What does Cronbach’s alpha mean?

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In other words, Cronbach's alpha is a way to determine the consistency and accuracy of a scale or questionnaire in measuring a specific concept. It is a valuable tool in research as it helps researchers to ensure that their measures are reliable and valid for use in their studies. A higher Cronbach's alpha value indicates a stronger relationship between the items on the scale, providing more confidence in the accuracy of the results. Overall, Cronbach's alpha is a crucial aspect of statistical analysis and interpretation for researchers using SPSS.

What does Cronbach's alpha mean?

Cronbach's alpha is a measure of internal consistency, that is, how closely related a set of items are as a group. It is considered to be a measure of scale reliability. A "high" value for alpha does not imply that the measure is unidimensional. If, in addition to measuring internal consistency, you wish to provide evidence that the scale in question is unidimensional, additional analyses can be performed. Exploratory factor analysis is one method of checking dimensionality. Technically speaking, Cronbach's alpha is not a statistical test - it is a coefficient of reliability (or consistency).

Cronbach's alpha can be written as a function of the number of test items and the

**average inter-correlation
among the items. Below, for conceptual purposes, we show the formula for
the Cronbach's alpha:**

$$ alpha = frac{N bar{c}}{bar{v} + (N-1) bar{c}}$$

Here N is equal to the number of items, $bar{c}$ is the average inter-item covariance among the items and $bar{v}$ equals the average variance.

One can see from this formula that if you increase the number of items, you increase Cronbach's alpha. Additionally, if the average inter-item correlation is low, alpha will be low. As the average inter-item correlation increases, Cronbach's alpha increases as well (holding the number of items constant).

An example

**Let's work through an example of how to compute Cronbach's alpha using SPSS, and how to check the dimensionality
of the scale using factor analysis. For this example, we will use a dataset that contains four test items - q1, q2, q3 and q4. You can download the dataset by clicking on https://stats.idre.ucla.edu/wp-content/uploads/2016/02/a**

lpha.sav.

To compute Cronbach's alpha for all four items - q1, q2, q3, q4 - use the reliability command:

RELIABILITY
/VARIABLES=q1 q2 q3 q4.

Here is the resulting output from the above syntax:

Reliability

```
[DataSet2] D:\documents\spss--alpha_faq\spss_faq.sav
```

Warnings

No SCALE subcommand was found. Scaling will be done on all specified variables.

Scale: ALL VARIABLES

Case Processing Summary

		N	%
Cases	Valid	60	100.0
	Excluded[a]	0	.0
	Total	60	100.0

a. Listwise deletion based on all variables in the procedure.

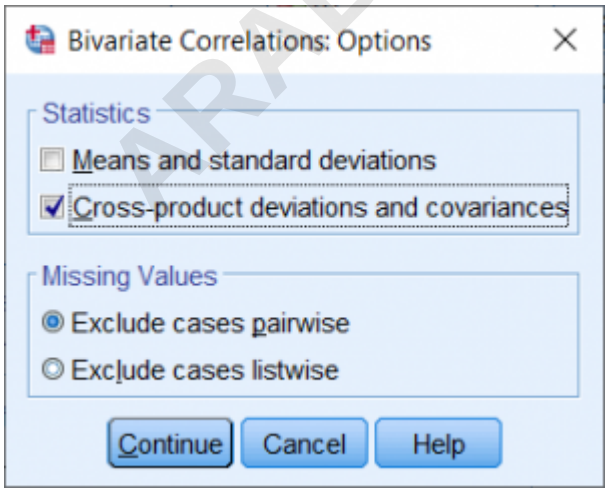
Reliability Statistics

Cronbach's Alpha	N of Items
.839	4

The alpha coefficient for the four items is .839, suggesting that the items have relatively high internal consistency. (Note that a reliability coefficient of .70or higher is considered "acceptable" in most social science research situations.)

Hand calculation of Cronbach's Alpha

For demonstration purposes, here is how to calculate the results above by hand. In SPSS, you can obtain covariances by going to *Analyze - Correlate - Bivariate*. Then shift `q1`, `q2`,`q3` and `q4` to the *Variables* box and click *Options*. Under *Statistics*, check *Cross-product deviations and covariances*. Click Continue and OK to obtain output.



Below you will see a condensed version of the output. Notice that the diagonals (in bold) are the variances and the off-diagonals are the covariances. We only need to consider the covariances on the lower left triangle because this is a symmetric matrix.

q1	q2	q3	q4		
q1	Covariance	**1.168**	.557	.574	.673
q2	Covariance	*.557*	**1.012**	.690	.720
q3	Covariance	*.574*	*.690*	**1.169**	.724
q4	Covariance	*.673*	*.720*	*.724*	**1.291**

Recall that $N=4$ is equal to the number of items, $bar{c}$ is the average inter-item covariance among the items and
$bar{v}$ equals the average variance. Using the information from the table above, we can calculate each of these components via the following:

$$bar{v} = (1.168 + 1.012 + 1.169 + 1.291)/4 = 4.64 / 4 = 1.16.$$

$$bar{c} = (0.557 + 0.574 + 0.690 + 0.673 + 0.720 + 0.724)/6 = 3.938 / 6 = 0.656.$$

$$ alpha = frac{4 (0.656)}{(1.16) + (4-1) (0.656)}=2.624/3.128=0.839.$$

The results match our SPSS obtained Cronbach's Alpha of 0.839.

Checking dimensionality

In addition to computing the alpha coefficient of reliability, we might also want to investigate the dimensionality of the scale. We can use the factor command to do this:

```
FACTOR
/VARIABLES q1 q2 q3 q4
/FORMAT SORT BLANK(.35).
```

Here is the resulting output from the above syntax:

Factor Analysis

Communalities

	Initial	Extraction
q1	1.000	.585
q2	1.000	.721
q3	1.000	.685
q4	1.000	.714

Extraction Method: Principal Component Analysis.

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.706	67.654	67.654	2.706	67.654	67.654
2	.541	13.531	81.185			
3	.400	10.006	91.191			
4	.352	8.809	100.000			

Extraction Method: Principal Component Analysis.

Component Matrix[a]

	Component
	1
q2	.849
q4	.845
q3	.828
q1	.765

Extraction Method: Principal Component Analysis.

a. 1 components extracted.

Looking at the table labeled Total Variance Explained, we see that the eigen value for the first factor is quite a bit larger than the eigen value for the next factor (2.7 versus 0.54).

Additionally, the first factor accounts for 67% of the total variance. This suggests that the scale items are unidimensional.

For more information