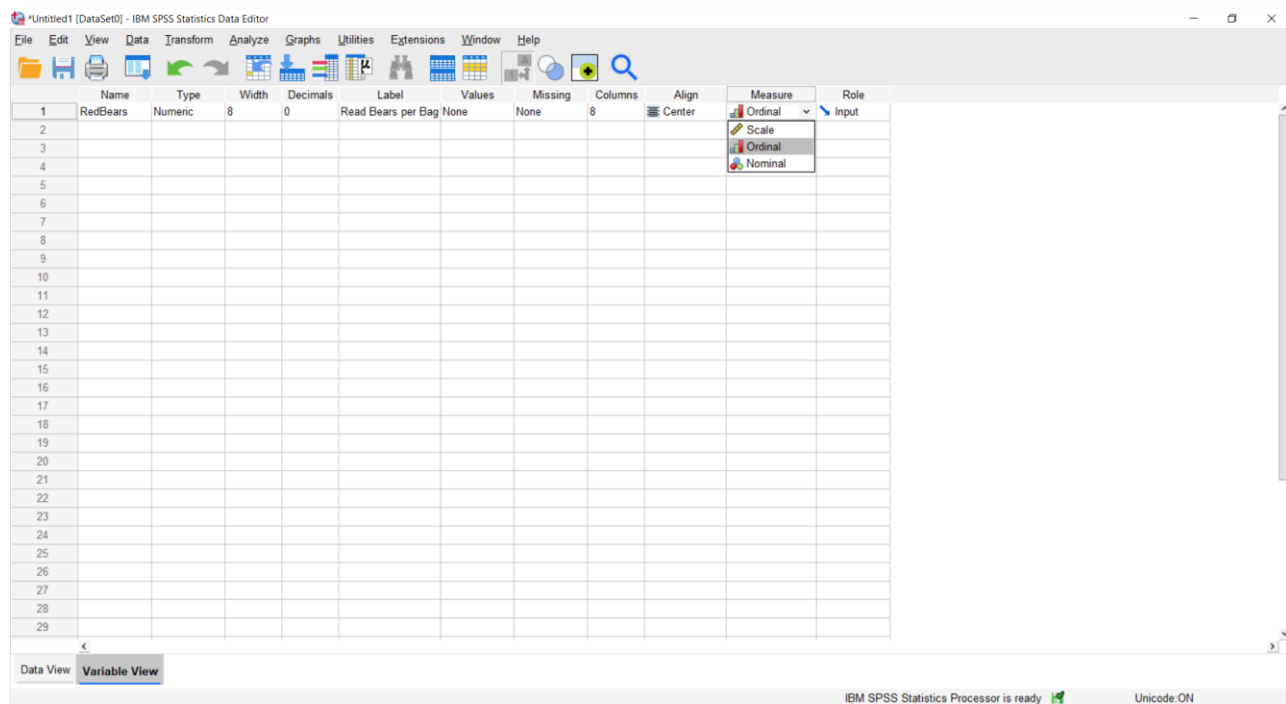
#### Data collection

We buy 10 bags and count the red bears of each bag. Now we open SPSS and put the data (the number of red bears per bag) as a variable in and adjust its characteristics.



