

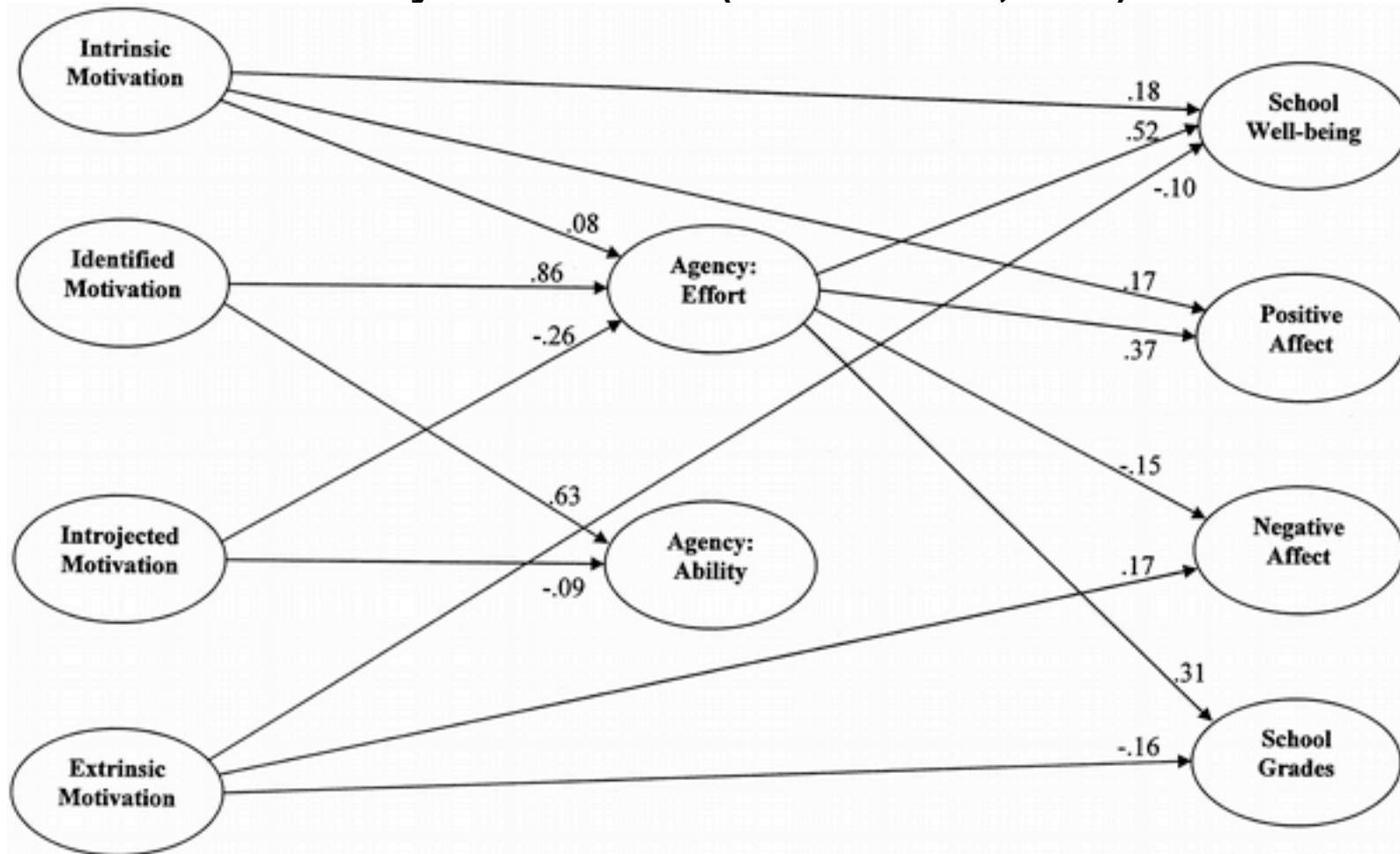
# Hybrid Models

- Definition
- Examples
- Why hybrid models?
- Two-step modeling
- Four-step modeling
- One-indicator latent variables
- Parcels

