

## Chapter 505

# Item Analysis

## Introduction

This procedure performs item analysis. Item analysis studies the internal reliability of a particular instrument (test, survey, questionnaire, etc.). This instrument usually consists of several questions (items) which are answered by a group of respondents. Issues that arise include whether the instrument measures what was intended (does a particular IQ test reliably measure an individual's intelligence?), whether it produces the same results when it is administered repeatedly, whether it contains cultural biases, and so on.

Item analysis is not the same as item response analysis. Item response analysis is concerned with the analysis of questions on a test which can be scored as either right or wrong. The Item Response Analysis program, discussed elsewhere, conducts this type of analysis.

## Discussion

Because of the central role of measurement in science, scientists of all disciplines are concerned with the accuracy of their measurements. Item analysis is a methodology for assessing the accuracy of measurements that are obtained in the social sciences where precise measurements are often difficult to secure. The accuracy of a measurement may be divided into two dimensions: validity and reliability. The *validity* of an instrument refers to whether it accurately measures the attribute of interest. The *reliability* of an instrument concerns whether it produces identical results in repeated applications. An instrument may be reliable but not valid. However, it cannot be valid without being reliable.

The methods described here assess the reliability of an instrument. They do not assess its validity. This should be kept in mind when using the techniques of item analysis since they address reliability, not validity.

An instrument may be valid for one attribute but not for another. For example, a driver's license exam may accurately measure an individual's ability to drive. However, it does not accurately measure that individual's ability to do well in college. Hence the exam is reliable and valid for measuring driving ability. It is reliable and invalid for measuring success in college.

Several methods have been proposed for assessing the reliability of an instrument. These include the retest method, alternative-form method, split-halves method, and the internal consistency method. We will focus on internal consistency here.

Cronbach's alpha) is the most popular of the internal consistency coefficients. It is calculated as follows:

$$\alpha = \frac{K}{K-1} \left[ 1 - \frac{\sum_{i=1}^K \sigma_{ii}}{\sum_{i=1}^K \sum_{j=1}^K \sigma_{ij}} \right]$$

where  $K$  is the number of items (questions) and  $\sigma_{ij}$  is the estimated covariance between items  $i$  and  $j$ . Note the  $\sigma_{ii}$  is the variance (not standard deviation) of item  $i$ .

## Item Analysis

If the data are standardized by subtracting the item means and dividing by the item standard deviations before the above formula is used, we get the standardized version of Cronbach's alpha. A little algebra will show that this is equivalent to the following calculations based directly on the correlation matrix of the items:

$$\alpha = \frac{K\bar{\rho}}{1 + \bar{\rho}(K - 1)}$$

where  $\bar{\rho}$  is the average of all the correlations among the  $K$  items.

Cronbach's alpha has at least three interpretations.

1. Cronbach's alpha is equal to the average value of alpha coefficients obtained for all possible combinations of dividing  $2K$  items into two groups of  $K$  items each and calculating the two-half tests.
2. Cronbach's alpha estimates the expected correlation of one instrument with an alternative form containing the same number of items.
3. Cronbach's alpha estimates the expected correlation between an actual test and a hypothetical test which may never be written.

Since Cronbach's alpha is supposed to be a correlation, it should range between -1 and 1. However, it is possible for alpha to be less than -1 when several of the covariances are relatively large, negative numbers. In most cases, alpha is positive, although negative values arise occasionally. What value of alpha should be achieved? Carmines (1990) stipulates that as a rule, a value of at least 0.8 should be achieved for widely used instruments. An instrument's alpha value may be improved by either adding more items or by increasing the average correlation among the items.

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## Data Structure

The data are entered in two or more variables. An example of data appropriate for this procedure is shown in the table below. These data are contained in the Item dataset. These data represent the responses of sixteen individuals to a four-item questionnaire.

### Item dataset

Item1	Item2	Item3	Item4
1	3	2	1
2	2	2	3
1	3	2	2
3	3	3	3
1	1	2	2
3	3	3	1
2	2	1	2
1	1	2	1
1	3	1	2
1	1	2	2
5	3	2	2
1	1	2	1
1	3	2	2
1	3	3	1
1	3	2	1
1	3	1	1

## Procedure Options

This section describes the options available in this procedure.

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### Variables Tab

Specify the variables to be analyzed.

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#### Item Variables

##### Item Variables

Specify two or more variables to be analyzed. These are the variables containing each individual's responses to the questionnaire. Each variable represents an item (question). Each row represents an individual.

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#### Frequency Variable

##### Frequency Variable

This optional variable contains the frequency (count) to be assigned to this row. Normally, each row receives a count of one. The values in this variable replace this default value.

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#### Options

##### Zero

Specify the value used as zero by the numerical routines. Because of round-off problems, values less than this amount (in absolute value) are changed to zero during the calculations.

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### Reports Tab

The following options control the format of the reports that are displayed.

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#### Select Reports

##### Reliability Report ... Covariance Report

Indicate whether to display the indicated report.

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#### Report Options

##### Precision

Specify the precision of numbers in the report. Single precision will display seven-place accuracy, while the double precision will display thirteen-place accuracy.

##### Variable Names

This option lets you select whether to display variable names, variable labels, or both.

## Example 1 – Item Analysis

This section presents an example of how to run an analysis of the data contained in the Item dataset.

You may follow along here by making the appropriate entries or load the completed template **Example 1** by clicking on Open Example Template from the File menu of the Item Analysis window.

### 1 Open the Item dataset.

- From the File menu of the NCSS Data window, select **Open Example Data**.
- Click on the file **Item.NCSS**.
- Click **Open**.

