

Principal Components and Factor Analysis

PSY 5102: Advanced Statistics for Psychological and Behavioral Research 2

Goals

- What is factor analysis?
- What are factors?
- Representing factors
 - Graphs and equations
- Extracting factors
 - Methods and criteria
- Interpreting factor structures
 - Factor rotation
- Reliability
 - Cronbach's alpha

When and Why Do We Use Factor Analysis?

- Take many variables and explain them with a few “factors” or “components”
- To see whether different measures are tapping aspects of a common dimension
 - This is similar to canonical correlation in some ways

General Steps in Factor Analysis

- ⦿ Step 1: Select and measure a set of variables in a given domain
- ⦿ Step 2: Screen data in order to prepare the correlation matrix
- ⦿ Step 3: Factor extraction
- ⦿ Step 4: Factor rotation to increase interpretability
- ⦿ Step 5: Interpretation of factors
- ⦿ Further Steps: Validate and determine reliability of the scales

Correlation Matrix

	Talk 1	Social Skills	Interest	Talk 2	Selfish	Liar
Talk 1	1.000					
Social Skills	.772	1.000				
Interest	.646	.879	1.000			
Talk 2	.074	-.120	.054	1.000		
Selfish	-.131	.031	-.101	.441	1.000	
Liar	.068	.012	.110	.261	.277	1.000

- ⦿ In factor analysis, we look to reduce the correlation matrix into smaller sets of *uncorrelated* dimensions

What is a Factor?

- ⦿ If several variables correlate highly, they might measure aspects of a common underlying dimension
 - These dimensions are called factors
- ⦿ Factors are classification axes along which the measures can be plotted
 - The greater the loading of variables on a factor, the more that factor explains relationships between those variables

What is a "Good" Factor?

- A good factor should...
 - Make sense
 - Be easy to interpret
 - Have a simple structure
 - Lack complex loadings

Problems with Factor Analysis

- Unlike many of the other analyses we have covered, there is no statistical criterion to serve as a comparison for the linear combination
- It is more art than science
 - There are a number of extraction methods (e.g., principal-components analysis)
 - There are a number of rotation methods (e.g., Orthogonal, Oblique)
 - Choice of the number of factors to extract
 - Community estimates

Types of Factor Analysis

- Exploratory factor analysis
 - Summarizing data by grouping correlated variables
 - Investigating sets of measured variables related to theoretical constructs
 - Usually done near the onset of research
 - This is the type of factor analysis that we will address

Types of Factor Analysis

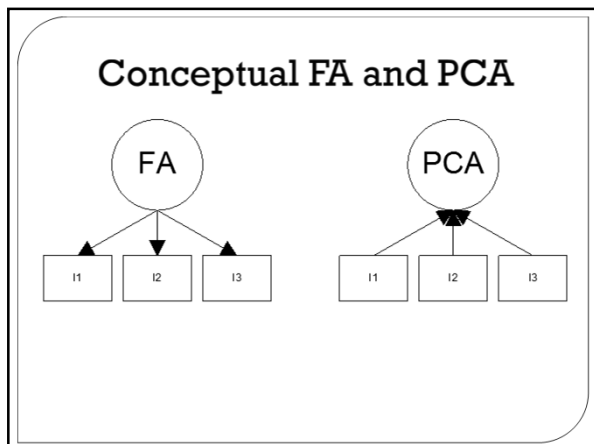
- ◎ **Confirmatory Factor Analysis**
 - More advanced technique
 - When factor structure is known...or at least theorized
 - This basically involves testing the generalization of a factor structure to new data
 - This is tested through Structural Equation Modeling which we will discuss later

Basic Terminology

- ◎ **Orthogonal Rotation**
 - Loading Matrix: correlation between each variable and the factor
- ◎ **Oblique Rotation**
- ◎ **Factor Correlation Matrix: correlations between the factors**
 - Structure Matrix: correlation between factors and variables
 - Pattern Matrix: unique relationship between each factor and variable uncontaminated by overlap between the factors
- ◎ **Factor Coefficient matrix: coefficients used to calculate factor scores (like regression coefficients)**

