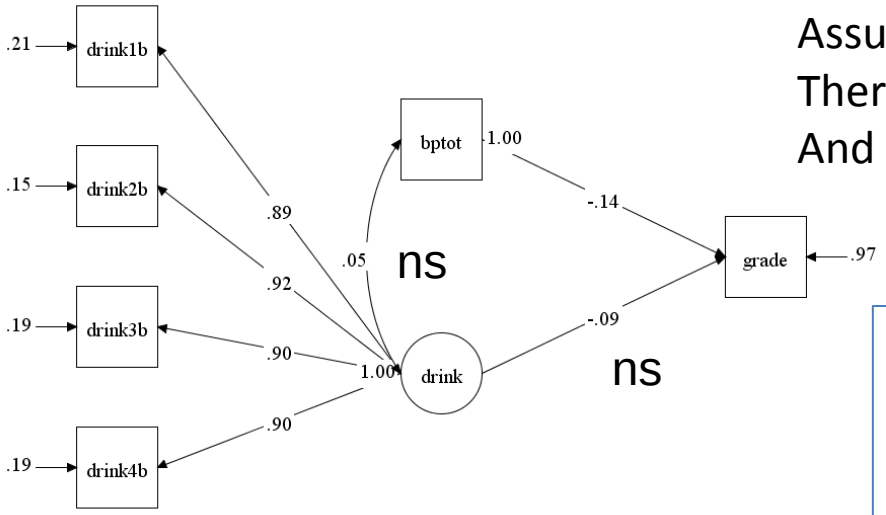
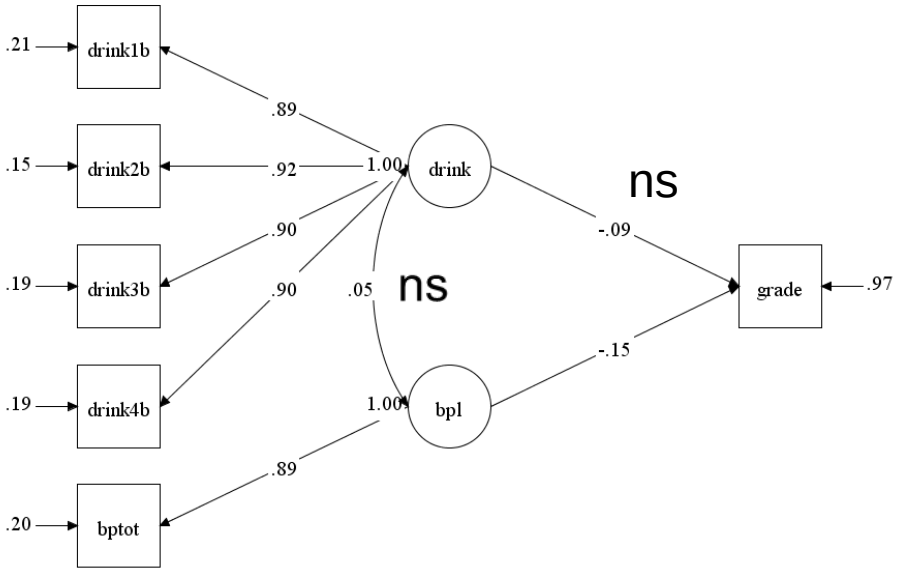
PSY 9555A (Oct 30): Full Model and Mediation

Example of a single observed variable as a latent variable

Variance of bptot = 300.43 (get from descriptives)
Assume reliability = .80 (i.e., 80% true score variance)
Therefore proportion error = .20
And error variance = 300.43 X .20 = 60.09




```
model:
drink by drink1b drink2b drink3b drink4b;
bpL by bptot;
bptot@60.09;
drink with bpL;
grade on drink bpL;
output: sampstat residual stdyx modindices tech4;
```



Tracing Rules

- How could we estimate by hand causal path coefficients from the correlations among a set of variables?

- We will see examples on the next pages that explain the rules below:

- The reproduced correlation between two variables in a model is the sum of all the paths that connect those two variables. Note that there can be more than one path.

