

In some cases, we would like to create a scale using a set of items from our surveys. These items are probably on a 4-point scale (or something like that) or may even be a series of yes/no or true/false questions. This data is typically ordinal and as such, we have a difficult time reporting means and standard deviations and doing various statistics like correlations and tests of group differences.

One possible option is to create a scale that approaches an interval level of measurement. This can be done in a number of ways. Perhaps the strongest method is through the use of Item Response Theory (IRT). However, IRT requires specialized training and software that is not user friendly. These methods also have very difficult to achieve assumptions about the nature of the data.

Other options include the use of reliability analysis, item statistics, and factor analysis. We will use a combination of these approaches to try to gain the strongest outcome possible.

### **SELECTING ITEMS**

The first task is to identify a set of items that you believe constitute a “scale” or are measuring a common trait or characteristic – to create a scale score or total score. Hopefully you have created a set of items prior to the analysis and written items based on some theory or practical understanding of the phenomena you are trying to investigate.

### **RELIABILITY AND ITEM ANALYSIS**

One first approach is to see how these items “behave” when added together. If you were to create a total score by simply adding up the scores on each item (for instance, the 1-4 score for each item), the Reliability procedure in SPSS will tell you the degree to which these scores would be consistent – that is, whether they are internally consistently measuring something. These analyses do not tell you “what” you are measuring, just that whatever you are measuring, you are measuring it consistently.

Here are the procedures for an SPSS Reliability and Item Analysis

Analyze → Scale → Reliability Analysis

Select the items to be included in the scale, click the arrow button to include them in the “Items” box

Click “Statistics” and select “Scale if item deleted” then “continue” and “OK”

OUTPUT FROM SPSS for the 2003 MINNESOTA OPINION SURVEY

R E L I A B I L I T Y    A N A L Y S I S    -    S C A L E    ( A L P H A )

Item-total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item- Total Correlation	Alpha if Item Deleted
ENCOUNTE	10.5342	6.1254	.6474	.8539
HELPING	10.5528	6.0363	.6391	.8553
WALKING	10.3602	6.5069	.6889	.8520
WALKING_	10.5031	5.9266	.7166	.8443
SHOPPING	10.4410	6.3106	.6447	.8545
ATTENDIN	10.5652	5.8598	.6274	.8587
DRIVING	10.5714	6.2589	.6236	.8570

Reliability Coefficients

N of Cases = 161.0

N of Items = 7

Alpha = .8719

This output reports the coefficient Alpha (reliability) to be 0.87 (pretty good). There are 161 cases and 7 items included in the scale. In SPSS, if a person skipped one or more of the questions, they are deleted from the analysis.

It also reports some item analyses, including the “corrected item-total correlation.” This is also known as the “discrimination” index. It tells us if each item, one at a time, is correlated to the scale as a whole – that is, does the item discriminate between people who score high or low on the scale. Another way to think about this is whether or not each question is related to the other questions as a set. The correlations are between 0.62 and 0.72 – very consistent and very high.

Since these questions ask about how an individual’s sense of safety has changed in several different activities since the law was enacted, we might consider the “scale” to be measuring overall change in sense of safety.

Another piece of information is “alpha if item deleted,” which indicates the effect on alpha (improvement or decline) if a specific item were deleted from the scale. As you can see, there are no significant improvements gained from the deletion of any given item.

## FACTOR ANALYSIS

Factor Analysis is a tool used for two primary purposes. Sometimes, there are too many variables and we cannot analyze or include all of the individual variables in the study. So we can find combinations of the variables that provide us with basically the same information. This is using factor analysis for data reduction (which is what SPSS calls it).

A second use is in the creation of measurement instruments. This can tell us whether or not the set of items we have selected actually “hang” together – whether or not it is likely that they are measuring the same trait or characteristic. Basically, what the factor analysis does is evaluate the correlations among the items and answers the question: which items seem to be highly correlated with some items and not others?

Now there are semester long courses on factor analysis because the mathematical models employed are not easy and there are many considerations to make at each step of the analysis. At any rate, a quick simple factor analysis might prove to be informative.

Here are some procedures for an SPSS Factor Analysis

Analyze → Data Reduction → Factor

Select the items you want to factor analyze and click the arrow to send them to the “variables” box

Click “extraction” to select “principle axis factoring” (a long story) & “continue”

Click “rotation” and select “varimax” and “continue”

Click “options” and select “sort by size” and “continue”

Click “OK”

There is a lot of output from a factor analysis, but basically, only one table that will inform us about the scale we are creating.

This is the Rotated Factor Matrix.

## Factor Matrix(a)

Rotated Factor Matrix(a)

	Factor	
	1	2
Magazines	.704	-.014
Radio	.626	-.064
Newspapers	.593	-.005
Internet	.453	-.005
Polls are influential	.125	.050
Polls are accurate	-.001	.892
Polls are reliable	.018	.744

Extraction Method: Principal Axis Factoring. Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 3 iterations.

This is a matrix of each item and their factor loadings on the factors “found” by SPSS. A factor is a trait or characteristic that is responsible for observed scores on the items – technically, this is called a latent trait – we do not directly observe this trait, we only can see it through the scores on items. What is (are) our latent trait(s)?

Factor loadings are the correlation between the item and each factor. So if the loading is higher for one factor than the other, we would say that it belongs to that factor and not the other.

What this tells us is that there is likely a single factor in our “latent” scale.

You can now consider your options: (1) is the reliability analysis strong enough to suggest you can combine items into a single scale, and (2) does the factor analysis supported this idea—can you safely combine these items into one or more scores.

A final consideration addresses the issue of the ordinal nature of the data. If you add variables that are ordinal together, you still have an ordinal measure – although it may look a bit more continuous because there is a greater range in total scores and you might even have something that looks like a normal distribution.

Since you have created a factor analysis of the scores, part of the output is also a factor matrix. This can be used to create a total score by weighting each item based on its factor loading. By weighting in this way, there is a transformation of the total score that occurs which creates something that approaches a interval scale of measurement.

Decide on the final factor structure that you which to use (the items that will be used to create a total scale score) and rerun the factor analysis with one additional step:

Click the option for “scores” and select “save as variables”

What this does is create a factor score for each person based on the items you used in the factor analysis.

Now if you received a result that said you had more than one factor and you still want to consider these items as constituting only one factor, you can force the factor analysis to extract only one factor for the purpose of creating a factor score for each person. Otherwise, you will get as many factor scores for each person as there are factors from the factor analysis.

To force SPSS to extract only one factor for the purpose of computing a single factor score:

Click the option for “extraction” and specify the “number of factors” at 1.

That about does it. Now you have scores for scales that are fairly well analyzed. You might consider doing a final reliability analysis on the items that you end up with in your final score.

Good luck with the rest.