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Effect Sizes for Social Phobia Example

This document describes methods for estimating various effect sizes for the social phobia example in Chapter 11. I assume you have read Chapter 10 on effect sizes in RETs and Chapter 11. In Chapter 10, I presented formulae for and described the strengths and weaknesses of different effect size indices. Most of the indices have been developed by methodologists outside the context of SEM, usually using OLS modeling for a single equation. To be sure, the general idea of standardized effect size indices can be imported to full information SEM (FISEM), but the statistical theory underlying such representations is not always straightforward. Because the social phobia example in Chapter 11 deals with continuous mediators and continuous outcomes, I focus on three indices in this document, the probability of exceptions to the rule (P_E), Cohen's *d*, and the percent or proportion of unique explained variance. I also offer comments on standardized regression coefficients. The estimates of the effect sizes in SEM sometimes require ad hoc analytic strategies so the estimates should be viewed as approximate. If you object to the ad hoc nature of a strategy I describe, then don't use it. My own preference is to complement unstandardized indices of effect size with the probability of exceptions to the rule index, P_E, but other scientists may feel differently.

One challenge faced when estimating SEM-based standardized effect sizes is that in FISEM and in some variants of LISEM, the effect size index is based on a combination of multiple path coefficients from different equations. This complicates the underlying statistical theory. Another challenge is that some of the OLS-based formulae I provide make use of the t ratios associated with a path coefficient whereas in traditional SEM, the critical ratios are analogous to z ratios based on asymptotic theory. The two ratios typically will be close in value but this requires large sample sizes and also depends on the broader model context. As such, it is best to treat the SEM results as approximate.

TRADITIONAL FISEM USING MAXIMUM LIKELIHOOD

Effect Size Indices for the Program Effect on the Outcome

Mplus reports the unstandardized total effect estimate using the combined coefficient method, i.e., it derives the total effect from combinations of path coefficients from different equations in the model. Mplus reports the standard error for the unstandardized effect, a critical ratio, confidence intervals, and a p value. To report a standardized version of the effect, some methodologists suggest that when the predictor being evaluated is binary ad the outcome is continuous that it is best to report a *partially standardized effect* which is an analog of Cohen's *d*. This method regresses Y onto the binary X while standardizing Y but not X. The resulting coefficient is the difference between the mean standardized Y for the two groups defined by the predictor. As I discuss in Chapter 10, the problem with doing so in an RET is that the standard deviation for Y is the posttest standard deviation. This SD may be inappropriate because it is artificial; it represents the SD of Y for a population that has half of its members having completed the intervention and the other half having not completed it, which is unlikely to occur in practice. The result, the argument goes, is an unrealistic effect size index in which the reference standard deviation has no external validity.

If despite this you want to calculate the partially standardized total effect, change the output line on your Mplus code to read

```
SAMP STANDARDIZED(ALL) MOD(ALL 4) RESIDUAL CINTERVAL TECH4 ;
```

and then examine the output for the total effect of the binary treatment condition under the section `STD` standardization. The result for the standardized Y mean difference for the social phobia example was -1.395; the total effect raw mean difference of -1.758 translates into a difference of -1.395 in Y standard deviation units. Mplus offers three forms of standardization (`STDYX`, `STDY`, `STD`) and the above command line will print all three of them on the output. It sometimes is difficult to discern which type of standardization reflects the Y partial standardized coefficient. You can double check this by dividing the raw mean difference (-1.758) by the square root of the variance of the outcome, in this case, `LSP3`. The variance of `LSP3` can be found in the `TECH4` output section of your Mplus output called `ESTIMATED COVARIANCE MATRIX FOR THE LATENT VARIABLES` and in this case it equals 1.587. Thus, -1.758 divided by the square root of 1.587 is -1.395. For a description of the three forms of standardization and some of the complications to their interpretation, see the Mplus user's manual.