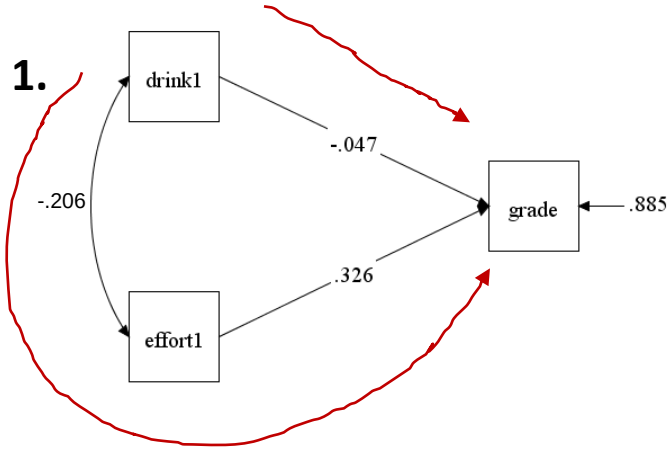
- If more than one coefficient makes up one path, the coefficients are multiplied.

- The basic rules describe permissions and restrictions in drawing all the different ways to get from one variable to another.

    - No loops allowed. Only go through a variable once.
    - No going forward the backward. But you can start backward and then go forward (e.g., from one loading to the next)
    - Only one curved arrow is allowed (no doubles) in a path

Tracing Rules

Example 1.

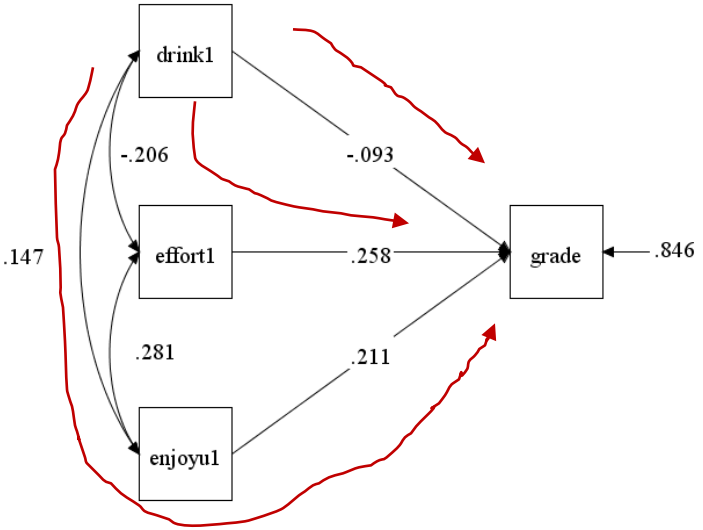


correlation between drink1 and grade =
-.047 + (-.206 x .326) = -.114

Example 2.

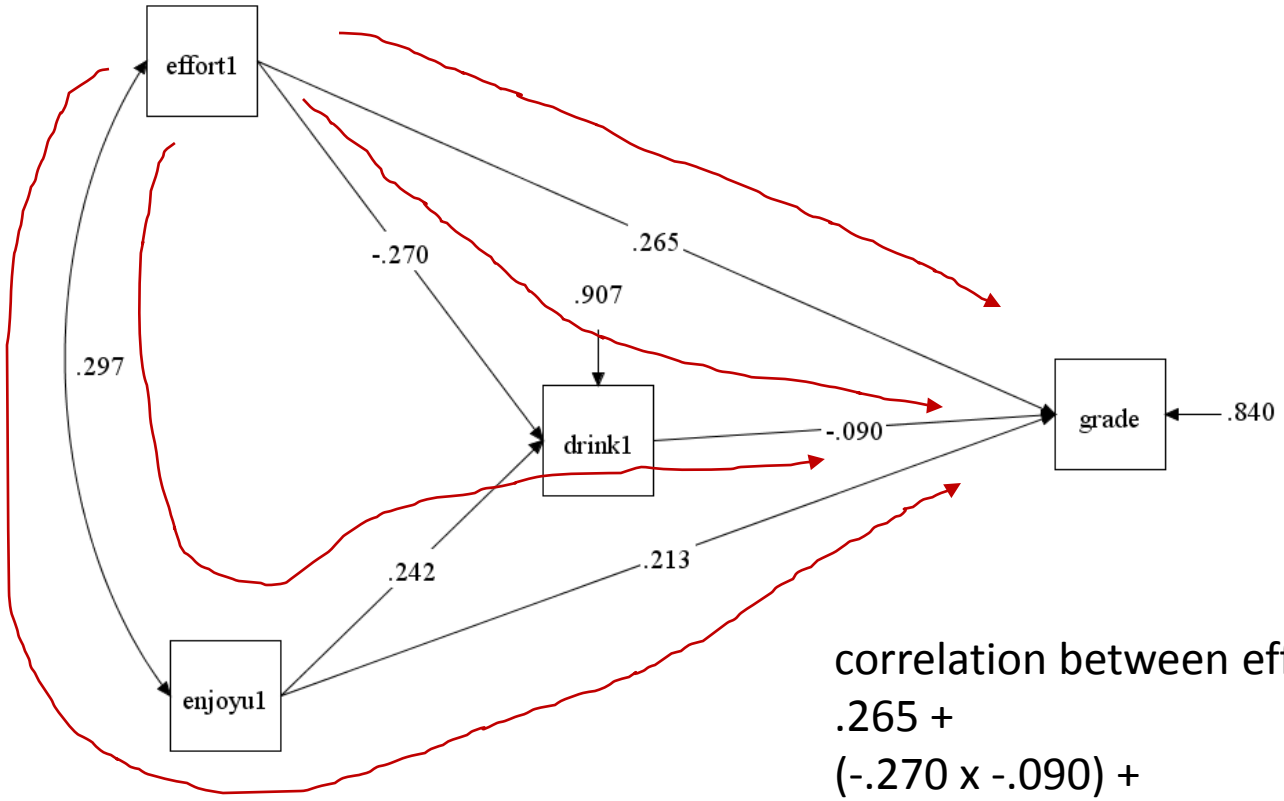
correlation between drink1 and grade:
-.093 + (-.206 x .258) + (.147 x .211) = -.114

Note: cannot go through two curved arrows
i.e., -.206 x .281 x .211 not allowed



Tracing Rules

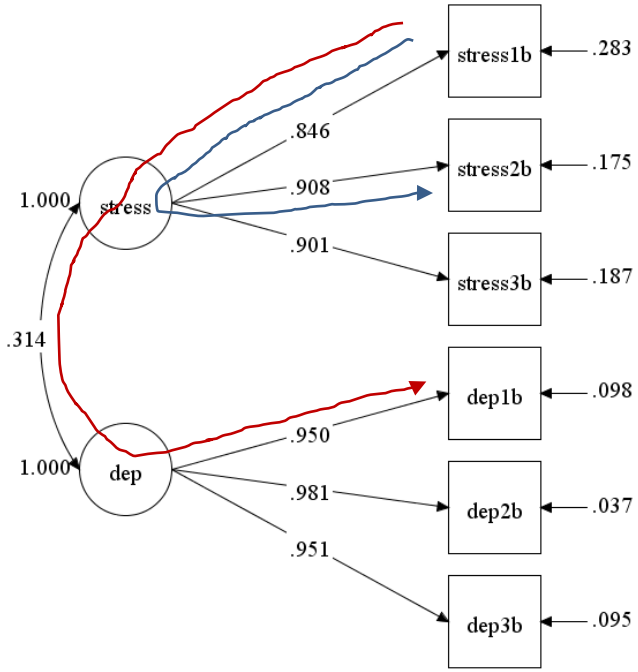
Example 3.



correlation between effort1 and grade:
.265 +
(-.270 x -.090) +
(.297 x .242 x -.090) +
(.297 x .213) = .346

Tracing Rules

Example 4.

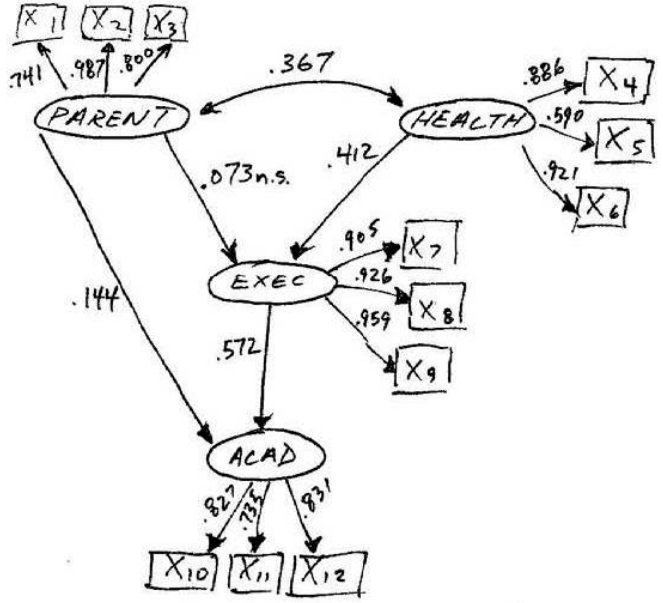


Correlation between stress1b and stress2b = (.846 x .908) = .768. Note that this is the correlation in the reproduced matrix. It will not be the exact same as the value in the observed data matrix (.772) because we have fixed the correlation between the residuals at 0

Correlation between stress1b and dep1b = (.846 x .314 x .950) = .252. The note above applies here also. The correlation in the observed matrix is .235

Tracing Rules

REPRODUCED CORRELATION MATRIX



Note. I left out the residual variables and variances

CORRELATIONS BETWEEN THE LATENT VARIABLES (TECH4 in Mplus)

	PARENT	HEALTH	EXEC	ACAD
PARENT	1			
HEALTH	.367	1		
EXEC	.224	.439	1	
ACAD	.272	.304	.605	1

parent ↔ exec = .073 = .073
.367 x .412 = +.151
.224

parent ↔ acad = .144 = .144
.073 x .572 = .042
.367 x .412 x .572 = +.086
.272

health ↔ acad = .412 x .572 = .236
.367 x .073 x .572 = .015
.367 x .144 = +.053
.304

Examples

$X_1 \leftrightarrow X_3 = .741 \times .800 = .593$

$X_1 \leftrightarrow X_4 = .741 \times .367 \times .886 = .241$

$X_{11} \leftrightarrow X_{12} = .735 \times .831 = .611$

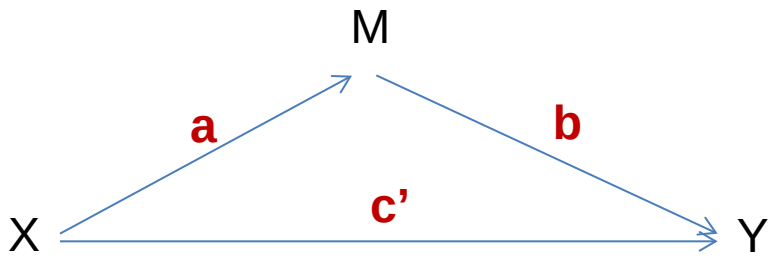
$X_1 \leftrightarrow X_{10}$ = .741 x .144 x .827 = .088
.741 x .073 x .572 x .827 = .026
.741 x .367 x .412 x .572 x .827 = +.053
.167

$X_9 \leftrightarrow X_{10}$ = .959 x .572 x .827 = .4536
.959 x .073 x .144 x .827 = .0083
.959 x .412 x .367 x .144 x .827 = +.0173
.479

