

Determining Power and Sample Size for Mediation Models

Alexander M. Schoemann ¹ Aaron J. Boulton ²

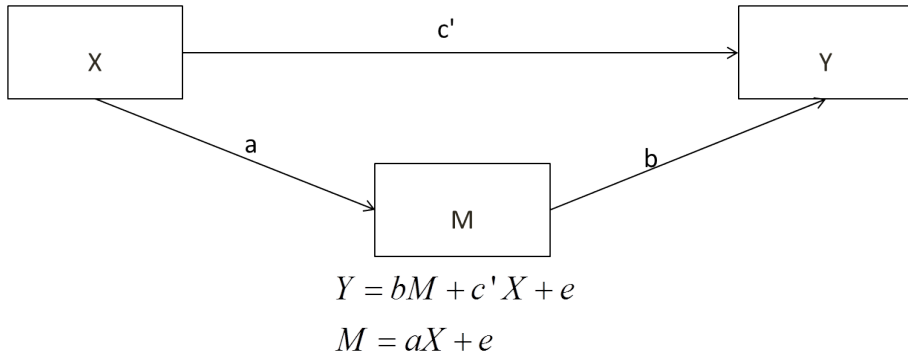
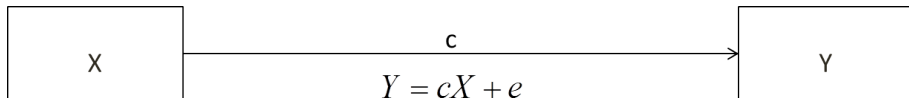
¹East Carolina University

²University of North Carolina - Chapel Hill

SSSP 2015

- Three variable system
 - Predictor variable - X
 - Outcome variable - Y
 - Mediator variable - M
- M (partially) explains the relationship between X and Y

Mediation Vocabulary



What do that paths tell us about mediation?

- When investigating mediation we are interested in if strength of the relationship between X and Y is reduced when M is included in the regression equation
 - Is the direct effect (c') less than the total effect (c)?
 - Does $c - c' = 0$?
- $c - c'$ is also called the indirect effect
- The indirect effect can also be estimated by multiplying $a*b$
- $a*b$ and $c - c'$ should provide the same value

Testing the indirect effect

- When we test for mediation we test if the indirect effect is different from zero.
 - If the indirect effect does not differ from zero there is no evidence of mediation
 - If the indirect effect differs from zero there is evidence of mediation

Testing the indirect effect

- There have been many methods developed to assess the indirect effect:
 - Difference in coefficients (Baron & Kenny, 1984)
 - Sobel test
 - Distribution of the product method
 - Bootstrap confidence intervals
 - Monte Carlo confidence intervals

Testing the indirect effect: Power

- Methods of testing the indirect effect have different power for the same data (e.g. Fritz & MacKinnon, 2007, MacKinnon, Lockwood, & Williams, 2004)
 - Difference in coefficients method has extremely low power (especially when c is small)
 - Distribution of the product, bootstrap CI and Monte Carlo CI have higher power
 - Power for these methods is generally comparable

Testing the indirect effect: Power

- What else affects power to detect an indirect effect?
 - Sample size
 - Effect size
 - Effect size of both the a and b path

Determining power for an indirect effect

- Methods of power analysis should match methods of analysis
- No analytic method of power analysis for distribution of the product, bootstrap CI or Monte Carlo CI!
- We need to use a Monte Carlo power analysis

