Path Analysis Examples

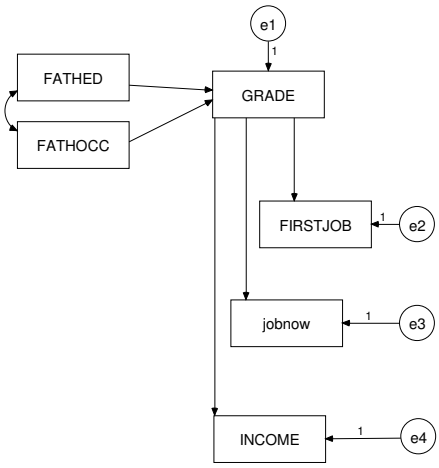
Session 3, Lecture 3

11/08/06

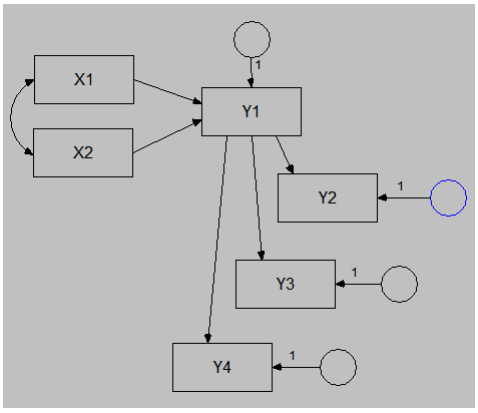
Outline

- Identification and estimation
- Indirect effects
- Review of path model notation
- Practice computing indirect effects
- Path model examples
  - Example 1: Fear of Dying
  - Example 2: Externalizing Behavior

A revisit of path model notation
Can you write out the equations for the following path model? (e=ε)



$$Y_1 = \gamma_{11}x_1 + \gamma_{21}x_2 + \varepsilon_1$$
$$Y_2 = \beta_{21}Y_1 + \varepsilon_2$$
$$Y_3 = \beta_{31}Y_1 + \varepsilon_3$$
$$Y_4 = \beta_{41}Y_1 + \varepsilon_4$$



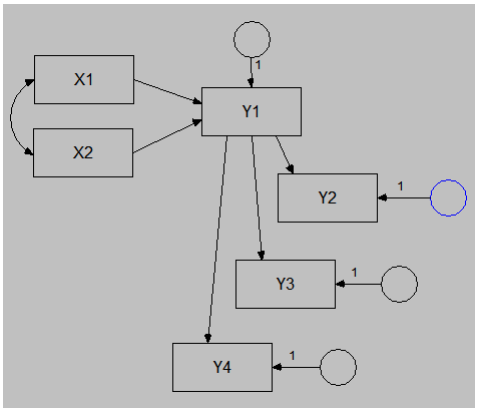
Is this model identified?

Null-B Rule - NO

Recursive Rule – YES

T-Rule: - YES

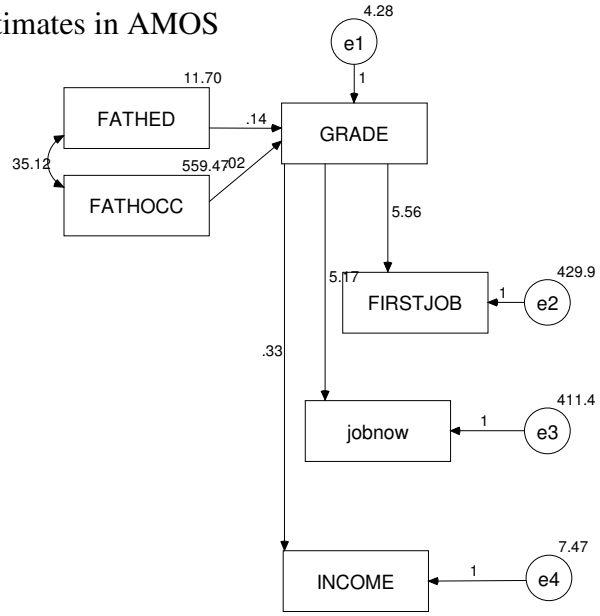
vars of exog. : 2
vars of errors for endog: 4
direct effects: 5
double-headed arrows: 1 +
Free Parameters: **12**



