OMEGA

SPSS

```
OMEGA items=list
      (/alpha=[0*][1])
      (/ha=[0*][1])
      (/boot=[0*][value])
      (/conf=[90][95*][99])
      (/subsets=[0*][1])
      (/sort=[1*][2][3])
      (/save=[0*][1])
      (/seed=[random*][value])
      (/decimals=[F7.3*]).
```

SAS

```
%OMEGA (data=filename,items=list
       ,alpha=[0*][1])
       ,ha=[0*][1])
       ,boot=[0*][value])
       ,conf=[90][95*][99])
       ,subsets=[0*][1])
       ,sort=[1*][2][3])
       ,save=[0*][1])
       ,seed=[random*][value])
       ,decimals=[7.3*]);
```

Options in parentheses are not required. Parentheses should not be used in an OMEGA command. Values in brackets are accepted arguments for the option. Brackets should not be typed into an OMEGA command. An OMEGA command should terminate with a period (".")
* Denotes the default if the option is omitted.

Overview

OMEGA generates McDonald's omega (McDonald, 1999) for quantifying the reliability of the sum or average of a set of items used as indicators of a construct in a unidimensional multi-item measurement scale. As discussed in Hayes and Coutts (2020), two methods of estimation are implemented in the OMEGA macro, one based on items loadings and error variances from a forced single-factor maximum likelihood factor analysis, and one based on the closed-form algorithm for estimating factor loadings described in Hancock and An (2020). OMEGA can also calculate various item-analysis statistics, such as reliability when an item is deleted and the average difference in reliability when an item is excluded versus included from all possible subtests that can be constructed from the set of items in the multidimensional measurement scale. An option is available for generating reliability for each possible scale that can be created from a subset of the items as well as the correlation between the sum or average of that subset of items and the scale score when all items are used. This option, useful for constructing brief forms of an existing measurement scale or for item analysis, is discussed in Hayes and Coutts (2020). OMEGA will also calculate Cronbach's alpha (Cronbach, 1951), and various item analysis statistics are also available when choosing α as the reliability measure.

Preparation

OMEGA is available as both a syntax-driven macro and as a custom dialog box (for those who prefer using SPSS' point-and-click graphical user interface for setting up an analysis). When using the syntax version, the omega.sps (omega.sas for SAS) file should be opened and executed. Once it has been opened, the file should be executed as is—do **not** modify the code at all. After execution, the user has access to the OMEGA command until SPSS/SAS is terminated. As the definition of a macro is only temporary, omega.sps (omega.sas) must be executed each time SPSS/SAS is opened. The custom dialog file (OMEGA.spd) can be installed permanently in SPSS.

Example OMEGA Syntax

```
SPSS: omega items=att1 att2 att3 att4 att5.
 SAS: %omega (data=survey,items=att1 att2 att3 att4 att5);
```

- Calculates McDonald's ω from responses to a 5-item multi-item measurement scale that consists of items named att1, att2, att3, att4, att5 in the data.
- ω is calculated using the item loadings and error variances resulting from a forced single factor exploratory factor analysis using maximum likelihood extraction.
- In SAS, the data file being analyzed is named "survey."

```
SPSS: omega items=att1 att2 att3 att4 att5/ha=1/boot=10000/subsets=1.
 SAS: %omega (data=survey,items=att1 att2 att3 att4 att5,ha=1/boot=10000,subsets=1);
```

- Calculates McDonald's ω from responses to a 5-item multi-item measurement scale that consists of items named att1, att2, att3, att4, att5 in the data.
- ω is calculated using the item loadings generated from the HA algorithm described in Hancock & An (2020) and Hayes and Coutts (2020).
- Constructs a 95% bootstrap confidence interval for ω using 10,000 bootstrap samples.
- Generates ω for all possible subsets of at least three items and computes the average gain in reliability when an item is included compared to when it is excluded from a scale.
- In SAS, the data file being analyzed is named "survey."

```
SPSS: omega items=att1 att2 att3 att4 att5/alpha=1/loo=1/stand=1.
 SAS: %omega (data=survey,items=att1 att2 att3 att4 att5,alpha=1,loo=1,stand=1);
```

