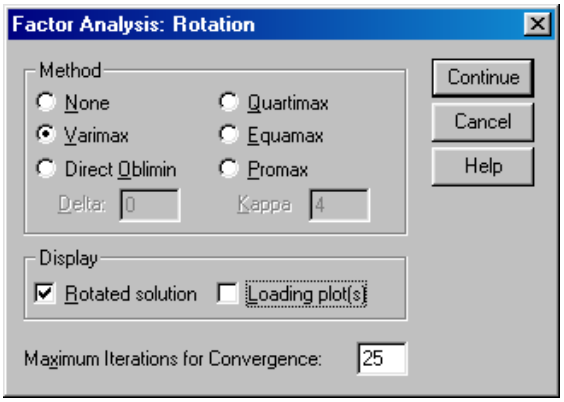
Factor Rotation

Back to the adolescent data -- let's look at different rotations of the three factors with $\lambda > 1.00$.

Varimax rotation

- tends to produce multiple group factors
- maintaining orthogonality often results in increased multivocality (loadings of variables on "primary factors" is decreased a bit and loadings on "secondary factors" is raised a bit)



It is easy and reasonable to criticize orthogonal rotations for being "simplistic" or "artificial". After all, most things we study are at least somewhat related. For example, if I told you that I had several anxiety and several depression measures and that they factored into 2 factors , you'd not be surprised. But if I told you that the two factors were "depression" and "anxiety," you'd not be surprised. If I told you that those 2 factors were uncorrelated, you'd probably be surprised.

Oblique solution help to reduce this artificiality.

Total Variance Explained

	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.048	38.097	38.097	3.048	38.097	38.097	2.304	28.798	28.798
2	1.709	21.363	59.459	1.709	21.363	59.459	2.093	26.163	54.961
3	1.340	16.746	76.205	1.340	16.746	76.205	1.699	21.244	76.205
4	.636	7.953	84.158						
5	.483	6.036	90.194						
6	.340	4.244	94.438						
7	.240	3.000	97.438						
8	.205	2.562	100.000						

Extraction Method: Principal Component Analysis.

Notce the variance "spreads out" across the 3 factors with this rotation -- common with Varimax.

- "sad" is a classic example of increased simple structure → goes from multivocal to univocal
  - so do several others
- note however, "extreme verbal abuse" → goes from univocal to multivocal
  - seems it would be very important to properly interpret why this variable is multi-vocal!

Component Matrix[a]

	Component		
	1	2	3
physical aggression	.758	.413	1.164E-03
property damage	.693	.489	-.199
theft	.362	.656	-.204
extreme verbal abuse	.826	6.589E-02	.235
sad	.540	-.510	.441
anxious	.654	-.335	.507
self-confidence	-.349	.539	.669
compliance	-.580	.450	.551

Extraction Method: Principal Component Analysis.

a. 3 components extracted.

Rotated Component Matrix[a]

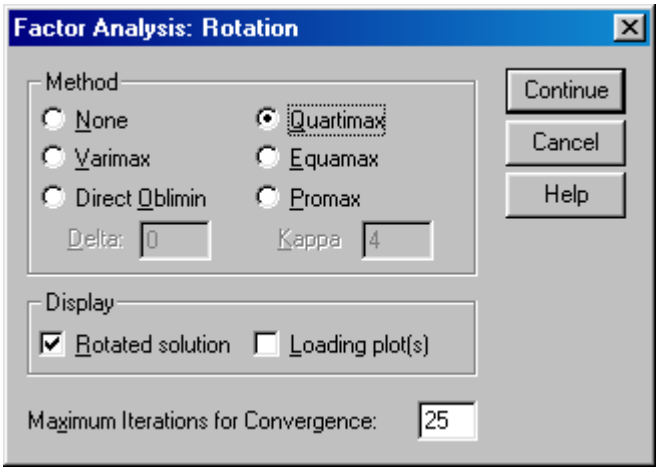
	Component		
	1	2	3
physical aggression	.807	.301	-6.51E-02
property damage	.853	9.875E-02	-.148
theft	.751	-.186	6.583E-02
extreme verbal abuse	.562	.645	-.105
sad	-8.06E-02	.846	-.155
anxious	.110	.884	-5.44E-02
self-confidence	3.339E-02	-2.60E-02	.927
compliance	-.165	-.209	.879

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 4 iterations.