### 2 Open the Item Analysis window.

- Using the Analysis menu or the Procedure Navigator, find and select the **Item Analysis** procedure.
- On the menus, select **File**, then **New Template**. This will fill the procedure with the default template.

### 3 Specify the variables.

- On the Item Analysis window, select the **Variables tab**.
- Double-click in the **Item Variables** box. This will bring up the variable selection window.
- Select **Item1 to Item4** from the list of variables and then click **Ok**. “Item1-Item4” will appear in the Item Variables box.

### 4 Specify the reports.

- On the Item Analysis window, select the **Reports tab**.
- Check all reports options so that all of the reports will be displayed.

### 5 Run the procedure.

- From the Run menu, select **Run Procedure**. Alternatively, just click the green Run button.

## Reliability Section

Reliability Section			If This Item is Omitted				R2
Variable	Item Values		Total	Total	Coef	Corr	Other
	Mean	Standard Deviation	Mean	Std.Dev.	Alpha	Total	
Item1	1.625	1.147461	6.0625	1.340087	0.0974	0.4932	0.2556
Item2	2.375	0.8850612	5.3125	1.778342	0.4506	0.2171	0.0921
Item3	2	0.6324555	5.6875	1.922455	0.4464	0.2193	0.0869
Item4	1.6875	0.7041543	6	1.897367	0.4583	0.1996	0.1371
Total			7.6875	2.15155	0.4704		

Cronbachs Alpha 0.470447    Std. Cronbachs Alpha 0.444639

This report shows important features of the reliability of the items on the instrument.

### Mean

The item average.

### Standard Deviation

The item standard deviation with divisor (n-1).

### Total Mean

The average total of the other items when this item is ignored.

## Item Analysis

### Total Std.Dev.

The standard deviation of the total of the other items when this item is ignored.

### Coef Alpha

This is the value of Cronbach's alpha when this item is omitted.

### Corr Total

This is the correlation between this item and the total of all other items. If this correlation is high, say greater than 0.95, then this item is redundant and might be omitted.

### R2 Other Items

This is the R-Squared that results if this item is regressed on the other items. If this value is high, say greater than 0.95, then this item is redundant and might be omitted.

### Cronbach's Alpha

Cronbach's alpha (or *coefficient alpha*) is a measure of internal reliability. Since Cronbach's alpha is a correlation, it can range between -1 and 1. In most cases it is positive, although negative values arise occasionally.

What value of alpha should be achieved? Carmines (1990) stipulates that as a rule, a value of at least 0.8 should be achieved for widely used instruments. An instrument's alpha value may be improved by either adding more items or by increasing the average correlation among the items.

### Std. Cronbach's Alpha

If the data are standardized by subtracting the item means and dividing by the item standard deviations before the above formula is used, we obtain the standardized version of Cronbach's alpha.

## Count Distribution Section

### Count Distribution Section

Variable	1	2	3	5
Item1	11	2	2	1
Item2	4	2	10	0
Item3	3	10	3	0
Item4	7	7	2	0
Total	25	21	17	1

This report shows the number of times each response was chosen for each item.

## Percentage Distribution Section

### Percentage Distribution Section

Variable	1	2	3	5
Item1	68.75	12.50	12.50	6.25
Item2	25.00	12.50	62.50	0.00
Item3	18.75	62.50	18.75	0.00
Item4	43.75	43.75	12.50	0.00
Total	39.06	32.81	26.56	1.56

This report shows the percentages of each of the possible responses for each item.

Item Analysis

**Item Detail Section**

Item Detail Section for Item1				
Value	Count	Individual Percent	Cumulative Percent	Percent Bar Chart
1	11	68.75	68.75	
2	2	12.50	81.25	
3	2	12.50	93.75	
5	1	6.25	100.00	
Total	16			

  

Item Detail Section for Item2				
Value	Count	Individual Percent	Cumulative Percent	Percent Bar Chart
1	4	25.00	25.00	
2	2	12.50	37.50	
3	10	62.50	100.00	
5	0	0.00	100.00	
Total	16			

  

Item Detail Section for Item3				
Value	Count	Individual Percent	Cumulative Percent	Percent Bar Chart
1	3	18.75	18.75	
2	10	62.50	81.25	
3	3	18.75	100.00	
5	0	0.00	100.00	
Total	16			

  

Item Detail Section for Item4				
Value	Count	Individual Percent	Cumulative Percent	Percent Bar Chart
1	7	43.75	43.75	
2	7	43.75	87.50	
3	2	12.50	100.00	
5	0	0.00	100.00	
Total	16			

This report provides an individual break down of the responses to each item.

**Correlation Section**

Correlation Section				
	Item1	Item2	Item3	Item4
Item1	1.000000	0.278989	0.275589	0.340351
Item2	0.278989	1.000000	0.119098	-0.013371
Item3	0.275589	0.119098	1.000000	0.000000
Item4	0.340351	-0.013371	0.000000	1.000000
Cronbachs Alpha	0.470447	Std. Cronbachs Alpha	0.444639	

This report presents the correlations between each pair of items.

**Covariance Section**

Covariance Section				
	Item1	Item2	Item3	Item4
Item1	1.316667	0.2833333	0.2	0.275
Item2	0.2833333	0.7833334	6.666667E-02	-8.333334E-03
Item3	0.2	6.666667E-02	0.4	0
Item4	0.275	-8.333334E-03	0	0.4958333
Cronbachs Alpha	0.470447	Std. Cronbachs Alpha	0.444639	

This report presents the covariances between each pair of items.