Sample Moments: (6*7)/2 = **21**

DF=21-12=**9**

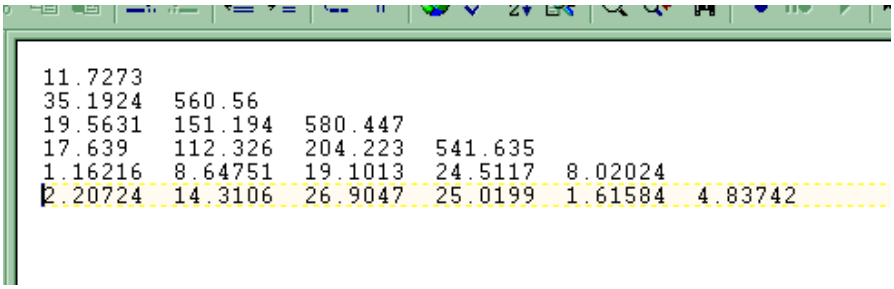
Estimates in AMOS



Setting up data for MPLUS

```
. correlate  fathed fathocc firstjob jobnow income grade, covariance
(obs=514)
```

	fathed	fathocc	firstjob	jobnow	income	grade
fathed	11.7273					
fathocc	35.1924	560.56				
firstjob	19.5631	151.194	580.447			
jobnow	17.639	112.326	204.223	541.635		
income	1.16216	8.64751	19.1013	24.5117	8.02024	
grade	2.20724	14.3106	26.9047	25.0199	1.61584	4.83742



```
11.7273
35.1924  560.56
19.5631  151.194  580.447
17.639   112.326  204.223  541.635
1.16216  8.64751  19.1013  24.5117  8.02024
2.20724  14.3106  26.9047  25.0199  1.61584  4.83742
```

Syntax in M+:

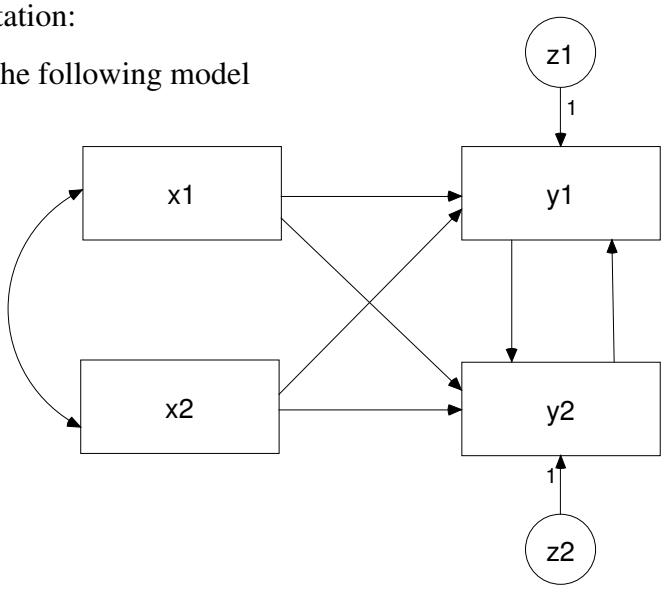
```
TITLE: Status attainment model;
DATA:
FILE IS C:\Documents and Settings\Jeannie\Desktop\Psychosocial II\mplusex.txt;
TYPE IS COVARIANCE;
NOBSERVATIONS ARE 514;
VARIABLE:
NAMES ARE fathed fathocc jobnow  firstjob income grade;
MODEL: grade ON fathed fathocc;
            firstjob ON grade;
            jobnow ON grade;
            income ON grade;
            fathed WITH fathocc;
jobnow WITH income@0;
firstjob WITH jobnow@0;
firstjob WITH income@0;
OUTPUT: standardized;
```

Review of Notation

- X exogenous observed variable – error (δ)
- Y endogenous observed variable – error (ε)
- ξ,Ξ exogenous latent variable
- η,H endogenous latent variable
- B,β coefficient(s) for endogenous variables
- Γ,γ coefficient(s) for exogenous variables
- Z,ζ latent errors
- Ψ,ψ covariance(s) for Z,ζ
- Φ,ϕ covariance(s) for exogenous variables

Matrix notation:

Consider the following model



In matrix notation:

$$\begin{bmatrix} y_1 \\ y_2 \end{bmatrix} = \begin{bmatrix} \gamma_{11} & \gamma_{12} \\ \gamma_{21} & \gamma_{22} \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 0 & \beta_{12} \\ \beta_{21} & 0 \end{bmatrix} \begin{bmatrix} y_1 \\ y_2 \end{bmatrix} + \begin{bmatrix} \zeta_1 \\ \zeta_2 \end{bmatrix}$$

$$\Gamma = \begin{bmatrix} \gamma_{11} & \gamma_{12} \\ \gamma_{21} & \gamma_{22} \end{bmatrix} \quad \mathrm{B} = \begin{bmatrix} 0 & \beta_{12} \\ \beta_{21} & 0 \end{bmatrix} \quad \mathrm{Z} = \begin{bmatrix} \zeta_1 \\ \zeta_2 \end{bmatrix}$$

$$\Phi = \begin{bmatrix} \phi_{11} & 0 \\ \phi_{12} & \phi_{22} \end{bmatrix} \quad \Psi = \begin{bmatrix} \psi_{11} & 0 \\ 0 & \psi_{22} \end{bmatrix}$$

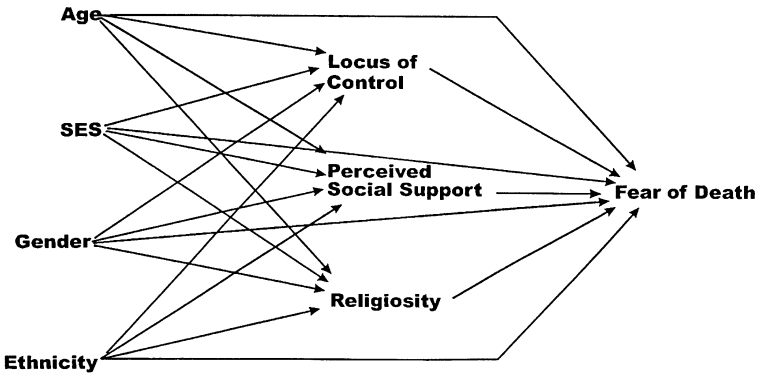
Path models, example 1:

"Personality and Demographic Factors in Older Adults' Fear of Death"

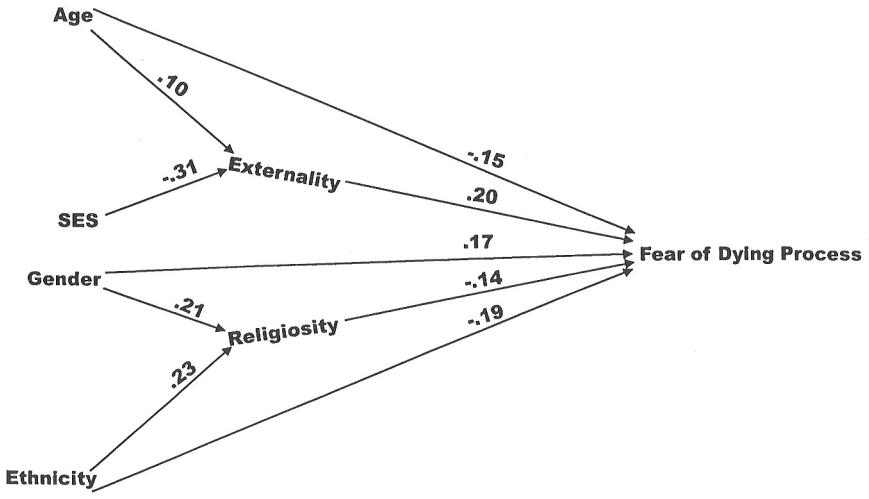
Victor G. Cicirelli - *Gerontologist* 1999 39:569-579

Participants included 388 subjects aged 60 to 100, sampled through seniors' organizations. At different centers participation rates ranged from 40% to 85%. All data is cross-sectional.