Monte Carlo Power Analysis

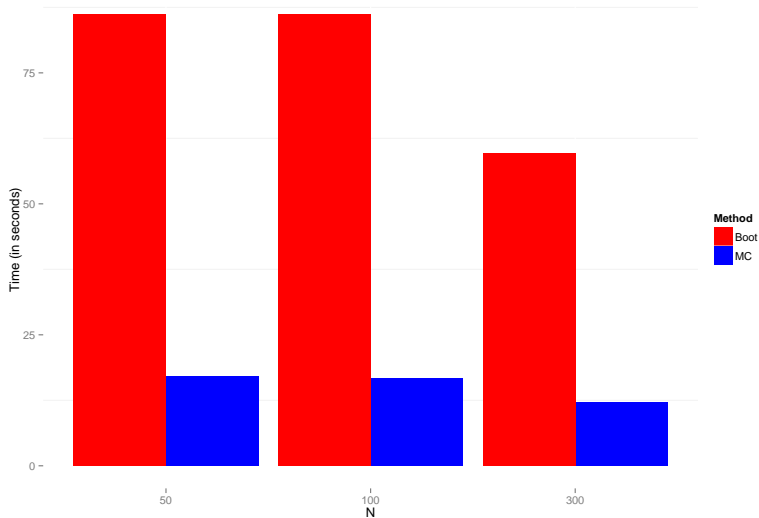
- General steps in a Monte Carlo Power Analysis
 - 1 Specify all population parameters
 - 2 Create a sample of size N , based on population parameters
 - 3 Analyze sample data from Step 2 with chosen statistical method(s)
 - 4 Repeat steps 2 and 3 for each of r replications (often $r > 1000$)
 - 5 The proportion of replications with a significant parameter is an estimate of power (for all parameters not equal to 0)

Monte Carlo Power Analysis

- Best practice approach for assessing power in mediation models (Zhang, 2014)
 - Can utilize bootstrapping, distribution of the product method, or Monte Carlo CI
- Two main limitations to Monte Carlo Power Analysis for mediation models
 - Limited, user friendly software (e.g. Mplus, bmem, simsem)
 - Very time consuming (especially with bootstrapping!)

- Overcoming limitations
 - Use Monte Carlo CI to test indirect effects
 - Faster than bootstrapping
 - Estimates of power are extremely similar ($r = .99$)

Monte Carlo Power Analysis



- Overcoming limitations
 - Use Monte Carlo CI to test indirect effects
 - Faster than bootstrapping
 - Estimates of power are extremely similar ($r = .99$)
 - Create user friendly software
 - Shiny app for simple mediation models

Power estimation app

- Available from MARlab.org
- Web based or run locally on your computer
 - Requires R is installed on a computer (it helps if RStudio is too)
- Population parameters can be entered as correlations or r^2 for each path

Power estimation app

shinyapps.io

Powered by R Studio

Monte Carlo Power Analysis for Indirect Effects

Written by Aaron Boulton & Alexander M. Schoemann

[Contact](#)

Calculate Power

Choose a Mediation Model:

Single Mediator

Choose an Input Method:

Correlations

Sample Size (N)

200

Number of Replications for MC Power Analysis

1000

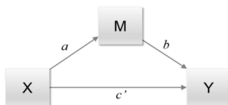
Number of Draws used to Calculate MC Confidence Intervals

20000

Confidence Level % (e.g., 95)

95

Random number seed



X: focal predictor
M: mediator
Y: outcome

a: effect of focal predictor on mediator
b: effect of mediator on outcome, controlling for focal predictor
c: effect of focal predictor on mediator, controlling for mediator

Indirect Effect (IE): $a \times b$ Total Effect (TE): $c + a \times b$

Input Options

Correlation between X and M

0.6

Correlation between X and Y

0.2

Correlation between M and Y

0.6

Variance of X variable

1

Variance of M variable

1

Variance of Y variable

1

- Expansion of models available in app
 - 2 and 3 mediator models
 - Conditional process models
- Integration of other methods of sample size determination
 - Accuracy in parameter estimation (Kelly & Maxwell, 2003)
 - Varying N Monte Carlo simulations (Schoemann, Pornprasernan, Miller, & Wu, 2014)

Thank you!

- Slides and shiny app from today at:
http://http://MARlab.org/Supplemental_Materials/
- email: schoemanna@ecu.edu

References

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