Obtaining Reliability Coefficients Using SAS

In this document I explain how to use SAS to obtain reliability coefficients.

The data for these examples are in the SAS dataset "testanx" In this study, test anxiety was measured at three times during the semester in an introductory statistics class. The test anxiety items were administered immediately after a course exam at each time point.

There are 20 test anxiety items at each time point, labeled ta1_1, ta2_2, etc. The first number refers to the administration time and the number after the underscore is the item number. So, item ta1_20 is the 20th item from the scale administered at the first time point. At the end of the dataset are three total scores, total1, total2, and total3. These are the total (sum) scores of the 20 items at times 1, 2 and 3. The items are shown at the end of this document.

Data for these items are in the file "textanx.sas7bdat." The items have been recoded in such a way that a higher value for each item indicates a higher level of test anxiety.

SAS offers several options for calculating reliability coefficients. Your choice will depend on the type of reliability coefficient you want to obtain. Here I explain how to obtain values for coefficient alpha (internal consistency), coefficients of stability (test-retest), and coefficients of equivalence (alternate forms) reliability coefficients.

Coefficients of stability or equivalence can be calculated by simply correlating the two total scores from different time points or test forms. If the total scores have already been entered into your data set, the correlation between them can be obtained using **proc corr**. If the data are entered as answers to individual items, you will first need to compute the total score. Instructions for computing total scores are included at the end of this document.

Coefficient Alpha

To obtain coefficient alpha in SAS, you must have scores on each individual item on the scale, as shown in the testanx dataset.

The following syntax will provide the value of coefficient alpha, the inter-item correlation matrix, the average item variance and inter-item correlation, and values of the corrected item-total correlation and alpha-if-item-deleted for the first 10 test anxiety items at the first time point.

```
proc corr data = testanx alpha noprob nomiss;
 var tai1_1 - tai1_10;
 run;
```

The default output is the inter-item correlation matrix and descriptive statistics (mean, SD, sum, minimum, and maximum) for each variable. To suppress this output, use the option **nosimple**. The option **noprob** will suppress the printing of *p*-values for correlations.

The option **alpha** will provide the value of coefficient alpha, and a table containing values of the corrected item-total correlations and alpha-if-item-deleted. The option **nomiss** requests listwise treatment of missing data, which is needed for computation of alpha.

Cronbach Coefficient Alpha	
Variables	**Alpha**
Raw	0.885963
Standardized	0.886515

The value of coefficient alpha is .886, based on 10 items. The value in the row labeled "Standardized" should only be interpreted if all items are in *z*-score form or another form in which item standard deviations are equal.

Cronbach Coefficient Alpha with Deleted Variable				
	Raw Variables		**Standardized Variables**	
Deleted Variable	**Correlation with Total**	**Alpha**	**Correlation with Total**	**Alpha**
tai1_1	0.598968	0.876542	0.598649	0.876970
tai1_2	0.658479	0.872385	0.657958	0.872726
tai1_3	0.626868	0.874294	0.628610	0.874835
tai1_4	0.690047	0.869706	0.691692	0.870280
tai1_5	0.506988	0.882242	0.510304	0.883166
tai1_6	0.550613	0.879500	0.553721	0.880140
tai1_7	0.708669	0.868520	0.710088	0.868938
tai1_8	0.669090	0.871209	0.664932	0.872222
tai1_9	0.634445	0.873911	0.631663	0.874616
tai1_10	0.557333	0.879656	0.554524	0.880084

The value of alpha, from the previous output, is .886. The numbers in the column labeled "Correlation with total" are the correlation of that item with the corrected total score (the sum of all the items, except the item being correlated). For example, for tai1_1, the correlation with total is the correlation of tai1_1 with the sum of the other nine items.

The values under "Alpha" tell us what the value of alpha would be if that item were not included on the scale. If alpha goes up when an item is left out of the scale, the item does not fit well on the scale because it is resulting in a lower scale reliability. This may be because the item is measuring a somewhat different construct, or a different aspect of the construct. Other reasons for low values are that the item lacks variance or has a distribution that is different from that of most other items.

The values in the columns under "Standardized Variables" should only be interpreted if all items are in z-score form or another form in which item standard deviations are equal.

The items all have moderate to high corrected item-total correlations. In addition, none of the 10 items results in a value of alpha-if-item-deleted that is lower than the overall alpha value of .886. These results are not surprising given the moderate to high values of the inter-item correlations, seen in the correlation matrix below. Coefficient alpha is driven primarily by the level of these correlations, resulting in the high value of .886 for this example.

Pearson Correlation Coefficients, N = 295										
	tai1_1	**tai1_2**	**tai1_3**	**tai1_4**	**tai1_5**	**tai1_6**	**tai1_7**	**tai1_8**	**tai1_9**	**tai1_10**
tai1_1	1.00000	0.47923	0.43551	0.50345	0.31278	0.32998	0.51540	0.45452	0.43302	0.36099
tai1_2	0.47923	1.00000	0.46021	0.49680	0.41374	0.42051	0.47981	0.52099	0.52514	0.37187
tai1_3	0.43551	0.46021	1.00000	0.51886	0.42602	0.37477	0.57046	0.41697	0.42330	0.37303
tai1_4	0.50345	0.49680	0.51886	1.00000	0.41384	0.51210	0.55114	0.51876	0.47721	0.36876
tai1_5	0.31278	0.41374	0.42602	0.41384	1.00000	0.37280	0.43943	0.32345	0.31335	0.28653
tai1_6	0.32998	0.42051	0.37477	0.51210	0.37280	1.00000	0.49733	0.37178	0.31780	0.36358
tai1_7	0.51540	0.47981	0.57046	0.55114	0.43943	0.49733	1.00000	0.52556	0.43407	0.45195
tai1_8	0.45452	0.52099	0.41697	0.51876	0.32345	0.37178	0.52556	1.00000	0.59022	0.48602
tai1_9	0.43302	0.52514	0.42330	0.47721	0.31335	0.31780	0.43407	0.59022	1.00000	0.50268
tai1_10	0.36099	0.37187	0.37303	0.36876	0.28653	0.36358	0.45195	0.48602	0.50268	1.00000

The matrix of intercorrelations among all the items is shown last in the output. Because alpha is determined largely by the magnitude of these correlations, examination of the matrix gives us an idea of how large alpha might be.

Coefficients of Stability

Coefficients of stability, or test-retest reliability coefficients, are simply the correlations of total scores obtained at two different timepoints. There are three total test anxiety scores in this dataset. These were obtained by summing the item scores obtained at each of the three timepoints: after the second, third, and fourth examinations in an introductory statistics class. If total scores are not included in a dataset, these can be obtained by using the instructions under "Obtaining Total Scores" at the end of this document.

Correlations among the three total scores can be obtained using **proc corr.**

```
proc corr data = testanx noprob;
 var total1 total2 total3;
 run;
```

As in the previous commands, the specification **noprob** suppresses the printing of *p*-values.

Pearson Correlation Coefficients Number of Observations			
	total1	**total2**	**total3**
total1	1.00000 295	0.85039 223	0.80639 230
total2	0.85039 223	1.00000 237	0.84878 207
total3	0.80639 230	0.84878 207	1.00000 248

The correlations (stability coefficients) for total1 and total2 and for total2 and total3 are quite high, at .850 and .849, respectively (the numbers below the coefficients are the sample sizes). The coefficient for total1 and total3 is somewhat lower, at .806. This likely reflects the longer time interval between these two scores. Recall that test-retest reliability is affected by the length of time between administration times, with longer intervals typically resulting in lower values of the coefficients.

Pairwise deletion is the default missing data treatment for **proc corr**. In pairwise deletion, cases are included in the computation of the correlation for any pair of variables for which they have complete data. In contrast, in listwise missing data treatment cases are excluded from the computation of all correlations if the cases have missing data on any of the variables.

For example, if a person had missing data for total1 but had data for total2 and total3, under pairwise deletion that person's data would be included in the correlation of total2 and total3, but would not be included in the computation of any other correlations. Under

listwise deletion, the person's data would not be included in the computation of any of the correlations.

To obtain correlations using listwise deletion, use the option **nomiss**.

Coefficients of Equivalence

Coefficients of equivalence are simply the correlations of total scores obtained from two parallel versions, or forms of the same test. Coefficients of equivalence can be obtained in the same way as coefficients of stability, by correlating the total scores from the two forms.

Obtaining Total Scores

For datasets that only include item scores, total scores can be obtained in the *data* step. There are two ways to do this.

The syntax

total = tai1_1 + tai1_2 + tai1_3 + tai1+4 + tai1_5 + tai1_6 + tai1_7 + tai1_8 + tai1_9 + tai1_10**;**

will create the total score only if a respondent has valid (non-missing) scores for each item. Any respondent with a missing value for any of the ten items will receive a missing value for the total.

Alternatively, the syntax

total = sum(of tai1_1 - tai1_10**);**

will create the total score from all items with valid values for each respondent. Thus, if a respondent has only answered 5 of the 10 items, that respondent's total score would be the sum of only the five items without missing values. (Respondents who do not answer any of the items are given missing values for the total score).

Test Anxiety Items

A number of statements that people have used to describe their feelings about taking tests are given below. Please read each statement and then mark the category that indicates how you felt when taking this exam. There are no right or wrong answers. Do not spend too much time on any one statement but give the answer that seems to describe how you felt about taking this test. Use the following codes for your answers:

1 = almost never
2 = sometimes
3 = often
4 = almost always

_____ 1. I feel confident and relaxed while taking tests.
_____ 2. While taking examinations I have an uneasy, upset feeling.
_____ 3. Thinking about my grade in a course interferes with my work on tests.
_____ 4. I freeze up on important exams.
_____ 5. During exams I find myself thinking about whether I'll ever get through school.
_____ 6. The harder I work at taking a test, the more confused I get.
_____ 7. Thoughts of doing poorly interfere with my concentration on tests.
_____ 8. I feel very jittery when taking an important test.
_____ 9. Even when I'm well prepared for a test, I feel very nervous about it.
_____ 10. I start feeling very uneasy just before getting a test paper back.
_____ 11. During tests I feel very tense.
_____ 12. I wish examinations did not bother me so much.
_____ 13. During important tests I am so tense that my stomach gets upset.
_____ 14. I seem to defeat myself while working on important tests.
_____ 15. I feel very panicky when I take an important test.
_____ 16. I worry a great deal before taking an important examination.
_____ 17. During tests I find myself thinking about the consequences of failing.
_____ 18. I feel my heart beating very fast during important tests.
_____ 19. After an exam is over I try to stop worrying about it, but I just can't.
_____ 20. During examinations I get so nervous that I forget facts I really know.