Factor Analysis vs. Principal-Components Analysis

- ◎ **FA produces factors**
 - PCA produces components
- ◎ **Factors cause variables**
 - Components are aggregates of the variables
- ◎ **FA analyzes only the variance shared among the variables (common variance without error or unique variance)**
 - PCA analyzes all of the variance
- ◎ **FA: "What are the underlying processes that could produce these correlations?"**
 - PCA: Just summarize empirical associations, very data driven

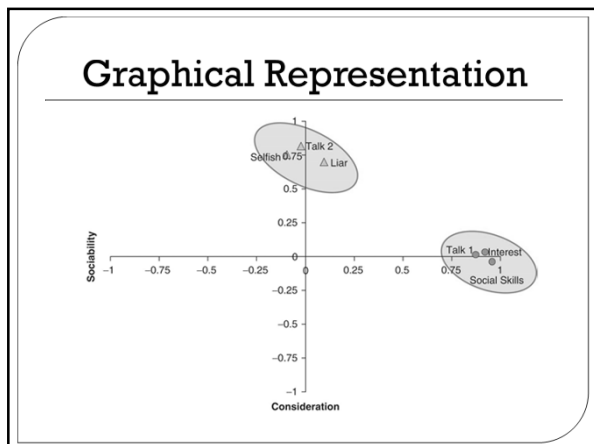


Principal-Components Analysis

- ◉ The goal of principal-components analysis is to identify a new set of a few variables that explain all (or nearly all) of the total variance
 - The goal is parsimony
- ◉ These principal-components are a linear function of the original variables
 - The first principal-component maximizes the amount of variance that is explained
- ◉ Eigenvector: the linear function
 - Their goal is to explain as much variability as possible
 - The number varies between analyses
- ◉ Eigenvalue: the total amount of variance that is explained by an eigenvector

How Many Factors to Extract?

- ◉ There are a number of strategies for deciding when to stop extracting factors or components
 - Percentage of variance that is explained
 - A specific number of factors may be extracted
 - Kaiser's stopping rule: only extracts (and retains) those factors with eigenvalues of at least 1
 - Scree test is a graphical procedure that depicts the eigenvalues



Mathematical Representation

$$Y = b_1X_1 + b_2X_2 \dots b_nX_n$$

$$Factor_i = b_1Variable_1 + b_2Variable_2 \dots b_nVariable_n$$

$$Y = b_1X_1 + b_2X_2 \dots b_nX_n$$

Sociability = b_1 Talk1 + b_2 Social Skills + b_3 Interest
 + b_4 Talk2 + b_5 Selfish + b_6 Liar

Consideration = b_1 Talk1 + b_2 Social Skills + b_3 Interest
 + b_4 Talk2 + b_5 Selfish + b_6 Liar

Factor Loadings

- ⦿ The b values in the equation represent the weights of a variable on a factor
- ⦿ These values are the same as the coordinates on a factor plot
- ⦿ They are called Factor Loadings
- ⦿ These values are stored in a *Factor pattern matrix* (A)

$$A = \begin{pmatrix} 0.87 & 0.01 \\ 0.96 & -0.03 \\ 0.92 & 0.04 \\ 0.00 & 0.82 \\ -0.10 & 0.75 \\ 0.09 & 0.70 \end{pmatrix}$$

Practical Concerns

- How many participants?
 - Subjects-to-variables ratio should be at least 5-to-1 (5 participants for every variable)

The SPSS Anxiety Questionnaire
 23 items that are intended to capture aspects of anxiety concerning statistical analyses