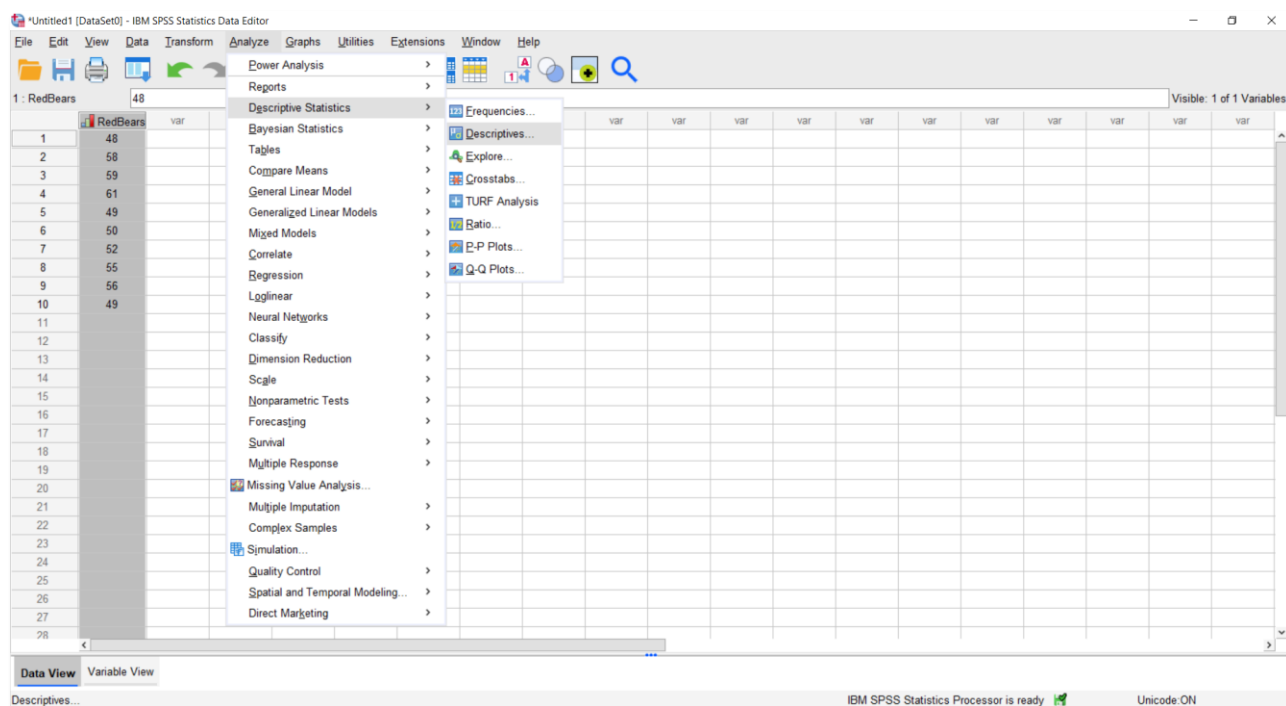
The screenshot shows the IBM SPSS Statistics Data Editor interface. The main window displays a dataset with 10 rows of data for the variable 'RedBears'. The data values are: 48, 58, 59, 61, 49, 50, 52, 55, 56, and 49. A tooltip is visible over the first cell, showing the variable's properties: Name: RedBears, Label: Read Bears per Bag, Type: Numeric, and Measure: Ordinal. The interface includes a menu bar (File, Edit, View, Data, Transform, Analyze, Graphs, Utilities, Extensions, Window, Help) and a toolbar with various icons. The status bar at the bottom indicates 'IBM SPSS Statistics Processor is ready' and 'Unicode: ON'.

