Mediation analysis - basics

Molslaboratoriet, Oct 2014

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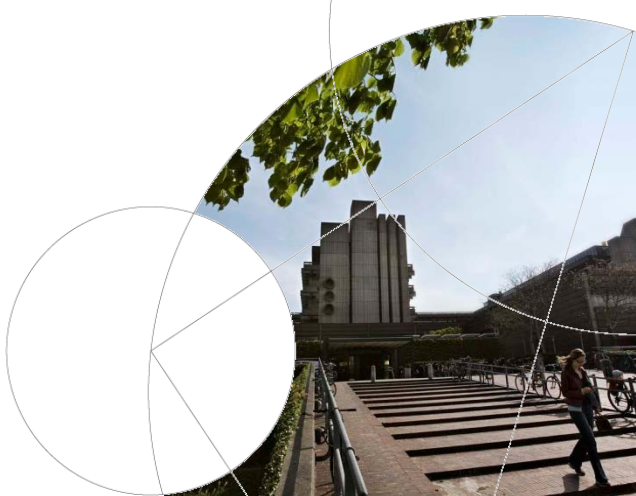

Objectives

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- To identify when a mediation analysis is the right solution.
- To know which assumptions that must be satisfied.
- To be able to conduct mediation analysis on the computer (in R).

Why mediation

- Once it has been established that an exposure causes a specific outcome the natural question is **HOW?**

- A typical answer to this question goes like this:

Exposure *A* causes variable *M* to change, which in turn causes outcome *Y* to occur.

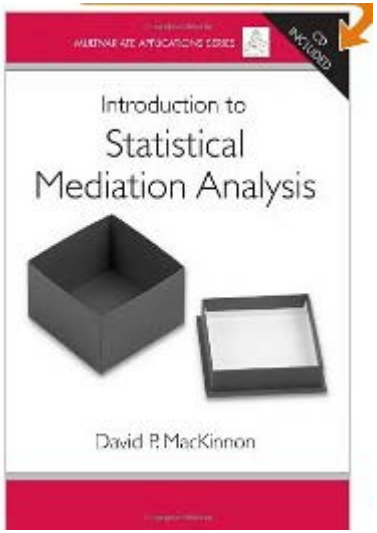
(sometimes supplemented with a number of alternative M's)

- Mediation analysis aims at quantifying the degree to which this answer is indeed the correct explanation for **HOW?**

Books and key references

Books

"Introduction to Statistical Mediation Analysis" by D. MacKinnon. (somewhat outdated)



AND

Tyler VanderWeele

- Home
- Curriculum Vitae
- Books
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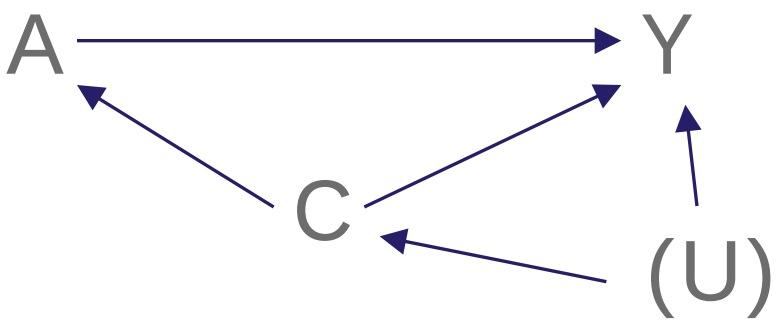
Books

Explanation in Causal Inference: Methods for Mediation and Interaction, by Tyler J. VanderWeele, is being published by Oxford University Press, and will be in print later in 2014.

DAG: A key tool

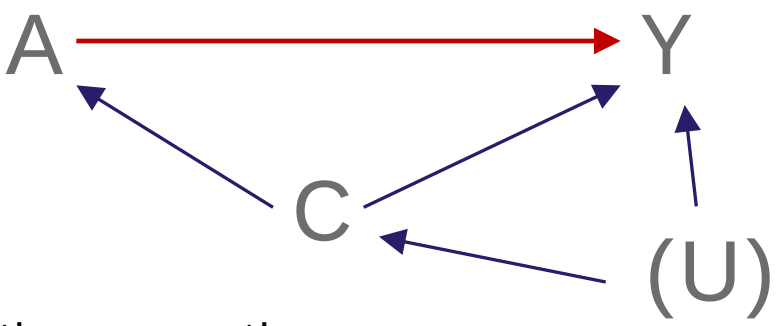


- DAGs (Directed Acyclic Graphs) are often used to depict causal relationships.
- The DAG is built from substance knowledge not from the data at hand.
- The real information in a DAG is in the direction of the arrows
- and in which arrows that are NOT there.

- Remember also to think of unmeasured confounders/variables (U in the DAG above).

DAGs: Two types of connections

- Following the direction of the arrows the red connection is the only one from A to Y.