Conceptual model for Cicirelli study



Results reported in Cicirelli study



Statistics reported in Cicirelli study

Table 1. Means and Standard Deviations of Total Group (N = 388) on Study Variables

Variable	*M*	*SD*
Age	72.65	7.73
Socioeconomic status	43.71	15.55
Religiosity	14.14	2.33
Locus of control—Externality	55.92	17.54
Perceived social support	0.99	0.34
Fear of dying	18.02	6.46
Fear of the unknown	10.30	4.54

Table 2. Intercorrelations of Multidimensional Fear of Death Scale Scores, Background Variables, and Psychosocial Variables (N = 388)

Variable	1	2	3	4	5	6	7	8	9
1. Fear of dying	—								
2. Fear of the unknown	32**	—							
3. Ethnicity	−20**	01	—						
4. Gender	16**	−08	−09	—					
5. Age	−08	−01	−25**	11*	—				
6. Socioeconomic status	03	−10*	−26**	−08	−02	—			
7. Externality	17**	31**	−02	−01	12*	−29**	—		
8. Religiosity	−14**	−45**	19**	20**	03	−05	−07	—	
9. Social support	10	−22**	−04	18**	−10	15**	−08	22**	—

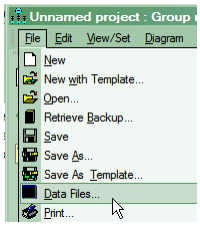
*p < .05; **p < .01.
Notes: For ethnicity, 0 = White, 1 = African American; for gender, 0 = male, 1 = female. Decimal points have been omitted.

AMOS syntax for Cicirelli data:

```
rowtype_,varname_,feardie,fearun,ethnic,gender,age,ses,e
xtern,relig,socsup
n,xx,388,388,388,388,388,388,388,388,388
corr,feardie,1
corr,fearun,.32,1
corr,ethnic,_.20,.01,1
corr,gender,.16,_.08,_.09,1
corr,age,_.08,_.01,_.25,.11,1
corr,ses,.03,_.10,_.26,_.08,_.02,1
corr,extern,.17,.31,_.02,_.01,.12,_.29,1
corr,relig,_.14,_.45,.19,.20,.03,_.05,_.07,1
corr,socsup,.10,_.22,_.04,.18,_.10,.15,_.08,.22,1
stddev,,6.46,4.54,.47,.44,7.73,15.55,17.54,2.33,.34
```

How to Run this in AMOS

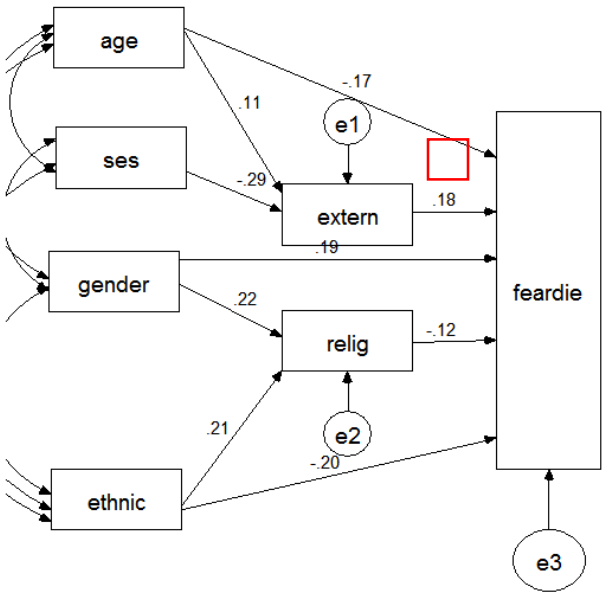
- Save syntax as a text file
- Go to AMOS, click on Data files
- Select file
- Continue as in AMOS guide.



Free AMOS!! You can get a demo copy of AMOS here:
http://www.assess.com/Software/AMOS.htm#Demo

Caveat: can only have 8 observed variables (or fewer)

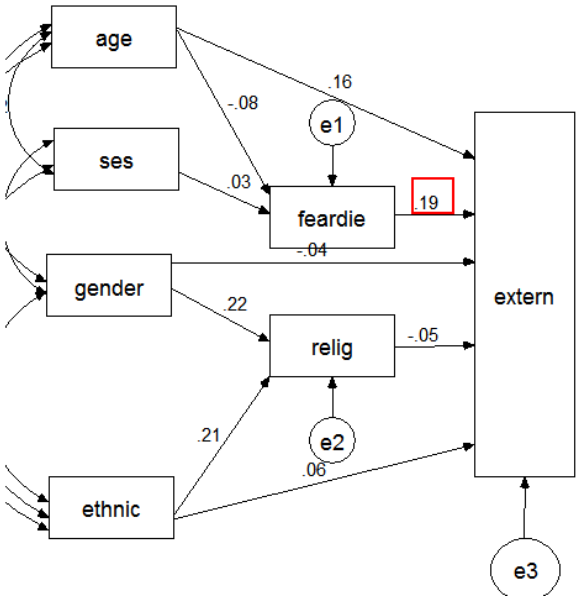
Model 1



Model 2

What is different between these two models?