Mediation in SEM

Model 1

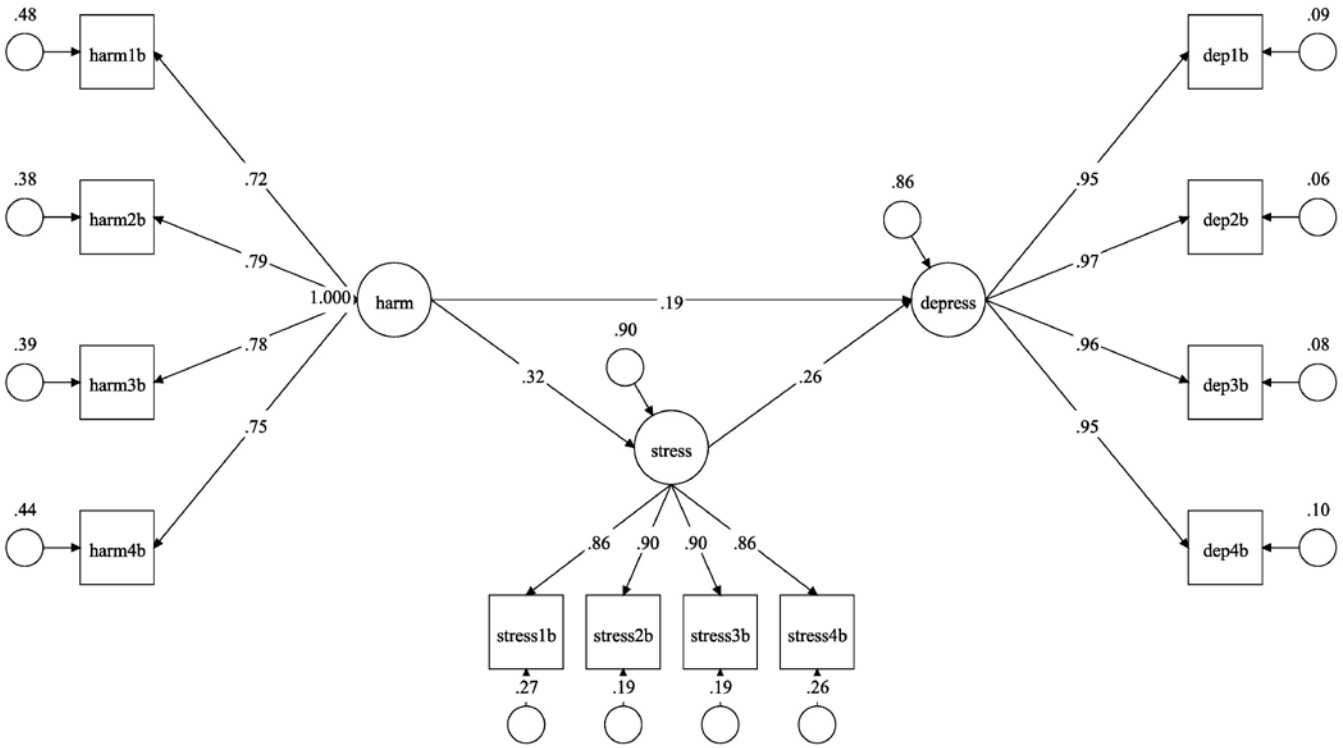
Model 2



- Similar to the Baron and Kenny's approach but simpler
- Mediated effect is **ab** and called **indirect** effect in SEM
- Path **c** in Model 1 is a **direct effect** and is a **total effect**
- Path **c'** in Model 2 is a **direct effect** (but not a **total effect**)
- The **total effect** in Model 2 = **direct effect** (**c'**) + **indirect effect** (**ab**)
- The **total effect** in Model 1 (**c**) = **total effect** in Model 2 (**c' + ab**)
- The mediated effect (**ab**) = **c – c'**
- Mplus provides tests of significance for direct, indirect, and total effects
- Mplus also provides a bootstrap option

An Example of Mediation

```
model: stress by stress1b stress2b stress3b stress4b;
harm by harm1b harm2b harm3b harm4b;
depress by dep1b dep2b dep3b dep4b;
depress on stress harm;
stress on harm;
model indirect:
depress IND harm;
output: sampstat residual stdyx modindices tech4;
```



An Example of Mediation

Chi-Square Test of Model Fit

Value	98.914	
Degrees of Freedom	51	
P-Value	0.0001	

RMSEA (Root Mean Square Error Of Approximation)

Estimate	0.048	
90 Percent C.I.	0.033	0.062
Probability RMSEA <= .05	0.590	

CFI/TLI

CFI	0.990
TLI	0.987

Chi-Square Test of Model Fit for the Baseline Model

Value	4683.424
Degrees of Freedom	66
P-Value	0.0000

SRMR (Standardized Root Mean Square Residual)

Value	0.020

STDYX Standardization

	Estimate	S.E.	Est./S.E.	Two-Tailed P-Value
STRESS BY				
STRESS1B	0.857	0.015	55.313	0.000
STRESS2B	0.899	0.012	73.429	0.000
STRESS3B	0.901	0.012	74.521	0.000
STRESS4B	0.858	0.015	55.880	0.000
HARM BY				
HARM1B	0.719	0.032	22.363	0.000
HARM2B	0.790	0.027	29.116	0.000
HARM3B	0.783	0.028	27.983	0.000
HARM4B	0.748	0.029	25.400	0.000
DEPRESS BY				
DEP1B	0.953	0.005	179.877	0.000
DEP2B	0.972	0.004	260.131	0.000
DEP3B	0.959	0.005	202.695	0.000
DEP4B	0.950	0.006	169.139	0.000
DEPRESS ON				
STRESS	0.265	0.050	5.301	0.000
HARM	0.186	0.054	3.457	0.001
STRESS ON				
HARM	0.319	0.051	6.223	0.000

An Example of Mediation

TOTAL, TOTAL INDIRECT, SPECIFIC INDIRECT, AND DIRECT EFFECTS

	Estimate	S.E.	Est./S.E.	Two-Tailed P-Value
Effects from HARM to DEPRESS				
Total	1.354	0.276	4.911	0.000
Total indirect	0.423	0.110	3.865	0.000
Specific indirect				
DEPRESS				
STRESS				
HARM	0.423	0.110	3.865	0.000
Direct				
DEPRESS				
HARM	0.930	0.278	3.346	0.001

STANDARDIZED TOTAL, TOTAL INDIRECT, SPECIFIC INDIRECT, AND DIRECT EFFECTS

STDYX Standardization

	Estimate	S.E.	Est./S.E.	Two-Tailed P-Value
Effects from HARM to DEPRESS				
Total	0.270	0.051	5.303	0.000
Total indirect	0.085	0.021	4.066	0.000
Specific indirect				
DEPRESS				
STRESS				
HARM	0.085	0.021	4.066	0.000
Direct				
DEPRESS				
HARM	0.186	0.054	3.457	0.001

An Example of Mediation (bootstrap)

```
analysis:
bootstrap = 1000;
model: stress by stress1b stress2b stress3b stress4b
harm by harm1b harm2b harm3b harm4b;
depress by dep1b dep2b dep3b dep4b;
depress on stress harm;
stress on harm;
model indirect:
depress IND harm;
output: sampstat residual stdyx modindices tech4;
```

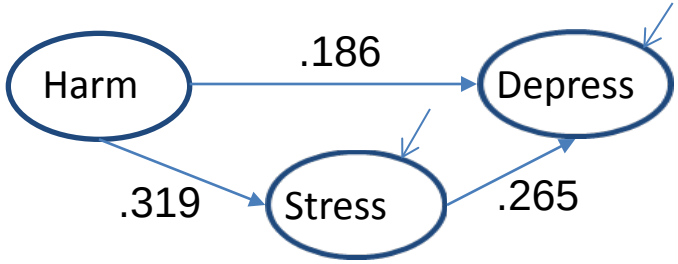
	Estimate	S.E.	Est./S.E.	Two-Tailed P-Value
Effects from HARM to DEPRESS				
Total	1.354	0.288	4.695	0.000
Total indirect	0.423	0.123	3.443	0.001
Specific indirect				
DEPRESS				
STRESS				
HARM	0.423	0.123	3.443	0.001
Direct				
DEPRESS				
HARM	0.930	0.261	3.571	0.000

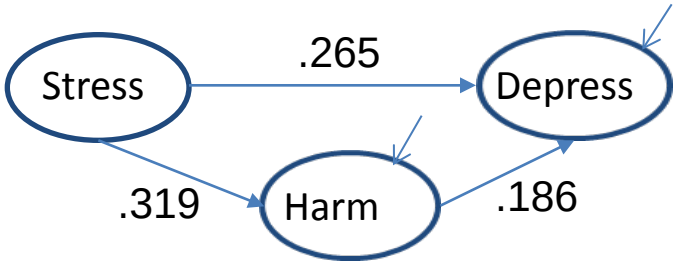
STANDARDIZED TOTAL, TOTAL INDIRECT, SPECIFIC INDIRECT, AND DIRECT EFFECTS

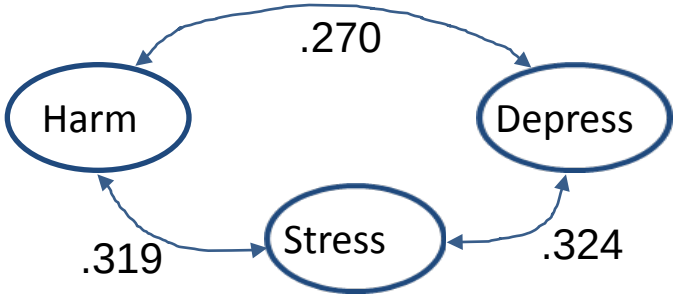
STDYX Standardization

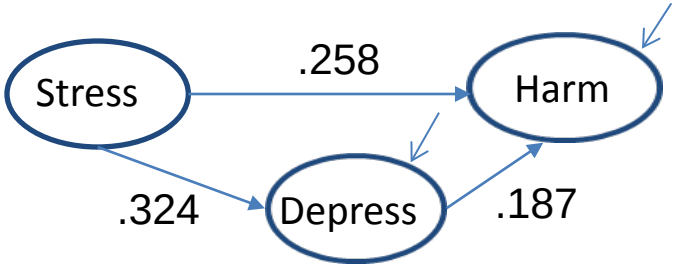
	Estimate	S.E.	Est./S.E.	Two-Tailed P-Value
Effects from HARM to DEPRESS				
Total	0.270	0.045	5.968	0.000
Total indirect	0.085	0.021	3.984	0.000
Specific indirect				
DEPRESS				
STRESS				
HARM	0.085	0.021	3.984	0.000
Direct				
DEPRESS				
HARM	0.186	0.047	3.983	0.000

