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Moderated mediation analysis: An illustration using the association of gender with delinquency and mental health

Jeremy N.V. Miles, Magdalena Kulesza, Brett Ewing, Regina A. Shih, Joan S. Tucker, and Elizabeth J. D'Amico

Department: RAND Health, University/Institution: RAND Corporation, Town/City: Santa Monica, State (US only): CA, Country: U.S.

Abstract

Purpose—When researchers find an association between two variables, it is useful to evaluate the role of other constructs in this association. While assessing these mediation effects, it is important to determine if results are equal for different groups. It is possible that the strength of a mediation effect may differ for males and females, for example – such an effect is known as moderated mediation.

Design—Participants were 2532 adolescents from diverse ethnic/racial backgrounds and equally distributed across gender. The goal of this study was to investigate parental respect as a potential mediator of the relationship between gender and delinquency and mental health, and to determine whether observed mediation is moderated by gender.

Findings—Parental respect mediated the association between gender and both delinquency and mental health. Specifically, parental respect was a protective factor against delinquency and mental health problems for both females and males.

Practical implications—Demonstrated the process of estimating models in Lavaan, using two approaches (i.e. single group regression and multiple group regression model), and including covariates in both models.

Keywords

structural equation modelling;	mediation; moderation;	delinquency; gende	r; mental health;
delinquency			

Introduction

Both impaired mental health functioning (e.g., depression, anxiety) and delinquent behavior (e.g., aggression, truancy) are common among adolescents (Achenbach & McConaughy, 1997; Cicchetti & Toth, 1991). Epidemiological data suggests that 18% of adolescents experience symptoms of depression (Rushton et al., 2002; Saluja et al., 2004).

Early onset of depression is a risk factor for adult depression (Pine et al., 1998), and early delinquency is associated with poor educational attainment, criminal behaviors, dependence

on public assistance and early pregnancies (Cote et al., 2001; Fontaine et al., 2008; Moffitt et al., 2001; Odgers et al., 2008; Schaeffer et al., 2006). There is robust evidence in the literature that females more often report more symptoms of depression and anxiety, whereas males tend to report more delinquency (see Albano and Kain, 2005; Moffit et al., 2001 for reviews). Still, mechanisms through which observed gender differences occur are not well understood. There is preliminary evidence that parental respect might be a protective mechanism against delinquency (Unger et al., 2002; 2006; Gil et al., 2000), although whether this is also the case for anxiety and depressive symptoms is unknown.

Mediation effects are increasingly seen as important in psychological research. A mediation effect occurs when a third variable explains the relationship between two other variables. Figure 1 shows a model, in which a predictor (x) is found to be associated, and presumed to be causally associated, with an outcome (y). The size of the effect from x to y is the total effect and is labelled c.

A mediating variable, m, can be added to this model, as shown in Figure 2. Variable m is hypothesized to be a measure of the mechanism by which the predictor x has its effect. The direct effect from x to y is now labelled c'. The effect from x to m is labelled a, and the effect from m to y is labelled a. The size of the effect from a to a is reduced by the total amount of the indirect effect, which is found as the product of a and a. Therefore:

$$c = ab + c'$$

Researchers are typically interested in the indirect effect (found as *ab*) which explains the extent to which the effect of *x* is mediated by *m*. To estimate the standard error and hence confidence intervals and p-value, bootstrapping is used, as the effect *ab* is not normally distributed (MacKinnon et al., 2007, Shrout and Bolger, 2002).

The use of moderator analyses also has a long history in psychological research through its use in analysis of variance (typically referred to as an interaction effect). A moderator effect occurs when the effect of one predictor is changed by a second predictor. For example, the association between gender and delinquency may vary as a function of parental monitoring (or, equivalently, the effect of parental monitoring may vary as a function of gender). To fully disentangle the nature of the relationships between variables it may be necessary to combine these two approaches. James and Brett (1984) introduced the term 'moderated mediation' for the situation in which a moderator is added to a mediation model, however there are several different ways in which a moderator may influence a mediational relationship (see Preacher et al., 2007).

This paper presents an example of moderated mediation in which an independent variable functions as a moderator of the path labelled b in Figure 2 using a sample of 2532 adolescents. Gender is treated as an exogenous variable, with parental respect as a mediating variable, and have two outcome variables: delinquency and mental health. In addition, gender acts as a moderator of the relationship between parental respect and the outcome variables, hence this is a moderated mediation model. Two equivalent models are demonstrated to estimate the parameters of the moderated mediation effect. Recognizing

alternative equivalent ways to parameterize a model may be seen as a problem (Hershberger, 1994, Hershberger, 2006, Raykov and Marcoulides, 2001), however the ability to respecify a model in different, but equivalent, ways allows us to easily relax assumptions, and to extend models in different ways.

Finally, little attention is paid in the methodological literature on moderator and mediator effects to confounding variables. If a variable (*Z*) is a predictor of all variables in a mediation model, then it is possible that spurious mediation effects will be found if this variable is not controlled. The paper demonstrates how confounding variables can be controlled for in statistical models of moderated mediation. All analyses use the Lavaan (Rosseel, 2012) package within the R statistical environment (R Development Core Team 2014) which is free and open source (other software which can analyze multiple group structural equation models and allow non-linear parameter constrains can also be used, including Mx/openMx, Lisrel, EQS, or Mplus [note that if a software package is not mentioned this should not be taken to imply that it cannot estimate such models, it is just that we are not sufficiently familiar with its capabilities at the time of writing]).

Method

Procedure

Data for the present study come from the 6th wave of a longitudinal investigation of two cohorts of youth (D'Amico et al., 2012), originally recruited from middle schools in the Los Angeles, California, metropolitan area. Participants were 2532 adolescents who completed a web-based survey between May 2013 and April 2014 and provided complete data for all predictors in the analysis. A Certificate of Confidentiality was obtained, and all procedures were approved by the individual schools, the school districts, and the institution's review board. See D'Amico et al., 2012 for more details on procedures.

The sample was 46% male and mean age was 16.2 years (sd 0.74, range 14–18). The race/ethnicity composition was 44% Hispanic, 31% non-Hispanic white (hereafter 'white'), 21% Asian, and 14% other.

Measures

Sociodemographic variables included age, gender, educational attainment of the respondent's mother, and race/ethnicity (Hispanic, Asian, other race, and White).

Delinquency was a summary score of 12 items indicating the frequency of different behaviors representing this construct (Tucker et al., 2002). Participants were asked how often they had done each of the following 12 things over the past year: skipped school; broken into property; stolen from a store; been sent out of the classroom; gotten into trouble with police; damaged others' property on purpose; run away from home; been involved in fights; been suspended from school; cheated on a test; sold drugs; driven a car under the influence (1 = not at all to 6 = 20 or more times). Higher scores indicate more involvement in these behaviors (α =0.86).

Mental Health Functioning was measured with the Mental Health Inventory (MHI-5; Stewart et al., 1992). The MHI-5 evaluates general mental health by assessing frequency (1=all the time to 6=never) of the following domains of mental health: anxiety (i.e. "How much of the time have you been a very nervous or anxious person?"); general positive affect (i.e. "How much of the time have you felt calm or peaceful?"; "How much of the time have you been a happy person?"); depression (i.e. "How much of the time have you felt downhearted or blue?"); and behavioral/emotional control (i.e. "How often have you felt so down in the dumps that nothing could cheer you up?"). The MHI-5 has been used in studies of adolescents (Tanielian et al., 2009; Theunissen et al., 2011). Higher scores correspond to better mental health (α =0.75).

Respect for Parents was assessed by a four item questionnaire adapted from Unger and colleagues (Unger et al., 2002) and used in previous studies (Shih et al., 2010; 2012). Participants were asked to respond on a 4-point Likert scale ranging from 1=strongly disagree to 4=strongly agree to questions measuring how important it was to participants that they care (i.e. "I will take care of my parents when they are old"), respect (i.e. "It's important to respect my parents) and honor their parents (i.e. "It is important to honor my parents") in addition to being a good person (i.e. "I will take care of my parents when they are old"). Higher scores indicate greater respect (α =0.91).

Results

Statistical analysis

A very brief introduction to regression models in Lavaan is presented first. The paper demonstrates that a difference between two groups can be tested using a regression framework or a multiple group framework using gender as predictor and delinquency as outcome. Then a moderator model is shown, which can be fitted as a single group using a multiplicative interaction term, or fitted as multiple groups. Next a mediation model is fit, with gender as predictor, delinquency as outcome, and parental respect as mediator. The mediation model is then adapted to a moderated mediation model. Again, two different, but equivalent, approaches are demonstrated – that of a multiplicative interaction term and a multiple groups approach. One advantage of a structural equation modeling approach is how straightforwardly it is possible to move from a single outcome to multivariate outcomes; this is demonstrated by adding mental health as a second outcome, and show how multivariate hypotheses can be tested using a Wald test. Finally, show how additional control variables can be added to the model and it is shown how this may alter conclusions.

Models in Lavaan

Estimating a structural equation model using the Lavaan package involves three steps. First, the model is set up using Lavaan syntax. Throughout this paper this setup is referred to as modelx. Second, the model is estimated using one of the estimation functions available in Lavaan. In this paper, the sem() function is used. The sem() takes as minimum arguments the name of the model, and the name of the dataset that the model is to be applied to (d is used throughout this paper). The fitted model is named fitx. Finally, the summary() function is applied to the fitted model to examine the results.

The effect of gender on delinquency

This effect can be evaluated within a structural equation modeling framework using a regression approach, or a multiple groups approach. The data are in a data frame named d. Model syntax for the regression model is named model1, and that model is then run using the sem() function. In Lavaan syntax, the symbol "~" means 'regressed on', hence "del ~ male" means that del (delinquency, the outcome) is regressed on male (the predictor). The intercept of del is requested by regressing del on a constant value of 1 – this is written as del ~ 1. Additional parameters can be created and tested in Lavaan using the ":=" operator.

The model is first set up, and labelled model1. The model runs, creating an output object fit1, and finally a summary of that object is created. Code and results (with some superfluous parts removed) are shown below:

```
model1 <- "
    del ~ male
    del ~ 1
 fit1 <- sem(model1, data=d)</pre>
> summary(fitModel1)
lavaan (0.5-16) converged normally after 1 iterations
  Number of observations
                                                      2533
  Estimator
                                                        ML
  Minimum Function Test Statistic
                                                     0.000
  Degrees of freedom
                                                          0
  P-value (Chi-square)
                                                     1.000
Parameter estimates:
  Information
                                                  Expected
  Standard Errors
                                                  Standard
          Estimate Std.err Z-value P(>|z|)
Regressions:
  del ~
                                 3.471
                                          0.001
    male
             0.069
                       0.020
 Intercepts:
    del
             1.431
                       0.013 106.730
                                          0.000
Variances:
             0.247
                       0.007
    del
```

The results of the regression show that males have delinquency scores which are, on average, 0.069 points higher than females. The standard error for this coefficient is 0.020 and p = 0.001. The intercept, which is the mean score for females, is 1.431, with a standard

error of 0.013. The regression equation could be written as: Delinquency = 1.431 + 0.0.069 * male.

The model results have provided the mean delinquency score for females as the intercept of the model (1.431), as well as the standard error (0.013), and the difference between the mean score for females and males (0.069) along with its standard error (0.021). We have not been provided with the mean score for males—this is calculated as 1.431 + 0.069 = 1.500, but the standard error is not easily calculated. However, Lavaan allows the creation of new parameters in the model as functions of other parameters. These new parameters are created by naming the regression and intercept parameters.

Lavaan names parameters implicitly, but parameters can be named explicitly in the model. To be consistent with the regression equation, b0 is used for the intercept, and b1 for the slope. A new parameter is defined as a function of other parameters using the := operator. This is modella, code and results follow.

```
modella <- "
    del ~ b1 * male
    del ~ b0 * 1
       maleMean:= b0 + b1
> fitla <- sem(modella, data=d)</pre>
> summary(fit1a)
                     Estimate Std.err Z-value P(>|z|)
Regressions:
  del ~
                                            3.471
    male
               (b1)
                         0.069
                                   0.020
                                                      0.001
 Intercepts:
    del
               (b0)
                         1.431
                                   0.013 106.730
                                                      0.000
Variances:
    del
                         0.247
                                   0.007
Defined parameters:
    maleMean
                         1.500
                                   0.015 102.658
                                                       0.000
```

The intercept (b0) and slope (b1) have been labelled, and a new parameter 'maleMean', which is their sum has been defined. This parameter has a value of 1.500 (as calculated based on the previous model) but a standard error is now also provided.

As an alternative to the regression approach, the same model can be fit via a multiple group approach. In the multiple group approach only the mean of each variable is estimated, and the effect of gender is calculated by finding the difference between the two means. When a

multiple group model is estimated two parameter labels are needed (one for each group), and these are combined into a vector using the c() function (c being short for 'combine'). When the sem() function is called, the group argument is used to tell sem() that the grouping variable is 'male' and it will estimate separate models for each group. This is model 2, shown below.

```
model2 <- "
    del ~ c(maleMean, femaleMean) * 1
    diff:= maleMean - femaleMean
 fit2 <- sem(model2, data=d, group="male")</pre>
> summary(fit2)
Group 1 [1]:
                   Estimate Std.err Z-value P(>|z|)
 Intercepts:
    del
           (mlMn)
                      1.500
                                0.018
                                         85.195
                                                    0.000
Variances:
    del
                      0.359
                                0.015
Group 2 [0]:
                   Estimate Std.err Z-value P(>|z|)
 Intercepts:
                                       135.617
                                                    0.000
    del
           (fmlM)
                      1.431
                                0.011
 Variances:
    del
                      0.153
                                0.006
Defined parameters:
                      0.069
                                0.021
                                          3.353
                                                    0.001
    diff
```

In these results, group 1 is the male group, and so the results the male mean in this section. Group 2 is the female group, where the female mean is calculated. In the regression approach (model 1) the female mean and the difference were presented, and a parameter was added to calculate the male mean. In this approach, two means appear in the results, and add a parameter, named diff, must be added to calculate the difference.

The same result for the means, and the difference between the means, was obtained using the using the regression approach (model 1) and the multiple group approach (model 2). However, there is a difference between the standard error using the regression approach and the standard error using the multiple groups approach. This difference occurs because the regression approach assumes homogeneity of variance, and the multiple group approach does not. The multiple group results (model2) show that the variance is considerably higher in the males (0.359) than the females (0.153). This discrepancy is resolved by either (a) using a technique that relaxes the assumption of homogeneity of variance in the regression approach, or (b) constraining the variances to equality in the multiple group approach.

For the regression approach the 'mlr' estimator is used. The mlr estimator is an implementation of the T2* chi-square statistic (Yuan and Bentler, 2000), itself a modification of the Satorra-Bentler scaled chi-square (Satorra and Bentler, 1994), which uses a sandwich estimator and does not assume homogeneity of variance. The argument estimator="mlr" is addted to the call to the sem() function to use this estimator. The code and relevant part of the output is shown below:

The standard errors of this regression approach now match the standard errors of the multiple group approach (which also does not assume homogeneity of variance). Alternatively the multiple group model can be fit constraining the variances of the males and females to be equal. This constrained is added by giving the the same name to the two parameters in the model (in this case, res, for residual variance) thereby forcing the homogeneity of variance assumption. Code and edited output:

```
model2a <- "
  del ~ c(maleMean, femaleMean) * 1
  del ~~ c(var, var) * del
  diff:= maleMean - femaleMean
  "
fit2a <- sem(model2a, data=d, group="male")
summary(fit2a)

Defined parameters:
  diff 0.069 0.020 3.461 0.001</pre>
```

The standard error of the multiple group approach now matches the standard error of the regression approach (which assumes homogeneity of variance). As an aside, the same result can be shown by carrying out a Student's t-test (which assumes homogeneity of variance) and Welch's t-test (which does not make the assumption).

Evaluating the gender-moderated relationship between parental respect and delinquency

Next, it is shown how a moderator model can be coded in Lavaan. In the first moderated model focused on the association between parental respect and delinquency, and considered whether the association is moderated by gender. The model can again be estimated using a regression based approach – by creating a multiplicative interaction term, or using multiple groups. A multiplicative interaction term is created first, by multiplying the two variables

together, as in regression. The new variable representing the interaction is named malexResp. This variable is generated in R with the following syntax:

```
> d$maleXResp <- d$male * d$respect
```

All three variables are then entered as predictors of MHI.

```
> model3 <- "
+ del ~ b1 * respect + b2 * male + b3 * maleXResp
> fit3 <- sem(model3, data=d, estimator="mlr")</pre>
> summary(fit3)
                     Estimate Std.err Z-value P(>|z|)
Regressions:
  del ~
    respect
               (b1)
                       -0.160
                                  0.029
                                          -5.473
                                                     0.000
                        0.006
    male
               (b2)
                                  0.213
                                           0.029
                                                     0.977
                        0.014
                                  0.055
                                                     0.801
    maleXRsp
              (b3)
                                           0.252
 Intercepts:
    del
                        2.036
                                  0.115
                                          17.772
                                                     0.000
Variances:
                        0.241
                                  0.029
    del
```

The labels for the parameters are in parentheses before each variable name are. Hence b1 is the regression of delinquency on respect, b2 is the effect of being male, and b3 is the regression of delinquency on the multiplicative interaction term. The regression parameter associated with respect is -0.160, with a standard error of 0.029. This is the regression effect for the females (because gender is dummy coded, and female is the reference). The difference between the males and females is given by the interaction term maleXresp (shortened to maleXRsp), which is 0.014, with a standard error of 0.055. The regression equation can be written as:

```
delinquency=b_0+b_1*respect+b_2*male+b3*male*respect
```

Values for male and female can be substituted to determine the slope for each group. For females, male = 0. Substituting 0 into the equation:

```
delinquency=b_0+b_1*respect+b_2*0+b3*0*respect
```

Any term that is multiplied by zero can obviously be ignored; therefore for the females, the parameter b_1 represents the effect of respect.

$$delinquency=b_0+b_1*respect$$

To find the male slope, substitute the value 1 for males. Multiplying any value by 1 does not change the value, so:

$$delinquency=b_0+b_1*respect+b_2*1+b3*1*respect$$

$$delinquency=b_0+b_1*respect+b_2+b3*respect$$

Rearranging that equation:

$$delinquency=b_0+b_2(b_1+b_3)*respect$$

The slope for males is therefore equal to the sum of b_1 and b_3 . This is not currently a parameter in the model, but can be added as shown in model 3a.

```
> model3a <- "
    del ~ b1 * respect + b2 * male + b3 * maleXResp
    maleReg:= b1 + b3
fit3a <- sem(model3a, data=d)</pre>
> summary(fit3a)
                      Estimate Std.err Z-value P(>|z|)
  del ~
    respect
               (b1)
                        -0.160
                                   0.028
                                            -5.748
                                                       0.000
    male
               (b2)
                         0.006
                                   0.140
                                            0.044
                                                       0.965
                         0.014
                                   0.037
                                            0.375
                                                       0.707
    maleXRsp
               (b3)
 Variances:
    del
                         0.241
                                   0.007
Defined parameters:
                        -0.146
                                   0.025
                                            -5.970
                                                       0.000
    maleReg
```

This moderator model can also be estimated using a multiple group approach. The regression approach gave the slope for females, and the difference between males and females, and a line was added to the model to calculate the slope for males. The multiple group approach estimates the slope for males (which is labelled blm) and the slope for females (blf). A new parameter is defined to calculate the difference between these two values (diffslopes).

```
> model4 <- "
    del ~ c(blm, blf) * respect
    diffSlopes:= blm - blf
> fit4 <- sem(model4, data=d, group="male")</pre>
> summary(fit4)
Group 1 [1]:
                         Estimate Std.err Z-value P(>|z|)
Regressions:
  del ~
    respect
                 (b1m)
                           -0.146
                                      0.030
                                               -4.940
                                                         0.000
 Intercepts:
    del
                            2.042
                                      0.111
                                               18.367
                                                         0.000
Variances:
    del
                            0.351
                                      0.015
Group 2 [0]:
                        Estimate Std.err Z-value P(>|z|)
Regressions:
  del ~
    respect
                 (b1f)
                           -0.160
                                      0.022
                                               -7.346
                                                         0.000
 Intercepts:
                            2.036
                                                         0.000
    del
                                      0.083
                                               24.525
Variances:
    del
                            0.147
                                      0.006
Defined parameters:
                            0.014
                                               0.379
                                                         0.705
    diffSlopes
                                      0.037
```

Some evidence of moderation is found in this model. There is a negative effect from parental respect to delinquency, indicating that greater respect is associated with less delinquency, however the effect is slightly stronger for females (-0.160) than for males (-0.146). The difference is given in the diffSlopes parameter, and this is not statistically significant.

Evaluating whether parental respect mediates the association between gender and delinquency

The next mediation model attempts to disentangle the association between gender and delinquency, determining if it is, in part or in whole, explained by parental respect. When estimating Model 1 it was established that the total effect (c in Figure 1) is equal to 0.069 and therefore ab + c' = 0.069. Again, the mediation model can be estimated using a multiple group approach, or a single group approach. The single group approach is shown in path

diagram format in Figure 3. The values for ab and c are calculated using the define parameter option.

Because the path of interest is given as ab, and this is not normally distributed, the bootstrap option in the sem() function is used to estimate the standard errors. The total effect (c) is also estimated in this model.

```
model5 <- "
    del ~ b * respect + cprime * male
    respect ~ a * male
    ab:= a * b
    c:= ab + cprime
> fit5 <- sem(model5, data=d, se="bootstrap")</pre>
 summary(fit5)
                       Estimate Std.err Z-value P(>|z|)
Regressions:
  del ~
                         -0.153
                                             -5.253
                                                        0.000
    respct
                 (b)
                                    0.029
    male
              (cprm)
                          0.058
                                    0.020
                                              2.914
                                                        0.004
  respect ~
    male
                 (a)
                         -0.068
                                    0.022
                                             -3.102
                                                        0.002
Variances:
    del
                          0.241
                                    0.029
                          0.280
                                    0.017
    respect
Defined parameters:
                          0.010
    ab
                                    0.004
                                              2.679
                                                        0.007
                          0.069
                                    0.020
                                              3.358
                                                        0.001
```

Again, the mediation model can be estimated using a multiple groups approach. For this approach, the model represented in the path diagram shown in Figure 4 is used. However, only path b is represented in the diagram directly. On Model 1 and Model 2 at the start of this section the regression of delinquency on gender could be represented as the difference between the two groups' means of delinquency in a multiple group model. In the same way, path a in the mediation model is represented by the difference between the means of respect for males and females, these are labelled respMeanMale and respMeanFemale, respectively. Path c' is calculated as the difference between the intercepts of delinquency for males and females. (Because delinquency is an endogenous variable, its mean is not estimated as a model parameter; instead, its intercept is modelled.) The total effect c is calculated using ab + cprime, and the indirect effect as a * b. Because of non-normality, bootstrapping is used to estimate standard errors.

One additional complication is that it is necessary to refer to the intercept of respect, and hence the fixed.x=FALSE argument must be added to the call to sem(). In the following code, the values of b (that is, the effects from respect to delinquency) are constrained to be equal across groups. The intercepts of delinquency are labelled delIntMale and delIntFemale, and so c' (cprime in the model) is the difference between these two values, and this represents the indirect effect of male on delinquency.

```
> model6 <- "
    del \sim c(b, b) * respect
    del ~ c(delIntMale, delIntFemale) * 1
    respect ~ c(respMeanMale, respMeanFemale) * 1
    a:= respMeanMale - respMeanFemale
    ab:= a * b
    cprime:= delIntMale - delIntFemale
    c:= a * b + cprime
> fit6 <- sem(model6, data=d, group = "male", fixed.x=FALSE,</pre>
+ se="bootstrap")
> summary(fit6)
lavaan (0.5-16) converged normally after 21 iterations
 Group 1 [1]:
                      Estimate Std.err Z-value P(>|z|)
Regressions:
  del ~
    respect
                         -0.156
                                    0.025
                                            -6.187
                                                       0.000
                 (b)
 Intercepts:
    del
              (dlIM)
                          2.076
                                    0.097
                                            21.289
                                                       0.000
    respct
                          3.703
                                    0.017 214.797
                                                       0.000
              (rsMM)
Variances:
    del
                          0.351
                                    0.058
    respect
                          0.345
                                    0.030
 Group 2 [0]:
                      Estimate Std.err Z-value P(>|z|)
 Regressions:
  del ~
                         -0.156
                                    0.025
                                            -6.187
                                                       0.000
    respect
                 (b)
 Intercepts:
    del
              (dlIF)
                          2.017
                                    0.099
                                            20.463
                                                       0.000
                                                       0.000
                          3.772
                                    0.012 314.200
    respct
              (rsMF)
 Variances:
```

del	0.147	0.017		
respect	0.225	0.020		
Defined parameters:				
a	-0.068	0.021	-3.232	0.001
ab	0.011	0.004	2.769	0.006
cprime	0.058	0.020	2.919	0.004
С	0.069	0.020	3.413	0.001

The results from model 6 very closely match the results from model 5. Of particular interest is the ab parameter, which represents the indirect (mediated) effect. Although this effect is small, it is statistically significant, indicating that some of the difference in delinquency between males and females may be explained by differences in respect.

Evaluating moderated mediation

That respect moderates the association between gender and delinquency, and that gender mediates the association between respect and delinquency has been establish. The next stage is to determine if there is a moderated mediation relationship.

It is helpful to represent the moderated mediation model as a conceptual path diagram, as shown in Figure 5. This figure is based on Figure 2, although real labels are used, rather than X, M and Y. In addition, a path from male to path b has been added—this is the moderator effect. It is hypothesized that the path from Respect to Delinquency varies as a function of gender.

The model cannot be estimated in this format. Instead, the model can be estimated using either the multiplicative regression approach, or the multiple groups approach. Using the multiplicative regression approach, as previously, multiplicative interaction term is created, and model represented in Figure 6 (Figure 6 is equivalent to Figure 5, but can be estimated directly) is fit. An additional parameter, b' is added to the model, to represent the b parameter for the interaction term.

The path b now represents the path from respect to delinquency for the females. The b' parameter is the difference between the male and female paths, and hence the regression of delinquency on respect for males is given by b + b'. The indirect effect of the predictor male is given by a * b. An indirect effect for each group can be calculated. For the females, the indirect effect is given by a * b, for the males, the effect is a * (b + b'). The code and output is shown below. The difference in the indirect effects – that is the moderated mediation effect – is given by the difference between the indirect effect for males and the indirect effect for females, labelled as indDiff in the model.

```
> model7 <- "
+ del ~ cprime * male
+ del ~ b * respect
+ del ~ bprime * maleXResp</pre>
```

```
respect ~ a * male
    respect ~~ maleXResp
    male ~~ maleXResp
    bmale:= b + bprime
    indMale:= bmale * a
    indFemale:= b * a
    indDiff:= indMale - indFemale
 fit7 <- sem(model7, data=d, fixed.x=FALSE,</pre>
          se="bootstrap")
> summary(fit7)
                         Estimate Std.err Z-value P(>|z|)
Regressions:
  del ~
    male
                (cprm)
                            0.006
                                      0.222
                                                0.028
                                                          0.978
                                      0.029
                   (b)
                           -0.160
                                               -5.485
                                                          0.000
    respct
                            0.014
                                      0.058
                                                0.242
                                                          0.809
    mlXRsp
                (bprm)
  respect ~
    male
                   (a)
                           -0.068
                                      0.021
                                               -3.192
                                                          0.001
Covariances:
  respect ~~
                                               10.999
                                                          0.000
    maleXResp
                            0.158
                                      0.014
  male ~~
    maleXResp
                            0.919
                                      0.005 178.383
                                                          0.000
Variances:
    del
                            0.241
                                      0.031
    respect
                            0.280
                                      0.018
                            0.248
                                      0.001
    male
    maleXResp
                            3.561
                                      0.025
Defined parameters:
    bmale
                           -0.146
                                      0.048
                                               -3.059
                                                          0.002
    indMale
                            0.010
                                      0.005
                                                2.190
                                                          0.029
    indFemale
                            0.011
                                                2.569
                                                          0.010
                                      0.004
    indDiff
                           -0.001
                                      0.004
                                               -0.230
                                                          0.818
```

The indirect for males is 0.010 (labelled indMale), and is statistically significant. Similarly, the indirect effect for females (labelled indFemale), 0.011, is also statistically significant. However, the difference between the two indirect effects: -0.001 (labelled indDiff) is not statistically significant, indicating that the mediation effect is not moderated by gender. In other words, there is no evidence of moderated mediation.

As with the prior models, the model can also be estimated using a multiple group approach. This approach is more intuitive, with somewhat clearer interpretation of parameters. Only small changes are required to modify the previous multiple group model (model 6). The parameter *b* is estimated for the males and the females separately, and the effects of gender are estimated by subtracting means (or intercepts) as in the previous models.

```
> model8 <- "
   del ~ c(bMale, bFemale) * respect
   del ~ c(delIntMale, delIntFemale) * 1
   respect ~ c(respMeanMale, respMeanFemale) * 1
   a:= respMeanMale - respMeanFemale
   abMale:= a * bMale
    abFemale:= a * bFemale
   bPrime:= bMale - bFemale
    intDiff:= abMale - abFemale
 fit8 <- sem(model8, data=d, group = "male", fixed.x=FALSE,
          se="bootstrap")
> summary(fit8)
Group 1 [1]:
                       Estimate Std.err Z-value P(>|z|)
Regressions:
  del ~
                                    0.047
                                                        0.002
    respct
                         -0.146
                                             -3.123
               (bMal)
Intercepts:
    del
               (dlIM)
                          2.042
                                    0.179
                                             11.395
                                                        0.000
    respct
               (rsMM)
                          3.703
                                    0.017
                                           220.355
                                                        0.000
Variances:
    del
                          0.351
                                    0.059
    respect
                          0.345
                                    0.030
Group 2 [0]:
                       Estimate Std.err Z-value P(>|z|)
Regressions:
  del ~
    respct
               (bFml)
                         -0.160
                                    0.029
                                             -5.576
                                                        0.000
 Intercepts:
                                                        0.000
    del
               (dlIF)
                          2.036
                                    0.112
                                             18.120
                                    0.013 287.831
                                                        0.000
    respct
               (rsMF)
                           3.772
Variances:
    del
                           0.147
                                    0.017
```

respect	0.225	0.021		
Defined parameters:				
a	-0.068	0.022	-3.149	0.002
abMale	0.010	0.005	2.207	0.027
abFemale	0.011	0.004	2.556	0.011
bPrime	0.014	0.054	0.256	0.798
intDiff	-0.001	0.004	-0.248	0.804

Again, a very close match is found between the two approaches. The indirect effect for males is 0.010 in both models, with standard errors equal to 0.005 (single group model) and 0.004 (multiple group model). Similarly, the indirect effect for females is similar -0.011 for both models, with standard errors of 0.004 for both models. The moderator effect is no longer statistically significant when the moderated mediation model is estimated. In both of these models the moderator effect is equal to 0.014 with standard errors of 0.054 and 0.058. The moderated mediation effect also fails to achieve statistical significance.

Evaluating additional outcome: mental health

One advantage of a structural equation modeling approach is that it allows us to estimate multivariate models with multiple outcome variables simultaneously where these measures might be considered parts of a multivariate system. Such an approach can also increase statistical power (Cole et al., 1993, Cole et al., 1994). An additional outcome variable, mental health functioning (MHI), is added to the models to demonstrate how a multivariate test is carried out. For each parameter of the model which is represented by a regression path to delinquency (i.e. a, b and b') a value for delinquency and a value for mental health functioning is estimated. To indicate these paths in the model, 'D' is added to the path for delinquency, and 'M' is added to the path for MHI. In addition, add a covariance in the residual correlation of delinquency and MHI is added using 'del ~~ mhi'.

```
> mode19 <- "
+ del ~ cprimeD * male
+ del ~ bD * respect
+ del ~ bprimeD * maleXResp
+
+ mhi ~ cprimeM * male
+ mhi ~ bM * respect
+ mhi ~ bprimeM * maleXResp
+
+ mhi ~ a * male
+ mhi ~ a * male
+ mhi ~ bprimeM * maleXResp
+ male ~ maleXResp
+ indMaleD:= bD + bprimeD
+ indMaleD:= bmaleD * a</pre>
```

```
indFemaleD:= bD * a
    indDiffD:= indMaleD - indFemaleD
    bmaleM:= bM + bprimeM
    indMaleM:= bmaleM * a
    indFemaleM:= bM * a
    indDiffM:= indMaleM - indFemaleM
> fit9 <- sem(model9, data=d, fixed.x=FALSE,</pre>
+ se="bootstrap")
              summary(fit9)
                          Estimate Std.err Z-value P(>|z|)
Regressions:
  del ~
    male
                 (cprD)
                             0.006
                                      0.217
                                                0.028
                                                          0.977
                            -0.160
    respct
                   (bD)
                                      0.029
                                               -5.546
                                                          0.000
    mlXRsp
                 (bprD)
                             0.014
                                      0.057
                                                0.246
                                                          0.805
  mhi ~
                             1.796
                                      0.589
                                                3.047
                                                          0.002
    male
                 (cprM)
                             0.996
                                      0.126
                                                7.934
                                                          0.000
    respct
                   (bM)
    mlXRsp
                 (bprM)
                            -0.350
                                      0.156
                                               -2.234
                                                          0.025
  respect ~
    male
                            -0.068
                                      0.022
                                               -3.139
                                                          0.002
                    (a)
 Covariances:
  del ~~
    mhi
                            -0.088
                                       0.021
                                               -4.271
                                                          0.000
  respect ~~
                                      0.014
                                               11.052
                                                          0.000
    maleXResp
                             0.158
  male ~~
    maleXResp
                             0.919
                                      0.005 171.927
                                                          0.000
 Variances:
    del
                             0.241
                                      0.028
                             3.622
    mhi
                                       0.096
                                      0.017
                             0.280
    respect
                             0.248
                                      0.001
    male
    maleXResp
                             3.561
                                      0.026
Defined parameters:
    bmaleD
                            -0.146
                                      0.047
                                               -3.106
                                                          0.002
    indMaleD
                             0.010
                                      0.005
                                                2.207
                                                          0.027
                             0.011
    indFemaleD
                                       0.004
                                                2.537
                                                          0.011
```

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indDiffD	-0.001	0.004	-0.230	0.818
bmaleM	0.646	0.093	6.979	0.000
indMaleM	-0.044	0.015	-2.862	0.004
indFemaleM	-0.068	0.024	-2.803	0.005
indDiffM	0.024	0.014	1.695	0.090

A multivariate test of the mediation effects can be done using the LavTestWald() function, which uses a Wald test of parameters. It is not possible (we believe) to use the Wald test when the estimates have been bootstrapped, and therefore the MLM estimator (which gives the Satorra-Bentler scaled chi-square) is used. The model is refit using the MLM estimator, and I this is labelled model 9a. A series of constraints is set up, in this case, that the two moderated mediation effects are both equal to zero. The specification for this model is named con9a. The Wald test function with is then used with the estimated model and constraints. The result gives a chi-square statistic of 3.21, with 2 df and p=0.201. The multivariate test has therefore not reached statistical significance.

As would be expected, this model can also be estimated using a multiple group approach, shown as model 10.

```
> model10 <- "
+    del ~ c(bMaleD, bFemaleD) * respect
+    del ~ c(delIntMaleD, delIntFemaleD) * 1
+
+    mhi ~ c(bMaleM, bFemaleM) * respect
+    mhi ~ c(delIntMaleM, delIntFemaleM) * 1
+
+    del ~~ mhi</pre>
```

```
respect ~ c(respMeanMale, respMeanFemale) * 1
   a:= respMeanMale - respMeanFemale
   abMaleD:= a * bMaleD
   abFemaleD:= a * bFemaleD
   bPrimeD:= bMaleD - bFemaleD
   intDiffD:= abMaleD - abFemaleD
   abMaleM:= a * bMaleM
   abFemaleM:= a * bFemaleM
   bPrimeM:= bMaleM - bFemaleM
    intDiffM:= abMaleM - abFemaleM
 fit10 <- sem(model10, data=d, group = "male", fixed.x=FALSE,</pre>
             se="bootstrap")
> summary(fit10)
Group 1 [1]:
                            Estimate Std.err Z-value P(>|z|)
Regressions:
  del ~
   respct (bMlD)
                              -0.146
                                         0.046
                                                  -3.151
                                                             0.002
  mhi ~
    respct
                    (bMlM)
                                0.646
                                         0.093
                                                   6.922
                                                             0.000
Covariances:
  del ~~
    mhi
                              -0.035
                                         0.034
                                                  -1.031
                                                             0.302
Intercepts:
                                2.042
                                         0.178
                                                  11.469
                                                             0.000
    del
                    (dIMD)
    mhi
                    (dIMM)
                                4.441
                                         0.352
                                                  12.601
                                                             0.000
                                3.703
                                         0.017 215.633
                                                             0.000
   respct
                    (rsMM)
Variances:
    del
                                0.351
                                         0.057
    mhi
                                3.404
                                         0.146
                                0.345
                                         0.030
    respect
Group 2 [0]:
                            Estimate Std.err Z-value P(>|z|)
Regressions:
  del ~
    respct
                    (bFmD)
                               -0.160
                                         0.030
                                                  -5.346
                                                             0.000
```

mhi ~					
respct	(bFmM)	0.996	0.119	8.349	0.000
Covariances:					
del ~~					
mhi		-0.132	0.023	-5.736	0.000
Intercepts:					
del	(dIFD)	2.036	0.117	17.347	0.000
mhi	(dIFM)	2.645	0.456	5.800	0.000
respct	(rsMF)	3.772	0.013	296.438	0.000
Variances:					
del		0.147	0.017		
mhi		3.806	0.138		
respect		0.225	0.020		
Defined parame	eters:				
a		-0.068	0.021	-3.220	0.001
abMaleD		0.010	0.004	2.277	0.023
abFemaleD		0.011	0.004	2.569	0.010
bPrimeD		0.014	0.054	0.256	0.798
intDiffD		-0.001	0.004	-0.240	0.811
abMaleM		-0.044	0.015	-2.923	0.003
abFemaleM		-0.068	0.023	-2.921	0.003
bPrimeM		-0.350	0.155	-2.257	0.024
intDiffM		0.024	0.014	1.758	0.079

The parameters match across the two models, and the two parameters of particular interest – the moderated mediation effects for mental health functioning and delinquency (indDiffM and intDiffD) have the same estimates, and very similar p-values, across the two models. A Wald test gives the multivariate significance of the two effects, in much the same way as the single group model. Using the Wald test to obtain the multivariate significance test gives the same results as the model 9.

```
> fit10a <- sem(model10, data=d, group = "male", fixed.x=FALSE,
+ estimator="mlm")
>
> con10a <- "
+ intDiffM == 0
+ intDiffD == 0
+ "
>
> lavTestWald(fit10a, constraints=con10a)
$stat
[1] 3.209363
```

```
$df
[1] 2
$p.value
[1] 0.2009535
```

Controlling for potentially confounding variables

Finally, consider control variables are considered. Omitting important control variables might mean that spurious mediation effects are found. The models are re-estimated with the following control variables: race (entered as three dummy coded variables: Hispanic, Asian and other, with white as the reference); mother's education, coded as 1 = did not complete high school, 2 = completed high school, 3 = some post-high school education, and 4=college degree, and age (in years).

To add these variables as covariates, the three endogenous variables (delinquency, mental health functioning and parental respect) are regressed on each of the covariates, and the exogenous variables (male and the male * respect interaction term) are correlated with the covariates. In addition, correlations between the covariates are added. One advantage of modeling in a statistical environment such as R is that models can be expanded, without rewriting the whole model. In the example below, model11 is created by adding the additional parameters to model9, using the paste0() function. Note that for model11, only the derived parameters are reported.

```
> model11 <- paste0(model9, "</pre>
+ mhi ~ hisp + asian + other + momed + age
+ del ~ hisp + asian + other + momed + age
 respect ~ hisp + asian + other + momed + age
 maleXResp ~~ hisp + asian + other + momed + age
+ male ~~ hisp + asian + other + momed + age
+ hisp ~~ asian + other + momed + age
+ asian ~~ other + momed + age
+ other ~~ momed + age
+ momed ~~ age
+ ")
> fit11 <- sem(model11, data=d, fixed.x=FALSE, se="bootstrap")</pre>
> summary(fit11)
                  Estimate Std.err Z-value P(>|z|)
Defined parameters:
                    -0.140
                               0.048
                                        -2.906
    bmaleD
                                                    0.004
    indMaleD
                     0.009
                               0.004
                                         2.008
                                                    0.045
                     0.010
                               0.004
                                         2.282
    indFemaleD
                                                   0.022
```

```
indDiffD
               -0.001
                         0.004
                                  -0.188
                                            0.851
               0.667
                                   7.008
                                            0.000
bmaleM
                         0.095
indMaleM
               -0.043
                         0.017
                                  -2.576
                                            0.010
indFemaleM
               -0.065
                         0.026
                                  -2.518
                                            0.012
indDiffM
                0.022
                                   1.559
                                            0.119
                         0.014
```

Similarly, a multiple group approach can be used. Again, model10 is modified to create model12 using the paste0() function. This is slightly complicated by the fact that explicitly regression parameters must be explicitly constrained across groups (failing to do this means that results are very difficult to interpret; the single group model implicitly has this constraint), and the means of the covariates must be free to vary across groups (this is the equivalent of allowing them to correlate with male).

```
> model12 <- paste0(model10, "</pre>
                       mhi \sim c(mh, mh) * hisp + c(ma, ma) * asian + c(mo, mo) * other + c(mm, mo) * other +
mm) * momed + c(my, my) *age
                       del \sim c(dh, dh) * hisp + c(da, da) * asian + c(do, do) * other + c(dm, do) * other +
                    * momed + c(dy, dy) *age
                        respect ~ c(rh, rh) * hisp + c(ra, ra) * asian + c(ro, ro) * other +
 c(rm, rm) * momed + c(ry, ry) *age
                      hisp ~ c(hMale, hFemale) * 1
                       asian ~ c(aMale, aFemale) * 1
                      other ~ c(oMale, oFemale) * 1
                      momed \sim c(mMale, mFemale) * 1
                       age ~ c(yMale, yFemale) * 1
                      hisp ~~ asian + other + momed + age
                      asian ~~ other + momed + age
                      other ~~ momed + age
                       momed ~~ age
> fit12 <- sem(model12, data=d, group="male", fixed.x=FALSE, se= "bootstrap")</pre>
 > summary(fit12)
     Defined parameters:
                                                                                       -0.065 0.023 -2.823 0.005
                        abMaleD
                                                                                            0.009 0.004
                                                                                                                                                                                2.043 0.041
                        abFemaleD
                                                                                            0.010 0.004
                                                                                                                                                                                2.234 0.025
                        bPrimeD
                                                                                           0.012 0.057
                                                                                                                                                                                 0.208 0.835
                        indDiffD
                                                                                       -0.001
                                                                                                                                   0.004
                                                                                                                                                                          -0.192 0.848
                        abMaleM
                                                                                       -0.043
                                                                                                                                  0.016
                                                                                                                                                                          -2.665 0.008
                        abFemaleM -0.065 0.025 -2.576 0.010
```

bPrimeM -0.341 0.153 -2.226 0.026 indDiffM 0.022 0.014 1.588 0.112

Again, only the derived parameters are presented. The parameters of interest are equal to the single group model, and standard errors and p-values are very close. In conclusion, a mediated effect of parental respect on the association between gender and delinquency is found, as well as on the association between gender and mental health. However, support for either moderation or moderated mediation is not found.

Discussion

The goal of this investigation was to gain further understanding about which constructs might be influential in explaining gender effects on delinquency and mental health functioning (SAMHSA, 2014; Nock et al., 2007; see Albano and Kain, 2005; Moffit et al., 2001 for reviews). In order to do so, we utilized and provide a detailed overview of how moderated mediation can be applied. Specifically, we demonstrated how structural equation modeling can be applied to evaluate multiple variables simultaneously while controlling for potential confounding variables at the same time. This rigorous method allows for a more accurate evaluation of associations between multiple variables thus resulting in more robust conclusions.

We replicated and extended previous reports of gender differences in delinquency and mental health functioning (Bakker et al., 2010; Van Loon et al., 2014; Jacobson and Crocket, 2000). Specifically, based on a large multiethnic sample of adolescents, the results show that parental respect mediated the association between gender and delinquency, such that parental respect was a protective factor against delinquency for both females and males.

Limitations

This study has several limitations. First, the cross-sectional nature of the study precludes causation. Second, although we made significant effort to assure participants of confidentiality, the addition of behavioral data corroborating our self-report measure of parent-child interaction would strengthen our methodology. Third, our measure of delinquency is limited in that the focus is on overt aggressive behavior, which is more common among boys, rather than more covert, relational aggression, which is more common among girls. To improve upon our investigation, future studies would benefit from considering more gender-appropriate assessment instruments of delinquency. Finally, because mediation is not defined statistically (Kenny, 2014), we must presume a mediation model and then test that with statistical methods. If the mediation model is incorrect, the parameters used to estimate that model will not be meaningful (Maxwell and Cole, 2007). Finally, our conceptual model has parental respect causally preceding delinquency, which we cannot fully test due to the cross-sectional nature of the data.

Conclusions

Our results suggest that prevention and intervention efforts targeting parent-child relationship factors such as parental respect might be helpful in decreasing delinquent behavior (Barnes et al., 2000; Hawkins et al., 1992; Kumpfer et al., 1996). Still, there is a

need for additional research in this area to better understand other factors that might contribute to these associations and thus help develop more comprehensive prevention approaches.

In addition, we demonstrated the use of structural equation modeling approaches for testing complex hypotheses about the relationship between variables. We present alternative parameterizations of equivalent models, which provide flexible means of thinking about our models. Given that "A model is a formal representation of a theory" (Bollen, 1989), this also allows us to advance our theory.

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References

- Achenbach, TM.; McConaughy, SH. Empirically based assessment of child and adolescent psychopathology: Practical applications. Thousand Oaks, CA: Sage; 1997.
- Aiken, LS.; West, SG. Multiple regression: testing and interpreting interactions. Newbury Park, CA: Sage: 1991.
- Albano, AM.; Krain, A. Anxiety and anxiety disorders in girls. In: Bell, DJ.; Foster, SL.; Mash, EJ., editors. Handbook of emotional and behavioral problems in girls. New York: Kluwer; 2005. p. 79-116
- Antshel KM. Integrating culture as a means of improving treatment adherence in the Latino population. Psychology, Health and Medicine. 2002; 7:435–449.
- Berwick DM, Murphy JM, Goldman PA, Ware JE, Barsky AJ, Weinstein MC. Performance of a fiveitem mental health screening test. Medical Care. 1991; 29:169–176. [PubMed: 1994148]
- Bakker MP, Ormel J, Verhulst FC, Oldehinkel AJ. Peer stressors and gender differences in adolescents' mental health: The TRAILS Study. Journal of Adolescent Health. 2010; 46:444–450. [PubMed: 20413080]
- Barnes GM, Reifman AS, Farrell MP, Dintcheff BA. The effects of parenting on the development of adolescent alcohol misuse: A six-wave latent growth model. Journal of Marriage and the Family. 2000; 62:175–186.
- Baron RM, Kenny DA. The moderator-mediator variable distinction in social psychological research: conceptual, strategic and statistical considerations. Journal of Personality and Social Psychology. 1986; 51(6):1173–1182. [PubMed: 3806354]
- Bollen, KA. Structural equations with latent variables. New York: Wiley; 1989.
- Capaldi DM, Chamberlain P, Patterson GR. Ineffective discipline and conduct problems in males: Association, late adolescent outcomes and prevention. Aggression and Violent Behavior. 1997; 2:343–353.
- Cicchetti, D.; Toth, SL. A developmental perspective on internalizing and externalizing disorders. In: Cichetti, D.; Toth, SL., editors. Internalizing and externalizing expression of dysfunction. Vol. 2. Hillsdale, N.J.: Erlbaum; 1991. p. 1-19.
- Cole DA, Maxwell SE, Arvey R, Salas E. Multivariate group comparisons of variable systems: MANOVA and structural equation modelling. Psychological Bulletin. 1993; 114(1):174–184.
- Cole DA, Maxwell SE, Arvey R, Salas E. How the power of MANOVA can both increase and decrease as a function of the intercorrelations among the dependent variables. Psychological Bulletin. 1994; 115(3):465–474.

Cote S, Zoccolillo M, Tremblay RE, Nagin D, Vitaro F. Predicting girls conduct disorder in adolescence from childhood trajectories of disruptive behaviors. Journal of the American Academy of Child and Adolescent Psychiatry. 2001; 40:678–684. [PubMed: 11392346]

- D'Amico EJ, Tucker JS, Miles JNV, Zhou A, Shih R, Green H. Preventing alcohol use with a voluntary after-school program for middle school students: Results from a cluster randomized controlled trial of CHOICE. Prevention Science. 2012; 13:415–425. [PubMed: 22311178]
- Ellickson PL, Tucker JS, Klein DJ. Sex differences in predictors of adolescent smoking cessation. Health Psychology. 2001; 20:186–195. [PubMed: 11403216]
- Fontaine N, Carbonneau R, Barker ED, Vitaro F, Hebert M, Cote SM, Nagin DS, Zoccolillo M, Tremblay RE. Girl's hyperactivity and physical aggression during childhood and adjustment problems in early adulthood: A 15-year longitudinal study. Archives of General Psychiatry. 2008; 65:320–328. [PubMed: 18316678]
- Gil AG, Wagner EF, Wega WA. Acculturation, feminism, and alcohol use among Latino adolescent males: Longitudinal Relations. Journal of Community Psychology. 2000; 28:443–458.
- Griffin KW, Botwin GJ, Scheier LM, Diaz T, Miler NL. Parenting practices as predictors of substance use, delinquency and aggression among urban minority youth: Moderating effects of family structure and gender. Psychology of Addictive Behaviors. 2000; 14:174–184. [PubMed: 10860116]
- Hankin BL, Abramson LY. Development of gender differences in depression: An elaborated cognitive vulnerability-transactional stress theory. Psychological Bulletin. 2001; 127:773–796. [PubMed: 11726071]
- Ho D. Filial, piety, authoritarian moralism, and cognitive conservatism in Chinese societies. Genetic, Social, and General Psychology Monographs. 1994:349–365.
- Hoeve M, Dubas JS, Eichelsheim VI, Van Der Laan PH, Smeenk W, Gerris JRM. The relationship between parenting and delinquency: A-meta analysis. Journal of Abnormal Child Psychology. 2009; 37:749–775. [PubMed: 19263213]
- Jaccard, J.; Turrisi, R. Interaction Effects in Multiple Regression. Thousand Oaks, CA: Sage; 1990.
- Jacobson KC, Crockett LJ. Parental monitoring and adolescent adjustment: An ecological perspective. Journal of Research on Adolescence. 2000; 10:65–97.
- James LR, Brett JM. Mediators, moderators, and tests for mediation. Journal of Applied Psychology. 1984; 69(2):307.
- Kenny, DA. Mediation. 2014. http://davidakenny.net/cm/mediate.htm downloaded 25 Feb, 2015
- Kumpfer, KL.; Molgaard, V.; Spoth, R. The strengthening families program prevention of delinquency and drug use. In: Peters, RD.; McMahon, RJ., editors. Preventing childhood disorders, substance abuse, and delinquency. Thousand Oaks, C.A.: Sage; 1996. p. 241-267.
- van der Laan AM, Veenstra R, Bogaerts S, Verhulst FC, Ormel J. Serious, minor and non-delinquents in early adolescence: The impact of cumulative risk and promotive factors. The TRIALS Study. Journal of Abnormal Child Psychology. 2010; 38:339–351. [PubMed: 19957027]
- van Loon LMA, van de Ven MOM, van Doesum KTM, Witteman CLM, Hossman CMH. The relation between parental mental illness and adolescent mental health: The role of family factors. Journal of Child and Family Studies. 2014; 23:1201–1214.
- MacKinnon DP, Fairchild AJ, Fritz MS. Mediation analysis. Annual Review of Psychology. 2007; 58:593–614.
- MacKinnon DP, Lockwood CM, Hoffman JM, West SG, Sheets V. A comparison of methods to test mediation and other intervening variable effects. Psychological Methods. 2002; 7(1):83–104. [PubMed: 11928892]
- Maxwell SE, Cole DA. Bias in cross-sectional analyses of longitudinal mediation. Psychological Methods. 2007; 12:23–44. [PubMed: 17402810]
- McMahon, RJ.; Wells, K.; Kotler, JS. Conduct problems. In: Mash, EJ.; Barkley, RA., editors. Treatment of Childhood Disorders. 3. New York: Guilford Press; 2006. p. 137-268.
- Moffitt TE, Caspi A. Childhood predictors differentiate life-course persistent and adolescence-limited antisocial pathways among males and females. Development and Psychopathology. 2001; 13:355–375. [PubMed: 11393651]

Nock MK, Kazdin AE, Hiripi E, Kessler RC. Prevalence, subtypes, and correlates of DSM-IV conduct disorder in the national comorbidity survey replication data. Psychological Medicine. 2007; 36(5): 699–710. [PubMed: 16438742]

- Odgers CL, Moffitt TE, Broadbent JM, Dickson N, Hancox RJ, Harrington H, Poulton R, Sears MR, Thomson WM, Caspi A. Female and male antisocial trajectories: from childhood origins to adulthood outcomes. Development and Psychopathology. 2008; 20:673–716. [PubMed: 18423100]
- Pine DS, Cohen P, Gurley D, Brook J, Ma Y. The risk for early-adulthood anxiety and depressive disorders in adolescents with anxiety and depressive disorders. Arch Gen Psychiatry. 1998; 55:56–64. [PubMed: 9435761]
- Preacher KJ, Hayes AF. SPSS and SAS procedures for estimating indirect effects in simple mediation models. Behavior Research Methods, Instruments, & Computers. 2004; 36(4):717–731.
- Preacher KJ, Rucker DD, Hayes AF. Addressing moderated mediation hypotheses: Theory, methods, and prescriptions. Multivariate Behavioral Research. 2007; 42(1):185–227.
- R Development Core Team. R: A Language and Environment for Statistical Computing. Vienna, Austria: R Foundation for Statistical Computing; 2014.
- Rose AJ, Rudolph KD. A review of sex differences in peer relationship processes: Potential trade-offs for the emotional and behavioral development of girls and boys. Psychology Bulletin. 2006; 132(1):98–131.
- Rosseel Y. lavaan: An R Package for Structural Equation Modeling. Journal of Statistical Software. 2012; 48(2):1–36.
- Rucker DD, Preacher KJ, Tormala ZL, Petty RE. Mediation analysis in social psychology: Current practices and new recommendations. Social and Personality Psychology Compass. 2011; 5(6): 359–371.
- Rushton JL, Forcier M, Schectman RM. Epidemiology of depressive symptoms in the National Longitudinal Study of Adolescent Health. Journal of American Academy of Child and Adolescent Psychiatry. 2002; 41:199–205.
- Safren SA, Gonzalez RE, Horner KJ, Leung AW, Heimburg RG, Juster HR. Anxiety in ethnic minority youth: Methodological and conceptual issues and review of the literature. Behavior Modification. 2000; 24:147–183. [PubMed: 10804678]
- Saluja G1, Iachan R, Scheidt PC, Overpeck MD, Sun W, Giedd JN. Prevalence of and risk factors for depressive symptoms among young adolescents. Archives of Pediatrics and Adolescent Medicine. 2004; 158:760–768. [PubMed: 15289248]
- Satorra, A.; Bentler, PM. Corrections to test statistics and standard errors in covariance structure analysis. In: von Eye, A.; Clogg, CC., editors. Latent variables analysis: applications for developmental research. Thousand Oaks: Sage; 1994.
- Schaeffer CM, Petras H, Ialongo N, Masyn KE, Hubbard S, Poduska J, Kellam S. A comparison of girls' and boys' aggressive-disruptive behavior trajectories across elementary school: Prediction to young adult antisocial outcomes. Journal of Consulting and Clinical Psychology. 2006; 74:500–510. [PubMed: 16822107]
- Shih RA, Miles JNV, Tucker JS, Zhou AJ, D'Amico EJ. Racial/ethnic differences in adolescent substance use: Mediation by individual, family, and school factors. Journal of Studies on Alcohol and Drugs. 2010; 71:640–651. [PubMed: 20731969]
- Shih RA, Miles JNV, Tucker JS, Zhou AJ, D'Amico EJ. Racial/ethnic differences in the influence of cultural values, alcohol resistance self-efficacy, and alcohol expectancies on risk for alcohol initiation. Psychology of Addictive Behaviors. 2012; 26(3):460–470. [PubMed: 22867294]
- Shrout PE, Bolger N. Mediation in Experimental and Non-experimental Studies: New Procedures and Recommendations. Psychological Methods. 2002; 7(4):422–445. [PubMed: 12530702]
- Stewart, AL.; Ware, JE.; Sherbourne, CD.; Wells, KB. Psychological distress/well-being and cognitive functioning measures. In: Stewart, A.; Ware, JE., editors. Measuring functioning and well-being: The medical outcomes study approach. Durham, NC: Duke University Press; 1992. p. 102-142.
- Substance Abuse and Mental Health Services Administration (SAMHSA). Results from the 2013 National Survey on Drug Use and Health: Summary of National Findings. Rockville, MD:

- Substance Abuse and Mental Health Services Administration; 2014. NSDUH Series H-48, HHS Publication No. (SMA) 14-4863
- Tanielian T, Jaycox LH, Paddock SM, Chandra A, Meredith LS, Burnam MA. Improving treatment seeking among adolescents with depression: Understanding readiness for treatment. Journal of Adolescent Health. 2009; 45:490–498. [PubMed: 19837356]
- Theunissen MJ, Jansen M, van Gestel A. Are mental health and binge drinking associated in Dutch adolescents? Cross sectional public health study. BMC Research Notes. 2011; 4(1):100. [PubMed: 21463499]
- Tucker JS, Ellickson PL, Klein DJ. Smoking cessation during the transition from adolescence to young adulthood. Nicotine and Tobacco Research. 2002; 4(3):321–332. [PubMed: 12215241]
- Unger JB, Ritt-Olson A, Teran L, Huang T, Hoffman BR, Palmer P. Cultural values and substance use in a multiethnic sample of California adolescents. Addiction Research and Theory. 2002; 10:257–279.
- Unger JB, Shakib S, Gallaher P, Ritt-Olson A, Mouttapa M, Palmer PH. Cultural/interpersonal values and smoking in an ethnically diverse sample of Southern California adolescents. Journal of Cultural Diversity. 2006; 13:55–63. [PubMed: 16696546]
- US Burden of Disease Collaborators. The State of US Health, 1990–2010: Burden of Diseases, Injuries, and Risk Factors. JAMA. 2013; 310(6):591–606. [PubMed: 23842577]
- Yuan K, Bentler PM. Three Likelihood-Based Methods for Mean and Covariance Structure Analysis With Non-normal Missing Data. Sociological Methodology. 2000; 30:167–202.

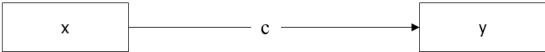


Figure 1. Path diagram showing the effect from predictor (x) to outcome (y).

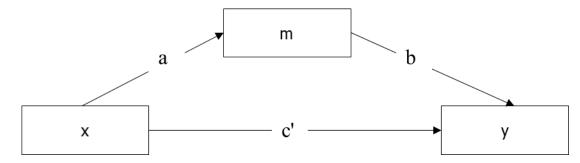


Figure 2. Path diagram showing mediation effect.

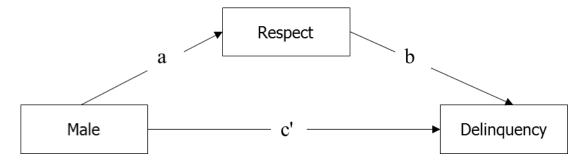


Figure 3. Path diagram showing mediation model.

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Male

Respect

b

Delinquency

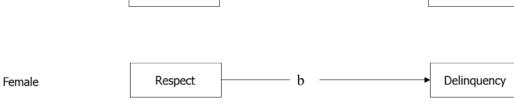


Figure 4. Multiple groups path diagram for mediation.

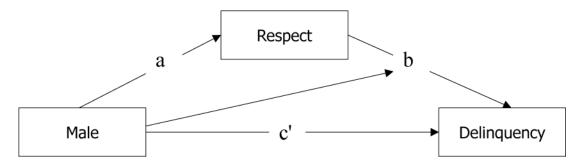


Figure 5. Conceptual path diagram showing moderated mediation.

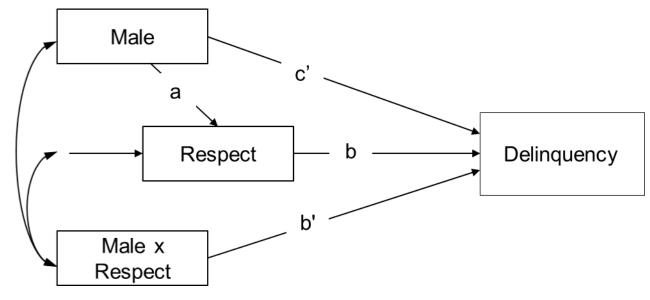


Figure 6. Path model for moderated mediation using multiplicative interaction term.