# Hybrid Model

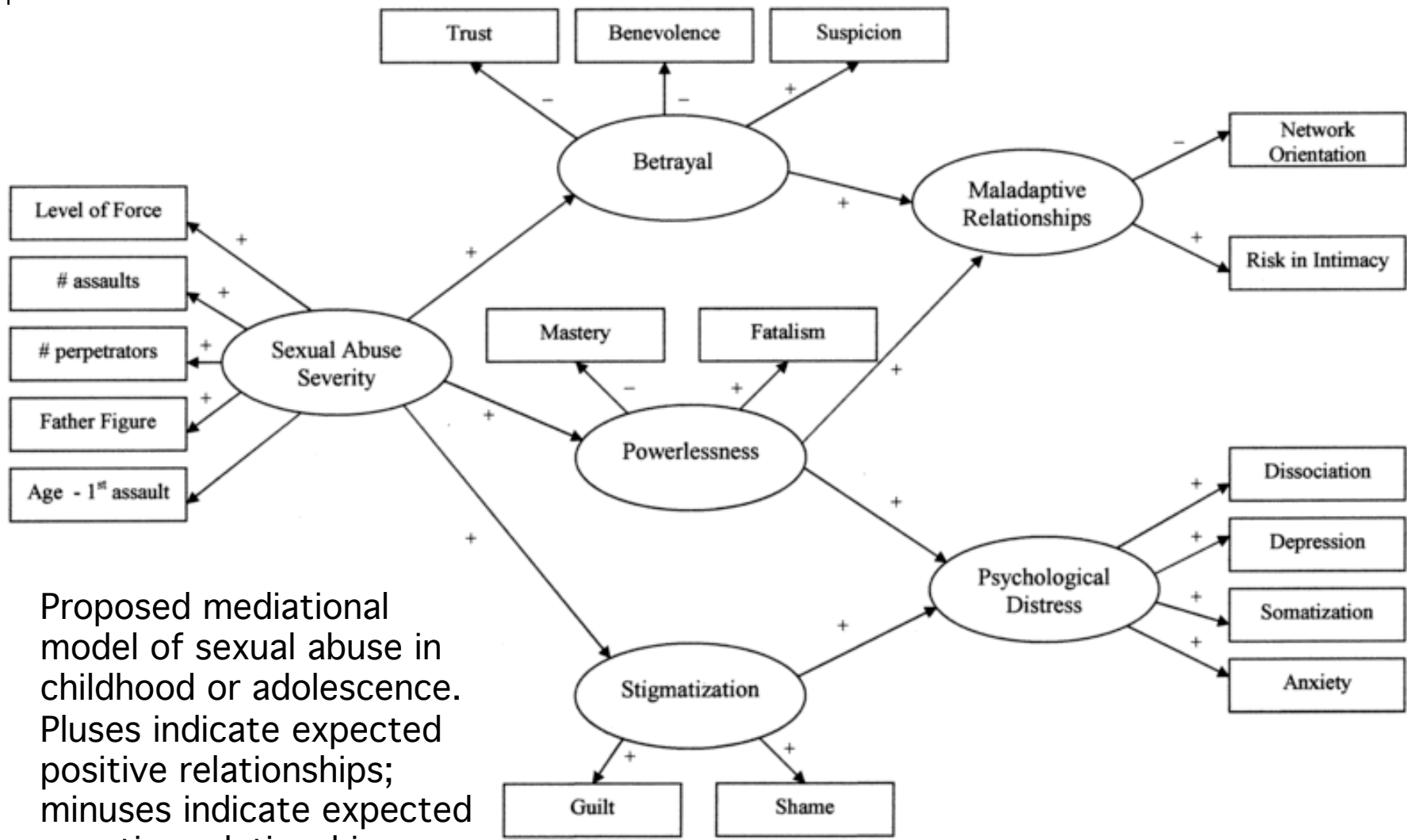
- Definition: includes a combination of latent and observed variables
- Like combining CFA and path analysis in one analysis
- Sometimes called "structural regression" models
- Most general type of SEM model
- Models can be quite complex

## Relations Among Personal Agency, Motivation, and School Adjustment in Early Adolescence (Walls & Little, 2005)



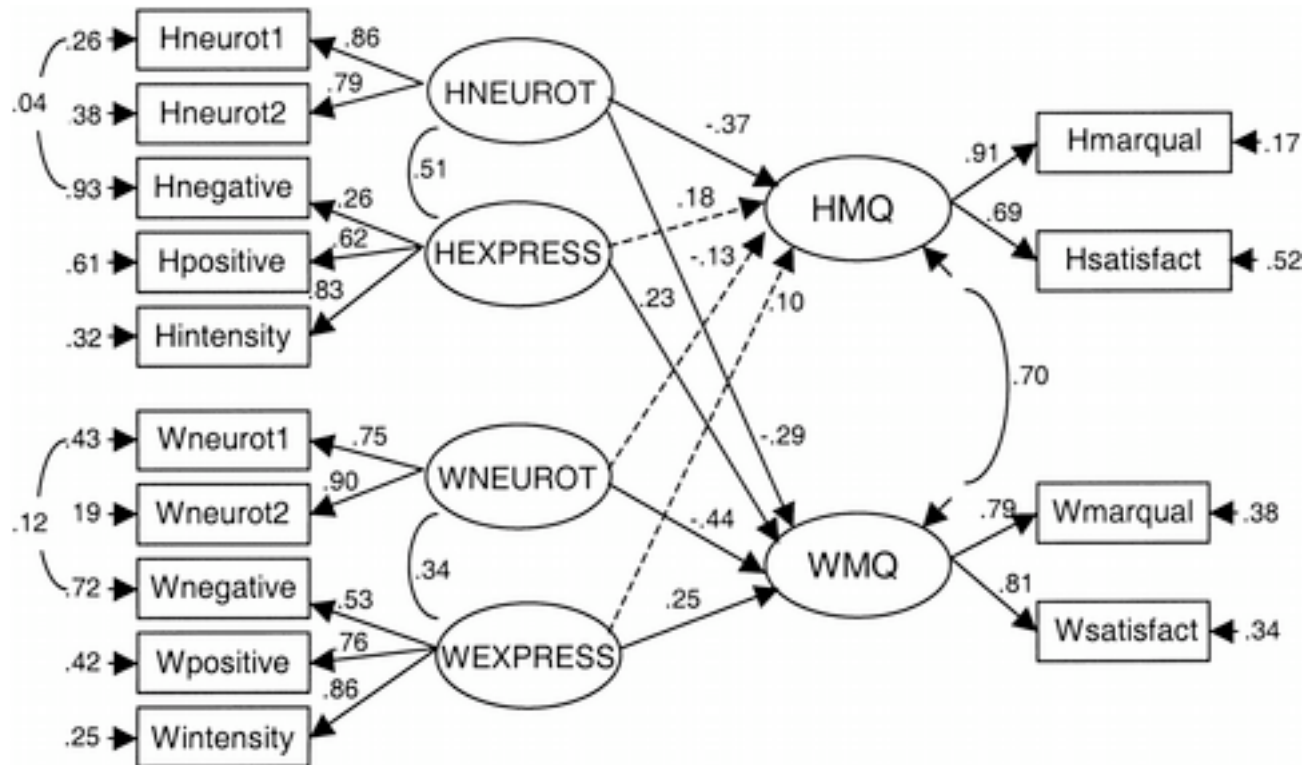
The structural model relating motive-control beliefs to adjustment. Model fit:  $\chi^2(642, N = 786) = 1,221.30, p = .00$ , root-mean-square error of approximation = .034 (.031|.037), nonnormed fit index = .96, comparative fit index = .97