- Calculates Cronbach's α from responses to a 5-item multi-item measurement scale that consists of items named att1, att2, att3, att4, att5 in the data.
- Implements the leave-one-out approach to item analysis, estimating α when each item is excluded from the scale.
- Generates standardized α (α if the items were all standardized to a common metric with a mean of zero and a standard deviation of 1).
- In SAS, the data file being analyzed is named "survey."

Data Format

The sum or average of a set of items in the measurement theory that justifies omega as a measure of reliability is generally conceptualized as a proxy for the unknown "true score." This true score is a value on a continuum from low to high. The computation of omega (as well as Cronbach's α) implemented in the OMEGA macro assumes that the items or indicators are all scaled consistently with the total score, resulting in correlations between item responses that are positive across all item pairs. Thus, when a multi-item measurement scale contains items that are "reverse-worded" or "reverse-keyed" relative to others, the reverse scoring should be completed prior to giving the data to the OMEGA macro.

Reliability Measure

The OMEGA macro can calculate either McDonald's ω or Cronbach's α. The default is McDonald's ω, which is calculated by estimating the item factor loadings in a maximum likelihood factor analysis (EFA-ML) forcing a single-factor solution (i.e., assuming the items represent a unidimensional scale). From the item loadings, the error variances are constructed (as one minus the items squared factor loading, multiplied by the variance of the item) and ω computed as discussed in McDonald (1999), Hayes and Coutts (2020) and elsewhere. No item analysis statistics (discussed below) are generated by the OMEGA macro when the loadings are estimated with EFA-ML.

An alternative approach to estimation of ω is discussed in Hancock and An (2020) and Hayes and Coutts (2020) and is implemented in the OMEGA macro. Rather than using an iterative factor analysis for estimating item loadings, this alternative, referred to here and in Hayes and Coutts (2020) as the HA algorithm, is a closed-form approach that estimates item loadings using products, ratios, and sums of the covariances of item responses. This approach is not quite as accurate as the EFA-ML approach to the estimation of item loadings, but because the computations are closed-form and can be conducted quickly, it is ideal for bootstrapping a confidence interval for ω as well the computation of various item analysis statistics discussed below. To tell OMEGA to use the HA algorithm rather than EFA-ML when estimating ω, include the **ha** option in the command line, with its argument set to 1 (i.e., **ha=1**). A disadvantage of the HA algorithm is that it can produce estimates of ω greater than 1 or less than 0, and sometimes the loadings can't be constructed when a computation in the algorithm requires taking the square root of a negative number. If the estimate is not in the 0 to 1 range or a computational error resulting from a negative square root occurs, the OMEGA macro displays "-99" for ω and related statistics in the output such as factor loadings.

If requested, the OMEGA macro can also generate Cronbach's α rather than McDonald's ω. Alpha is requested with the use of the **alpha** option, setting its argument to 1 (i.e., **alpha=1**). When this option is used, α is generated in the output rather than ω.

Standardized Reliability

Unless otherwise specified, OMEGA generates an unstandardized measure of reliability of the sum or average of the items. If the scale score to be used in data analysis is constructed as the sum or average of *standardized* items, then standardized reliability is a more appropriate metric of reliability. In addition to unstandardized reliability (as well as factor loadings and error variances), the OMEGA macro will produce a standardized ω or standardized α if so requested through the use of the **stand** option, setting its argument to 1 (i.e., **stand=1**). In addition to standardized ω, the macro will show the standardized item factor loadings and error variances. Standardized reliability, loadings, and error variances are not available for omega when estimated using the HA algorithm.