Quartimax rotation

- tends to produce a general factor and additional smaller multiple group factors



- Quartimax rotation won't make strong group factors "go away"
- but you know you have a weak factor structure if varimax & quqrtimax give importantly different solutions

- one source of a weak factor structure that gives different solutions from different rotations is over factoring

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	3.048	38.097	38.097	3.048	38.097	38.097	2.337	29.214	29.214
2	1.709	21.363	59.459	1.709	21.363	59.459	2.083	26.040	55.254
3	1.340	16.746	76.205	1.340	16.746	76.205	1.676	20.951	76.205
4	.636	7.953	84.158						
5	.483	6.036	90.194						
6	.340	4.244	94.438						
7	.240	3.000	97.438						
8	.205	2.562	100.000						

Extraction Method: Principal Component Analysis.

Still got some "spreading around" of the variance across the factors -- looks much the same as the varimax

- Pretty strong sign for "group factors" → got them from both varimax and quartimax
- Remember, "strong" solutions won't be "hidden" by the rotation you select

Component Matrix[a]

	Component		
	1	2	3
physical aggression	.758	.413	1.164E-03
property damage	.693	.489	-.199
theft	.362	.656	-.204
extreme verbal abuse	.826	6.589E-02	.235
sad	.540	-.510	.441
anxious	.654	-.335	.507
self-confidence	-.349	.539	.669
compliance	-.580	.450	.551

Extraction Method: Principal Component Analysis.

a. 3 components extracted.

Rotated Component Matrix[a]

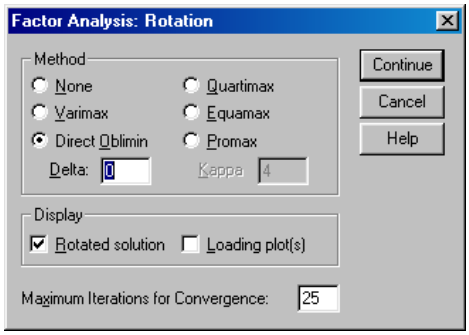
	Component		
	1	2	3
physical aggression	.814	.285	-4.99E-02
property damage	.856	8.321E-02	-.135
theft	.746	-.203	7.244E-02
extreme verbal abuse	.576	.634	-8.73E-02
sad	-6.10E-02	.850	-.142
anxious	.129	.882	-3.86E-02
self-confidence	2.063E-02	-4.15E-02	.927
compliance	-.181	-.220	.873

Extraction Method: Principal Component Analysis.
Rotation Method: Quartimax with Kaiser Normalization.

a. Rotation converged in 4 iterations.

Direct Oblimin rotation

- Tends to produce varimax-looking factors, but which are oblique



Delta is a parameter that "controls" the extent of obliqueness amongst the factors.

- Negative values "decrease" factor correlations
- "0" is the default
- Positive values (don't go over .8) "permit" additional factor correlation

When you do an oblique rotation you get two different matrices that can be used for interpretation:

- the **structure** matrix holds the correlations between each variable and each factor (same as with orthogonal rotations)
- the **pattern** matrix holds the beta weights to reproduce variable scores from factor scores

There is considerable disagreement about which of these is the better basis for factor interpretation:

- Those who like using the structure matrix point out the long history of naming or interpreting factors (and other composite variables -- ldf, canonical correlation) in terms of the "variables with which they correlate."
- Those who like using the pattern matrix point out that there is often "simpler structure" in the pattern matrix
- Those who like using the structure matrix point out that the apparent "simpler structure" (i.e., fewer multivocal items) in the pattern matrix is an illusion, made possible because of the correction for collinearity by the beta weights.
- Typically, the interpretation based on the two matrices will be similar …

Delta = 0

Pattern Matrix[a]

	Component		
	1	2	3
physical aggression	.241	.787	-1.36E-02
property damage	1.783E-02	.848	-.119
theft	-.240	.779	6.824E-02
extreme verbal abuse	.608	.507	-2.52E-02
sad	.858	-.163	-7.26E-02
anxious	.896	3.050E-02	3.954E-02
self-confidence	9.405E-02	7.397E-02	.949
compliance	-8.61E-02	-.113	.875

Extraction Method: Principal Component Analysis.
Rotation Method: Oblimin with Kaiser Normalization.

a. Rotation converged in 9 iterations.

Structure Matrix

	Component		
	1	2	3
physical aggression	.379	.829	-.146
property damage	.191	.862	-.203
theft	-.123	.731	.051
extreme verbal abuse	.701	.613	-.218
sad	.847	-.010	-.261
anxious	.891	.180	-.176
self-confidence	-.118	.000	.919
compliance	-.313	-.211	.906

Extraction Method: Principal Component Analysis.
Rotation Method: Oblimin with Kaiser Normalization.

Promax Rotation

- An oblique rotation that tends to produce group factors that look like Direct Oblimin & Varimax
- Promax computations are more much quicker, so it is commonly used with very large factorings