Reliability Analysis using R Commander

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Once an instrument is deemed valid (e.g., measuring what its suppose to measure), the next step is to measure its reliability. The term *reliability* refers to the consistency of an instrument over repeated measurements (Malhotra, 2019). Reliability is often determined by measuring the proportion of systematic variation in a scale. Cronbach (1951) developed the alpha statistic as a way to measure reliablity by calculating the average of all possible split-half coefficients. Much has been written about the Cronbach's alpha statistic. The general rule of thumb for acceptable levels can be seen in Table 1.
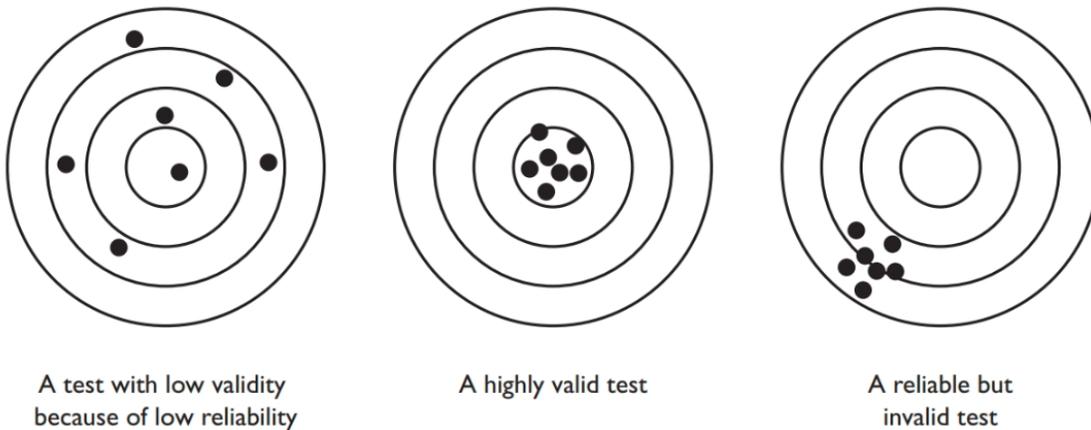
Table 1

Relationship between Cronbach's alpha and Internal Consistency Judgement

Cronbach's Alpha	Internal Consistency
$>.90$	Excellent
.80-.90	Good
.70-.80	Acceptable
.60-.70	Questionable
$<.60$	Poor

The connectiveness between validity and reliability can be illustrated as *hitting the center of a target* (Figure 1; Krathwohl, 2009).

Figure 1

Graphical Illustration of Validity and Reliability

A test with low validity because of low reliability

A highly valid test

A reliable but invalid test

The center bullseye demonstrates both high validity and high reliability. In this case, an instrument measures what it is supposed to measure (shot pattern in the center) and is reliable (the disperson of shots is low).

Conversely, the bullesye on the left displays an instrument with low validity because the dispersion of shots is wide (low reliability). Finally, the bullesye on the right demonstrates a reliable (low disperson) but invalid instrument. The instrument is considered invalid because it is not measuring what it is supposed to measure (center of target).

Assessing Survey Reliability using R Commander

Prior to assessing reliability, data must be loaded into R Commander. For this illustration, data from Smith (2018) was loaded. For a refresher in how to select and load data in R Commander, see Fox (2017, pp. 23-27). Once data is loaded, select the Statistics/Dimensional analysis/Scale reliability menu option (Figure 2).
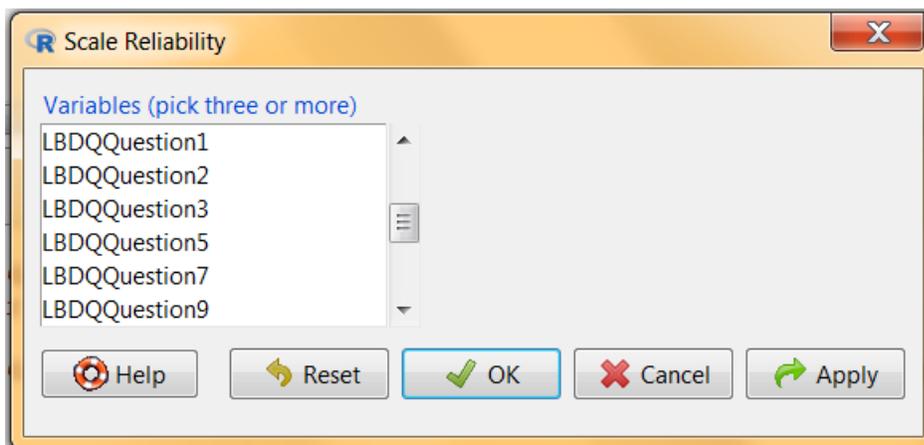
Figure 2