Fear of dying and externality have been exchanged



Syntax for path models in M+

Data file looks like:

6.46 4.54 .47 .44 7.73 15.55 17.54 2.33 .34
1.0
.32 1.0
-.2 .01 1.0
.16 -.08 -.09 1.0
-.08 -.01 -.25 .11 1.0
.03 -.10 -.26 -.08 -.02 1.0
.17 .31 -.02 -.01 .12 -.29 1.0
-.14 -.45 .19 .20 .03 -.05 -.07 1.0
.10 -.22 -.04 .18 -.10 .15 -.08 .22 1.0

Syntax for path model 1 in M+

```
TITLE: Cicirelli path analysis;
DATA:
   FILE IS d:/teaching/data/feardie.dat;
   TYPE IS CORRELATION STDEVIATIONS;
   NOBSERVATIONS ARE 388;
VARIABLE:
   NAMES ARE feardie fearun ethnic gender age ses
                extern relig socsup;
   USEVAR = feardie extern relig age ses gender ethnic;
MODEL: feardie ON age extern gender relig ethnic;
                extern ON age ses;
                 relig ON gender ethnic;
OUTPUT: standardized;
```

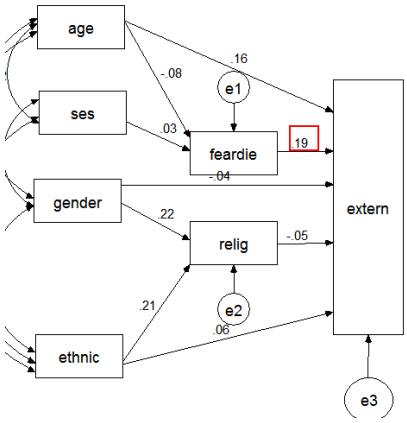
MPLUS Results Model 1

	Estimates	S.E.	Est./S.E.	Std	StdYX
FEARDIE ON					
AGE	-0.140	0.041	-3.393	-0.140	-0.169
EXTERN	0.066	0.018	3.752	0.066	0.180
GENDER	2.743	0.719	3.816	2.743	0.188
RELIG	-0.338	0.137	-2.468	-0.338	-0.123
ETHNIC	-2.727	0.690	-3.950	-2.727	-0.199
EXTERN ON					
AGE	0.259	0.109	2.368	0.259	0.114
SES	-0.325	0.054	-5.963	-0.325	-0.288
RELIG ON					
GENDER	1.159	0.258	4.485	1.159	0.219
ETHNIC	1.040	0.242	4.297	1.040	0.210

Syntax for path model 2 in M+

Same as Model 1, except for model statement

- Will have a sub-statement for each endogenous variable
- In a regression equation, one says "regress y ON x"
- Endogenous variables on anything that has a straight arrow pointing toward it
- regress extern on age feardie gender relig ethnic;
- regress feardie on age ses;
- regress relig on gender ethnic;



Syntax for path model 2 in M+

```
TITLE: Cicirelli path analysis;
DATA:
   FILE IS d:/teaching/data/feardie.dat;
   TYPE IS CORRELATION STDEVIATIONS;
   NOBSERVATIONS ARE 388;
VARIABLE:
   NAMES ARE feardie fearun ethnic gender age ses
                extern relig socsup;
   USEVAR = feardie extern relig age ses gender ethnic;
MODEL: regress extern on age feardie gender relig ethnic;
       regress feardie on age ses;
       regress relig on gender ethnic;

OUTPUT: standardized;
```

Remember to put semicolons after each regression statement

MPLUS Results Model 2

	Estimates	S.E.	Est./S.E.	Std	StdYX
EXTERN ON					
AGE	0.358	0.117	3.076	0.358	0.157
FEARDIE	0.530	0.134	3.942	0.530	0.195
GENDER	-1.698	2.034	-0.835	-1.698	-0.042
RELIG	-0.385	0.388	-0.991	-0.385	-0.051
ETHNIC	2.402	1.949	1.233	2.402	0.064
FEARDIE ON					
AGE	-0.066	0.042	-1.570	-0.066	-0.079
SES	0.012	0.021	0.561	0.012	0.028
RELIG ON					
GENDER	1.159	0.258	4.485	1.159	0.219
ETHNIC	1.040	0.242	4.298	1.040	0.210

Which is the Better Model?