	SD	D	N	A	SA	
1	Statistics make me cry	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
2	My friends will think I'm stupid for not being able to cope with SPSS	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
3	Standard deviations excite me	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
4	I believe that Pearson is attacking me with correlation coefficients	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
5	I don't understand statistics	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
6	I have little experience of computers	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
7	All computers hate me	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
8	I have never been good at mathematics	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
9	My friends are better at statistics than me	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
10	Computers are useful only for playing games	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
11	I did badly at mathematics at school	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
12	People try to tell you that SPSS makes statistics easier to understand but it doesn't	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
13	I worry that I will cause impossible damage because of my incompetence with computers	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
14	Computers have minds of their own and deliberately go wrong whenever I use them	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
15	Computers are out to get me	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
16	I keep spouting at the mention of normal tendency	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
17	I slip into a coma whenever I see an equation	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
18	SPSS always crashes when I try to use it	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
19	Everybody looks at me when I use SPSS	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
20	I can't sleep for thoughts of eigenvalues	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
21	I wake up under my duvet thinking that I am trapped under a normal distribution	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
22	My friends are better at SPSS than I am	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
23	If I am good at statistics people will think I am a nerd	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Initial Considerations

- The quality of analysis depends upon the quality of the data (“Garbage In” → “Garbage Out”)
- Test variables should correlate quite well
 - $r > .3$
- Avoid Multicollinearity:
 - several variables highly correlated, $r > .80$
- Avoid Singularity:
 - some variables perfectly correlated, $r = 1$
- Screen the correlation matrix and eliminate any variables that obviously cause concern

Further Considerations

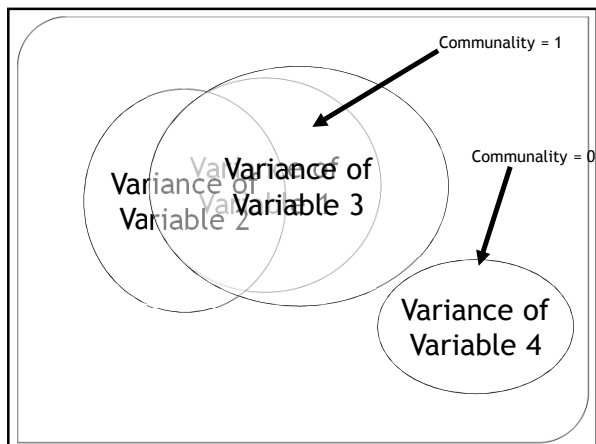
- ⊙ **Determinant:** Indicator of multicollinearity
 - Should be greater than 0.00001
- ⊙ **Kaiser-Meyer-Olkin (KMO):** Measures sampling adequacy
 - Should be greater than 0.5
- ⊙ **Bartlett's Test of Sphericity:** Tests whether the R-matrix is an identity matrix
 - Should be significant at $p < .05$
- ⊙ **Anti-Image Matrix:** Measures of sampling adequacy on diagonal
 - Off-diagonal elements should be small
- ⊙ **Reproduced:** Correlation matrix after rotation
 - Most residuals should be $< |0.05|$