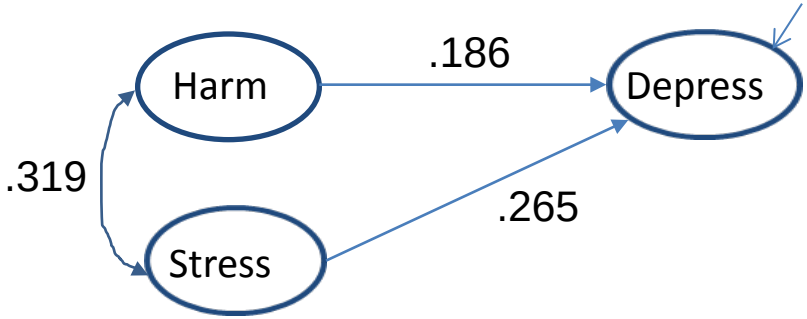
An Example of Mediation: Equivalent Models









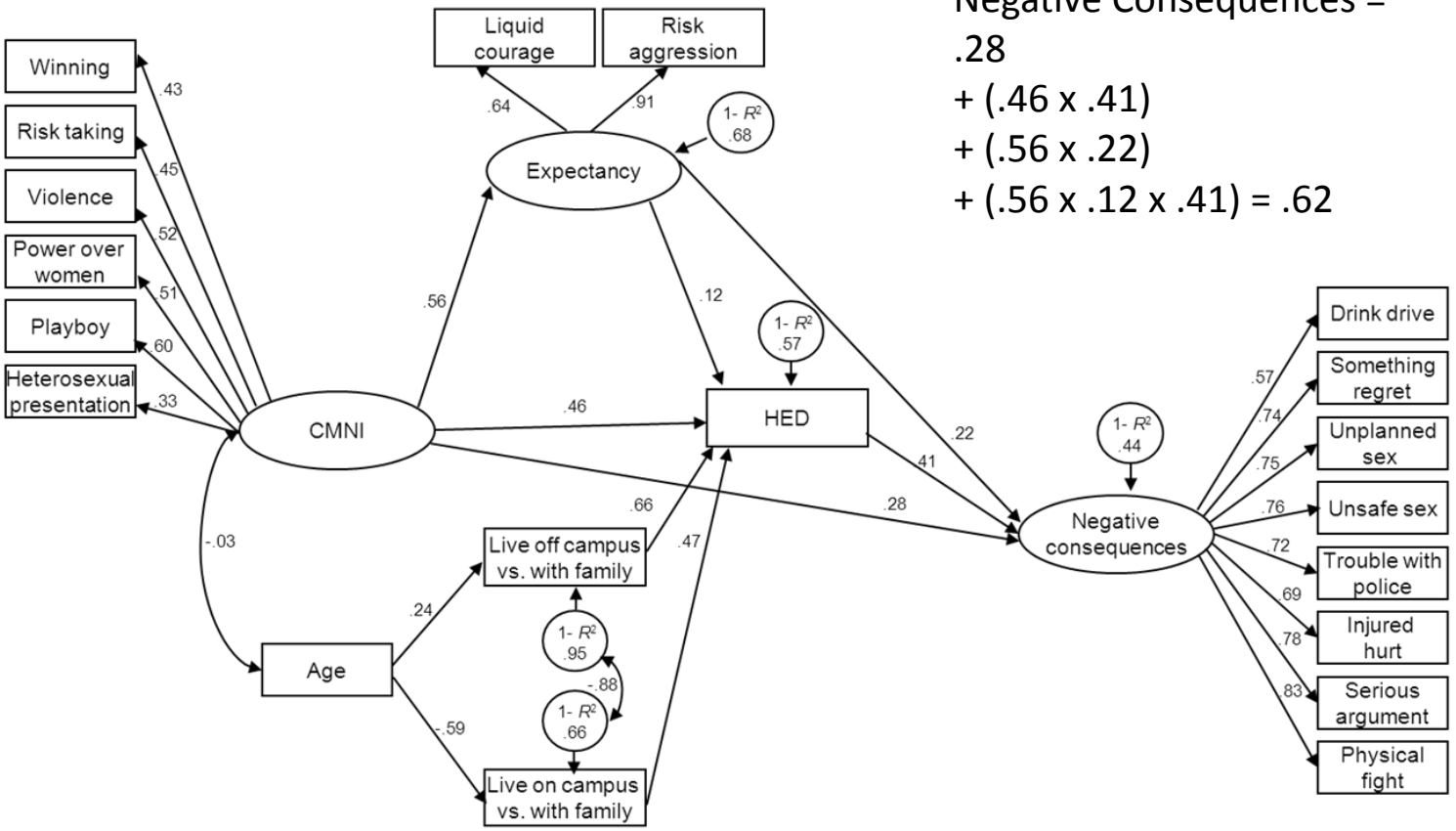


These models all have the same fit:
$X^2_{(51)} = 98.91$, $p = .001$

Note. Indicator variables are left out of the figure

A More Complex Example of Mediation

Total effect of CMNI on Negative Consequences = .28
+ (.46 x .41)
+ (.56 x .22)
+ (.56 x .12 x .41) = .62



Note. All coefficients (standardized) are significant at alpha = .001 except the effect of Expectancy on HED which is significant at p < .05 and the correlation between CMNI and Age which is not significant.

A More Complex Example of Mediation

STDYX Standardization

	Estimate	S.E.	Est./S.E.	Two-Tailed P-Value
Effects from CMNI to CON_LAT				
Total	0.619	0.032	19.364	0.000
Total indirect	0.342	0.044	7.710	0.000
Specific indirect				
CON_LAT				
HED8				
CMNI	0.190	0.035	5.395	0.000
CON_LAT				
EXP				
CMNI	0.124	0.032	3.924	0.000
CON_LAT				
HED8				
EXP				
CMNI	0.028	0.015	1.817	0.069
Direct				
CON_LAT				
CMNI	0.278	0.060	4.616	0.000
Effects from CMNI to HED8				
Total	0.526	0.070	7.506	0.000
Total indirect	0.068	0.037	1.811	0.070
Specific indirect				
HED8				
EXP				
CMNI	0.068	0.037	1.811	0.070
Direct				
HED8				
CMNI	0.458	0.084	5.427	0.000

A More Complex Example of Mediation

Example of a paragraph to include in a method section to describe the analyses:

> To test a structural equation model (SEM) linking masculinity, alcohol outcome expectancies, HED and negative consequences, we used a two-step SEM approach (see Kline, 2011) consisting of an initial analysis of the measurement model (i.e., how well the latent variables are defined by the indicator variables) followed by an analysis of the full SEM model. Refinements to the models were performed by modifying one parameter at a time and re-investigating each new model. Analyses were performed with Mplus Version 6.12 (Muthén and Muthén, 1998-2012) using a weighted least squares estimation (WLSMV in Mplus) to account for outcome variables that were not measured on a continuous scale but on binary or ordered scales (i.e., negative consequences and heavy episodic drinking).

The Full Model

Example of a paragraph describing the results:

The final SEM model is presented in Figure 1. Prior SEM analyses included testing an initial measurement model. Specifically, inspection of the loadings led to a decision to remove the Emotional Control indicator variable from the model because its loading on the CMNI latent variable was too small (standardized loading was .12). This finding is consistent with the low correlation between Emotional Control and all other variables. No other measurement modifications were required. The final model had good fit with $X^2_{(162)} = 608.54$, $p < .001$, and *CFI* = .94, *TLI* = .93 and *RMSEA* = .04. All the indices support the model as a close fit to the data. All parameters in the final model in Figure 1 were statistically significant with the exception of the correlation between CMNI and age.

The Full Model

Second paragraph describing the results:

The model in Figure 1 shows that the CMNI was directly associated with HED (.46) and with negative drinking consequences (.28). An indirect link between the CMNI and negative drinking consequences was found through both alcohol expectancy and HED. These two indirect effects have standardized regression coefficients of 0.19 and 0.12 respectively, and both were significant at $p < .001$ (based on bootstrapped standard errors associated with the unstandardized coefficients). Given that the total effect of CMNI on negative drinking consequences was 0.62, the two mediated effects account for 30.5% (.189/.619) and 20.0% (.124/.619) of the total effect, respectively. The mediated effect of expectancy in the relationship between CMNI and HED had a standardized coefficient value of 0.07 (representing 12.9% of the total effect of CMNI on HED) but was not statistically significant ($p = .070$). Finally, we tested the mediated effect for CMNI through alcohol expectancy to HED and then through HED to drinking consequences, but this was found to be non-significant ($p=.069$).