

**Understanding and Using Multiple Mediation
Models in Occupational Health:
An Introduction and Guide to Application**

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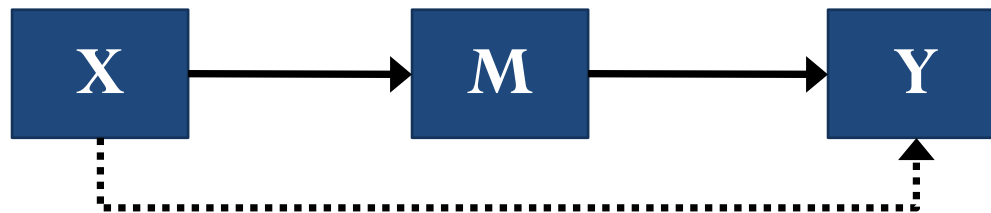
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Objectives

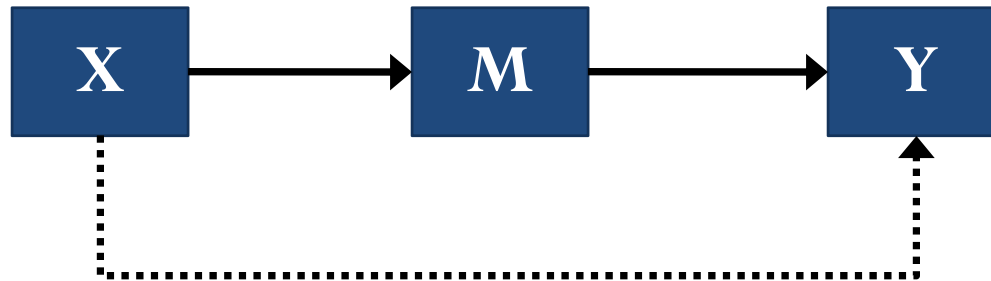
- Mediation refresher
- Promise of multiple mediation
- Multiple mediation analysis options
- Summarization/presentation tips and strategies
- Examples to mimic
- Recommended informational resources and reading

Mediation?

- Many theories and conceptual models involve multiple variables that are connected in some form of “process” relationship
- When the relationship between X and Y is at least partially explained by the presence of a third variable (M), we refer to this relationship as at least partially mediated



Mediation?



- Implied is the presence of an indirect effect of X on Y, through M
- Implicit are presumed causal connections:
 - $X \rightarrow M, M \rightarrow Y, X \rightarrow Y$
 - To properly test this requires careful research design and strong theory (Stone-Romero & Rosopa, 2008)
- Sometimes mediation is partial and sometimes it's complete
- **Mediation \neq Moderation**

Divining Mediation

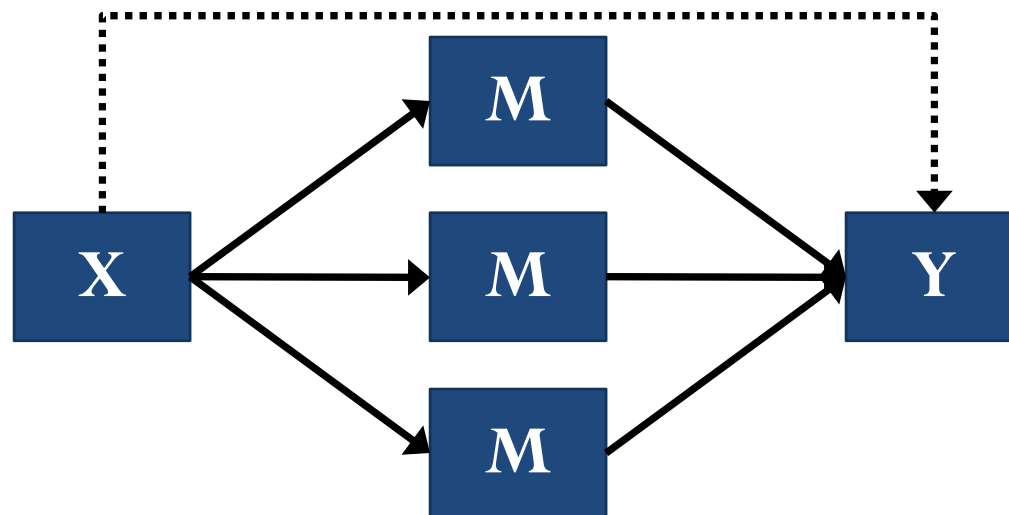
- Statistical approaches for testing mediational relationships abound
 - MacKinnon et al. (2002) compared **14** different approaches
- Despite this diversity, the “everlasting gobstopper” (i.e., dominant) approach for the last 20+ years has been based on Baron & Kenny’s (1986) causal steps:
 - 1) **$X \rightarrow Y$**
 - 2) **$X \rightarrow M$**
 - 3) **$M \rightarrow Y$**
 - 4) **$X \rightarrow Y$ decreases when M is present**
- There are better, more informative analytical methods now

Main Causal Steps Limitations

- Researchers who rely on the causal steps approach to mediation are limited in several ways, including (but not limited to) the following (Preacher & Hayes, 2008; Shrout & Bolger, 2002):
 - Effects of multiple mediators cannot be simply tested and/or compared against each other in a single model
 - There is no “built-in” or consistently used technique for statistically testing indirect effects (the ones that pass through the mediator)
 - Researchers may miss/ignore fully mediated relationships in which X and Y are not related, *except* through the mediator or set of mediators (e.g., Collins, Graham, & Flaherty, 1998)
 - Very large sample sizes are needed to maintain adequate statistical power and acceptable Type I error rates (e.g., Preacher & Hayes, 2004)

The Promise of Multiple Mediation

- Do mediators really function independently from each other?
 - More true to reality to expect multiple factors to function simultaneously as mediators of a broader relationship
- Multiple mediation improves our ability as researchers to identify, model, and predict outcomes with complex antecedent chains



Benefits of Multiple Mediation Analysis

- Can identify specific and total indirect effects
 - Via one mediator *and* through all mediators as a set
- Can contrast mediators to determine relative influence
 - Not really possible when running multiple separate regression analyses to test each mediator separately
- Can begin to account for collinearity among mediators
 - If M1, M2, and M3 are involved, the specific indirect effect through M1 only exists when M2 and M3 are also included (closer to reality)
- Does not require you to expect, nor identify a significant $X \rightarrow Y$
 - Indirect effects are the primary focus

How to Test for Multiple Mediation

- *Weakest*: Causal steps analysis
- *Stronger*: multiple mediation analysis using OLS
 - SPSS/PASW macro and syntax (Preacher & Hayes, 2008)
 - Requires fewer participants than SEM
 - Relatively simple to use
 - Permits bootstrapping, corrected confidence intervals, and comparison of indirect effects
- *Strongest*: ML/MLM (SEM)
 - Mplus (Preacher & Hayes, 2008)
 - Full-fledged measurement + structural model helps account for measurement error
 - Permits bootstrapping, corrected confidence intervals, and comparison of indirect effects

Multiple Mediation in SPSS

- Preacher and Hayes (2008) provide researchers with a free and relatively easy multiple mediator testing option
- Relies on pre-constructed, partially completed syntax files (macros) that researchers can copy and paste into SPSS and then manipulate to analyze their own data
- This macro is especially useful if you:
 - Have never considered multiple mediator models before
 - Do not have intermediate/advanced SEM knowledge
 - Have rather small N and questionable normality
 - Bootstrapping helps

Bootstrapping?

- Bootstrapping is a method of generating, from your data, a representation of the sampling distribution of your indirect effects
- It does not assume symmetry or normality of the sampling distribution of the indirect effect
- Bootstrapping draws a large number of mini-samples (with replacement) from your data, and re-analyzes the specified relationships
- This is especially important in multiple mediation research, given the complexity of the models being analyzed
 - Indirect effects are rarely normally distributed
- This helps improve the quality of our inferences
 - Especially when based on bias-corrected estimates (% bootstrap estimates tend to be asymmetrical, but this can be fixed)

Confidence Intervals (CI)?

- Null hypothesis testing is still dominant for most social science research
- Despite this, hunting for $p < \alpha$ fails to tell us much beyond whether our estimates are likely due to error or something potentially more meaningful
- CI help us say more about the accuracy and/or quality of our estimates:
 - 95% CI for a particular effect indicates that if we collected 100 additional samples and recalculated this effect, 95 of these recalculated effects would fall within the bounds of our 95% CI
 - A narrower CI indicates more accurate estimates

More on Preacher & Hayes' Method

- This approach to multiple mediation allows researchers to:
 - Estimate both the total indirect effect of X on Y (through a set of M)
 - Test specific hypotheses regarding the role of specific mediators (M) and their relative influence in the overall model
- The ability to test multiple mediators simultaneously within SPSS opens many avenues for researchers and practitioners to explore and conveys several important benefits:
 - Possible to test whether an entire set of potential mediators plays a role (from an overall effect perspective).
 - Possible to establish the relative impact of specific mediators in a set
 - Inclusion of multiple mediators into a single, tested model reduces the chances that findings will be biased by missing variables or factors

Running Preacher & Hayes' Syntax

- Download and read Preacher & Hayes (2008)
- Check quantpsy.org frequently for updated syntax
- Download the most recent version of the SPSS syntax to your computer
 - Also download any supplementary files that may be there and review them (they are updated sometimes, so it's good to check before each analysis)
- Open your data file, open the macro syntax and run the complex syntax (it's complexity will make you feel stupid, but that's ok) – this will prepare your computer to run this type of analysis
 - Missing values should be purged from the data set prior to running this analysis; it will use listwise deletion anyways
 - All mediators must be quantitative; no categorical mediators
- Copy and paste the first few lines of the code at the end of the syntax file and begin to modify it as necessary to fit your analyses
- The Preacher & Hayes macro is long, but once you run the code to prepare your computer for this analysis, the actual portion of the syntax that you have to modify is rather straightforward

INDIRECT $y = dv/x = iv/m = mlist\ covlist/c = cov/boot = z/conf = ci/normal = n/contrast = t/percent = p/bc = b/bca = d$.

Required elements:

- **dv** = dependent variable, iv is the independent variable
- **mlist** = list of one or more mediator variables through which the IV \rightarrow dv

Optional elements:

- **covlist** = list of covariates, cov is the number of covariates in covlist (default is 0)
- **z** = number of bootstrap resamples desired in increments of 1000 (at least 5000 recommended; default is 1000)
- **ci** = desired confidence for confidence intervals (1 to 99; default is 95)
- **n** set to 1 to print normal theory standard errors for indirect effects (default is 0)
- **t** set to 1 to do all possible pairwise contrasts between indirect effects (default is 0)
- **p** set to 1 to print percentile confidence intervals
- **b** set to 1 for bias-corrected confidence intervals
- **d** set to 0 to disable printing of bias-corrected and adjusted confidence intervals

Example Syntax

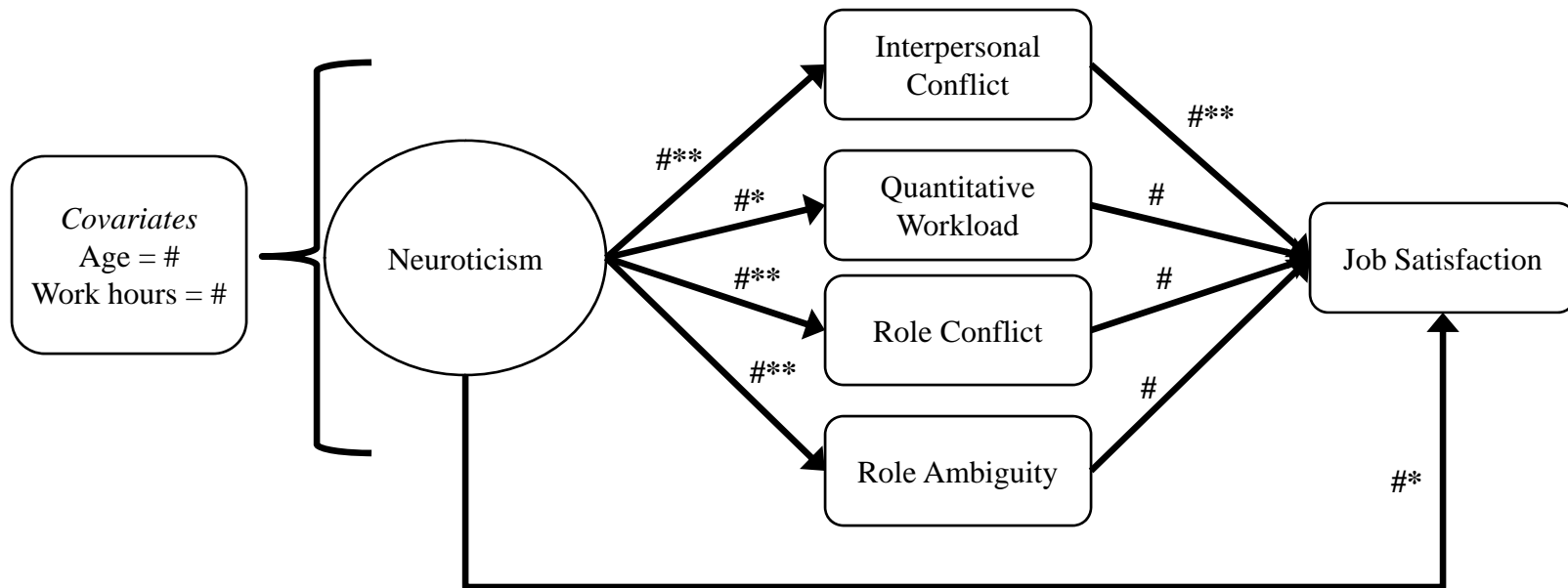
- **INDIRECT y = jsattot/x = neurottot/m = ipctot qwtot rolectot roleatot Age Wrkhrs /c = 2/boot = 5000/conf = 95/contrast = 1/percent = 1/bc = 1/bca = 0 .**

This syntax excerpt is testing the indirect effects of neuroticism on job satisfaction through four stressors, controlling for age and workhours (two covariates). 5000 bootstrapped samples will be run, and 95% CI have been requested, in both percentile and bias-corrected forms (the latter is the recommended one to focus on when interpreting the results).

Summarization & Presentation Ideas

- *In the text*
 - Discuss the findings in the text, but with this type of output, it is more efficient to summarize in tables and figures
 - “The total indirect effect between X and Y was -2.00, suggesting that as X increases by one unit, Y decreases by -2.00 units through X's effect on M, which in turn affects Y.”
- *In tables*
 - Report point estimates and bias-corrected 95% or 99% confidence intervals for each estimate
 - Report overall R^2 for the model
- *In figures*
 - Illustrate the main model, showing the point estimates for the various paths

Possible Figural Summarization



Published Examples to Consider

- Here are a couple of example papers that may serve as helpful examples if you try to use the Preacher & Hayes (2008) multiple mediation macro:
 - Danaher, B. G., Smolkowski, K., Seeley, J. R., & Severson, H. H. (2008). Mediators of a successful web-based smokeless tobacco sensation program. *Addiction, 103*, 1706-1712.
 - Buffardi, L. E., & Campbell, W. K. (2008). Narcissism and social networking web sites. *Personality and Social Psychology Bulletin, 34*, 1303-1314.
 - Wittmann, M., Arce, E., & Santisteban, C. (2008). How impulsiveness, trait anger, and extracurricular activities might affect aggression in school children. *Personality and Individual Differences, 45*(7), 618-623.

Additional Recommended Resources

- www.quantpsy.org
- *facebook*: Statistical Mediation and Moderation Analysis Group
- Baron, R. M., & Kenny, D. A. (1986). The moderator-mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. *Journal of Personality and Social Psychology*, 51(6), 1173-1182.
- Special issue *ORM*, April 2008
- Hayes, A. F. (in press). Beyond Baron and Kenny: Statistical mediation analysis in the new millennium. *Communication Monographs*.
- Preacher, K. J., & Hayes, A. F. (2008). Asymptotic and resampling strategies for assessing and comparing indirect effects in multiple mediator models. *Behavior Research Methods*, 40(3), 879-891.
- Preacher, K. J., & Hayes, A. F. (2004). SPSS and SAS procedures for estimating indirect effects in simple mediation models. *Behavior Research Methods, Instruments, & Computers*, 36(4), 717-731.