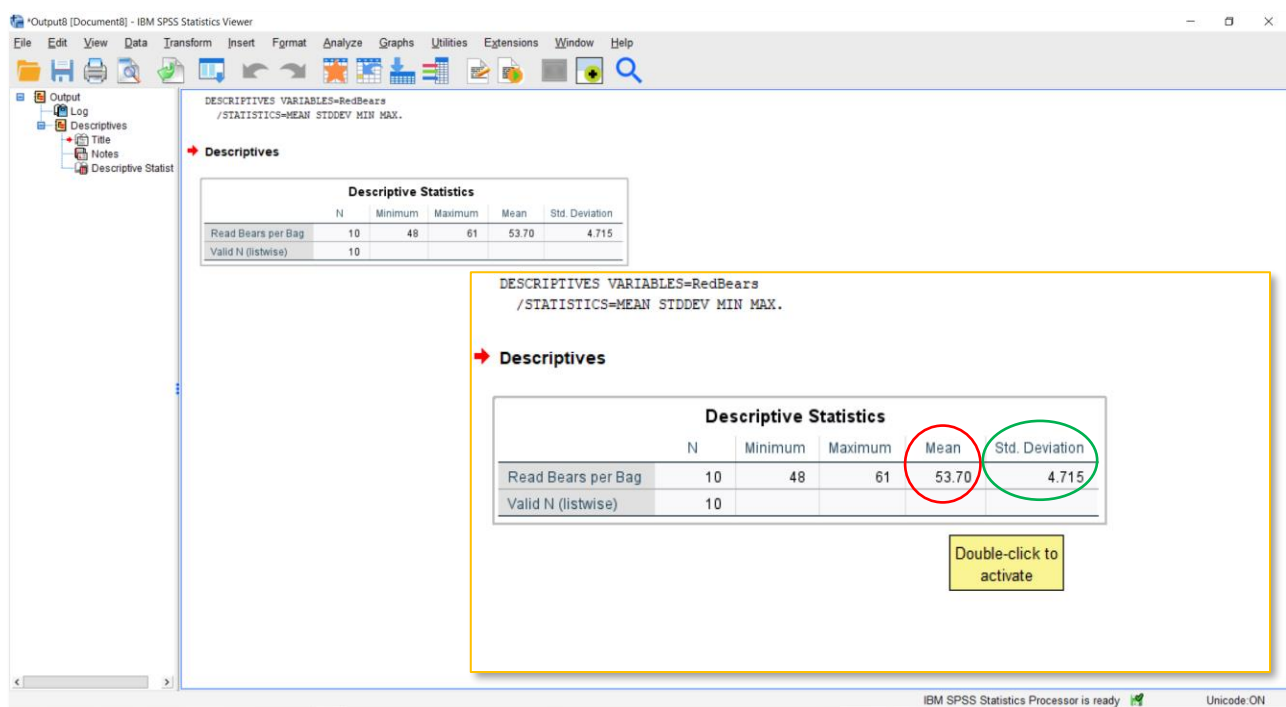
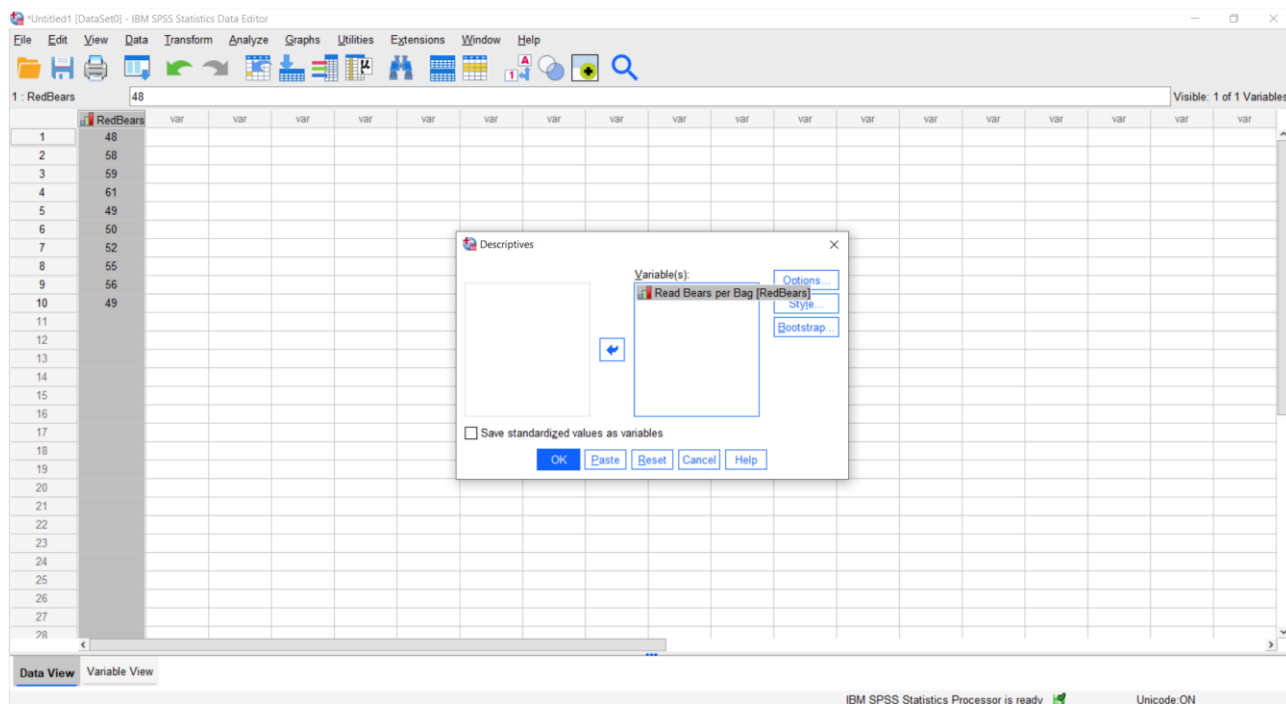
Case	RedBears
1	48
2	58
3	59
4	61
5	49
6	50
7	52
8	55
9	56
10	49



*Mean and standard deviation calculation* – descriptive statistics

Now we calculate the mean ( $\bar{x}$ ) and the standard deviation (SD) of the red bears per bag.

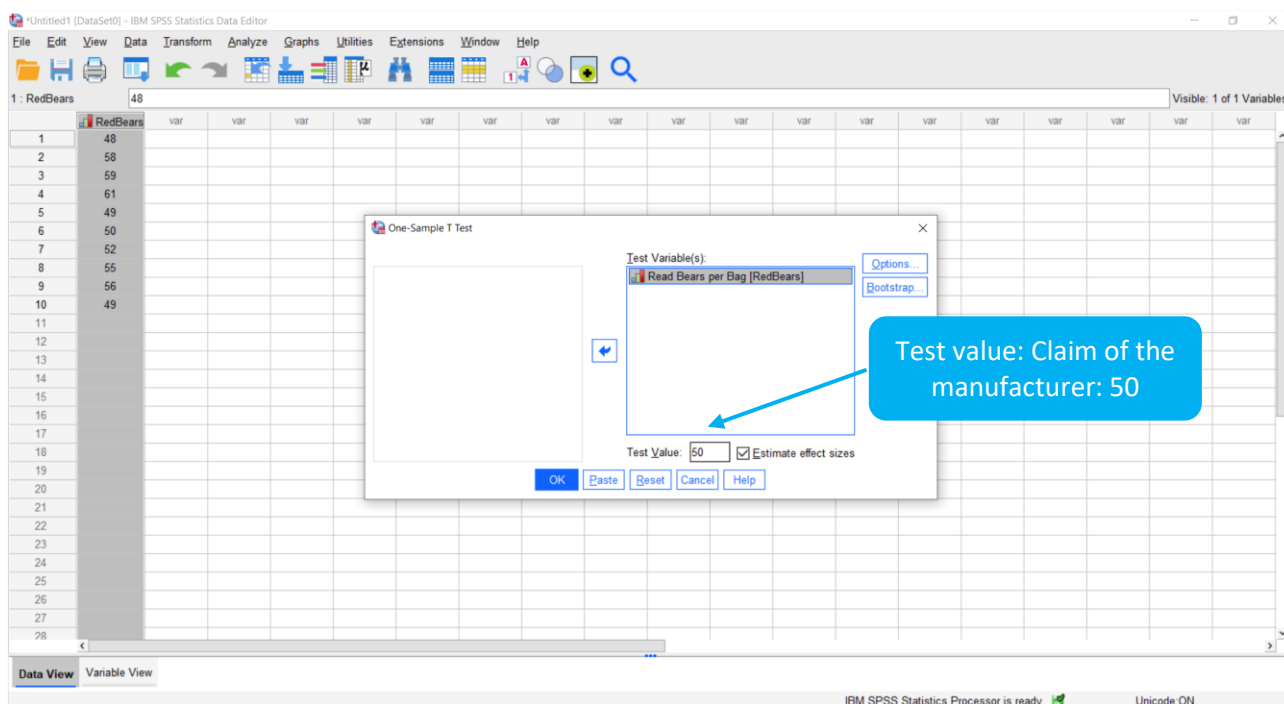
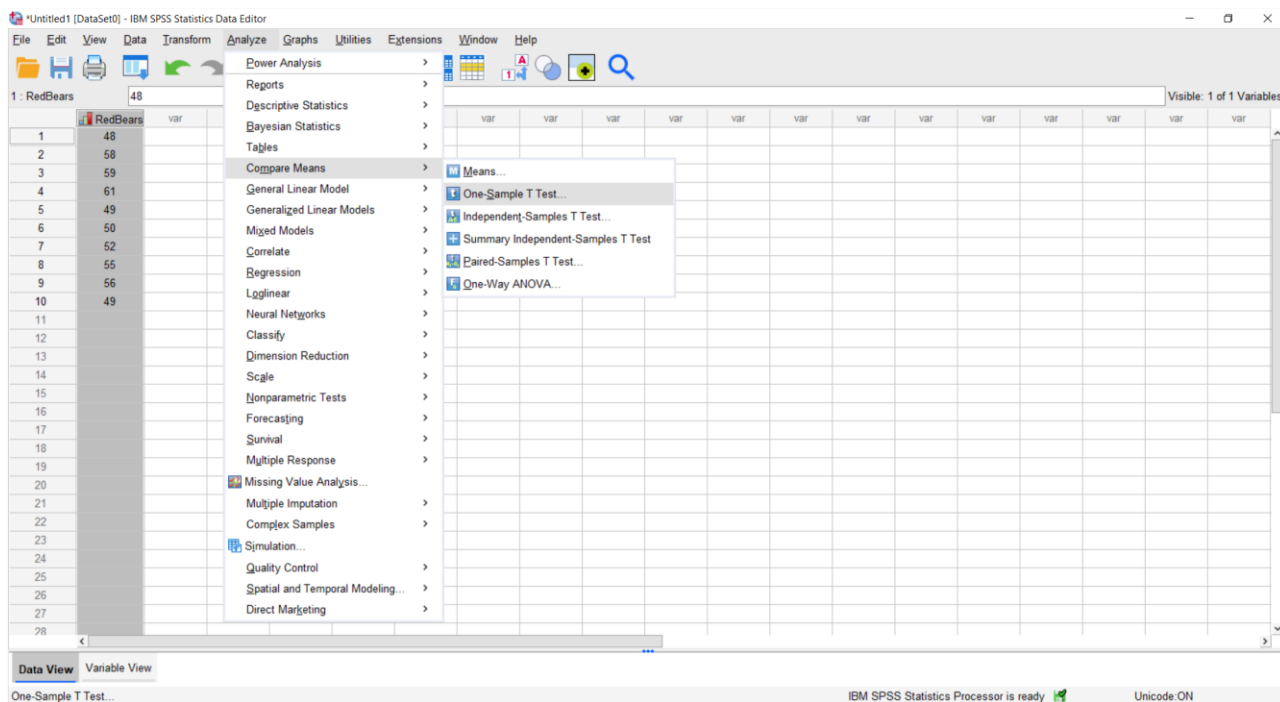




There are on average 53.70 red bears per bag. And the SD for our sample is 4.715. This means, that there are on average **more** than 50 red bears in each bag. Good for us. Nevertheless, the seller seems to be a liar as he claimed to give us **exactly** 50 red bears per bag.

### One-sample t-test – inferential statistics

To test our result for statistical significance, we perform a one-sample-t-test. We set the alpha-level ( $\alpha$ ) as the probability of rejecting the null hypothesis when the null hypothesis is actually true. In other words: It is the probability of making a wrong decision. It is set by the scientist and often at  $\alpha = 0.05$ , meaning we tolerate a chance of 5% being wrong when rejecting it.



The screenshot shows the IBM SPSS Statistics Viewer interface. The main window displays the results of a one-sample t-test for the variable 'Read Bears per Bag'. The output is organized into three tables:

**One-Sample Statistics**

	N	Mean	Std. Deviation	Std. Error Mean
Read Bears per Bag	10	53.70	4.715	1.491

**One-Sample Test**

Test Value = 50

	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Read Bears per Bag	2.481	9	.035	3.700	.33	7.07

**One-Sample Effect Sizes**

	Standardizer <sup>a</sup>	Point Estimate	95% Confidence Interval	
			Lower	Upper
Read Bears per Bag	Cohen's d	4.715	.785	1.484
	Hedges' correction	5.160	.717	1.356

a. The denominator used in estimating the effect sizes. Cohen's d uses the sample standard deviation. Hedges' correction uses the sample standard deviation, plus a correction factor.

The p-value (yellow circle) is below the set alpha-level of 0.05. We can successfully reject the  $H_0$ , thus we can claim, that the manufacturer is **lying to us** and we proved it with statistical significance.