Mediation: Background, Motivation, and Methodology

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for Genetics of Addiction
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Outline & Goals

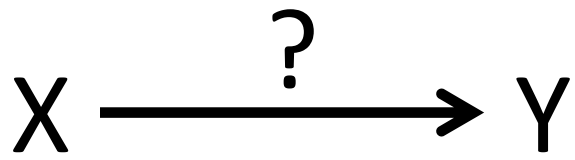
- Points for this talk:
  - What is mediation?
  - Why are people (researchers) interested?
  - How is (simple) mediation assessed?
  - Extension to more complex models.
  - Example from a project at MDA.
  - Available software.

But first...

- How many of you have experience with mediation?
- Requests from PI or collaborators?
- Speak up!

What is mediation?

- "...represents the generative mechanism through which the focal independent variable is able to influence the dependent variable of interest."[1]



- Warning: There be sloppy language...

[1]Baron & Kenny (1986)

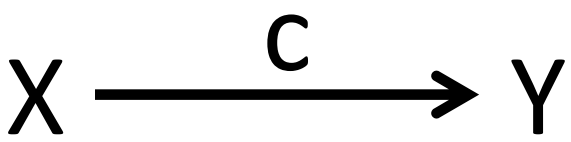
Why are people interested?

- Psychologists **love** mechanisms!
- Theory building & Intervention design
- For example:
  - Stress & heart disease
  - Functional brain imaging & neural networks
  - Intervention for sun protection
- 1986 publication[1] generally regarded as kicking off modern thinking on mediation

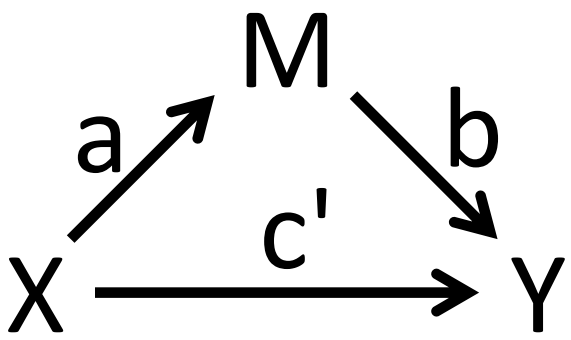
[1]Baron & Kenny (1986)

How is mediation assessed?

- Historically, three(ish) major approaches
- The “magic triangle”



$Y = cX$



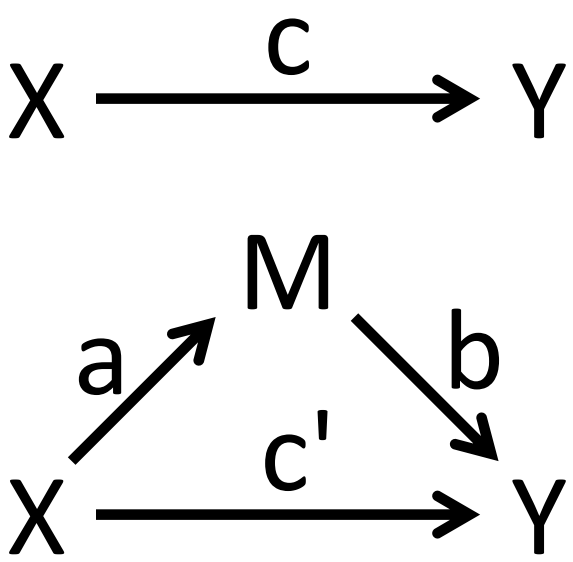
$M = aX$

$Y = bM + c'X$

$c = c' + ab$ OR $c - c' = ab$

How is mediation assessed?

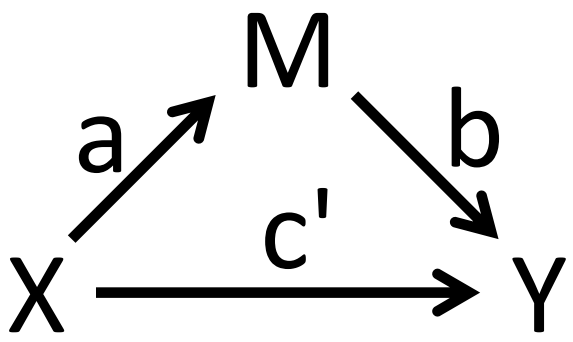
- The "Causal steps" method[1]
  1. X predicts Y (c is sig.)
  2. X predicts M (a is sig.)
  3. M predicts Y, controlling for X (b is sig.)
  4. When M is in model, X no longer predicts Y (c‘ is zero)
- It's just bad...



[1]Baron & Kenny (1986)

How is mediation assessed?

- The "Sobel Test" method[1]
  - Sometimes called the "delta method"
  - Simple formula that approximates the standard error of ab
  - Very low power[2] (due to mismatch between assumed & actual distribution of ab)

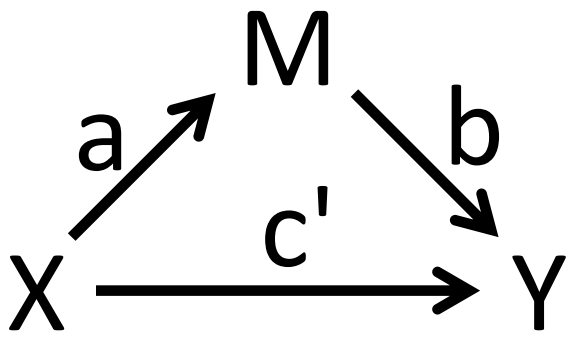


[1]Sobel (1982)

[2]MacKinnon, Warsi, & Dwyer (1995)

How is mediation assessed?