Correlation	001	002	003	004	005	018	000	001	002	003
001	1.000	.099	.237	.438	.402	-.189	.214	.228	.104	.024
002	-.099	1.000	.318	-.112	-.119	.203	-.202	-.205	.231	.100
003	-.237	.318	1.000	-.280	-.370	.342	-.258	-.417	.204	.180
004	.438	-.112	-.280	1.000	.601	-.188	.243	.410	-.088	-.024
005	.402	-.119	-.370	.601	1.000	-.188	.200	.338	-.133	-.042
006	.217	.074	-.227	.278	.287	-.187	.201	.272	-.168	-.089
007	.205	-.189	-.362	.409	.339	-.289	.221	.483	-.169	-.070
008	.331	-.050	-.028	.348	.289	-.189	.176	.286	.079	-.020
009	-.092	.318	.300	-.128	-.096	.249	-.189	-.136	.287	.171
010	.214	-.054	-.189	.216	.288	-.127	.254	.193	-.131	-.062
011	.387	-.144	-.361	.389	.298	-.200	.288	.348	-.162	-.088
012	.348	-.188	.410	.442	.347	-.287	.286	.441	-.187	-.048
013	.388	-.143	-.318	.344	.302	-.227	.204	.374	-.188	-.083
014	.338	-.188	-.371	.381	.319	-.254	.228	.389	-.170	-.048
015	.248	-.188	-.312	.334	.281	-.210	.208	.300	-.188	-.082
016	.499	-.182	-.419	.418	.396	-.287	.288	.421	-.188	-.082
017	.371	-.087	-.327	.383	.310	-.183	.208	.383	-.128	-.092
018	.347	-.184	-.378	.382	.322	-.287	.238	.430	-.180	-.080
000	-.189	.020	.342	-.188	-.188	1.000	-.248	.278	.224	.122
000	.214	-.202	-.328	.243	.200	-.249	1.000	.488	-.100	-.038
001	.328	.228	.417	.410	.328	.278	.488	1.000	.128	-.088
002	-.104	.231	.204	-.098	-.133	.234	-.100	-.129	1.000	.230
003	-.054	.100	.180	-.024	-.042	.100	-.020	-.058	.200	1.000
Big (name)	001	.000	.000	.000	.000	.000	.000	.000	.000	.410
002	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
003	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
004	.000	.000	.000	.000	.000	.000	.000	.000	.000	.443
005	.000	.000	.000	.000	.000	.000	.000	.000	.000	.211
006	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
007	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
008	.000	.008	.000	.000	.000	.000	.000	.000	.000	.008
009	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
010	.000	.000	.000	.000	.000	.000	.000	.000	.000	.001
011	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
012	.000	.000	.000	.000	.000	.000	.000	.000	.000	.008
013	.000	.000	.000	.000	.000	.000	.000	.000	.000	.004
014	.000	.000	.000	.000	.000	.000	.000	.000	.000	.021
015	.000	.000	.000	.000	.000	.000	.000	.000	.000	.001
016	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
017	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
018	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
019	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
020	.000	.000	.000	.000	.000	.000	.000	.000	.000	.008
021	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
022	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
023	.410	.000	.000	.000	.000	.000	.000	.000	.000	.000

R Determinant = 5.2718E-04

Finding Factors: Community

- ⊙ **Common Variance:**
 - Variance that a variable shares with other variables
- ⊙ **Unique Variance:**
 - Variance that is unique to a particular variable
- ⊙ **The proportion of common variance in a variable is called the communality**
 - Communality = 1, All variance shared
 - Communality = 0, No variance shared
 - $0 < \text{Communality} < 1$ = Some variance shared



Finding Factors

- ◎ We find factors by calculating the amount of common variance
 - Circularity
- ◎ Principal Components Analysis:
 - Assume all variance is shared
 - All communalities = 1
- ◎ Factor Analysis
 - Estimate communality
 - Use squared multiple correlation (SMC)
- ◎ Principal Components and Factor Analysis will identify similar factors when there are a large number of variables (i.e., more than 30) and the communalities are high (i.e., greater than .7)

	Initial	Extraction
Q01	1.000	.435
Q02	1.000	.414
Q03	1.000	.530
Q04	1.000	.469
Q05	1.000	.343
Q06	1.000	.654
Q07	1.000	.545
Q08	1.000	.739
Q09	1.000	.484
Q10	1.000	.335
Q11	1.000	.690
Q12	1.000	.513
Q13	1.000	.536
Q14	1.000	.488
Q15	1.000	.378
Q16	1.000	.487
Q17	1.000	.683
Q18	1.000	.597
Q19	1.000	.343
Q20	1.000	.484
Q21	1.000	.550
Q22	1.000	.464
Q23	1.000	.412

