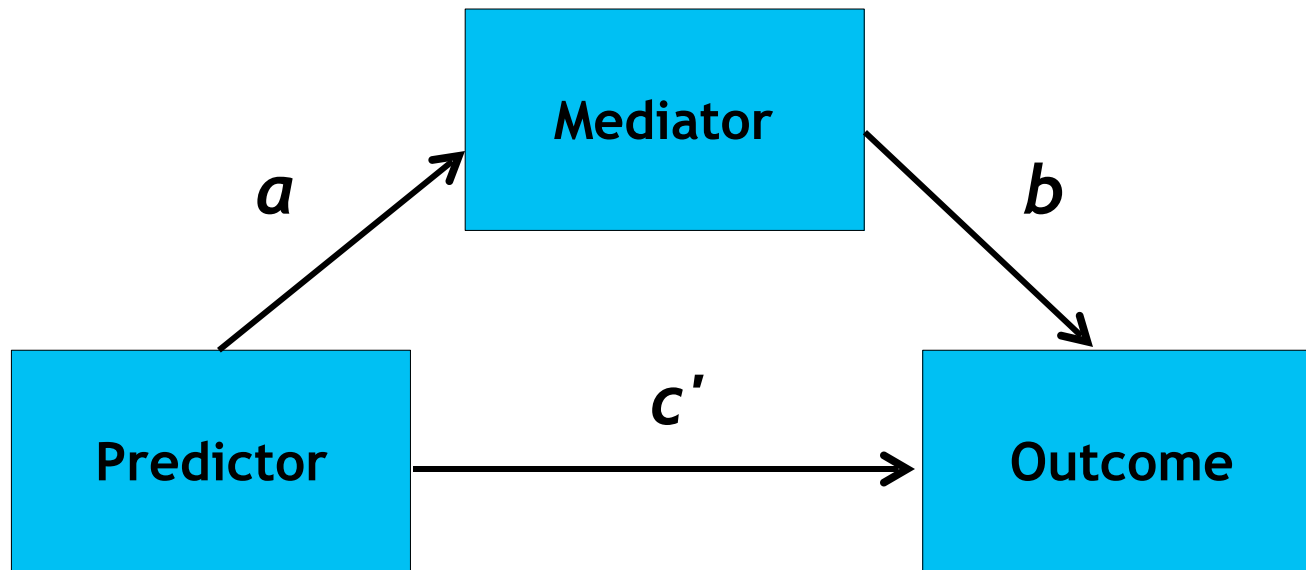


ACCURATE INDIRECT EFFECTS IN MULTILEVEL MEDIATION FOR REPEATED MEASURES DATA

Amanda Sharples and Elizabeth Page-Gould
University of Toronto



Mediation

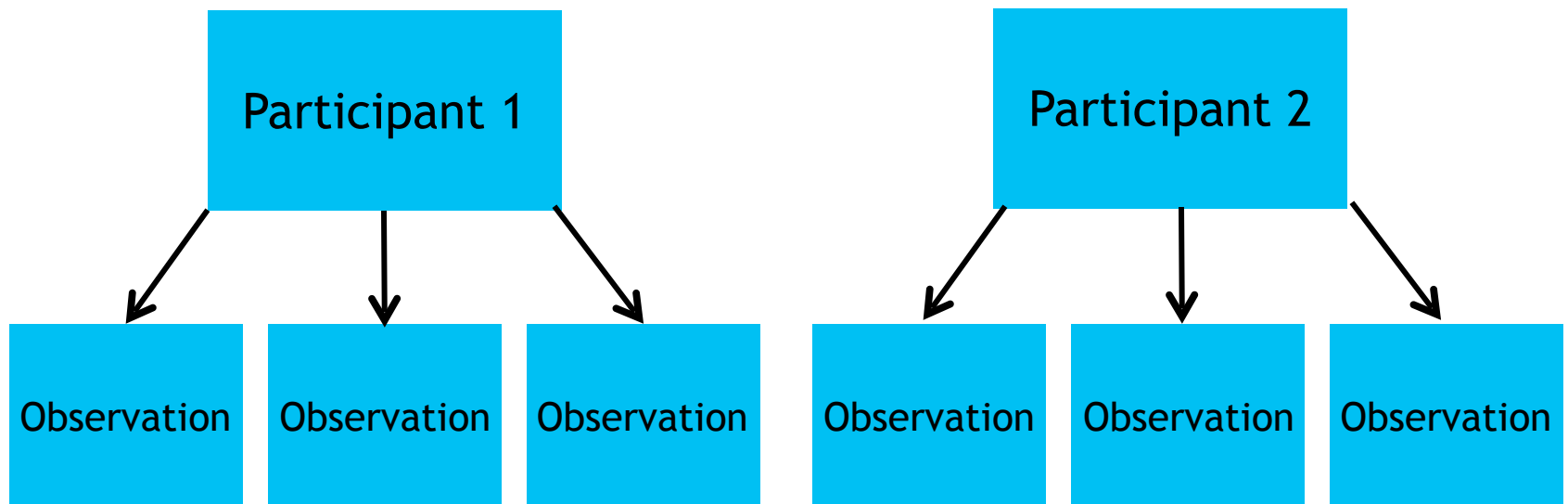


$$\text{Indirect effect} = a \times b$$
$$\text{Total effect} = \text{Indirect effect} + c'$$

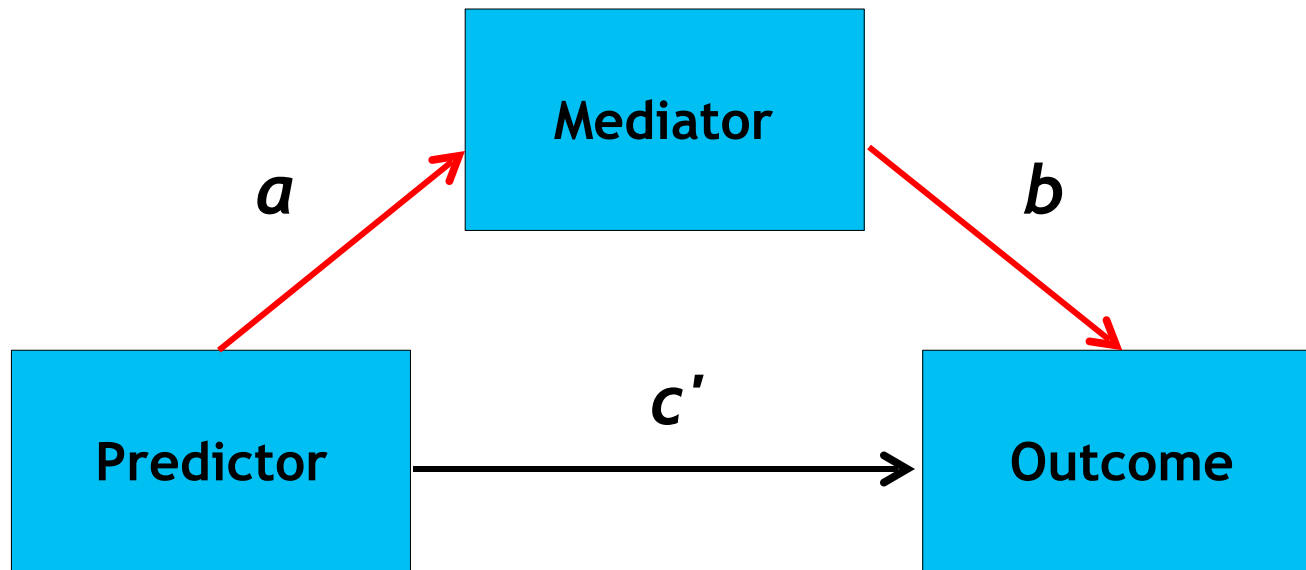


Multilevel Models

Nested (Repeated Measures) Data



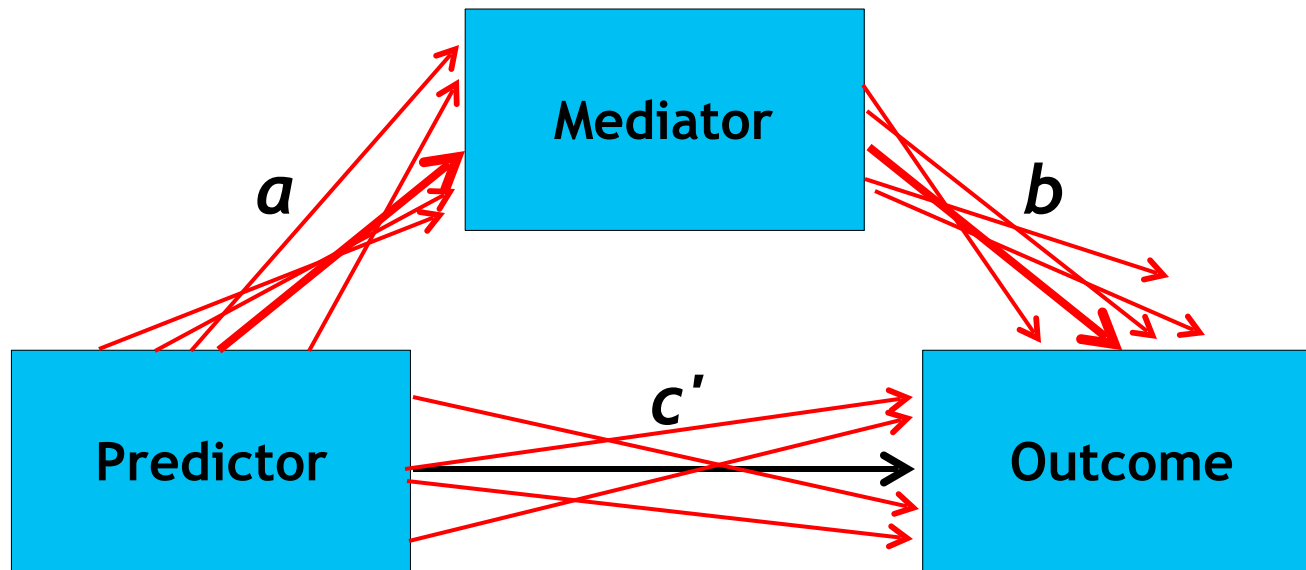
Multilevel Mediation



$$\text{Indirect effect} = a \times b$$
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Multilevel Mediation

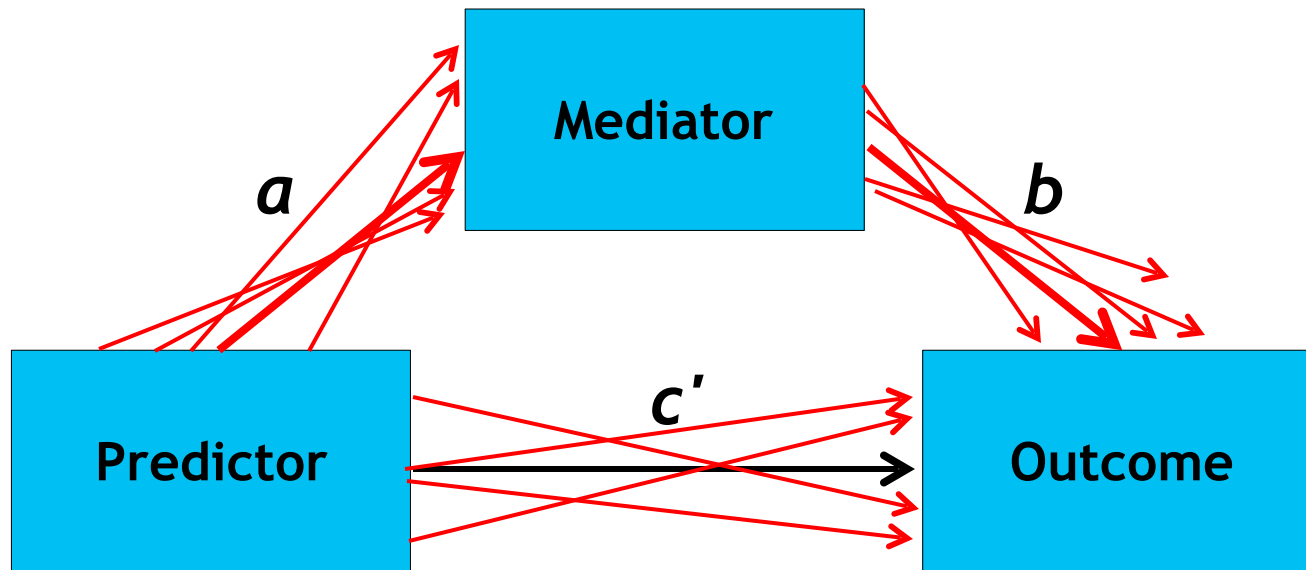


$$\text{Indirect effect} = a \times b$$
$$\text{Total effect} = \text{Indirect effect} + c'$$



The Wrong Way to Do Multilevel Mediation

USE FIXED SLOPES TO CALCULATE INDIRECT EFFECT



$$\text{Indirect effect} = a \times b$$

$$\text{Total effect} = \text{Indirect effect} + c'$$



Why is this Bad?

- The indirect effect is biased.
 - So the total effect is biased too.
- They are biased by how much the random slopes a and b covary.

Bauer, Preacher, & Gil (2006); Kenny, Korchmaros, and Bolger (2003)

