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 σ_{ij} is the estimated covariance between items i and j. Note the σ_{ii} is the variance (not standard deviation) of item i.

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 by 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.

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

Example 1 – Item Analysis

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

Setup

To run this example, complete the following steps:

1 Open the Item example dataset

- From the File menu of the NCSS Data window, select **Open Example Data**.
- Select **Item** and click **OK**.

2 Specify the Item Analysis procedure options

- Find and open the **Item Analysis** procedure using the menus or the Procedure Navigator.
- The settings for this example are listed below and are stored in the **Example 1** settings file. To load these settings to the procedure window, click **Open Example Settings File** in the Help Center or File menu.

Variables Tab

Item Variables..... **Item1-Item4**

Reports Tab

All Reports Options..... **Checked** (Check all reports options so that all of the reports will be displayed.)

3 Run the procedure

- Click the **Run** button to perform the calculations and generate the output.

Reliability Section

Reliability Section

	Item Values		If This Item is Omitted				
Variable	Mean	Standard Deviation	Total Mean	Total Std.Dev.	Coef Alpha	Corr Total	R2 Other Items
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		

Coefficient Alpha

Cronbach's Alpha	0.470447
Standardized Cronbach's 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.

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 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

<table>
<tr><th>Value</th><th>Count</th><th>Individual Percent</th><th>Cumulative Percent</th><th>Percent Bar Chart</th></tr>
<tr><td>1</td><td>3</td><td>18.75</td><td>18.75</td><td>|||||||||||||</td></tr>
<tr><td>2</td><td>10</td><td>62.50</td><td>81.25</td><td>|||||||||||||||||||||||||||||||||||||||||||</td></tr>
<tr><td>3</td><td>3</td><td>18.75</td><td>100.00</td><td>|||||||||||||</td></tr>
<tr><td>5</td><td>0</td><td>0.00</td><td>100.00</td><td>|</td></tr>
<tr><td>Total</td><td>16</td><td></td><td></td><td></td></tr>
</table>

Item Detail Section for Item4

<table>
<tr><th>Value</th><th>Count</th><th>Individual Percent</th><th>Cumulative Percent</th><th>Percent Bar Chart</th></tr>
<tr><td>1</td><td>7</td><td>43.75</td><td>43.75</td><td>||||||||||||||||||||||||||||||</td></tr>
<tr><td>2</td><td>7</td><td>43.75</td><td>87.50</td><td>||||||||||||||||||||||||||||||</td></tr>
<tr><td>3</td><td>2</td><td>12.50</td><td>100.00</td><td>|||||||||</td></tr>
<tr><td>5</td><td>0</td><td>0.00</td><td>100.00</td><td>|</td></tr>
<tr><td>Total</td><td>16</td><td></td><td></td><td></td></tr>
</table>

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

Coefficient Alpha

Cronbach's Alpha = 0.470447
Standardized Cronbach's 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	0.06666667	-0.008333334
Item3	0.2	0.06666667	0.4	0
Item4	0.275	-0.008333334	0	0.4958333

Coefficient Alpha

Cronbach's Alpha = 0.470447
Standardized Cronbach's Alpha = 0.444639

This report presents the covariances between each pair of items.