Model 1

TESTS OF MODEL FIT

Chi-Square Test of Model Fit

Value	7.822
Degrees of Freedom	6
P-Value	0.2514

Chi-Square Test of Model Fit for the Baseline Model

Value	135.667
Degrees of Freedom	15
P-Value	0.0000

CFI/TLI

CFI	0.985
TLI	0.962

Loglikelihood

H0 Value	-7163.755
H1 Value	-7159.844

Information Criteria

Number of Free Parameters	12
Akaike (AIC)	14351.510
Bayesian (BIC)	14399.042
Sample-Size Adjusted BIC (n* = (n + 2) / 24)	14360.967

Model 2

TESTS OF MODEL FIT

Chi-Square Test of Model Fit

Value	77.094
Degrees of Freedom	6
P-Value	0.0000

Chi-Square Test of Model Fit for the Baseline Model

Value	135.667
Degrees of Freedom	15
P-Value	0.0000

CFI/TLI

CFI	0.411
TLI	-0.473

Loglikelihood

H0 Value	-7198.391
H1 Value	-7159.844

Information Criteria

Number of Free Parameters	12
Akaike (AIC)	14420.781
Bayesian (BIC)	14468.313
Sample-Size Adjusted BIC (n* = (n + 2) / 24)	14430.238

Coming Soon in Lecture 7

Path models, example 2:

"Developmental Pathways Leading to Externalizing Behaviors in 5 Year Olds Born Before 29 Weeks of Gestation"

Pascale C. Girouard, Raymond H. Baillargeon, Richard E. Tremblay, Jacqueline Glorieux, Francine Lefebvre, Philippe Robaey - *Developmental and Behavioral Pediatrics* 1998 19:244-253

Data comes from 62 infants born before 29 weeks of gestation

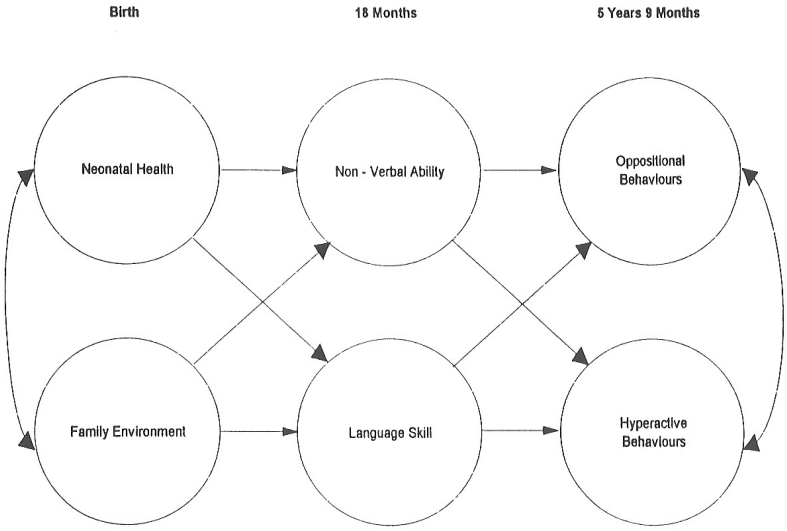
Statistics reported in Girouard et al. study

Table 5. Correlations Between the Measured Variables Included in the Path Analysis Model

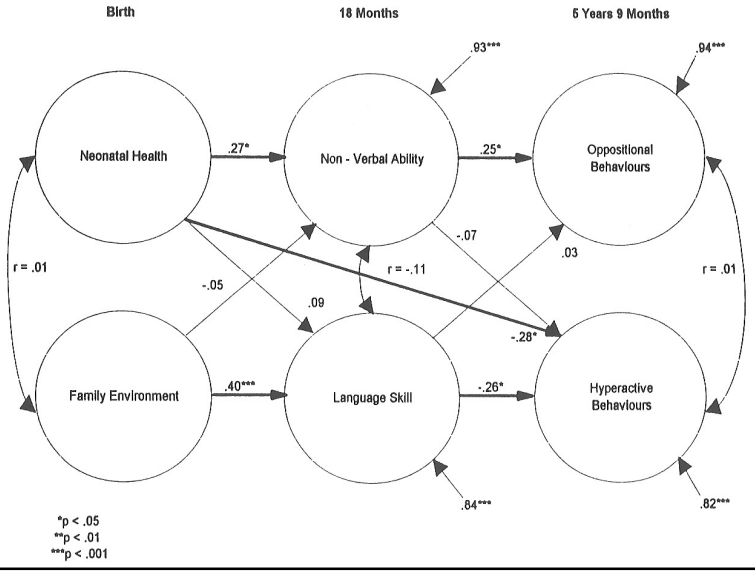
Variables	1	2	3	4	5
1. Neonatal health					
2. Family environment	.01				
3. Language skill	.10	.40***			
4. Nonverbal ability	.27*	−.04	−.11		
5. Hyperactive behaviors	−.33**	−.32*	−.29*	−.13	
6. Oppositional behaviors	.25*	.07	.01	.26*	.01

