

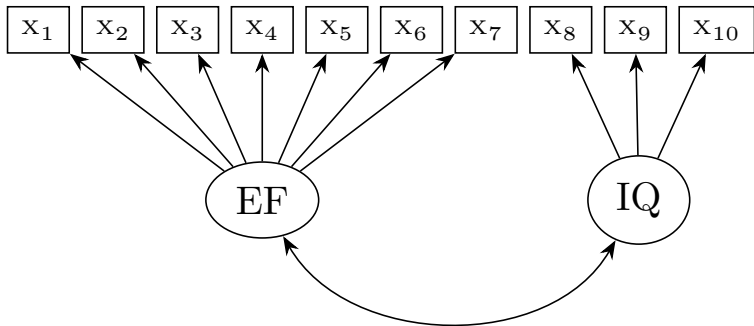
# Statistical Analysis Using Structural Equation Models

EPsy 8266

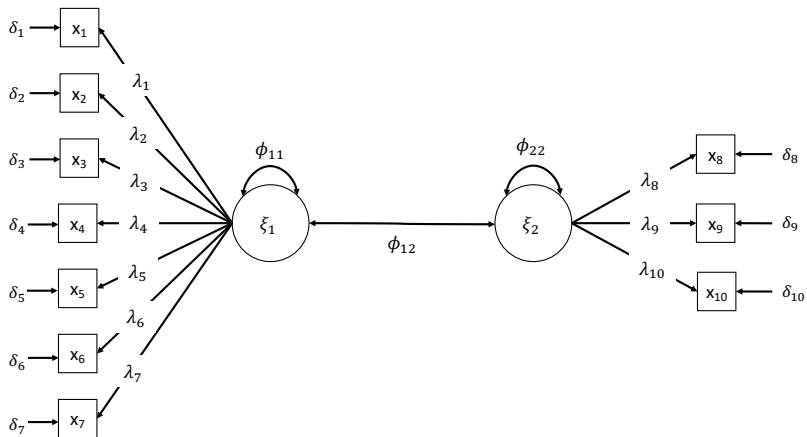
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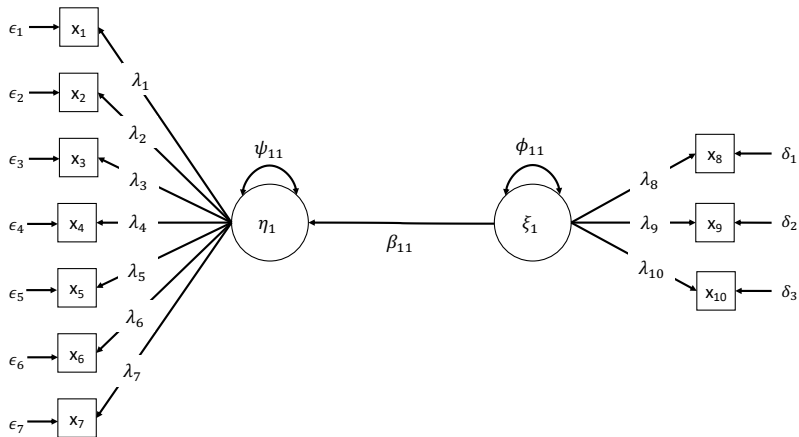
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## From CFA ...



... to SR model



## What happened?

Initially, IQ and EF had an unanalyzed (correlational) association

Now, IQ is considered a cause of EF

EF is now endogenous

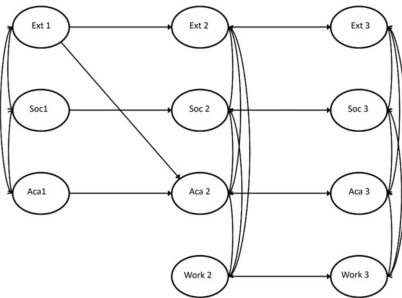
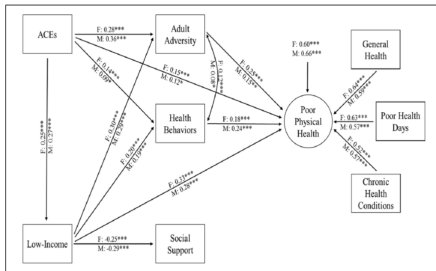
LISREL notation is different now (lavaan syntax is the same)

# Distinctions from observed variable (OV) path analysis

- ▶ In OV path analysis, exogenous variables are assumed to be measured without error
  - ▶ In an SR model with exogenous factors, then measurement error is partialled out.
- ▶ In OV path analysis, disturbances contain measurement error and omitted causes.
  - ▶ in an SR model with endogenous factors, then the disturbances contain only omitted causes.

# SR models

Can be either a fully or partially latent SR model

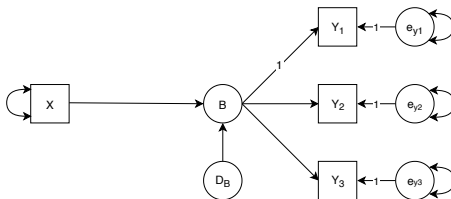


# Single indicators

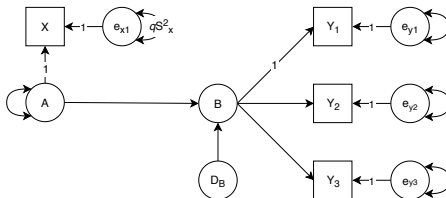
- ▶ Single indicators do not have to be treated as observed.
- ▶ Factors could be created where the error variance is fixed (based on previous research or theory).
  - ▶ It does not affect the df
  - ▶ Need to specify a value (or a range of values) because it will likely result in identification problems
  - ▶ A path model could be respecified so that every single indicator has measurement error partialled out



## Single indicator as observed



## Single indicator as latent



where  $q$  is  $1 - R_{xx}$

# Why you might want to do this?

Is any variable measured perfectly?

Hayduk & Littvay (2002) mention that demographic variables are likely always reported with some error

Possibly set error variance to 5% to account for this.

Relatedly, is it better to have many okay or potentially unrelated indicators or one really good one?

# Identification in SEMs

- ▶ If the CFA is identified AND
- ▶ The structural paths are (same rules as path analysis) THEN
- ▶ The model is identified (this is a **sufficient** condition)
- ▶ For a single indicator factor, if pattern coefficient and error variance fixed, it's identified.

# CFA rules

- ▶ **Standard CFA** is identified if 1) single factor with 3 indicators or 2) two or more factors each with 2 indicators

## Indicators with correlated errors for CFAs (Kline, p. 203)

*For each factor*, at least one of the following must hold:

(Rule 9.2a)

1. There are at least three indicators whose errors are uncorrelated with each other.
2. There are at least two indicators whose errors are uncorrelated and either
  - a. the errors of both indicators are not correlated with the error term of a third indicator for a different factor, or
  - b. an equality constraint is imposed on the loadings of the two indicators.

*For every pair of factors*, there are at least two indicators, one from each factor, whose error terms are uncorrelated.

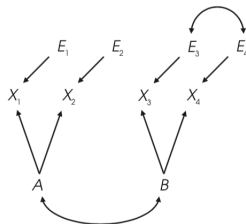
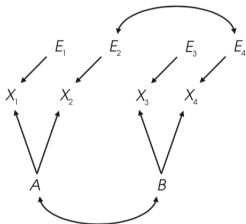
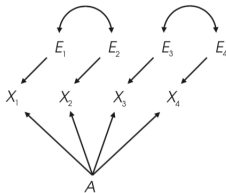
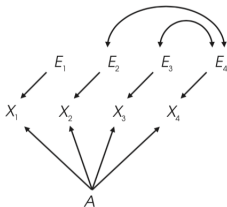
(Rule 9.2b)

*For every indicator*, there is at least one other indicator (not necessarily of the same factor) with which its error term is not correlated.

(Rule 9.2c)

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# Identified or not?