Extraction Method: Principal Component

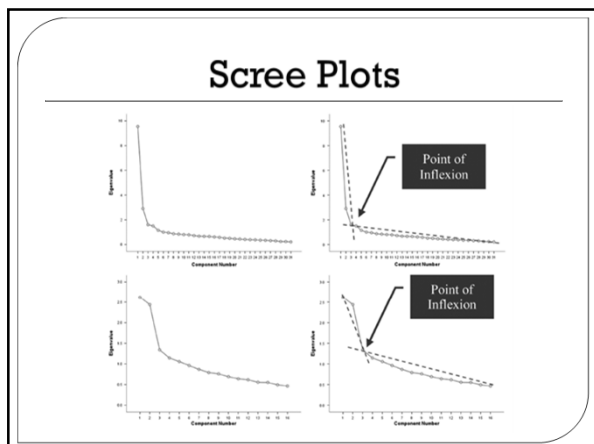
Factor Extraction

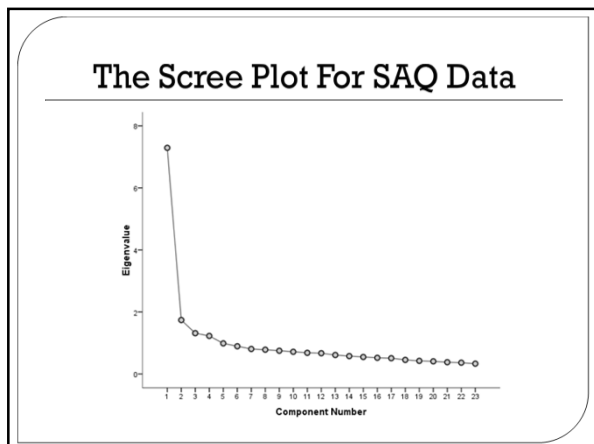
- **Kaiser's Extraction**
 - Kaiser (1960): retain factors with Eigenvalues > 1
- **Scree Plot**
 - Cattell (1966): use 'point of inflexion' of the scree plot
- **Which Rule?**
 - Use Kaiser's Extraction when
 - less than 30 variables, communalities after extraction > 0.7
 - sample size > 250 and mean communality ≥ 0.6
 - Scree plot is good if sample size is > 200

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	7.290	31.696	31.696	7.290	31.696	31.696	3.730	16.219	16.219
2	1.739	7.560	39.256	1.739	7.560	39.256	3.340	14.523	30.742
3	1.317	5.725	44.981	1.317	5.725	44.981	2.553	11.099	41.842
4	1.227	5.330	50.317	1.227	5.330	50.317	1.949	8.475	50.317
5	.988	4.295	54.612						
6	.895	3.893	58.504						
7	.806	3.502	62.007						
8	.753	3.404	65.410						
9	.751	3.265	68.676						
10	.717	3.117	71.793						
11	.684	2.972	74.765						
12	.670	2.911	77.676						
13	.612	2.661	80.337						
14	.578	2.512	82.849						
15	.549	2.388	85.236						
16	.523	2.275	87.511						
17	.508	2.210	89.721						
18	.456	1.982	91.704						
19	.424	1.843	93.546						
20	.408	1.773	95.319						
21	.379	1.650	96.969						
22	.364	1.583	98.552						
23	.333	1.448	100.000						

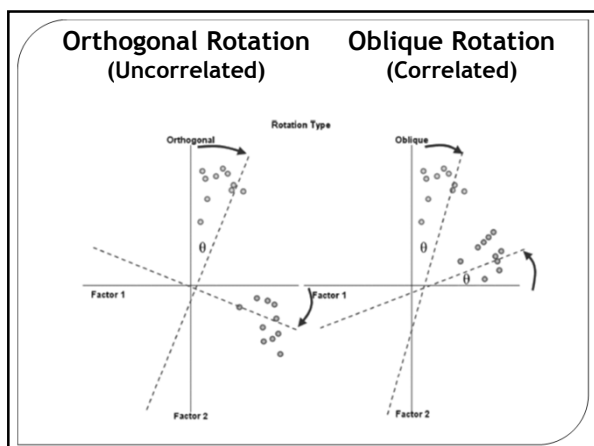
Extraction Method: Principal Component Analysis.





Rotation

- ◉ To aid interpretation it is possible to maximize the loading of a variable on one factor while minimizing its loading on all other factors
- ◉ This is known as Factor Rotation
- ◉ There are two types
 - Orthogonal (factors are uncorrelated)
 - Oblique (factors intercorrelate)



Before Rotation

Component Matrix				
	Component			
	1	2	3	4
Q18	.701			
Q07	.655			
Q16	.679			
Q13	.673			
Q12	.669			
Q21	.658			
Q14	.656			
Q11	.662			-.400
Q17	.543			
Q04	.634			
Q03	-.029			
Q15	.593			
Q01	.396			
Q05	.555			
Q08	.549	.401		-.417
Q10	.437			
Q20	.408		-.404	
Q19	-.427			
Q09	.627			
Q02	.548			
Q22	-.405			
Q06	.562		.571	
Q23				.507

Extraction Method: Principal Component Analysis.
a. 4 components extracted.

Orthogonal Rotation

Rotated Component Matrix*				
	Component			
	1	2	3	4
I have little experience of computers	.800			
SPSS makes crashes when I try to use it	.654			
I worry that I will cause irreparable damage because of my incompetence with computers	.647			
All computers hate me	.630			
Computers hate things of their own and deliberately go wrong whenever I use them	.576			
Computers are useful only for playing games	.650			
Computers are out to get me	.489			
I can't sleep for thoughts of eigen vectors		.677		
I feel so under my duet thinking that I am trapped under a normal distribution		.661		
Standard deviations excite me		-.567		
People try to tell you that SPSS makes statistics easier to understand but I object	.473	.623		
I dream that Pearson is attacking me with correlation coefficients		.616		
I sleep openly at the mention of central tendency		.614		
Statistics makes me cry		.496		
I don't understand statistics		.429		
I have never been good at mathematics			.633	
I slip into a coma whenever I see an equation			.747	
I feel sorry at mathematics at school			.747	
My friends are better at statistics than me				.645
My friends are better at SPSS than I am				.646
If I'm good at statistics my friends will think I'm a nerd				.568
My friends will think I'm stupid for not being able to code with SPSS				.842
Everybody looks at me when I use SPSS				.427

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
a. Rotation converged in 9 iterations.

Oblique Rotation

Pattern Matrix*				
	Component			
	1	2	3	4
I can't sleep for thoughts of eigen vectors	.708			
I feel so under my duet thinking that I am trapped under a normal distribution	.891			
Standard deviations excite me	-.616			
I dream that Pearson is attacking me with correlation coefficients	.405			
I sleep openly at the mention of central tendency	.400			
Statistics makes me cry				
I don't understand statistics				
My friends are better at SPSS than I am		.643		
My friends are better at statistics than me		.621		
If I'm good at statistics my friends will think I'm a nerd		.616		
My friends will think I'm stupid for not being able to code with SPSS		.827		
Everybody looks at me when I use SPSS				.888
I have little experience of computers				.713
SPSS makes crashes when I try to use it				.693
All computers hate me				.660
I worry that I will cause irreparable damage because of my incompetence with computers				.660
Computers hate things of their own and deliberately go wrong whenever I use them				.632
Computers are useful only for playing games				.653
People try to tell you that SPSS makes statistics easier to understand but I object		.412		.462
Computers are out to get me				.411
I can't sleep for thoughts of mathematics				-.802
I slip into a coma whenever I see an equation				-.174
I feel sorry at mathematics at school				-.174

Extraction Method: Principal Component Analysis.
Rotation Method: Oblimin with Kaiser Normalization.
a. Rotation converged in 23 iterations.