*$p < .05$; **$p < .01$; ***$p < .001$.

Conceptual model for Girouard et al. study

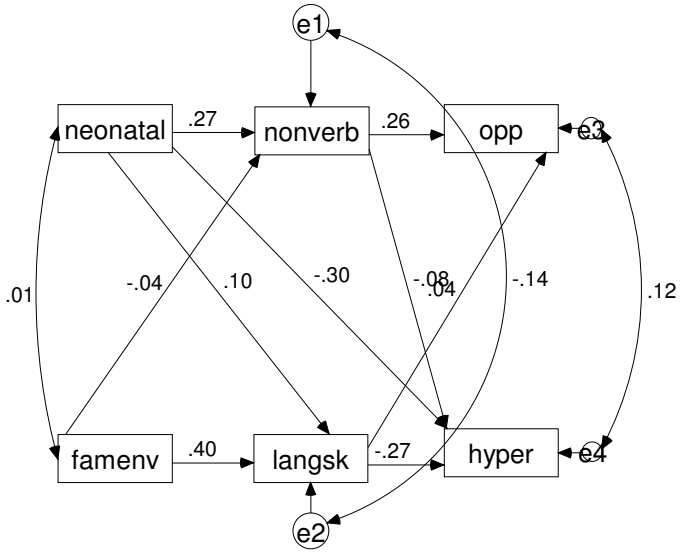


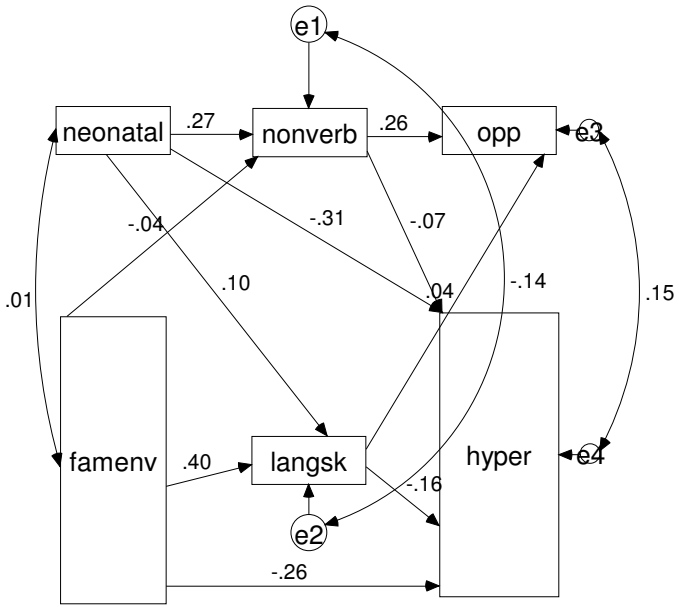
Results reported in Girouard et al. study



AMOS syntax for Girouard et al. study:

rowtype_,varname_,neonatal,famenv,langsk,nonverb,hyper,
opp
n,xx,62,62,62,62,62,62
corr,neonatal,1
corr,famenv,.01,1
corr,langsk,.10,.40,1
corr,nonverb,.27,-.04,-.11,1
corr,hyper,-.33,-.32,-.29,-.13,1
corr,opp,.25,.07,.01,.26,.01,1
stddev,,55,7,12.1,3,4,4





Conclusions:

d) structural equation models cannot and do not "discover" causal relationships

e) theory is paramount for a structural equation model

f) good structural equation models represent causal paths that are "undebatable"

g) path diagrams and structural equation models highlight model assumptions