## Complex CFA structures (Kline, p. 204)

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### Pattern coefficients

For every complex indicator in a nonstandard CFA model:

(Rule 9.3)

In order for the multiple pattern coefficients to be identified, both of the following must hold:

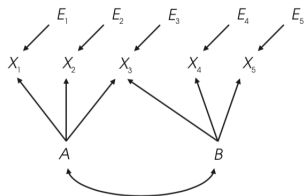
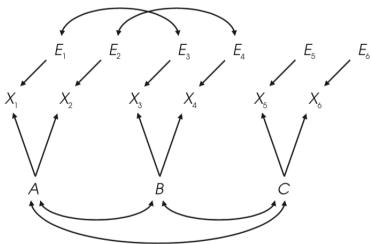
1. *Each factor on which the complex indicator depends* must satisfy Rule 9.2a for a minimum number of indicators.
2. *Every pair of those factors* must satisfy Rule 9.2b that each factor has an indicator that does not have an error correlation with a corresponding indicator on the other factor of that pair.

### Error correlations

In order for *error correlations* that involve complex indicators to be identified, both of the following must hold: (Rule 9.4)

1. Rule 9.3 is satisfied.
2. For each factor on which a complex indicator depends, there must be at least one indicator with a single loading that does not have an error correlation with the complex indicator.

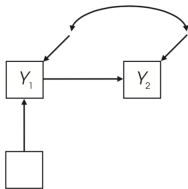
# Identified or not?



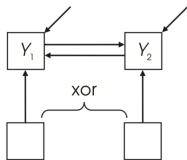
# Ridgdon's rules for non-recursive models

Direct feedback loop

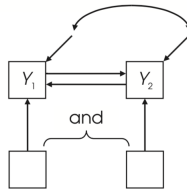
(a) Bow pattern



(b) No disturbance correlation



(c) With disturbance correlation



Recall recursive models are identified.



# Constructive Thought Strategies and Job Satisfaction: A Preliminary Examination - Houghton & Jinkerson (2007)

Purpose: To examine the role of cognitive processes in influencing job satisfaction.

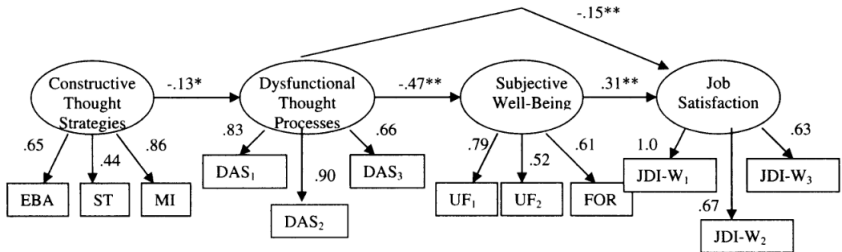
## Hypotheses

1. Subjective well-being will be positively related to job satisfaction
2. Dysfunctional thought processes will be negatively related to subjective well-being.
3. Constructive thought strategies will be negatively related to dysfunctional thought processes
4. Dysfunctional thought processes will be negatively related to job satisfaction.
5. The effects of dysfunctional thought processes on job satisfaction will be partially mediated through subjective well-being.
6. The effects of constructive thought strategies on job satisfaction will be fully mediated through dysfunctional thought processes and subjective well-being.

# Abstract

*In order to examine the potential of constructive thought strategies for enhancing employee job satisfaction, an existing dispositional model of job satisfaction was expanded and tested. Structural equation modeling techniques indicated significant relationships among constructive thought strategies, dysfunctional thought processes, subjective well-being, and job satisfaction. In addition, two competing models were examined to test for the full or partial mediation of the effects of constructive thought strategies on job satisfaction. The implications of these findings for constructive thought strategy training interventions are discussed, along with directions for future research efforts.*

# Path Diagram



# Activity

1. Fit a single factor CFA
2. Fit the model as a four factor CFA
3. Compare the single to the four factor CFA using the chi-square test of difference
4. Assess the fit of the four factor CFA
  - ▶ Global fit (chi-square test of model fit, RMSEA, CFI, TLI, SRMR)
  - ▶ Local fit
    - ▶ Correlation residuals,  $abs(x) > .10$ . How many?
    - ▶ Standardized residuals,  $abs(x) > 1.96$ . How many?
  - ▶ Modification indices
  - ▶ **Modify if necessary**
5. Fit the SR model
6. Compare the fit of the SR model to the four factor CFA using the chi-square test of difference
7. Assess the fit of the SR model