Item Analysis

The OMEGA macro will generate a few statistics that are useful for making decisions about item inclusion or exclusion when a scale is being developed or when constructing a shortened version of an existing measurement scale. These statistics are generated only when using the HA algorithm for estimating ω or when estimating reliability with Cronbach's α.

Leave-one-out. For each item in the set of items listed in the OMEGA command, the OMEGA macro can calculate the reliability of the sum or average of the items when the item is excluded from the scale. This leave-one-out item analysis statistic is generated in the output through the use of the **loo** option, setting its argument to 1 (**loo=1**), and is available for both ω and α.

All possible subsets of items. The OMEGA macro can generate an estimate of reliability for the sum or average of all possible subsets of items with at least 3 (for omega) or 2 (for α) items from the set of items listed in the OMEGA command. This information is printed in the output with the use of the

subsets option, setting its argument to 1 (i.e., **subsets=1**). As illustrated in Hayes and Coutts (2020), the OMEGA output will produce a table containing as many rows as possible subsets, with entries in the rows set to 0 or 1 under the item column labels indicating whether (1) or not (0) the item is included in the subset. The last two columns of the table contain the estimate of reliability for the subset and the correlation between the sum or average of the items in the subset and the sum or average of all of the items. These two columns can be useful for finding an adequate short or "brief form" of a measurement scale with acceptable reliability but a strong correlation with the scores that result when using all the items. The subsets option will also generate a table showing the average difference in reliability when an item is included in a scale compared to when it is not, calculated from all possible subsets of items. See Hayes and Coutts (2020) for a discussion of the use of **subsets** option.

By default, the rows of the table of subset scales is printed in descending order of reliability (subsets with higher reliability toward the top). This can be changed with the **sort** option. The default argument is 1 (i.e., **sort=1**), for sorting the table by reliability. The table can be printed in descending order of the subset-full scale correlation by specifying **sort=2** in the command line. Alternatively, the table can be sorted by decreasing number of items in the subset using sort option 3 (**sort=3**).

The subsets table produced with the sort option can be saved if desired for further statistical analysis. To do so, use the **save** option, setting its argument to 1 in the command line (i.e., **save=1**). When this option is used, a new data file will be created in the active SPSS session containing all the subsets, reliability, and subset-full scale correlations. This file is not permanent and so should be saved to a storage medium for later analysis if so desired.

Bootstrap Confidence Interval for Reliability

For omega using the HA method as well for Cronbach's α, a confidence interval for reliability can be generated through bootstrapping using the **boot** option, with the number of bootstrap samples specified following an equals sign (e.g., **boot=10000** for 10,000 bootstrap samples; the number of bootstrap samples requested following the equals sign must be at least 1000). The lower and upper endpoints of a 95% confidence interval are constructed using the percentile method, with the lower end and upper ends defined as the 2.5th and 97.5th percentiles of the bootstrap distribution of the estimates of reliability generated when randomly sampling the rows of the data with replacement (or the 5th and 95th, or 0.5th and 99.5th percentiles for 90 and 99% confidence intervals, respectively). These are displayed in the output under the headings "BOOTLLCI" and "BOOTULCI," respectively. The standard deviation of the bootstrap estimates, printed in the output under "BootSE" can be interpreted as an bootstrap estimate of the standard error of reliability. The default level of confidence is 95%. This can be changed with the **conf** option, setting its argument to 90 or 99 (i.e., **conf=90** or **conf=99**).

On occasion, reliability cannot be estimated from a bootstrap sample. When this occurs, the bootstrap sample will be replaced with another bootstrap sample, and the bootstrapping will continue until the requested number of bootstrap estimates is generated or twice as many attempts have been made as the number of bootstrap samples requested. The number of times that a bootstrap sample is replaced during the bootstrapping procedure is displayed at the bottom of the output.

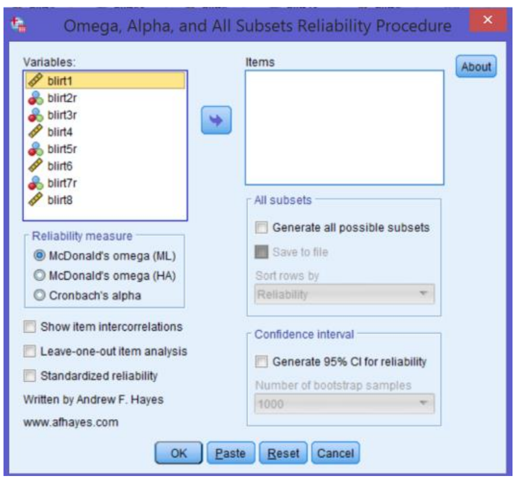
Bootstrap confidence intervals will differ from execution to execution of the same analysis even when nothing else has changed. The more bootstrap samples that are used to construct the interval, the smaller the variation will be between runs. This variation can be eliminated with the use of the **seed** option, which seeds the random number generator used to produce bootstrap samples. Any seed between 1 and 2,000,000,000 can be used in the seed option (e.g., **seed=234654**). By default, OMEGA uses a random number to seed the generator. When the **seed** option is used, the seed will be printed at the bottom of the output.

A confidence interval for reliability is not available for ω using the EFA-ML method for computation.

Numerical Resolution in Output

By default, numerical output is displayed to three digits of resolution following the decimal. This can be adjusted with the use of the **decimals** option. The default in SPSS is "F7.3" meaning that numbers can occupy up to seven characters in a column and three of these are allocated to numbers to the right of the decimal point. To change resolution in the SPSS version, the argument following **decimals** should begin with "F" followed by the number of characters, a decimal point, and the number of characters following the decimal. For example, for six characters and two following the decimal, use decimals=F6.2. The same convention is used in the SAS version, except the F should be left off (e.g., decimals=6.2)

OMEGA Dialog Box



A custom dialog file for OMEGA is available for SPSS users who prefer using the graphical user interface for command execution. Not all functions of OMEGA are available through the dialog box. Administrative access to the computer may be required to install custom dialog files, as may executing SPSS as an administrator. See the SPSS documentation for instructions on the installation of custom dialog files. When successfully installed, the OMEGA option will be nested in the SPSS menu system under "Analyze"→ "Scale"

Notes

- OMEGA uses listwise deletion for exclusion of cases with missing data. There are no built-in procedures to handle missing data other than listwise deletion. OMEGA does not integrate with the multiple imputation routine in SPSS.
- OMEGA does not accept STRING formatted variables . All variables should be NUMERIC format.
- OMEGA may confuse variables in the data file that are the same in the first eight characters of their variable names. To avoid incorrect output, make sure variable names in the data file that are being used in an OMEGA command are unique in the first eight characters.
- If omega or factor loadings cannot be computed when using the HA algorithm, OMEGA will produce "-99" in relevant sections of output.

- “Reverse-keyed” or “Reverse-worded” items should be reverse-scored prior to analysis, such that the correlations between item responses are all positive.

- The meaningfulness of ω and α as measures of the reliability assumes unidimensionality of the item set. Neither of these reliability measures should be interpreted as measures of unidimensionality. Omega or alpha can be large even when the item set is measuring more than one dimension, so high ω and α should not be used as evidence that the item set is measuring only one dimension or factor.

References

Cronbach, L. J. (1951). Coefficient alpha and the internal structure of tests. *Psychometrika, 16*, 297-334.

Hancock, G. R., & An, J. (2020). A closed-form alternative for estimating omega reliability under unidimensionality. *Measurement: Interdisciplinary Research and Perspective, 18,* 1-14.

Hayes, A. F., & Coutts, J. J. (2020). Use omega rather than Cronbach’s alpha for reliability. But… *Communication Methods and Measures, 14,* 1-24.

McDonald, R. P. (1999). *Test theory: A unified treatment.* Mahwah, NJ: Lawrence Erlbaum.