What Do the Factors Represent?

- We assume that algebraic factors represent psychological constructs
 - Factor 1: Fear of statistics (e.g., "I can't sleep for thoughts of eigenvectors")
 - Factor 2: Fear of peer evaluation (e.g., "My friends are better at statistics than me")
 - Factor 3: Fear of computers(e.g., "All computers hate me")
 - Factor 4: Fear of mathematics (e.g., "I have never been good at mathematics")
- The nature of these psychological dimensions is 'guessed at' by looking at the loadings for a factor
- There is no way to "know" what the factor represents...rather we have to decide ourselves
 - The same set of items may be referred to as "social dominance" by one researcher but "aggression" by another

Reliability

- Test-Retest Method
 - Complete the same measure on two occasions and calculates the correlation
- Alternate Form Method
 - Complete two slightly different forms of the same measure and calculates the correlation
- Split-Half Method
 - Splits the questionnaire into two random halves and calculates the correlation
- Cronbach's Alpha
 - Basically splits the questionnaire into all possible halves, calculates the scores, correlates them, and averages the correlation for all splits
 - Ranges from 0 (no reliability) to 1 (complete reliability)

Interpreting Cronbach's Alpha

- Kline (1999)
 - Reliable if $\alpha > .7$
- Depends on the number of items
 - More questions = bigger α
- Treat Subscales separately
- Remember to reverse score reverse phrased items!
 - If not, α is reduced and can even be negative

Reliability for Fear of Statistics Subscale

Item-Total Statistics					
	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
Statistics makes me cry	21.76	21.442	.539	.343	.602
Standard deviations excite me	20.72	19.825	.549	.309	.600
I dream that Pearson is attacking me with correlation coefficients	21.35	20.410	.575	.355	.796
I don't understand statistics	21.41	20.942	.494	.272	.607
People try to tell you that SPSS makes statistics easier to understand but it doesn't	20.97	20.639	.572	.337	.796
I weep openly at the mention of central tendency	21.25	20.451	.597	.389	.793
I can't sleep for thoughts of eigen vectors	20.51	21.176	.419	.244	.618
I wake up under my duvet thinking that I am trapped under a normal distribution	20.86	19.939	.606	.399	.791

Reliability Statistics		
Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.821	.823	8

Reliability for the Fear of Peer Evaluation Subscale

Item-Total Statistics					
	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
My friends will think I'm stupid for not being able to cope with SPSS	11.46	8.119	.339	.134	.515
My friends are better at statistics than me	10.24	6.395	.391	.167	.476
Everybody looks at me when I use SPSS	10.79	7.381	.316	.108	.522
My friends are better at SPSS than I am	10.20	7.282	.378	.144	.487
If I'm good at statistics my friends will think I'm a nerd	9.65	7.938	.239	.069	.563

Reliability Statistics		
Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.570	.572	5

Reliability for Fear of Computers Subscale

Item-Total Statistics					
	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
I have little experience of computers	15.67	17.814	.619	.396	.791
All computers hate me	15.17	17.727	.619	.385	.789
Computers are useful only for playing games	15.81	20.736	.400	.167	.624
I worry that will cause irreparable damage because of my incompetence with computers	15.64	16.809	.607	.384	.784
Computers have minds of their own and deliberately go wrong whenever I use them	15.22	18.719	.577	.350	.788
Computers are out to get me	15.33	19.322	.491	.250	.612
SPSS always crashes when I try to use it	15.52	17.832	.647	.447	.786

Reliability Statistics		
Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.823	.821	7

Reliability for Fear of Mathematics Subscale

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
I have never been good at mathematics	4.72	2.470	.684	.470	.740
I did badly at mathematics at school	4.70	2.453	.682	.467	.742
I slip into a coma whenever I see an equation	4.49	2.504	.652	.425	.772

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.819	.819	3