Accessing Scale Reliabilty function in R Commander
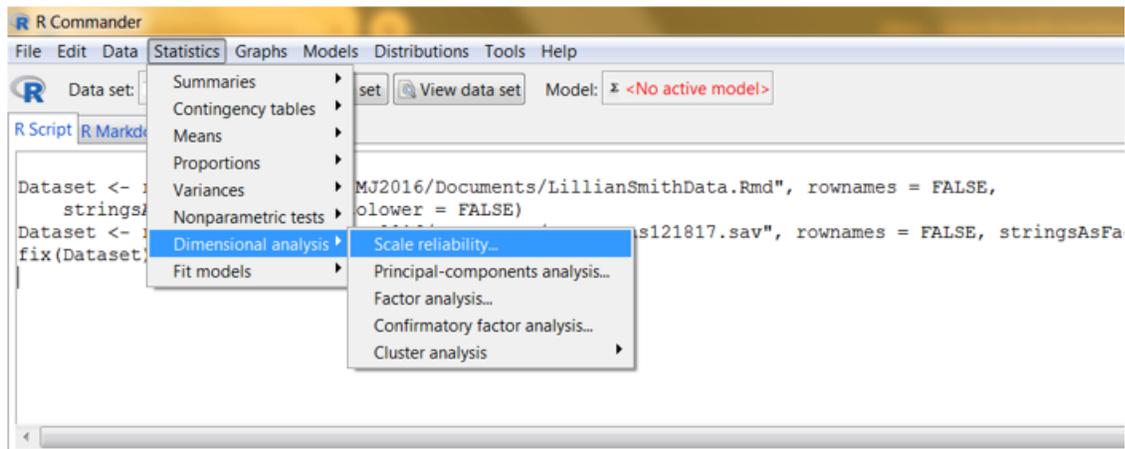
Once selected, a user is offered variables from the selected data set. R Commander displays the first six items in a window. A user must scroll up and down to select the items that align with an *a priori* dimension. A user must select at least three items (Figure 3).
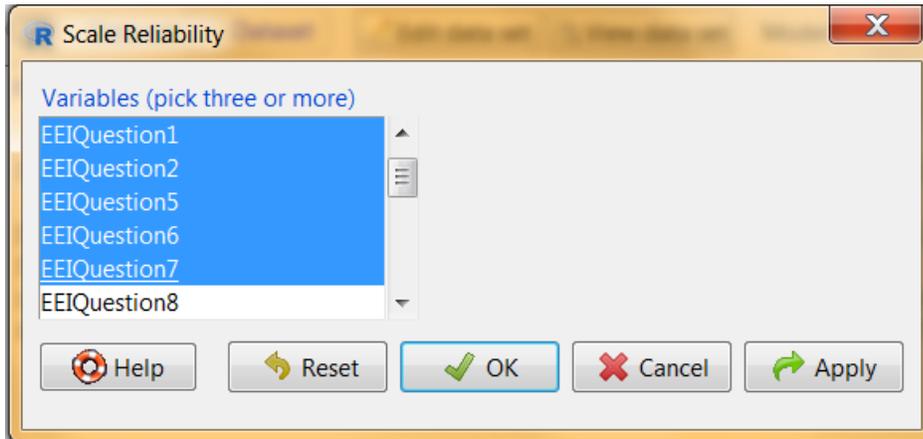
Figure 3

Selecting Variables to Assess in R Commander (pre-selection)

For illustration purposes, the first five items of the six items offered in the variable window are selected (Figure 4).

Figure 4

Selecting Variables to Assess in R Commander (post-selection)

Once the items are selected, pressing *OK* will result in a pre-packaged reliablity analysis being displayed in the Output window (Figure 5).

Figure 5

R Commander Output from Cronbach's Alpha function

```
Output

> reliability(cov(Dataset[, c("EEIQuestion1", "EEIQuestion2", "EEIQuestion5", "EEIQuestion6", "EEIQuestion7")], use = "complete.obs"))
Alpha reliability =  0.7455
Standardized alpha =  0.7534

Reliability deleting each item in turn:
            Alpha Std.Alpha r(item, total)
EEIQuestion1 0.7200    0.7261        0.4564
EEIQuestion2 0.6800    0.6831        0.5709
EEIQuestion5 0.6749    0.6899        0.5771
EEIQuestion6 0.6556    0.6712        0.6254
EEIQuestion7 0.7665    0.7676        0.3595
```

The output lists five specific statitical elementes. First, the overall reliability is displayed (0.7455). This is the Cronbach's alpha statistic based on the selected item's covariance matrix. Second, the standardized alpha statistic is provided (0.7534). Standardized alpha differs from the Cronbach alpha statistic as it based on the selected item's correlation matrix. The standardized alpha is appropriate when items selected have different scales (e.g., combining a 5-point Likert item with a 7-point Likert item). For a detailed discussion of the differences between unstandardized and standardized alpha, see Falk and Savalei (2011).

Next, in table format, three statistics relating to each item are displayed -

- Alpha
- Standardized Alpha
- r(item, total)

These three statistics are displayed for information purposes and can provide valuable information for a researcher. An item's Alpha statistic and Standardized Alpha statistic are the unstandardized and standardized Cronbach's alpha correlation between the item and the total score from the scale (i.e., item-total correlations). Finally, the r(item,total) is the item-total correlation without that item itself (i.e., item-rest correlation or corrected item-total correlation); low item-total correlations indicate that that item doesn't correlate well with the scale overall (Revelle, 2019).

Reporting Results in APA format

Many psychological, personality, and behavioral instruments measure multiple dimensions. For example, the Job Satisfaction Survey (Spector, 1985, 1997, 2001), is a 36-item instrument that measures nine dimensions. When reporting multidimensional instrument reliability, researchers generally use a table, where dimensions, reliablity statistics, and confidence intervals are listed. Prefacing this table is a statement about the overall reliability of the instrument. When a unidimensional instrument is evaluated, reporting survey reliability is generally stated in narrative form, such as -

> A reliability analysis was peformed on the [name] survey instrument. The Cronbach's alpha statistic exceeded .70 ($\alpha = .746$), thus the instrument was deemed reliable.

References

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