Advanced Experimental Design
Psych 464
Jeffrey D. Leitzel, Ph.D.

Factor Analysis

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Outline/overview

- Applications of Factor Analysis
- Types of Factor Analysis (EFA vs. CFA)
- Terminology/Concepts
  - Factor loadings
  - Communality
  - Eigenvalues
- Rotation
- Art of interpretation
- Dataset concerns
- Example(s)

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Factor analysis

- widely used (and misused) multivariate technique
- salvage poorly planned and executed research
- fertile ground for "fishing expeditions"
- assumption - smaller number of dimensions underlying relations in the data

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Uses of Factor Analysis

- 1. data reduction
  - large number of variables
  - reduce to smaller number of dimensions
- 2. select a subset of variables
  - composite measure
  - drop those that don't fit
- 3. multicollinearity in multiple regression
  - combine highly correlated predictors
  - create uncorrelated factors to use as predictors
- 4. scale/index construction/validation
  - have ideas about areas of domain
  - construct items to measure each
  - determine whether items selected represent coherent constructs

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Simple structure

- want items in scales that represent only one factor per item
- items representing more than one factor are factorially complex
- generally drop these items during the measure construction phase

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Exploratory vs. Confirmatory

- EFA: any indicator can be associated with any/all other factors
- no restrictions on loadings
- CFA: determine whether the number of factors and the loadings conform with what is expected
- do items purported to measure a factor or latent construct actually belong together?

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Terminology - components vs. factors

- principal components analysis yields components
- principal axis factoring yields factors
- will use factors and components interchangeably

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Principal Components Analysis

- most commonly used form of factor analysis
- seeks linear combination of variables that extracts the maximum variance
- this variance is removed and the process is repeated

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Principal Axis Factoring

- same strategy
- operates only with the common variance
- seeks the smallest # of factors that can account for common variance
- PCA tries to account for common and unique variance

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Factor loadings

- correlations between the items and the factors
- squared factor loading is the % of variance in that variable that can be explained by the factor
- in PCA it is labeled the component matrix, in PAF the factor matrix, with an oblique rotation called the pattern matrix.

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Communality

- h^2
- squared multiple correlation for a variable using all factors as predictors
- % of variance in the variable that can be explained by all factors

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Eigenvalues

- a.k.a. characteristic roots
- reflect variance in all variables accounted for by each factor
- sum of the squared factor loadings
- Eigenvalue/# variables = proportion of variance explained by a factor

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Criteria for # of factors to retain:

- 1. Kaiser criterion - keep all with eigenvalues greater than or equal to 1.0
- 2. scree test - plot components on x axis and eigenvalues on y axis
  - where plot levels off the "scree" has occurred
  - keep all factors prior to leveling
  - criticized as generally selecting too few factors
- 3. Comprehensibility - a non mathematical criterion
  - retain factors that can be reasonably interpreted
  - fit with the underlying theory
- ideally, retained factors account for 60 and preferably 75% of variance

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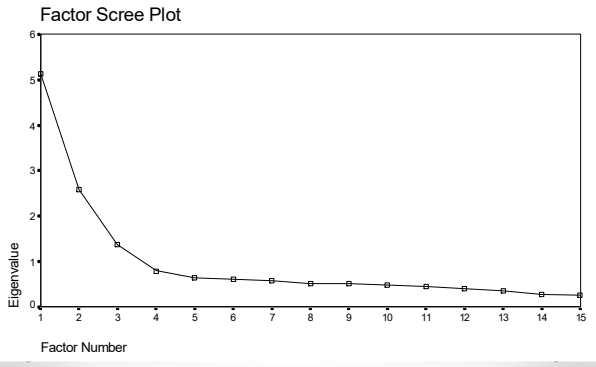
Scree test



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Rotation

- facilitates interpretation
- unrotated solutions: variables have similar loadings on two or more factors
- makes hard to interpret which variables belong to which factor

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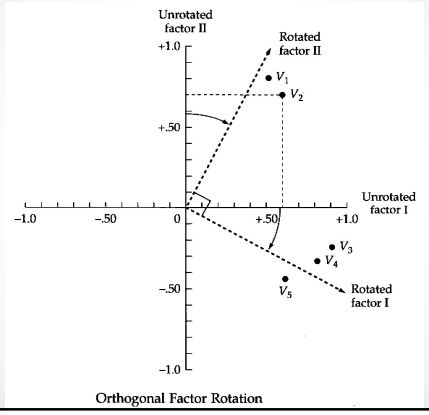
Orthogonal rotation



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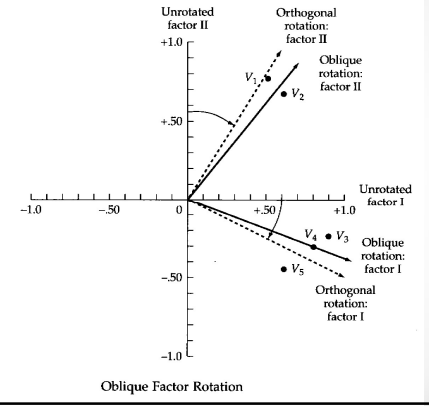
Oblique rotation



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Rotated and Unrotated Factor Loadings

	Unrotated Factor Loadings		Rotated Factor Loadings	
Variables	I	II	I	II
V1	.50	.80	.03	.94
V2	.60	.70	.16	.90
V3	.90	-.25	.95	.24
V4	.80	-.30	.84	.15
V5	.60	-.50	.76	.13

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Types of rotation

- Varimax rotation
  - most commonly used
  - uncorrelated factors
- Oblimin
  - an oblique rotation
  - allows factors to be correlated
  - does not mean they will be
- There are many others

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When to use oblique rotation?

- constructs not reasonably expected to be uncorrelated
- unsure, request oblique rotation and examine factor correlation matrix, if correlations exceed .32 oblique warranted

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How many…?

- …cases?
  - many "rules" (in order of popularity)
    - 10 cases per item in the instrument
    - subjects to variables ratio of no less than 5
    - 5 times the number of variables or 100
    - minimum of 200 cases, regardless of stv ratio
- …variables?
  - constructing a scale start with large number of items
  - measure domains with "best indicators" want at least 3 indicators of each
  - more indicators = greater reliability of measurement

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Interpreting loadings

- minimum cut-off is .3
- .4 or below is considered weak
- .6 and above is considered strong
- moderate at all points in between
- Guidelines from Comrey and Lee (1992)
  - .71 excellent
  - .63 very good
  - .55 good
  - .45 fair
  - .32 poor

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Final considerations

- Size of loadings effected by
  - homogeneity of the sample
  - restricted range
    - correlations will be lower
    - smaller loadings worth attention
- Naming factors
  - descriptive names for the factors
  - very important part of process
  - fitting findings into informational network of the field

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