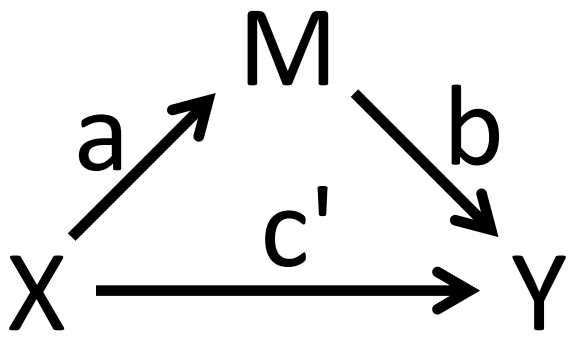
- The "Bootstrap" method[1]
  - Non-parametric method involving sampling with replacement
  - Confidence intervals derived from bootstrap sample (e.g., bias corrected, percentile)



[1]Shrout & Bolger (2002)

How is mediation assessed?

- The "Monte Carlo" method[1]
  - Generate random normal deviates representing a and b (m_a and s_a; m_b and s_b)
  - CI derived as quantiles of ab



[1]Preacher & Selig (2012)

How is mediation assessed?

- What are the relative merits? [1]
  - Power: BC bootstrap but can be too liberal[2]
  - Type-I: Monte Carlo
  - Best balance: Percentile CI

[1]Hayes & Sharkow (2013)

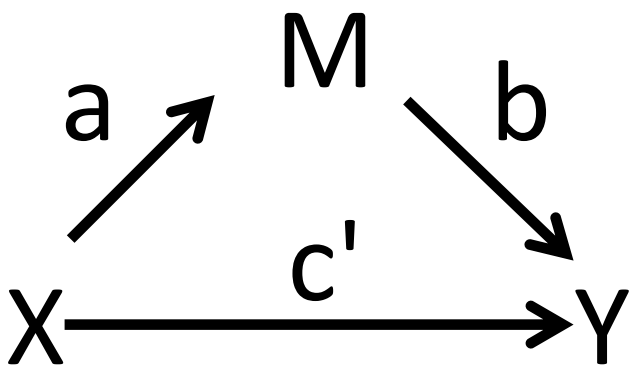
[2]Fritz, Taylor, and MacKinnon (2012)

Multiple Mediators

- Seldom interested in a single variable
  - More likely multiple candidate variables mediating relationship between variables of interest
- In reality, these multiple mediators likely don't operate independently of one another
- Natural extension to multiple mediators
  - Parallel & Serial paths

Parallel mediators

- Recall the single mediator
- Only one additional formula required for each parallel mediator



$M = aX$

$Y = bM + c'X$

Parallel mediators

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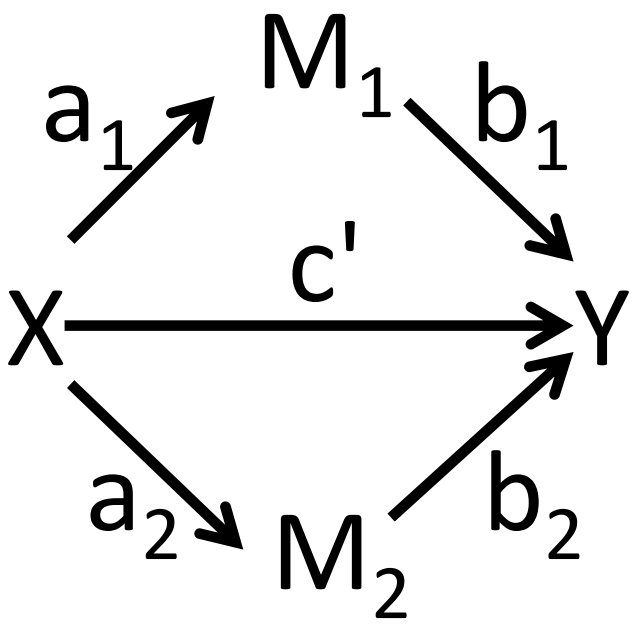


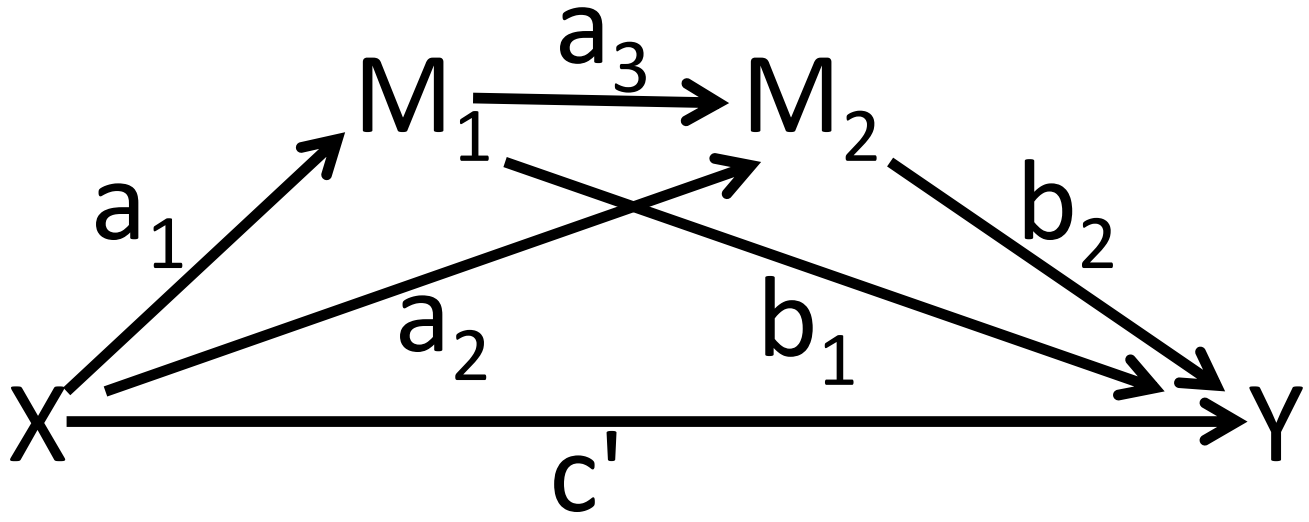
$M_1 = a_1X$

$M_2 = a_2X$

$Y = b_1M_1 + b_2M_2 + c'X$

Serial mediators

- Mediators are placed in series



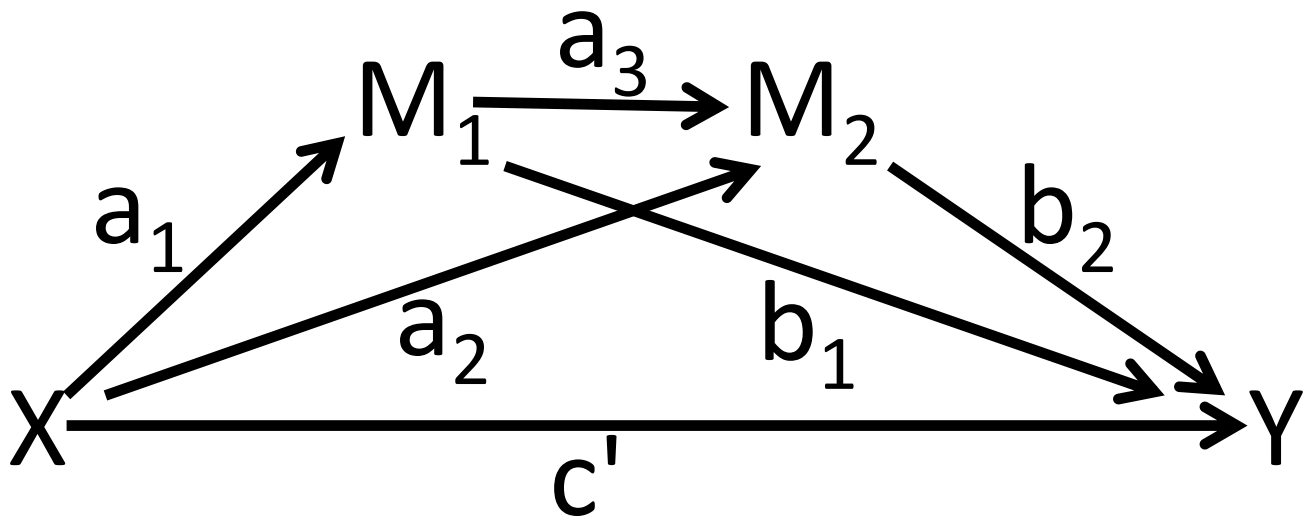
$M_1 = a_1X$

$M_2 = a_2X + a_3M_1$

$Y = b_1M_1 + b_2M_2 + c'X$

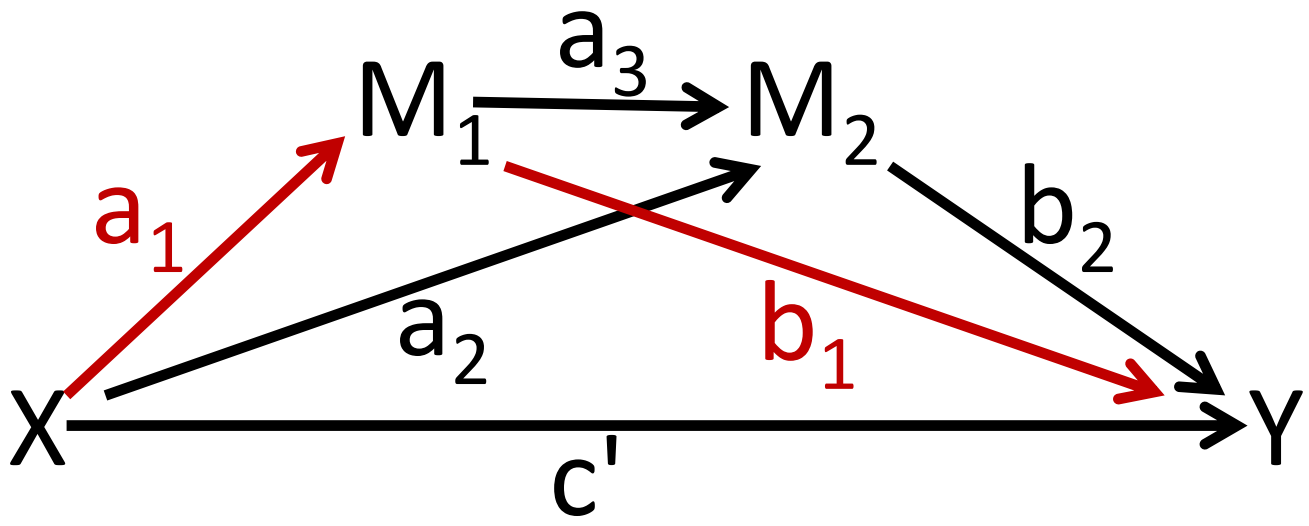
Serial mediators

- Creates an additional path



Serial mediators

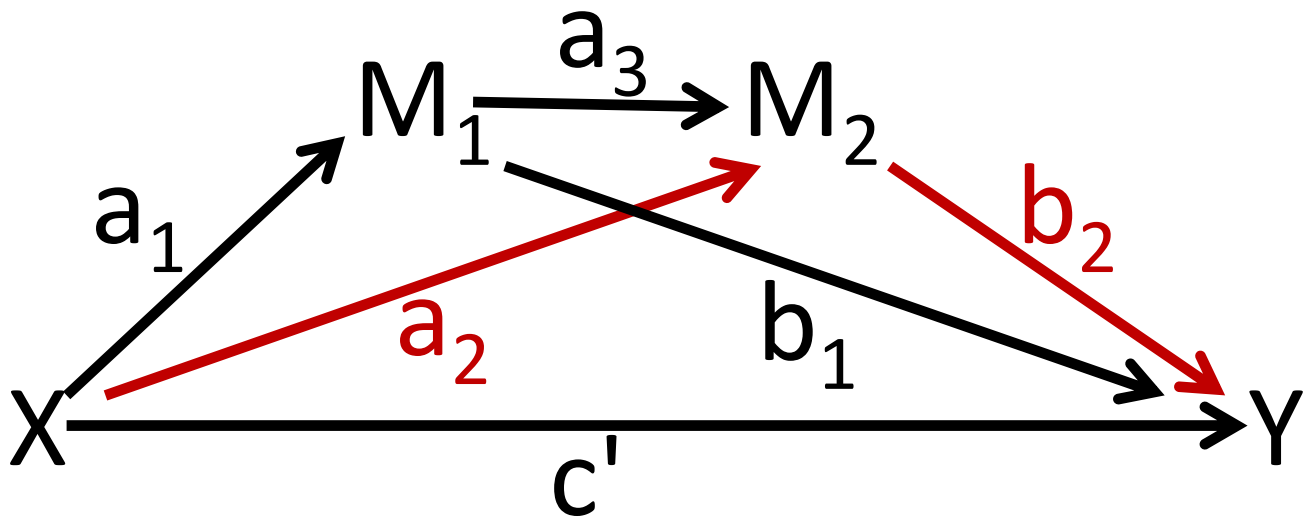
- Creates an additional path



1) a_1b_1

Serial mediators

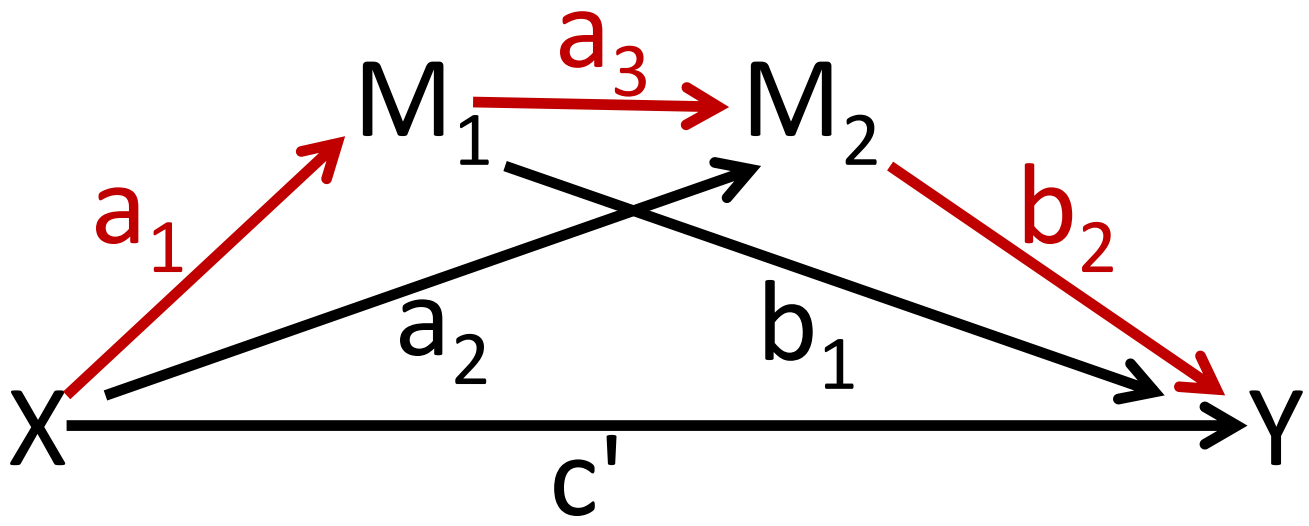
- Creates an additional path



1) a_1b_1
2) a_2b_2

Serial mediators

- Creates an additional path



1) a_1b_1
2) a_2b_2
3) $a_1a_3b_2$

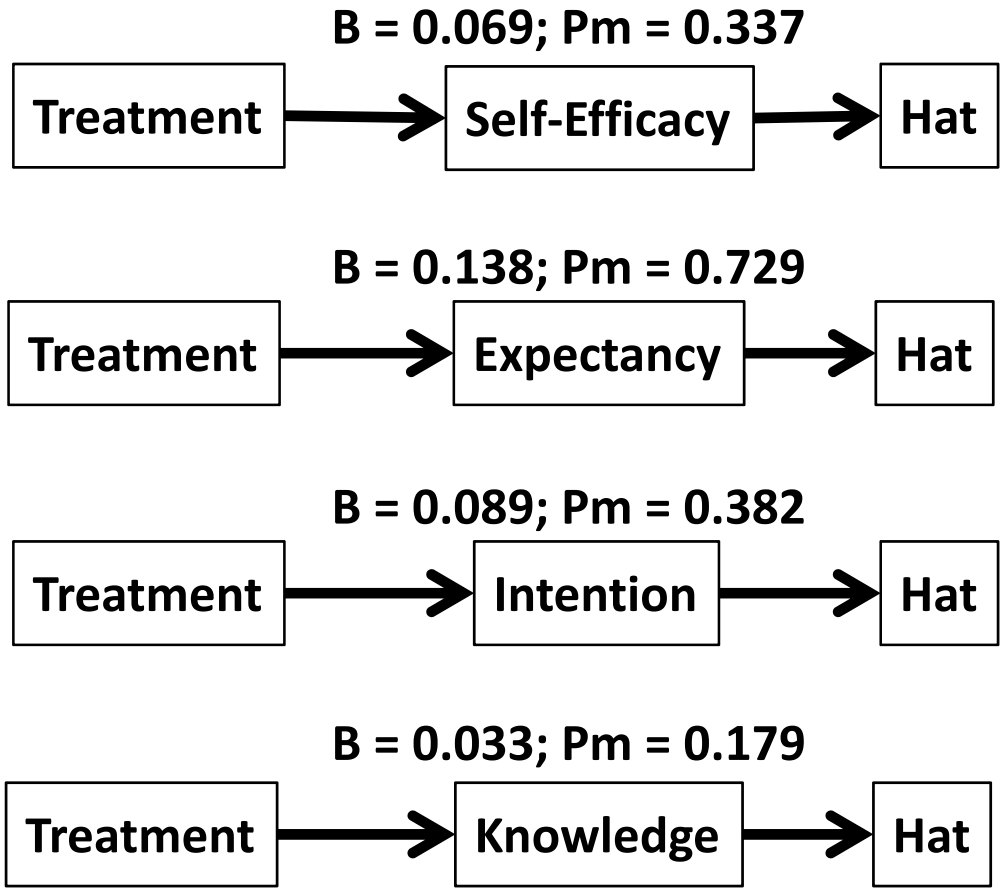
An example

- Sun protection intervention
- Target population:
  - Melanoma survivors with a child ≤ 12 years-old
  - N = 281
- Primary outcome:
  - Children's wide-brimmed hat use

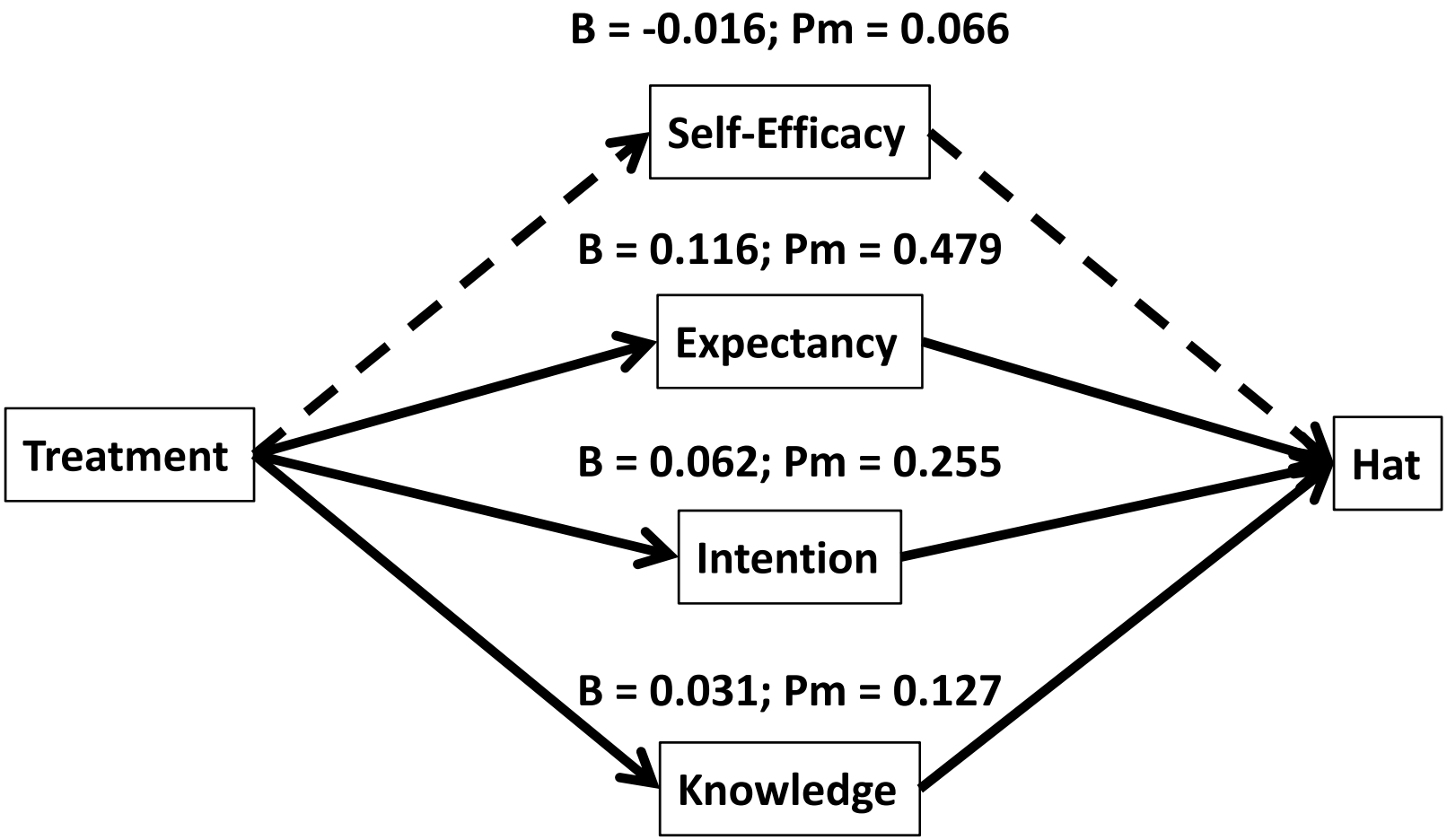
Variables

- X: Treatment (vs. Control)
- Mediators:
  - Self-Efficacy
  - Expectancy
  - Intention
  - Knowledge
- Y: Hat use

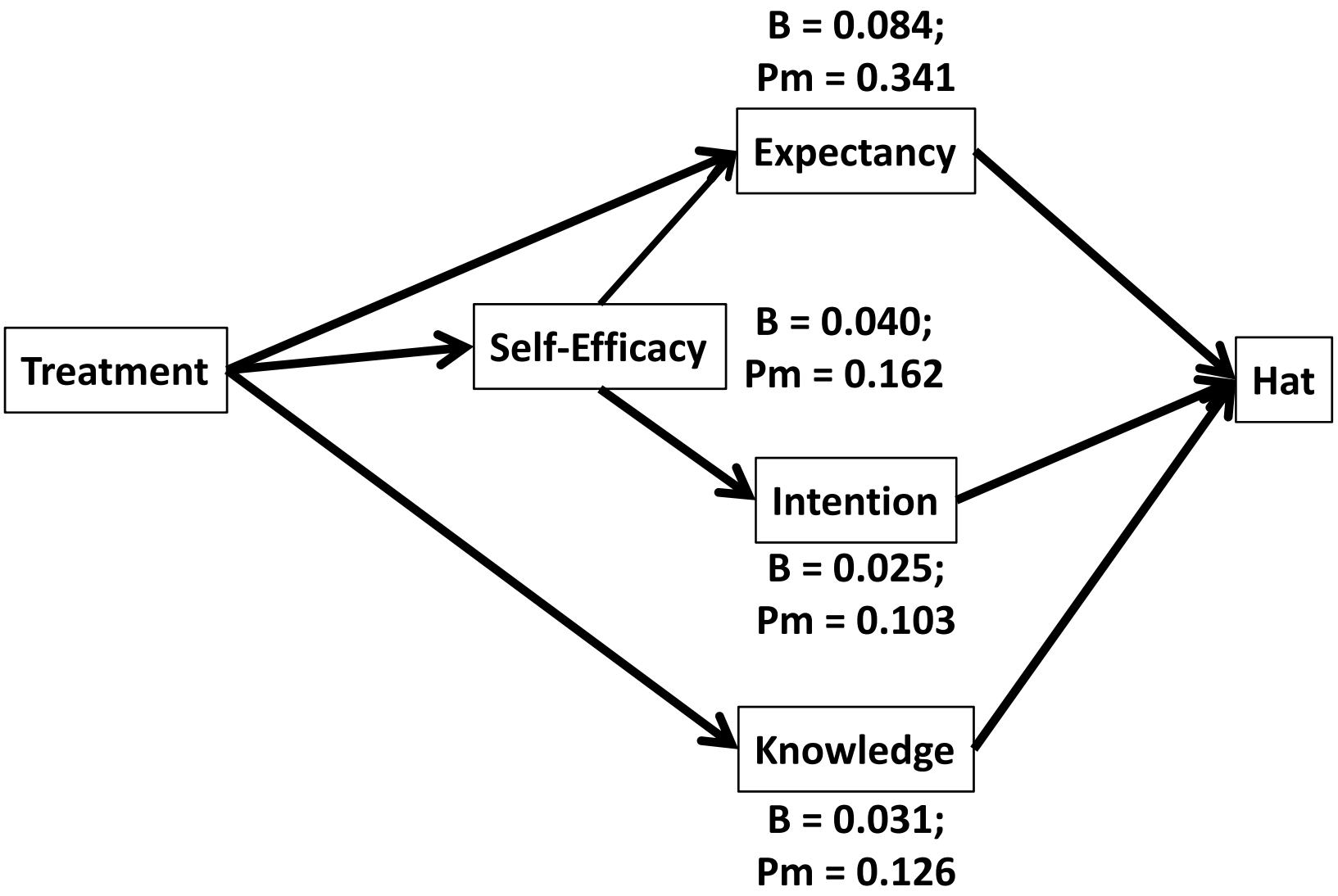
Single Mediators



Parallel Mediators



Serial Mediators



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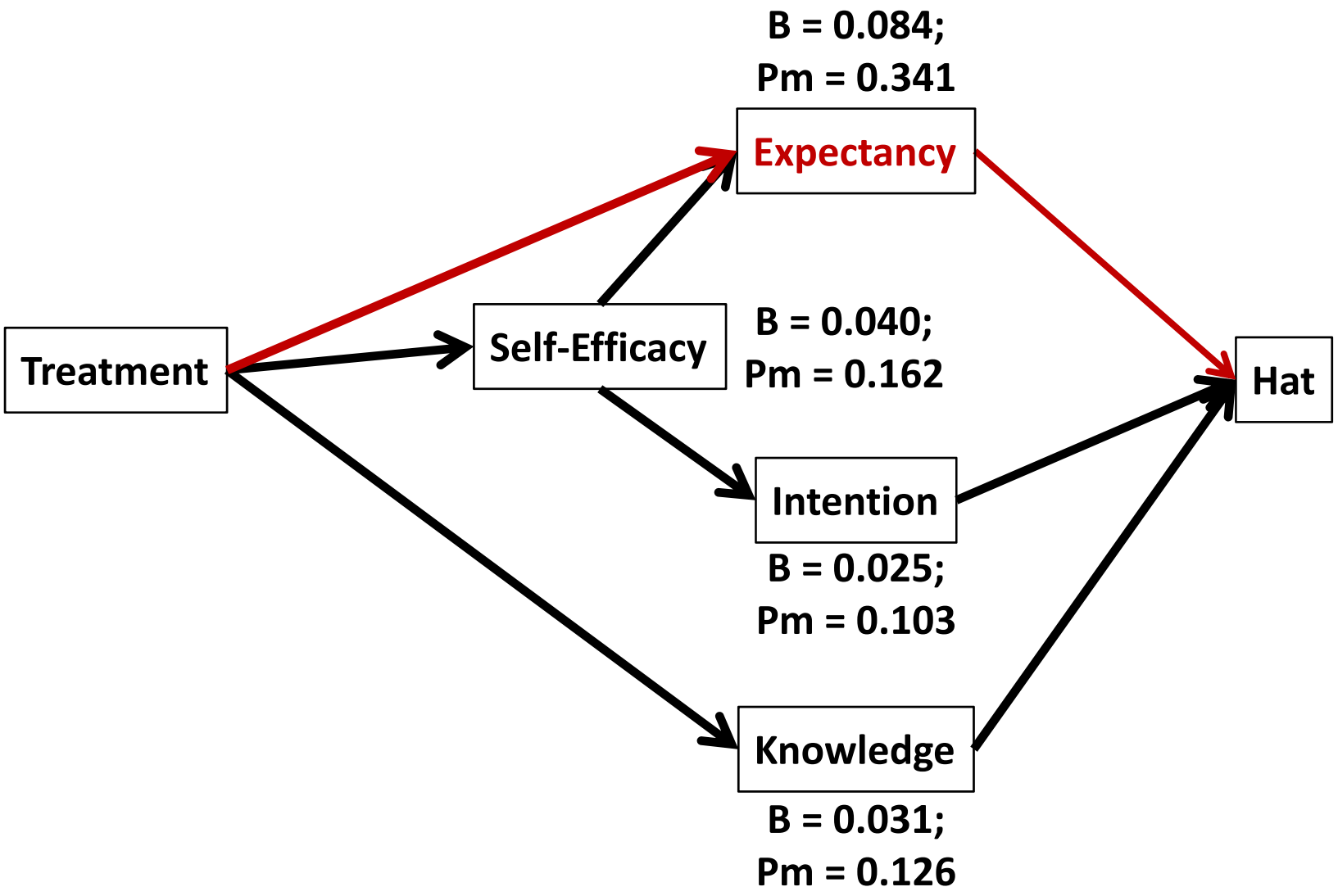

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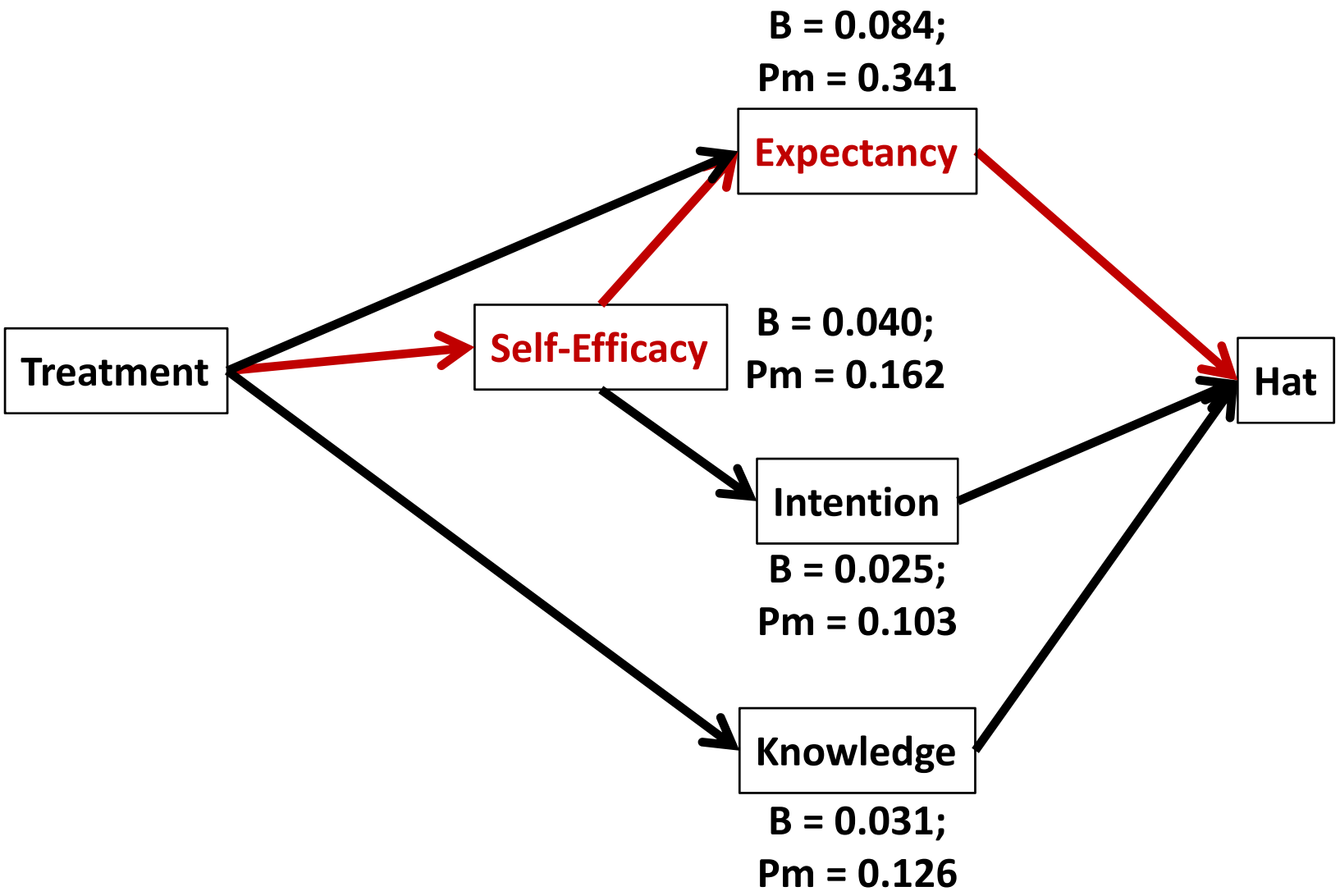

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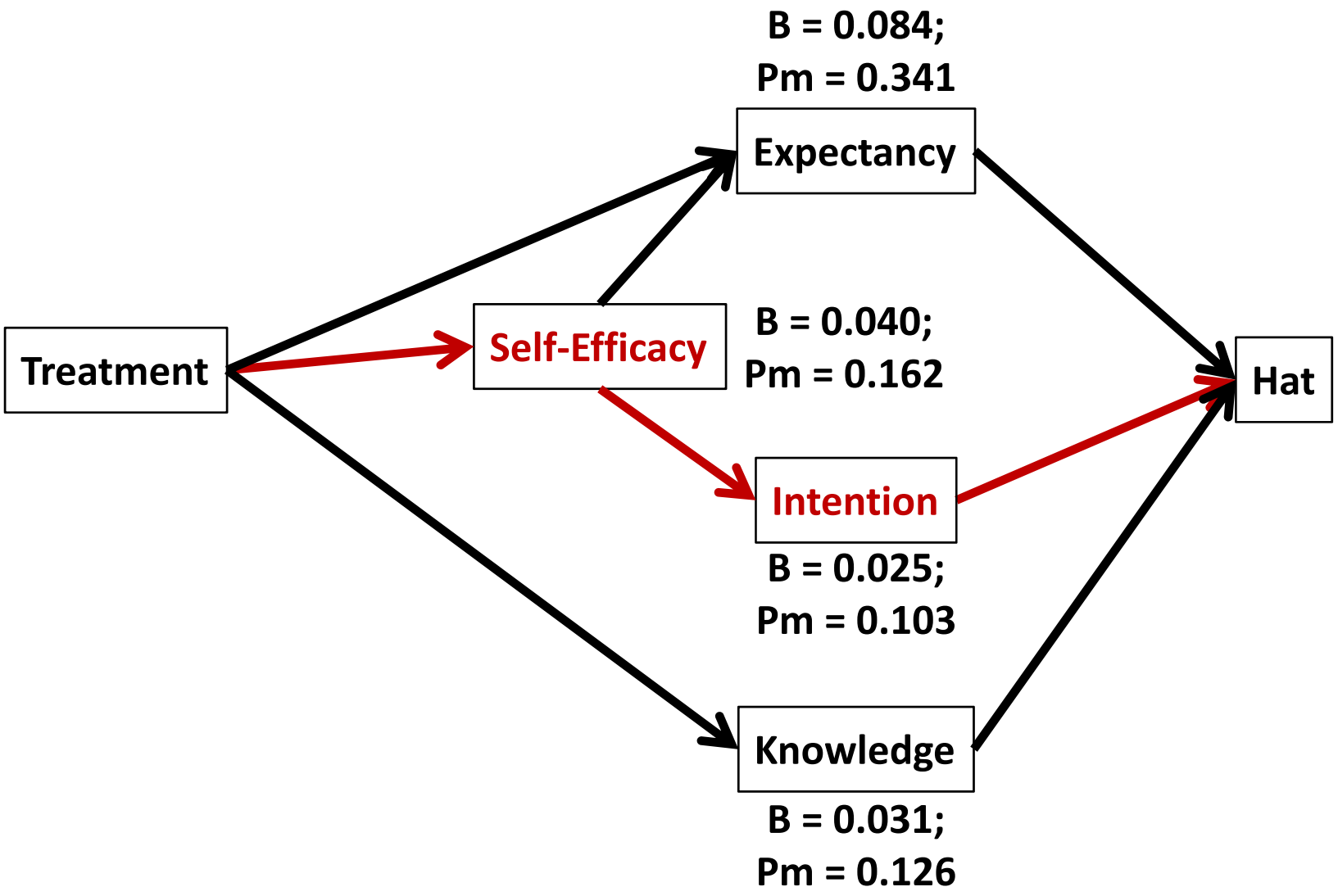

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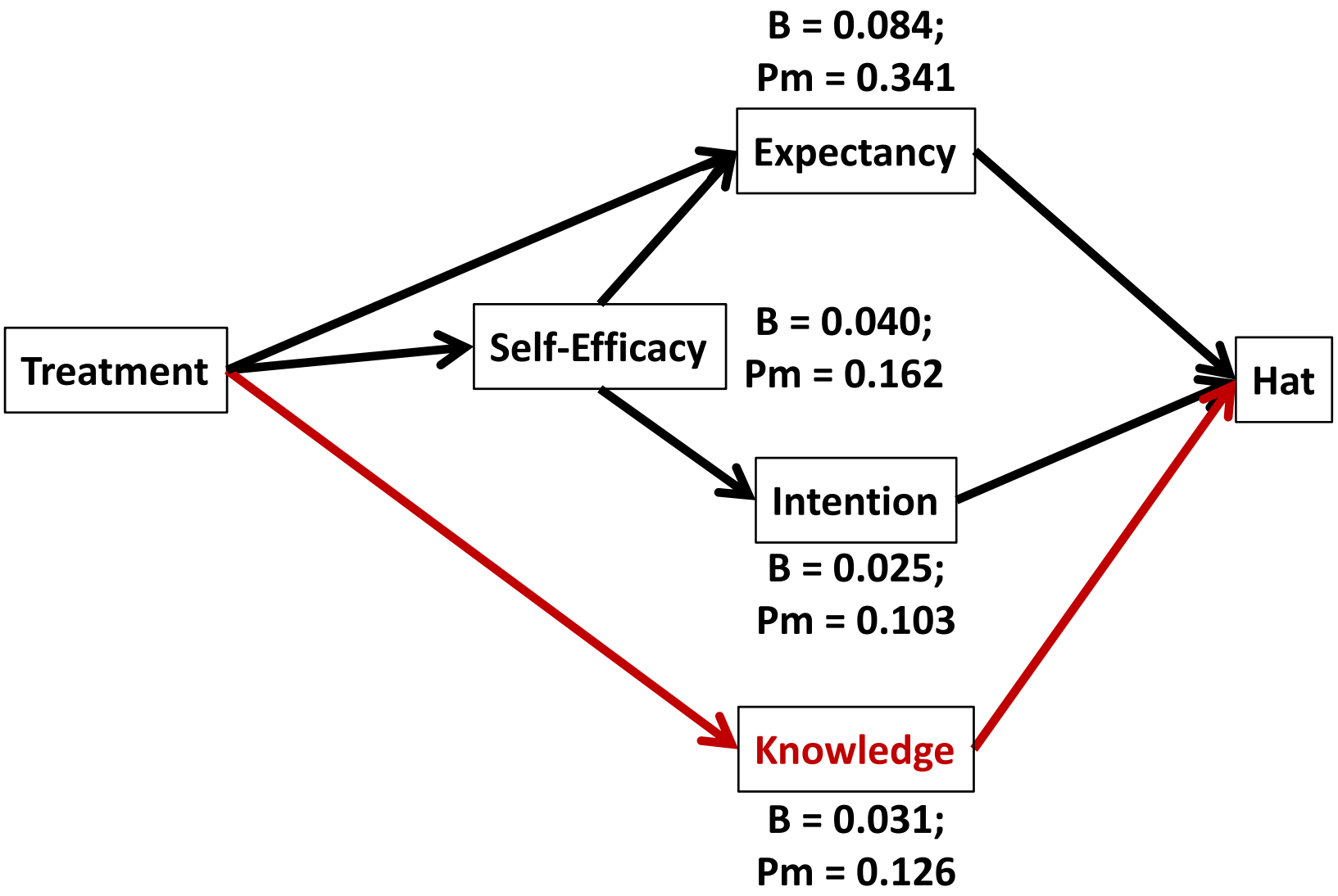

Available Software

- PROCESS for SPSS and SAS[1]
- mediation package in R[2] (potential outcomes framework)
- Online resources[3]
- Any number of packages for SEM
- Of course, not that hard to code...

[1]Hayes (2013)

[2]Imai (2014)

[3]Selig & Preacher (2008)

Thanks!