It turns out that one cannot estimate P_E, Cohen's *d*, nor the unique explained variance for the reported program total effect using the formulae in Chapter 10 because the needed information is either not available on the Mplus output or the underlying statistical theory for the formulae does not apply to FISEM. However, there is a workaround you can use. The workaround shifts to an LISEM framework by executing an Mplus program that regresses the outcome onto the treatment condition variable plus the relevant covariates (in this case, the baseline outcome and the two baseline covariates of biological sex and parental hypercriticism) in a separate, single-equation Mplus analysis. This analysis violates the spirit of FISEM which estimates the total effect by combining coefficients from multiple equations. Critics argue that the workaround method is ad hoc relative to traditional FISEM. Others feel one can obtain a reasonable approximation of the standardized indices for the total program effect using the workaround and they point to the fact that it could even be more accurate than the combined coefficient method because it is not tied to correct model specification about relationships between the program and mediators and the mediators and the outcome. To apply the method to the social phobia example, I regress the posttreatment latent social phobia variable onto the treatment condition dummy variable and the covariates of biological sex, parental hypercriticism, and the baseline latent social phobia variable. Table 1 presents the relevant syntax. I do not comment on the syntax because it should be self-explanatory after reading Chapter 11.

Table 1: Mplus Syntax for Total Program Effect

```
TITLE: TOTAL EFFECT ONLY ANALYSIS  ;
DATA: FILE IS c:\mplus\ret\newchap11\chap11M.txt ;
 VARIABLE:
    NAMES ARE ID CR1 SPAI1 SPIN1 CR3 SPAI3 SPIN3
      NEGAPP2 PSKILLS2 EXTERN2 NEGAPP1 PSKILLS1 EXTERN1
      HYPER SEX TREAT ;
    USEVARIABLES ARE CR1 SPAI1 SPIN1 CR3 SPAI3 SPIN3
      HYPER SEX TREAT ;
   MISSING ARE ALL (-9999) ;
 ANALYSIS:
   ESTIMATOR = MLR ;  !Robust maximum likelihood
 MODEL:
 !Specify latent variables
       LSP1 BY CR1 SPAI1 SPIN1 ;
       LSP3 BY CR3 SPAI3 SPIN3 ;
     [CR1@0] ; [CR3@0] ; [LSP1] (mean1) ; [LSP3] (int1) ;
 !Specify equation
   LSP3 ON LSP1 TREAT SEX HYPER  ;
 !Specify correlation of latent variable with exogenous variables
   LSP1 WITH TREAT SEX HYPER ;
 OUTPUT:
   SAMP STANDARDIZED(STDYX) MOD(ALL 4) RESIDUAL CINTERVAL TECH4 ;
```

The model based on this syntax fit the data well as reflected by the global and localized fit indices. Here is the Mplus output for the relevant equation:

```
                                                   Two-Tailed
                    Estimate       S.E.  Est./S.E.    P-Value

 LSP3     ON
    TREAT             -1.749      0.106    -16.424      0.000
    SEX               -0.032      0.102     -0.319      0.750
    HYPER             -0.050      0.107     -0.468      0.640
    LSP1               0.439      0.081      5.442      0.000
```

The coefficient for the treatment condition variable was -1.749, which is close to the total effect value of -1.758 reported by Mplus in the original FISEM analysis. For the probability of exception, I applied the formula for it from Chapter 10 using the program on my website titled *Prob of except: Continuous*. This program also requires the squared multiple correlation for this equation (it was 0.525 on the Mplus output), and the standard deviation of `LSP3` across the full sample (it was 1.256). The latter value is found in the `TECH4` output section that reports the variance of `LSP3`, for which the square root is 1.256. Using the program for the probability of exceptions on my website, I find the approximate P_E to be 0.08.