- However ignoring the directions of the arrows there are many more (the red and the blue).

- It is only the red arrow that denotes a causal influence of A on Y, but a simple regression of Y on A would include both the red and the blue connections.

A case

Parenting practices and intergenerational associations in cognitive ability

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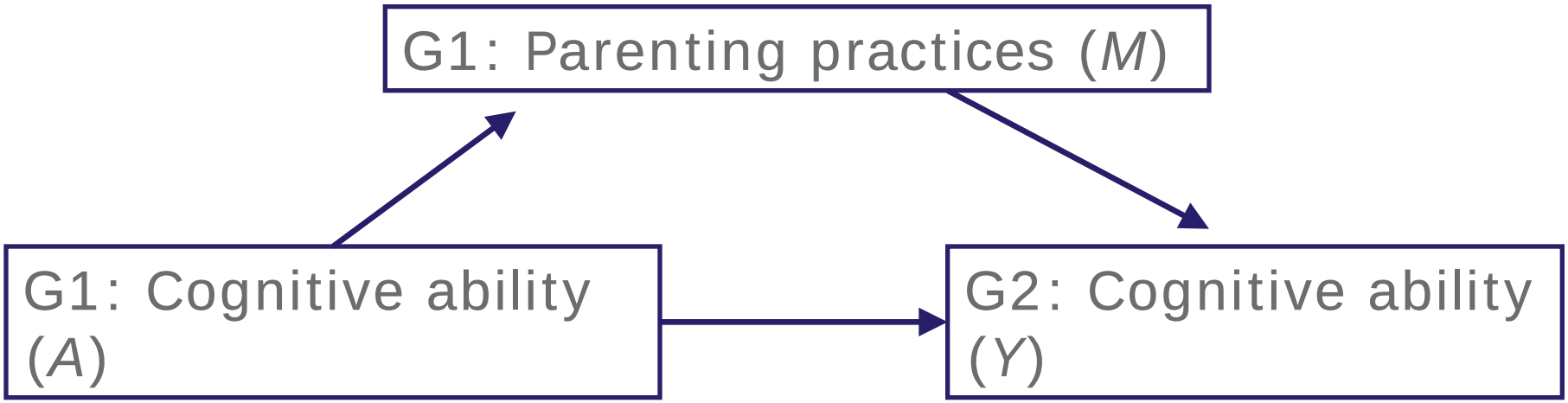
Background Cognitive ability is an important contributor to life chances, with implications for cycles of advantage or disadvantage across generations. Parenting practices are known to influence offspring cognitive development, but the extent to which these mediate intergenerational continuities and discontinuities in cognitive ability has not been adequately studied.

Simplistic DAG



- Confounding??
- How are these measured??

- Let us assume for the next few slides that
  - there is no confounding
  - and all are measured as a numeric score (say 1-100)

Mediation analysis in the pure linear case (I/II)

- Assume both mediator (*M*) and outcome (*Y*) are well modeled by a simple linear model.
- Mediation through *M* can then be assessed as follows:

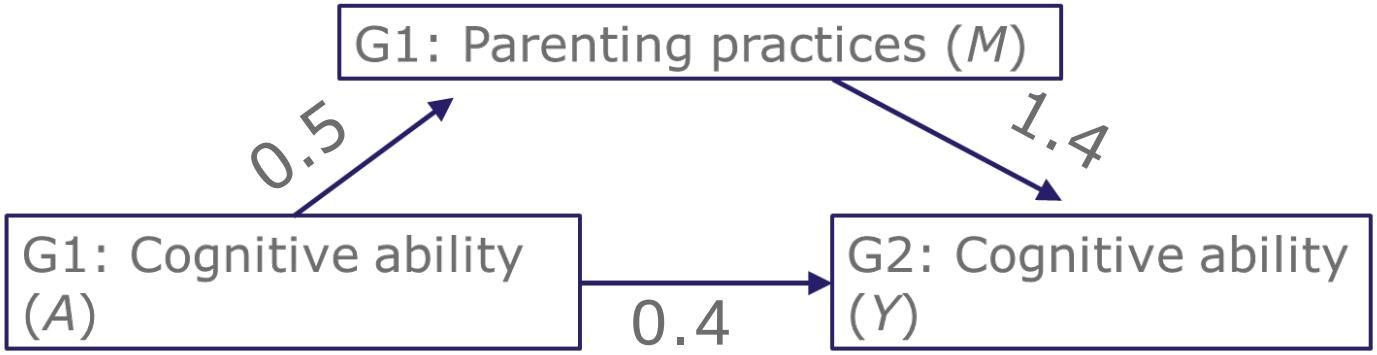
1. Run a regression of the outcome on the mediator and the exposure (and perhaps confounders):
   $E[Y|A=a, M=m] = 0.1 + 0.4*a + 1.4*m$

2. Run a regression of the mediator on the exposure (and perhaps confounders):
   $E[M|A=a] = 0.2 + 0.5*a$

3. Add estimates from steps 1 and 2 to the graph

Mediation analysis in the pure linear case (II/II)

3. Add estimates from steps 1 and 2 to the graph



4. Compute direct (DE), indirect (IE), and total effects (TE) as well as mediated proportion (IE/TE).

DE	IE	TE	IE / TE
0.4	0.5*1.4= 0.7	0.4+0.7 = 1.1	0.7/1.1 = 64%

Notes

- The models must not include interactions!
- Confounders can be included as simple additive effects.
- This technique is also known as path-analysis or the Baron & Kenny approach.