## Childhood and Adolescent Sexual Abuse of Community Women: Mediated Effects on Psychological Distress and Social Relationships (Kallstrom-Fuqua, Weston, & Marshall, 2004)



Proposed mediational model of sexual abuse in childhood or adolescence. Pluses indicate expected positive relationships; minuses indicate expected negative relationship

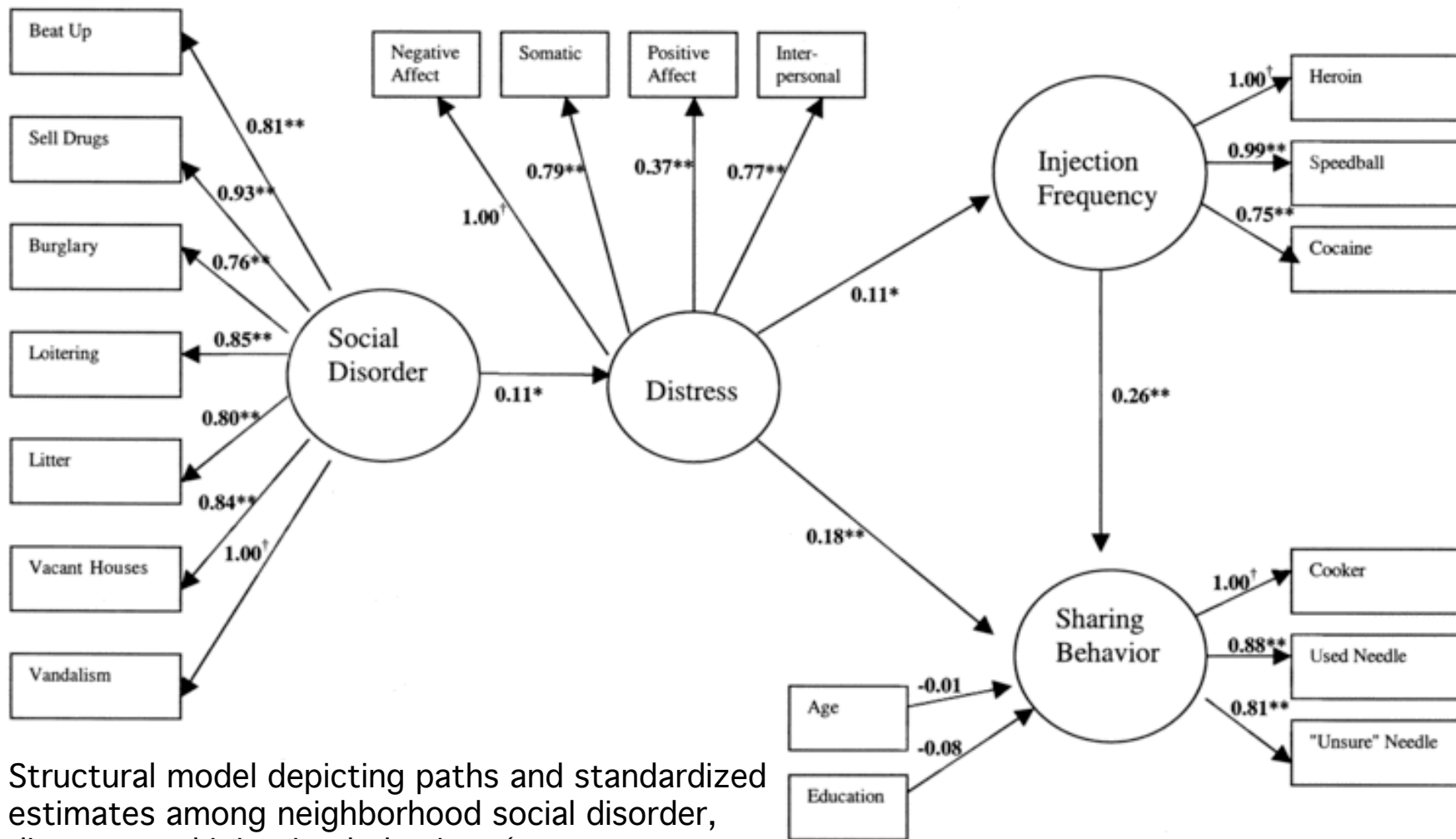
## Emotional Expressiveness and Neuroticism: Do They Predict Marital Quality? (Lavee & Ben-Ari, 2004)



Standardized coefficients for a model of husbands' and wives' neuroticism and emotional expressiveness as predictors of marital quality. All coefficients are significant at  $p < .05$ , except those shown in dashed arrows. Model fit statistics:  $\chi^2(60, N = 197) = 74.22, p = .10$ , root-mean-square-error of approximation = 0.035, nonnormed fit index = .98, comparative fit index = .99, adjusted goodness-of-fit index = .91.

Variables with the prefix H and W refer to husband and wife, respectively; neurot1 and neurot2 are random split halves of the Neuroticism scale; negative = negative emotions expressivity; positive = positive emotions expressivity; intensity = impulse intensity; marqual = scores on the marital quality scale; satisfact = satisfaction with the relationship. NEUROT = Neuroticism; EXPRESS = Emotional Expressiveness; MQ = Marital Quality

## Neighborhood Social Disorder as a Determinant of Drug Injection Behaviors: A Structural Equation Modeling Approach (Latkin et al., 2005)



Structural model depicting paths and standardized estimates among neighborhood social disorder, distress, and injection behaviors (measurement error terms not shown). Daggers indicate parameters fixed at 1. \*p <.05 (t test). \*\*p <.01 (t test)

# Analyzing SEM Examples

- How many exogenous variables? Endogenous?
- Are all variables latent or is there a mixture of latent and manifest?
- How many indicators? How were they formed? (items, scales)? How high are the loadings?
- How was scale set for latent variables?
- Can you summarize the main relationships/findings of the model? What is the largest path?
- Comment on fit.
- Is there anything in the diagram that you don't understand?

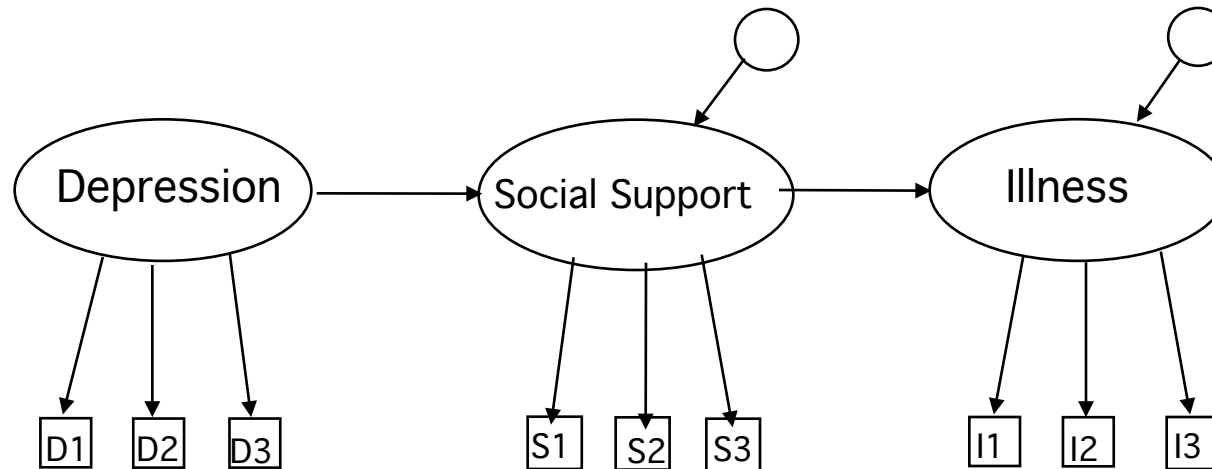
# Fit of Hybrid Models

- If hybrid model has bad fit, could be due to:
  - » measurement part
  - » structural part
- Two-step method of fitting recommended
  - » First, specify model as CFA
    - just testing measurement part
    - fit must be good to proceed
    - if not, respecify
  - » Second, add structural components of model
    - Must have improved fit to claim validity of structural model



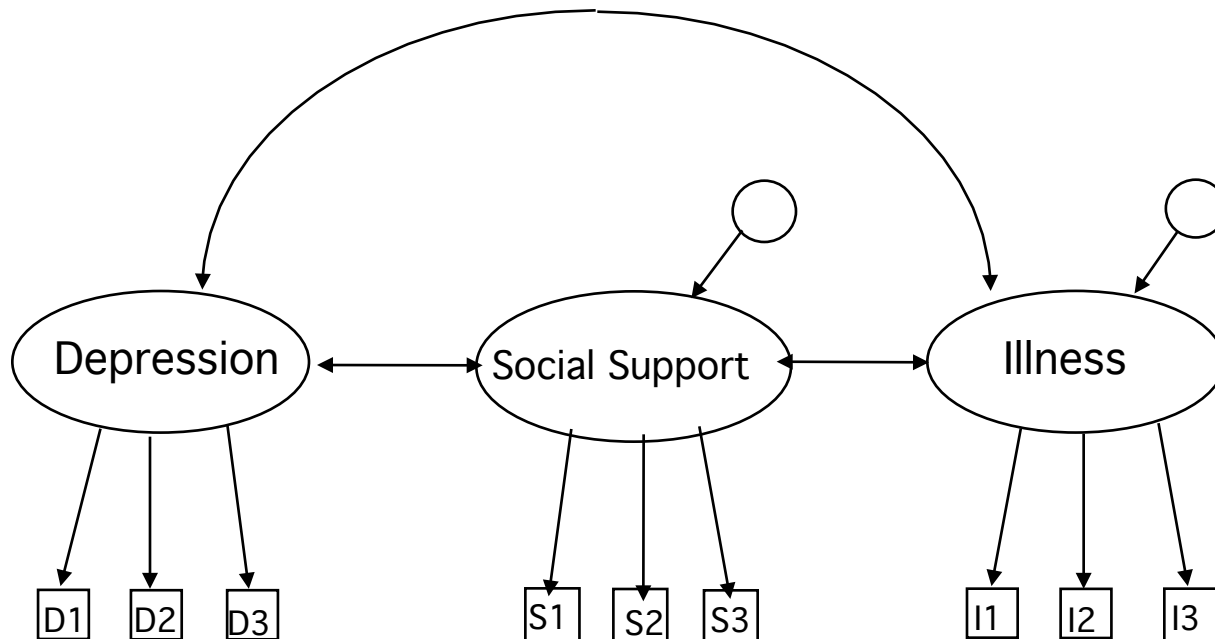
# Example: Two-Step Fit

- Model we want to test



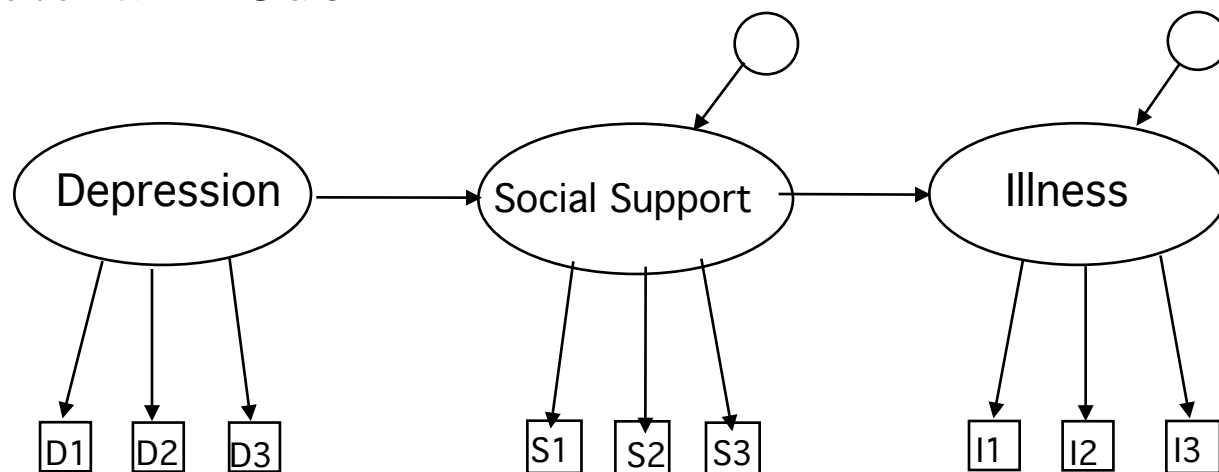
# Step One: CFA

- First specify the model as a CFA
  - » i.e., put double-headed arrows between all latent variables



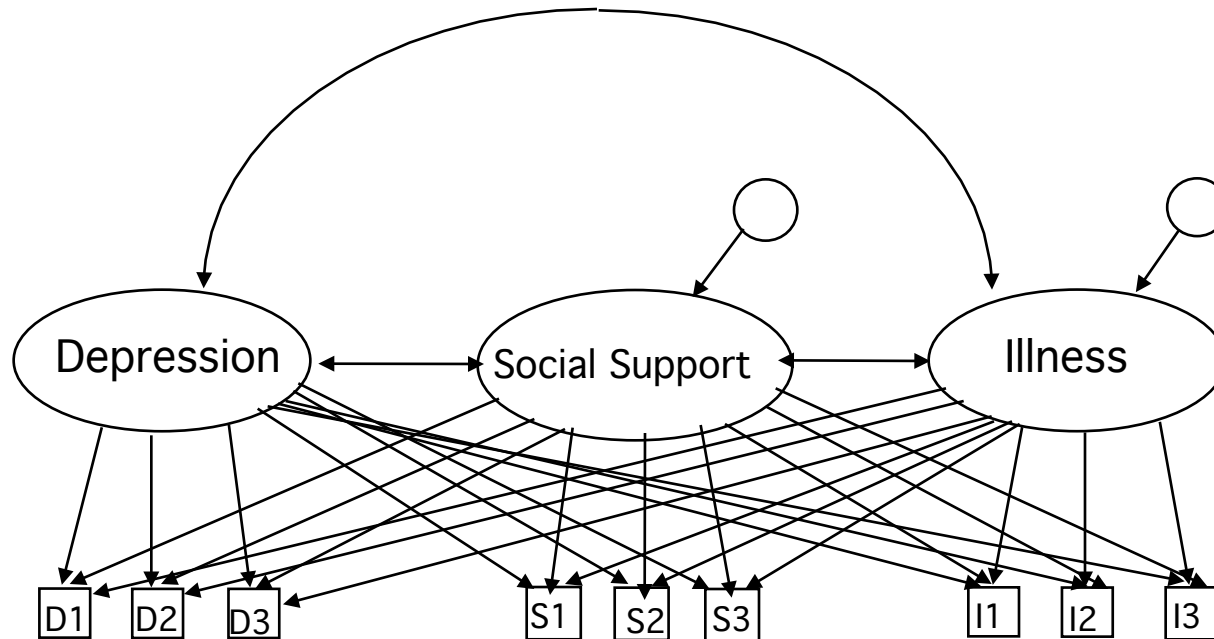
## Step Two: Add Structural Component

- Respecify the model to include the structural components
- Note that this model is nested within the CFA model because some paths have been removed
- If fit is appreciably worse, there are problems with this structural model



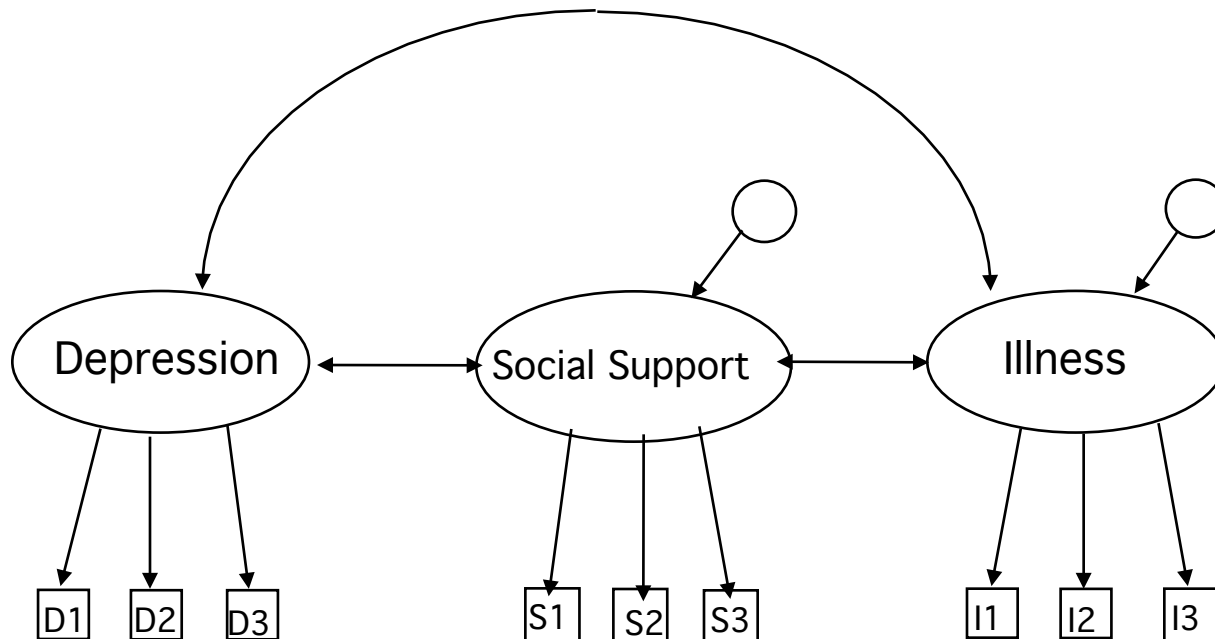
# Four-Step Process: Step 1

- Splits test of measurement model into two tests
  - » First, test a factor model that is like an exploratory model
  - » Paths from every latent variable to every indicator
  - » (but, four indicators per factor needed/recommended)



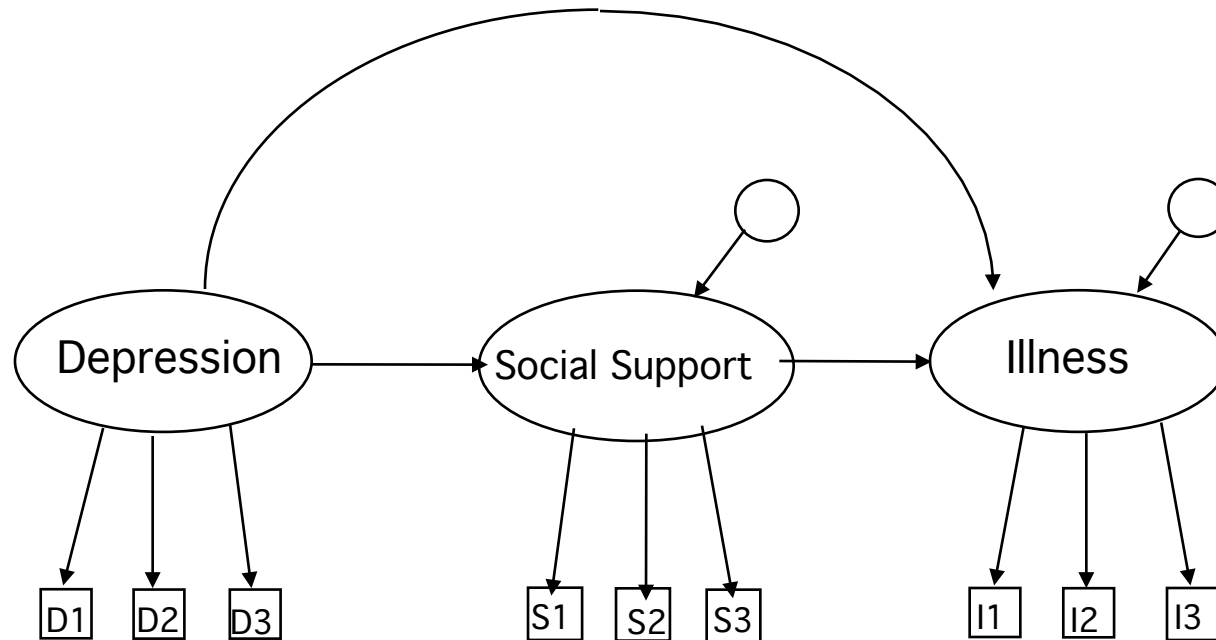
## Four-Step Process: Step 2

- Now specify the model as a CFA
  - » i.e., each indicator loads on just one factor



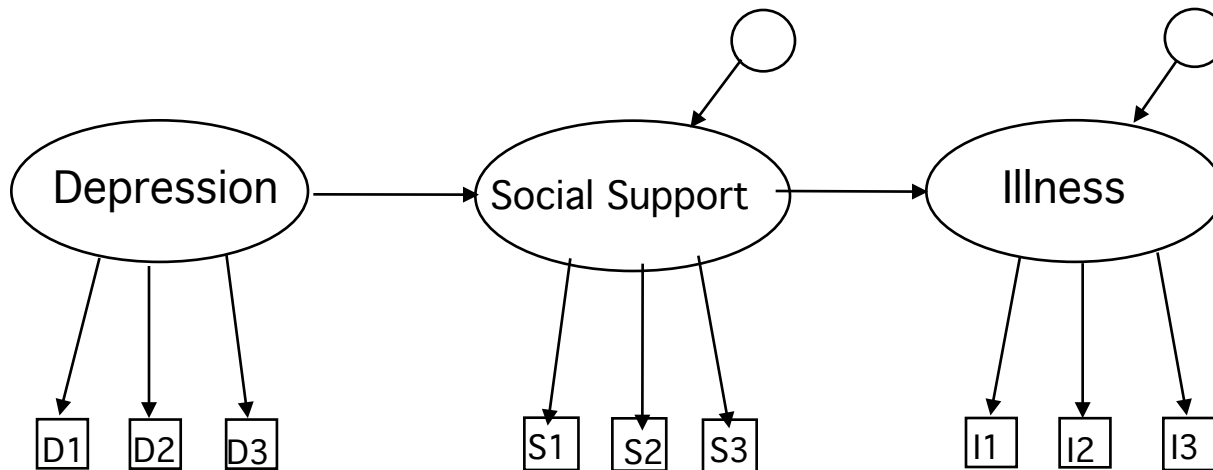
## Four-Step Process: Step 3

- Now specify causal paths instead of unanalyzed associations
  - » perhaps a fully saturated model



## Four-Step Process: Step 4

- Refine the structural part of the model
  - » perhaps testing nested models



# What to Use for Indicators

- Items
  - » Use individual items from a scale
  - » Problems
    - each item is not a very reliable measure, in and of itself
    - responses to individual items may depart markedly from normal distribution
      - » less true for sums of items because of central limit theorem
    - if scale has many items, good fit for measurement model will be difficult to obtain



# What to Use for Indicators

- Scales
  - » Use different scales designed to measure the same construct
    - Depression: BDI and CESD
    - Authoritarianism: RWA and F-scale
  - » Solves all problems with item indicators
  - » But:
    - not economical to have to collect multiple measures of same thing (participant fatigue)
    - many constructs do not have multiple measures
    - for some that do, older measures have been discredited
      - » that's why new measures were developed
      - » so validity of older measures is suspect

# One-Indicator Models

- Kline notes that it's possible to model a latent variable with only one indicator
  - » use your one measure/scale as a single indicator
  - » note that if you have too many one-indicator variables, identification may be a problem
- Set the variance of the error/disturbance term to equal the reliability of the scale \* the observed variance of the indicator
  - » e.g., use the alpha of the scale as an estimate of reliability

## What to Use for Indicators

- Parcels; may also be called ‘testlets’
  - » Composites (or "parcels") of 2 or more items
    - by summing or averaging them
  - » More reliable than items, less reliable than scales
  - » More normally distributed than items, less so than scales
  - » More economical: only need to collect one measure of each construct
  - » Usually get good indicators (high loading) and good fit
- Note that the use of parcels is somewhat controversial
  - » e.g., Little, Cunningham, Shahar, & Widaman (2002). To parcel or not to parcel: Exploring the question, weighing the merits. *Structural Equation Modeling* 9(2), 151-173.

# Creating a Parcel

- Simplest: Divide items randomly into 2 or 3 groups
  - » use each group as one indicator
- Better: Divide items using a rational strategy
  - » want to create “testlets” that are balanced and therefore equivalent (parallel measures)
  - » consider subscales
    - each testlet has some items from each subscale
  - » consider characteristics of items
    - e.g., if half of items are reversed each testlet should have a balance between reverse-scored and straight-scored items
  - » other distinctions between items
  - » may want to split highest-loading items among testlets

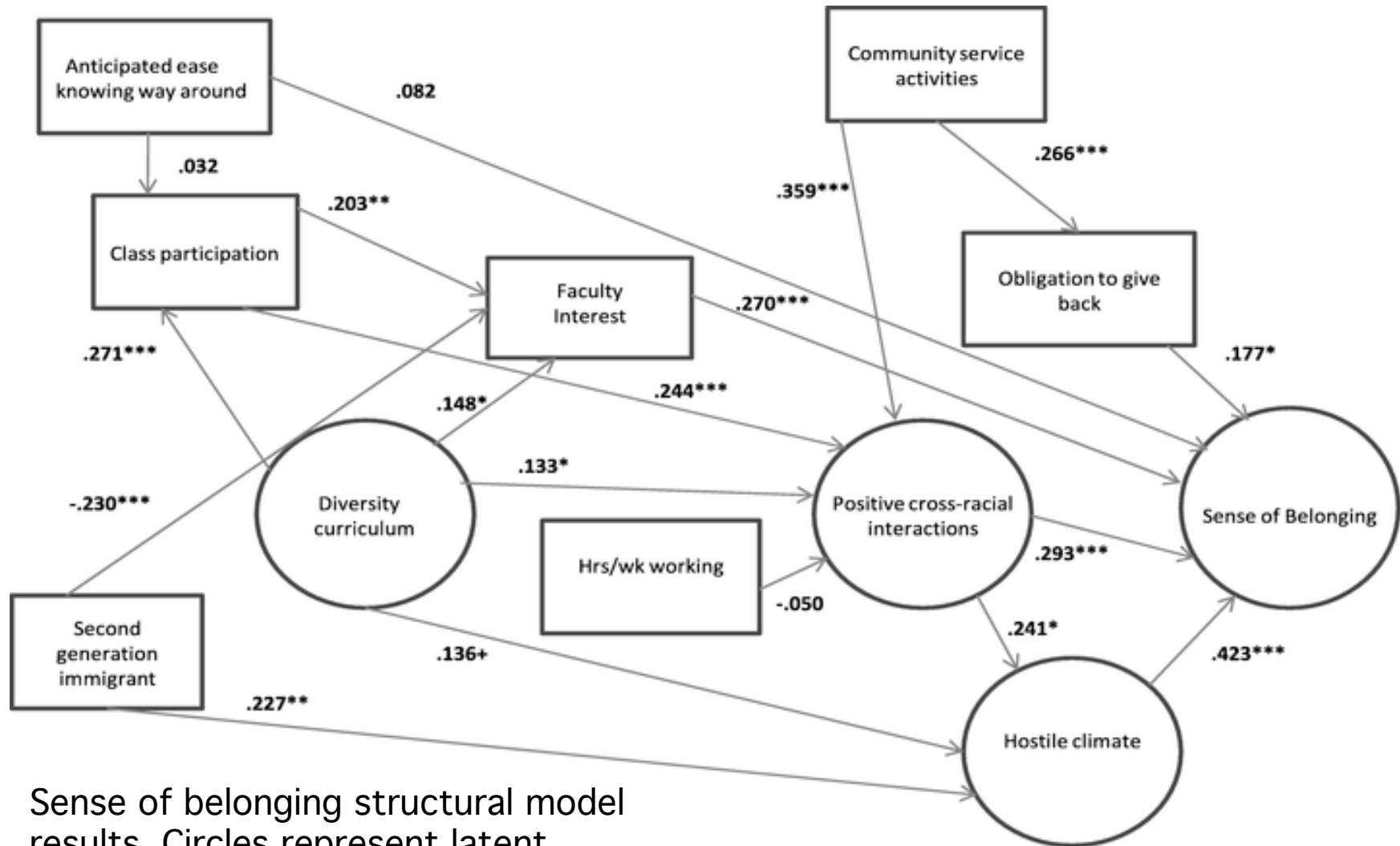
# Authoritarian Parenting

- All items positively worded (no reverse coding needed)
- No subscales
- But, certain concepts seem to be present
  - » Use of force
    - "Even if her own children didn't agree with her, my mother felt that it was for our own good if we were forced to conform to what she thought was right."
  - » Meeting expectations
    - "As I was growing up, my mother often told me exactly what she wanted me to do and how she expected me to do it."
  - » Disagreements/questioning authority
    - "As I was growing up, my mother did not allow me to question any decision she had made."

# Authoritarian Parenting

- Each of the three parcels should include one item from each content domain
- **Parcel 1**
  - » Even if her own children didn't agree with her, my mother felt that it was for our own good if we were **forced** to conform to what she thought was right.
  - » As I was growing up, my mother often told me exactly what she wanted me to do and how she **expected** me to do it.
  - » As I was growing up, my mother did not allow me to **question** any decision she had made.
  - » As I was growing up my mother let me know what behavior was expected of me, and if I didn't meet those expectations, she punished me.
- **Parcel 2**
  - » My mother has always felt that more **force** should be used by parents in order to get their children to behave the way they are supposed to.
  - » Whenever my mother told me to do something as I was growing up, she **expected** me to do it immediately without asking any questions.
  - » While I was growing up, my mother would get very upset if I tried to **disagree** with her.
- **Parcel 3**
  - » My mother has always felt that most problems in society would be solved if we could get parents to strictly and **forcibly** deal with their children when they don't do what they are supposed to as they are growing up.
  - » As I was growing up, I knew what my mother **expected** of me in the family and she insisted that I conform to those **expectations** simply out of respect for her authority.
  - » My mother felt that wise parents should teach their children early just who is **boss** in the family.

# Nunez (2009) Figure 1



Sense of belonging structural model results. Circles represent latent constructs and squares represent single indicator variables.

## Questions on Nunez

- How many indicators? How many total observed variables?
- Why did she use the Satorra-Bentler  $\chi^2$ ?
- Can we confirm df for her two reported models?
  - » "This measurement model indicated a good fit for the Latino sample: Satorra–Bentler  $\chi^2(129, N = 313) = 204.468$ "
  - » "The structural model . . . also appeared to fit the data reasonably well: Satorra–Bentler  $\chi^2(264, N = 313) = 469.682$ "
- Did she use the two-step method, per Kline?
- Can you think of any equivalent or alternative models?