For Cohen's *d*, I need to divide the raw difference of -1.749 by the covariate adjusted pooled standard deviation for the two groups. This can be obtained from the output for the syntax in Table 1 from the `MODEL RESULTS` section. It is the square root of the reported residual variance for `LSP3`, which is the square root of 0.749, which equals 0.865. The value of this analog of Cohen's *d* is -1.749/0.865 = -2.02.

Computation of the analog to the squared semi-part correlation for the variable `TREAT` to document the proportion of unique explained variance in LSP3 by `TREAT` requires the squared R for the equation (which was 0.525), the sample size (N=333), the number of predictors (4), and the absolute value of the critical ratio for `TREAT` (16.424). The result using the program on my website called *z or t to part/semipart r* was 0.391. The treatment condition accounts for approximately 39% of the variation in the posttest latent social phobia variable over and above the covariates.

Standardized Effect Size Indices for Program Effects on Mediators

To assess program effects on mediators, the social phobia example has two scenarios; (1) the program affects perceived social skills (PSS) directly but (2) it affects negative cognitive appraisals (NCA) and external locus of control (ELC) both directly *and* through PSS. The calculation of standardized effect size indices for program effects on PSS is straightforward but doing so for NCA and ELC is more complicated due to the multiple ways that the intervention influences them. I consider each scenario, in turn.

Effect of Program on Perceived Social Skills

Here is the relevant output from Mplus reporting the unstandardized direct effect of the program on PSS (the output is reproduced from Chapter 11):

```
                                                   Two-Tailed
                    Estimate       S.E.    Est./S.E.    P-Value
PSKILLS2 ON
    TREAT              1.173      0.050     23.638      0.000
    HYPER              0.022      0.061      0.363      0.716
    SEX                0.045      0.049      0.912      0.362
    PSKILLS1           0.508      0.059      8.618      0.000
```

To calculate P_E, I use the program called *Prob of exceptions: Binary* on my website. It requires as input the coefficient associated with the intervention (1.173), the squared multiple correlation for the equation (0.657, found in the output section `STANDARDIZED MODEL RESULTS` in the subsections `STDYX Standardization` and `R-SQUARE`), and the standard deviation of `PSKILLS2`, which is located in the `TECH4` output in the estimated covariance matrix section. The diagonal entry for `PSKILLS2` in this matrix is a variance (0.595), whose square root is 0.771. The probability of exception based on the program is 0.03.

For Cohen's *d*, I need to divide the coefficient(1.173) by the residualized standard deviation for `PSKILLS2`. The latter is obtained from the output for the main FISEM syntax in Table 1 in Chapter 11 in the `MODEL RESULTS` section. It is the square root of the reported residual variance for `PSKILLS2`, which is the square root of 0.204 or 0.452. The approximate value of Cohen's *d* is 1.173/.452 = 2.60.

For the proportion of unique explained variance in `PSKILLS2` associated with the intervention, I use the program called *z or t to part/semipart r* on my website. The program requires the critical ratio for the `TREAT` coefficient (23.638), the sample size (333), the number of predictors (4), and the squared multiple correlation of the equation (0.657). The approximate squared semi-part correlation associated with the `TREAT` predictor was 0.58. [1]

Effect of Program on Negative Cognitive Appraisals and External Locus of Control

For negative cognitive appraisals, there are two ways by which the program affects this mediator. First, there is a direct effect of the treatment on negative cognitive appraisals due to program activities explicitly designed to change negative appraisals. Second, there is an indirect effect of the program on negative appraisals through perceived social skills. To determine program effects on negative appraisals, I need to take both sources into account.

[1] As noted on the website, some methodologists would set the number of predictors to equal zero for this example.

The FISEM analysis used a combined coefficient method to derive the estimate (see Chapter 11). The unstandardized effect is reported in the Mplus output section `TOTAL, TOTAL INDIRECT, SPECIFIC INDIRECT, AND DIRECT EFFECTS` and the subsection `Effects from TREAT to NEGAPP2`. Here is the relevant output:

```
                                                     Two-Tailed
                    Estimate       S.E. Est./S.E.     P-Value

Effects from TREAT to NEGAPP2

  Total               -1.132      0.053    -21.220      0.000
```

It turns out you cannot estimate P_E, Cohen's *d*, nor the unique explained variance for the program effect on negative cognitive appraisals using the formulae I present in Chapter 10 because the estimated causal effect relies on combining multiple path coefficients. One way to obtain estimates of these parameters is to use the direct regression method that regresses the `NEGAPP2` onto the treatment condition variable plus relevant covariates in a separate, single-equation Mplus analysis, much like I did for the total effect of the treatment condition on the posttest latent social phobia. To apply the method to the social phobia example, I regress `NEGAPP2` onto the treatment condition and the covariates of biological sex, parental hypercriticism, and the baseline negative appraisals variable, omitting `PSKILLS2` from the equation so that I do not hold it constant since the treatment affects `NEGAPP2` through it. Table 2 presents the relevant syntax, which is self-explanatory. I can omit the `WITH` statement from the program because there is no baseline latent variable; Mplus by default takes the exogenous correlations into account.[2]

Table 2: Mplus Syntax for Program Effect on Negative Cognitive Appraisals

```
TITLE: PROGRAM EFFECT ON NEGAPP2  ;
DATA: FILE IS c:\mplus\ret\newchap11\chap11M.txt ;
 VARIABLE:
    NAMES ARE ID CR1 SPAI1 SPIN1 CR3 SPAI3 SPIN3
      NEGAPP2 PSKILLS2 EXTERN2 NEGAPP1 PSKILLS1 EXTERN1
      HYPER SEX TREAT ;
    USEVARIABLES ARE NEGAPP2 NEGAPP1 HYPER SEX TREAT ;
   MISSING ARE ALL (-9999) ;
 ANALYSIS:
   ESTIMATOR = MLR ;  !Robust maximum likelihood
 MODEL:
 !Specify equation
   NEGAPP2 ON NEGAPP1 TREAT SEX HYPER  ;
```

[2] Some analysts might include it anyway to maintain a random predictor framework that `WITH` produces.

```
OUTPUT:
   SAMP STANDARDIZED(STDYX) MOD(ALL 4) RESIDUAL CINTERVAL TECH4 ;
```

The model was just-identified, so indices of fit are irrelevant. Here is the Mplus output for the relevant equation:

```
                                                     Two-Tailed
                    Estimate       S.E.  Est./S.E.      P-Value

 NEGAPP2   ON
    TREAT             -1.128       0.055    -20.586       0.000
    NEGAPP1            0.451       0.057      7.857       0.000
    SEX               -0.042       0.055     -0.759       0.448
    HYPER              0.081       0.061      1.328       0.184
```

The coefficient for `TREAT` was -1.128, which is close to the value of -1.132 reported by Mplus in the original FISEM analysis. For the probability of exception, the applicable formula from Chapter 10 and implemented by the program on my website requires the squared multiple correlation for this equation (it was 0.590 on the Mplus output), and the standard deviation of `NEGAPP2` across the full sample (it was 0.785). The latter value is obtained from the `TECH4` output that reports the variance of `NEGAPP2`, for which the square root is 0.785. Using the program for the probability of exceptions on my website, I found the approximate P_E to be 0.06.

For Cohen's *d*, I need to divide the difference -1.128 by the covariate adjusted pooled standard deviation for the two groups. This is obtained from the output for the syntax in Table 2 from the `MODEL RESULTS` section. It is the square root of the reported residual variance for `NEGAPP2`, which is the square root of 0.253, which equals 0.503. The value of this analog of Cohen's *d* is -1.128/0.503 = -2.24.

Computation of the analog to the squared semi-part correlation for the variable `TREAT` to document the proportion of unique explained variance in LSP3 by `TREAT` requires the squared R for the equation (which was 0.590), the sample size (N=333), the number of predictors (4), and the critical ratio for `TREAT` (20.586). The result using the program on the website was 0.530.

The same method is used for the program effect in external locus of control.

Keep in mind that the approach I am using here is somewhat ad hoc as it mixes LISEM logic with FISEM logic. However, it provide me a sense of P_E and *d* and is useful in that respect.

Standardized Effect Size Indices for Mediator Effects on Outcomes

To evaluate effect size of the mediators on social phobia, I again must consider two scenarios. First, for negative cognitive appraisals and external locus of control, the mediators only have direct effects on posttest social phobia. The calculation of the standardized effect sizes is straightforward in these cases. The mediator perceived social skills, however, directly affects social phobia but it also affects social phobia indirectly through its effects on negative cognitive appraisals and external locus of control. The calculation of standardized effect size indices for the effects of perceived social skills on social phobia must take these diverse sources of influence into account. I consider the two scenarios, in turn. The effect size indices of primary interest are the probability of exceptions to the rule and the proportion of unique explained variance. Cohen's *d* is not relevant for a continuous predictor and a continuous outcome, which characterizes the current analysis.

Effect of Negative Cognitive Appraisals and External Locus of Control on Social Phobia

The output section from the original FISEM analysis reported in Chapter 11 that is relevant to calculating the desired effect size indices for negative appraisals and external locus of control is presented in Table 3. It is taken from the section called `MODEL RESULTS`. and represents the unstandardized coefficients.

Table 3: Mplus Output for Mediator Effects on Social Phobia

	Estimate	S.E.	Est./S.E.	Two-Tailed P-Value
LSP3 ON				
NEGAPP2	0.390	0.095	4.100	0.000
PSKILLS2	-0.707	0.099	-7.109	0.000
EXTERN2	-0.002	0.091	-0.017	0.986
TREAT	-0.488	0.136	-3.581	0.000
SEX	-0.002	0.088	-0.026	0.979
HYPER	-0.186	0.103	-1.803	0.071
LSP1	0.347	0.072	4.835	0.000

For negative cognitive appraisals, to calculate the probability of exceptions to the rule using the program on my website called *Prob of exception: Continuous*, I need to input the estimated partial correlation between the negative cognitive appraisals and the latent social phobia outcome. I use the program called *z or t to part/semipart correlation* to estimate the partial correlation. This requires as input the critical ratio for the negative appraisal coefficient (4.100), the sample size (333), the number of predictors (7)[3], and the squared correlation for the equation (0.670). The program reports the squared partial correlation (0.049) and the square root of this is 0.221. The P_E is 0.43.

Computation of the analog to the squared semi-part correlation for NEGAPP2 relative to explained variance in LSP3 requires the squared R for the equation (which was 0.670), the sample size (N=333), the number of predictors (7), and the critical ratio for NEGAPP2 (4.100). The result using the relevant program on the website was 0.017.

The same methods can be used to calculate the desired effect size indices for external locus on control.

Effect of Perceived Social Skills on Social Phobia

The output section from the original FISEM analysis reported in Chapter 11 for the estimated unstandardized effect of perceived social skills on latent social phobia is:

```
Effects from PSKILLS2 to LSP3

                                                     Two-Tailed
                   Estimate       S.E. Est./S.E.       P-Value

Total               -0.883       0.084    -10.459      0.000
```

I cannot estimate P_E or the unique explained variance for the effect of perceived social skills on the latent social phobia variable using the programs on my website because the estimate of the causal effects relies on combined coefficients. One way to obtain estimates of these parameters is to use the same (ad hoc) method I used for the total effect of the treatment on the outcome. For the current case, I regresses LSP3 onto perceived social skills, the treatment condition variable plus relevant covariates in a separate, single-equation Mplus analysis. I exclude NEGAPP2 and EXTERN2 from the equation so that I do not hold them constant because PSKILLS2 impacts LSP3, in part, through them. Table 4 presents the relevant syntax, which is self-explanatory. Note that PSKILLS2 functions as an exogenous variable in this model.

Table 4: Mplus Syntax for Effect of Perceived Social Skills on Social Phobia

```
TITLE: PERCEIVED SOCIAL SKILLS EFFECT OF SOCIAL PHOBIA  ;
DATA: FILE IS c:\mplus\ret\newchap11\chap11M.txt ;
 VARIABLE:
```

[3] As noted on the website, some methodologists would set the number of predictors to equal zero in this example.

```
    NAMES ARE ID CR1 SPAI1 SPIN1 CR3 SPAI3 SPIN3
      NEGAPP2 PSKILLS2 EXTERN2 NEGAPP1 PSKILLS1 EXTERN1
      HYPER SEX TREAT ;
    USEVARIABLES ARE CR1 SPAI1 SPIN1 CR3 SPAI3 SPIN3
      PSKILLS2 HYPER SEX TREAT ;
   MISSING ARE ALL (-9999) ;
 ANALYSIS:
   ESTIMATOR = MLR ;  !Robust maximum likelihood
 MODEL:
 !Specify latent variables
       LSP1 BY CR1 SPAI1 SPIN1 ;
       LSP3 BY CR3 SPAI3 SPIN3 ;
    [CR1@0] ; [CR3@0] ; [LSP1] (mean1) ; [LSP3] (int1) ;
 !Specify equations
   LSP3 ON LSP1 PSKILLS2 TREAT SEX HYPER  ;
 !Specify correlations of latent variable with exogenous variables
 !Include PSKILLS2 because it is functioning as an exogenous variable
   LSP1 WITH TREAT SEX HYPER PSKILLS2 ;
 OUTPUT:
   SAMP STAND(STDYX)  MOD(ALL 4) RESIDUAL CINTERVAL TECH4 ;
```

The model fit the data well as reflected by the global and localized fit indices. Here is the Mplus output for the relevant equation:

```
                                                   Two-Tailed
                    Estimate       S.E.  Est./S.E.    P-Value
LSP3     ON
    PSKILLS2          -0.880      0.087    -10.170      0.000
    TREAT             -0.725      0.129     -5.604      0.000
    SEX               -0.019      0.090     -0.214      0.831
    LSP1               0.369      0.073      5.091      0.000
```

The coefficient for `PSKILLS2` was -0.880, which is close to the value of -0.883 reported by Mplus in the original FISEM analysis. For the probability of exception, the program on my website requires the partial correlation for the `PSKILLS2` predictor. I use the program called *z or t to part/semipart correlation* to estimate the partial correlation. This requires as input the critical ratio for perceived social skills (10.170), the sample size (333), the number of predictors (4), and the squared correlation for the equation (0.647). The program reports the squared partial correlation (0.240) and the square root of this is 0.490. The P_E is 0.0.34.

Computation of the squared semi-part correlation analog for `NEGAPP2` to document the proportion of unique explained variance in LSP3 requires the squared R for the equation (which was 0.647), the sample size (N=333), the number of predictors (4), and the critical ratio for `PSKILLS2` (10.170). The result using the program on my website was 0.11.

BAYESIAN SEM

As noted in the main text of Chapter 11, relatively little attention has been given to standardized effect size estimation in Bayesian modeling. Instead, the focus is on unstandardized indices of effect size. In this respect, you can use the latitude strategy I outline in Chapter 10 but with credible intervals instead of confidence intervals. You cannot use the OLS based formulae I present for effect size indices in Chapter 10 given the very different statistical theory and philosophy underlying Bayesian analysis. One can make creative use of some of the Bayesian SEM output to derive standardized effect size indices but doing so is beyond the scope of the current book.

OLS BASED LISEM

Standardized Effect Size Indices for the Program Effect on the Outcome

As noted in Chapter 11, the total effect of the program on the outcome using OLS-based LISEM can be estimated using either the direct regression method or the combined coefficient method. I calculate the effect size indices here using the direct regression method that regresses `CR3` onto `TREAT`, `CR1`, `SEX` and `HYPER` using any software that has a multiple regression program. The unstandardized coefficient was -1.73 ±0.22 ($t(332) = 15.41$, $p < 0.05$), which compares favorably to the estimate from the FISEM analysis where the result was -1.76 ±0.21 ($z = 16.86$, $p < 0.05$).

For the probability of exception, the applicable program on my website requires the squared multiple correlation for the equation (it was 0.44), and the standard deviation of `CR3` across the full sample (it was 1.36). Using the program for the probability of exceptions on my website, I found the approximate P_E to be 0.11

For Cohen's *d*, I need to divide the difference -1.73 by the covariate adjusted pooled standard deviation for the two groups. This can be obtained from the output labeled mean square residual (or mean square error) and it is the square root of this value. The mean square residual was 1.050 and the square root if it is 1.025. The value of Cohen's *d* is -1.73/1.025 = -1.69.

Computation of the analog to the squared semi-part correlation for the variable `TREAT` to document the proportion of unique explained variance in LSP3 by `TREAT` requires the squared R for the equation (which was 0.44), the sample size (N=333), the number of predictors (4), and the critical ratio for `TREAT` (15.41). The result using the program on the website was 0.42.

Effect Size Indices for Program Effect on Mediators

To assess program effects on mediators using OLS-based LISEM, I work with two scenarios. First, the program affects perceived social skills (PSS) directly. Second it affects negative cognitive appraisals (NCA) and external locus of control (ELC) both directly and indirectly through PSS. The calculation of standardized effect size indices for program effects on PSS is straightforward but such calculations for NCA and ELC is more complicated due to the multiple ways that the program influences them. I consider each scenario, in turn.

Effect of Program on Perceived Social Skills

For perceived social skills, I regress `PSKILLS2` onto `TREAT` and the covariates `HYPER`, `SEX` and `PSKILLS1`. The unstandardized regression coefficient for `TREAT` was 1.173 ±0.10 ($t(328) = 23.486$, $p < 0.05$). To calculate P_E, I use the program called *Prob of exceptions: Binary* on my website. It requires as input the coefficient associated with the intervention (1.173), the squared multiple correlation for the equation (0.657), and the standard deviation of `PSKILLS2`, which was 0.772. The probability of exception based on the program is 0.03.

For Cohen's *d*, I divide the coefficient(1.173) by the residualized standard deviation for `PSKILLS2`. The latter is the square root of the mean square residual reported on the regression output, which is the square root of 0.207, which is 0.455. The value of Cohen's *d* is 1.173/.455 = 2.58.

The proportion of unique explained variance in `PSKILLS2` associated with the intervention is the squared semi-part correlation for `TREAT` holding constant `HYPER`, `SEX` and `PSKILLS1`. This is readily obtained from standard regression output and it was 0.58.

Effect of Program on Negative Cognitive Appraisals and External Locus of Control

For negative cognitive appraisals, there are two ways by which the program affects this mediator. First, there is a direct effect of the treatment on negative cognitive appraisals due to program activities explicitly designed to change negative appraisals. Second, there is an indirect effect of the program on negative appraisals through perceived social skills. To determine program effects on negative appraisals, I need to take both sources into account. I can use either the direct regression method or the combined coefficient method. It turns out that for the calculation of P_E and the other standardized indices, the most straightforward approach is the direct regression method. I regress `NEGAPP2` onto `TREAT` and the covariates `HYPER`, `SEX` and `NEGAPP1`, but I explicitly exclude from the equation the other mediator that is said to influence `NEGAPP2`, namely `PSKILLS2`. The unstandardized regression coefficient for `TREAT` was -1.128 ±0.11 ($t(328) = 20.276$, $p < 0.05$). To calculate P_E, I use the program called *Prob of exceptions: Binary* on my website. It requires as input the coefficient associated with the intervention (-1.128), the squared multiple correlation for the equation (0.590), and the standard deviation of NEGAPP2, which was 0.787. The probability of exception based on the program is 0.06.

For Cohen's *d*, I divide the coefficient(-1.128) by the residualized standard deviation for NEGAPP2. The latter is the square root of the mean square residual reported on the regression output, which is the square root of 0.257, which is 0.507. The value of Cohen's *d* is -1.128/.507 = -2.22.

The proportion of unique explained variance in NEGAPP2 associated with the intervention is the squared semi-part correlation for TREAT holding constant HYPER, SEX and NEGAPP1. This is readily obtained from standard regression output and it was 0.51.

The same method is used for the program effect in external locus of control.

Standardized Effect Size Indices for Mediator Effects on Outcomes

To assess effects of the mediators on social phobia using OLS-based LISEM, I again need to consider two scenarios. First, for negative cognitive appraisals and external locus of control, the mediators only have direct effects on posttest social phobia. The calculation of the standardized effect size indices is straightforward in these cases. The mediator perceived social skills directly affects social phobia but it also affects it indirectly through its effects on negative cognitive appraisals and external locus of control. The calculation of standardized effect size indices for the effects of perceived social skills on social phobia must take these diverse sources into account. I consider the two cases, in turn.

Effect of Negative Cognitive Appraisals and External Locus of Control on Social Phobia

For both the analysis of the mediators NEGAPP2 and EXTERN2, I regress CR3 onto NEGAPP2, EXTERN2, PSKILLS2, TREAT, SEX, HYPER and CR1 using standard OLS regression software. The unstandardized regression coefficient for negative cognitive appraisals was 0.38 ±0.20 ($t(324) = 3.76$, $p < 0.05$). To calculate the probability of exceptions using the program on my website called *Prob of exception: Continuous*, I need to input the estimated partial correlation NEGAPP2 and CR3 holding constant the other predictors from the above equation. I generate this from the regression package and find it to equal .204. Based on this input, the P_E is 0.43.

The semi-part correlation for NEGAPP2 is reported on the regression output. It equaled 0.136, the square of which is 0.018. The percent of unique explained variance in CR3 due to NEGAPP2 is 1.8%. The same methods are used to calculate the standardized effect size indices for external locus on control.

Effect of Perceived Social Skills on Social Phobia

The most straightforward way to estimate P_E and the unique explained variance for the effect of perceived social skills on CR3 is to use the direct regression method. I use standard OLS software to regress `CR3` onto `PSKILLS2`, `TREAT`, `SEX`, `HYPER` and `CR1` omitting `NEGAPP2` and `EXTERN2` from the equation so that I do not hold them constant. The unstandardized regression coefficient for `PSKILLS2` was -0.929 ±0.21 ($t(327) = 9.24$, $p < 0.05$). To calculate the probability of exceptions using the program on my website called *Prob of exception: Continuous*, I need to input the estimated partial correlation NEGAPP2 and CR3 holding constant the other predictors from the above equation. I generate this from the regression package and find it to equal -.455. Based on this input, the P_E is 0.35.

The semi-part correlation for `PSKILLS2` is directly reported on the regression output. It equaled -0.341, the square of which is 0.12. The percent of unique explained variance in `CR3` due to `PSKILLS2` is 12%.

QUANTILE, ROBUST REGRESSION, BAYESIAN, AND BOLLEN'S LISEM

Standardized effect size indices in the context of LISEM are not available for quantile regression, robust regression, and Bayesian regression. Again, I could offer possibilities, but doing so is beyond the scope of this book. Bollen's LISEM is inherently tied to least squares regression methods but it uses a version of it known as two stage least squares in the context of instrumental regression. One could, in theory, bring to his approach the OLS-based LISEM strategies I described above, but the pragmatics of doing so have not been developed.