How to obtain confidence intervals for IE and IE/TE (manual version)

Step 1: Collect information

Source*	Estimate	Std. error	Covariance**
Y on M and A (effect of A)	0.4	0.1	0.0002
Y on M and A (effect of M)	1.4	0.2	
M on A (effect of A)	0.5	0.3	No need.

*If required you can also include pre-treatment covariates.

** In R you obtain this using the **vcov**-function.

How to obtain confidence intervals for IE and IE/TE (manual version)

Step 2: Enter information in Excel sheet (available from T. Lange or http://publicifsv.sund.ku.dk/~thla/mediation/quick_calculator_path_effects.xlsx)

16	**Type input here:**											
17		Est	SE									
18	Y on M and A (effect of M)	1,4	0,2									
19	M on A (effect of A)	0,5	0,3									
20	Y on M and A (effect of A)	0,4	0,1									
21	Covariance b/w ests in row 22 and 24	0,0002										
22												
23	**Results:**											
24	Implied correlation b/w estimates		0,2357									
25	Implied SE for Total effect		0,4544									
26												
27		Direct effect			Indirect effect			Total effect			Mediated proportion*		
28		Est	CI		Est	CI		Est	CI		Est	CI	
29	On linear scale	0,4000	0,2048	0,5966	0,7000	-0,1127	1,5919	1,1000	0,2581	2,0277	0,6364	-0,2533	0,8354
30	* Defined as IE/TE												
31													

How to obtain confidence intervals for IE and IE/TE (R version)

Step 1: Fit both regressions in R

```
fitYonMandA <- lm(Y ~ M + A, data=myData)
fitMonA     <- lm(M ~ A, data=myData)
```

Step 2: Use the package "mediation"

```
library(mediation)
medObj <- mediate(fitMonA, fitYonMandA,
    treat="A", mediator="M", sims=5)
summary(medObj)
```

Output:

	Estimate	95% CI Lower	CI Upper
ACME	0.694	-0.113	1.592
ADE	0.401	0.205	0.600
Total Effect	1.095	0.258	2.028
Prop. Mediated	0.635	-0,253	0.835

Difference of coefficients method

- In purely linear models mediation can also be estimated by an alternative approach know as *difference of coefficients.*

- The idea is:
  1. Estimate a regression for the outcome including exposure and mediator (as well as confounders).
  2. Estimate a regression for the outcome including only the exposure (and again all confounders).
  3. Indirect effect will correspond to the difference between the two estimates associated with the exposure.

- NOTE: In non-linear models this approach will be biased!!

- This approach is (also) referred to as the Baron & Kenny approach.

Mediator vs. moderator

The **moderator–mediator** variable distinction in social psychological research: Conceptual, strategic, and statistical considerations.
RM Baron, DA Kenny - Journal of personality and social ..., 1986 - psycnet.apa.org
Abstract 1. In this article, we attempt to distinguish between the properties of **moderator** and **mediator** variables at a number of levels. First, we seek to make theorists and researchers aware of the importance of not using the terms **moderator** and **mediator** interchangeably **...**
Citeret af 43598 Relaterede artikler Alle 71 versioner Web of Science: 22188 Citer Gem

- Since the highly cited paper by Baron & Kenny moderators and mediators have been discussed together.
- However, they are not particular related!
- Mediation concerns causal structure.
- Moderation concerns statistical modelling.

Mediator vs. moderator – an example

Does watching porn make you more sexist? Depends if you're a gentleman, study says

ZOSIA BIELSKI
The Globe and Mail
Published Friday, Sep. 06 2013, 3:10 PM EDT
Last updated Friday, Sep. 06 2013, 4:58 PM EDT

Pornography and Sexist Attitudes Among Heterosexuals

Gert Martin Hald[1,2], Neil N. Malamuth[3] and Theis Lange[4]

Article first published online: 10 JUN 2013
DOI: 10.1111/jcom.12037

Issue

Journal of Communication
Volume 63, Issue 4, pages 638–660, August 2013

THE GLOBE AND MAIL

- No effect of exposure to pornography among men of medium to high agreeableness on hostility to towards women.
- Highly significant effect of exposure to pornography among men of low agreeableness on hostility to towards women.
- Mediation analysis among low-agreeableness men show: