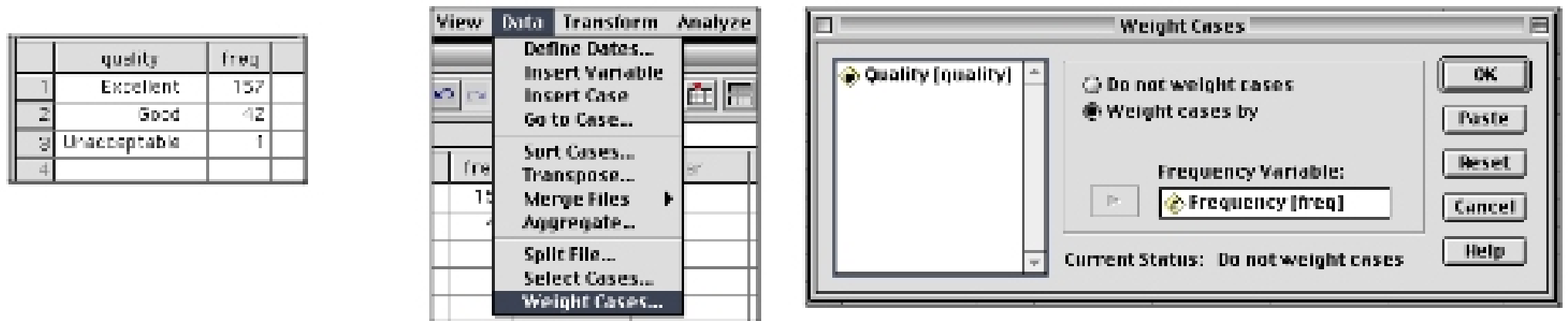


A machine has a record of producing 80% excellent, 17% good, and 3% unacceptable parts. After extensive repairs, a sample of 200 produced 157 excellent, 42 good, and 1 unacceptable part. Have the repairs changed the nature of the output of the machine? Use SPSS with  $\alpha = 0.05$ .

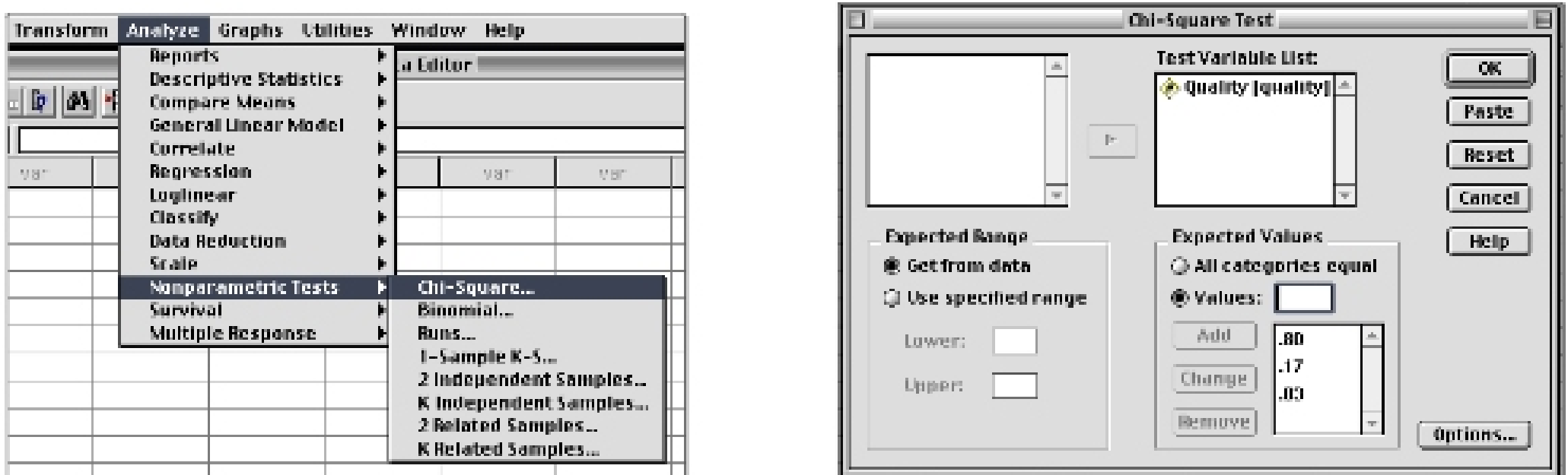
1. Enter the data into one variable (Quality: 1 = Excellent, 2 = Good, 3 = Unacceptable) so that there are 157 Excellent (1), 42 Good (2), and 1 Unacceptable (3). This method enters raw data.

or

Enter the category values into one variable and the observed frequencies into another variable (see left figure, below). Then weight the category values variable by the observed frequencies variable (see two right figures, below). This method enters tabulated data.



2. Select Analyze → Nonparametric Tests → Chi-Square... (see left figure, below).
3. Select “Quality” as the test variable and enter the values for the null hypothesis proportions in numerical order by category value [i.e.,  $P(\text{Excellent}) = 0.80$ , then  $P(\text{Good}) = 0.17$ , then  $P(\text{Unacceptable}) = 0.03$ ]. (See right figure, below.)



4. Your output gives the expected frequencies table (Step 4.1), the Chi-Square test statistic and  $p$ -value (Step 4.3), as well as a footnote for checking the assumptions (Step 4.2).

**NPar Tests**

**Chi-Square Test**

**Frequencies**

Quality

	Observed N	Expected N	Residual
Excellent	157	160.0	-3.0
Good	42	34.0	8.0
Unacceptable	1	6.0	-5.0
Total	200		

Test Statistics

	Quality
Chi-Square <sup>a</sup>	8.105
df	2
Asymp. Sig.	.047

<sup>a</sup>. 0 cells (.0%) have expected frequencies less than 5. The minimum expected cell frequency is 6.0.

**Step 1: Hypotheses**

$H_0$ : The repairs did not change the nature of the output of the machine.  
[i.e., the proportions remained the same]

$H_a$ : The repairs did change the nature of the output of the machine.  
[i.e., the proportions changed after the repairs]

**Step 2: Significance Level**

$\alpha = 0.05$

**Step 3: Critical Value and Rejection Region**

Reject the null hypothesis if  $p\text{-value} \leq 0.05 = \alpha$ .

**Step 4.1: Calculate Expected Frequencies**

Quality

	Observed N	Expected N	Residual
Excellent	157	160.0	-3.0
Good	42	34.0	8.0
Unacceptable	1	6.0	-5.0
Total	200		

**Step 4.2: Check Assumptions**

All expected frequencies are  $\geq 5$  (smallest value is 6).

**Step 4.3: Test Statistic**

Test Statistics

	Quality
Chi-Square <sup>a</sup>	8.105
df	2
Asymp. Sig.	.047

<sup>a</sup>. 0 cells (.0%) have expected frequencies less than 5. The minimum expected cell frequency is 6.0.

**Step 5: Conclusion**

Since  $p\text{-value} = 0.047 \leq 0.05$ , we shall reject the null hypothesis.

**Step 6: State conclusion in words**

At the  $\alpha = 0.05$  level of significance, there is enough evidence to conclude that the repairs changed the nature of the output of the machine (the proportions are not what they used to be).