$$\text{Bias} = \text{COV}(a_i, b_i) = \sigma_{ab}$$

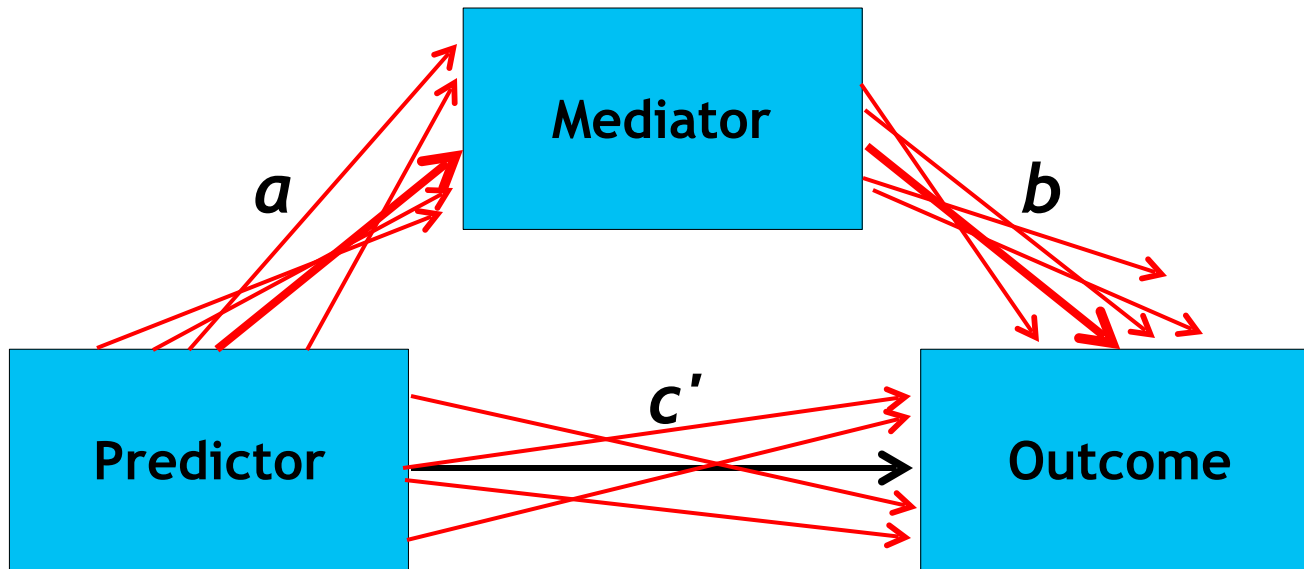
$$\text{Real indirect effect} = (a \times b) + \text{COV}(a_i, b_i)$$

$$\text{Real total effect} = (a \times b) + \text{COV}(a_i, b_i) + c'$$



The Right Way to Do Multilevel Mediation

TAKE RANDOM SLOPES INTO ACCOUNT



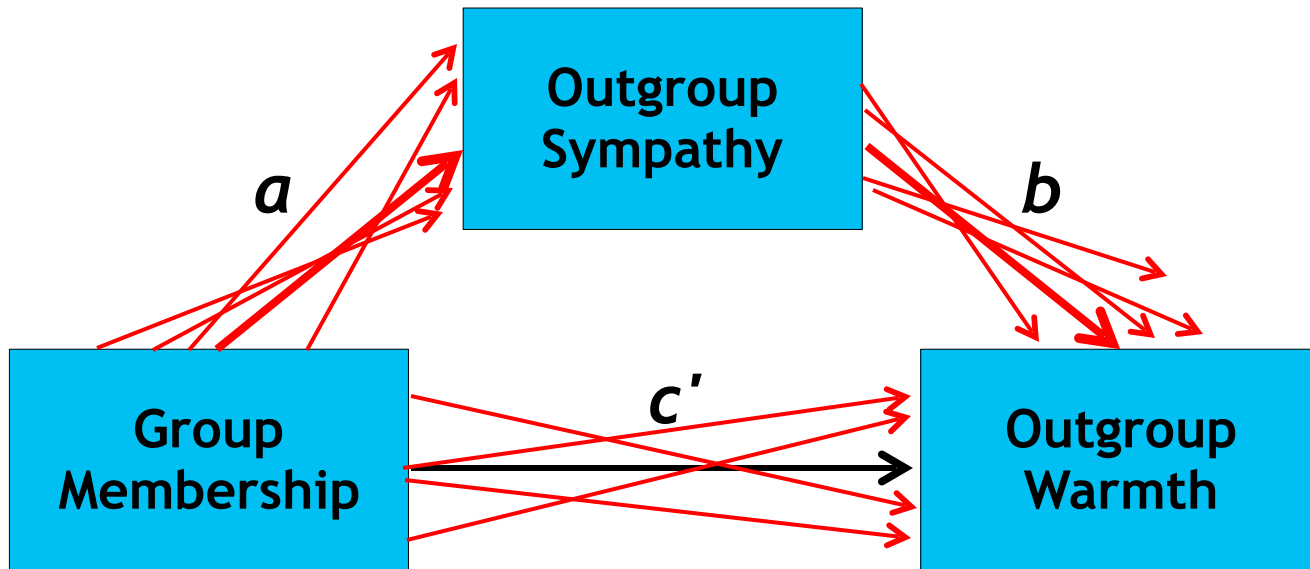
$$\text{Indirect effect} = \text{Mean}(a_i \times b_i)$$

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The Right Way to Do Multilevel Mediation

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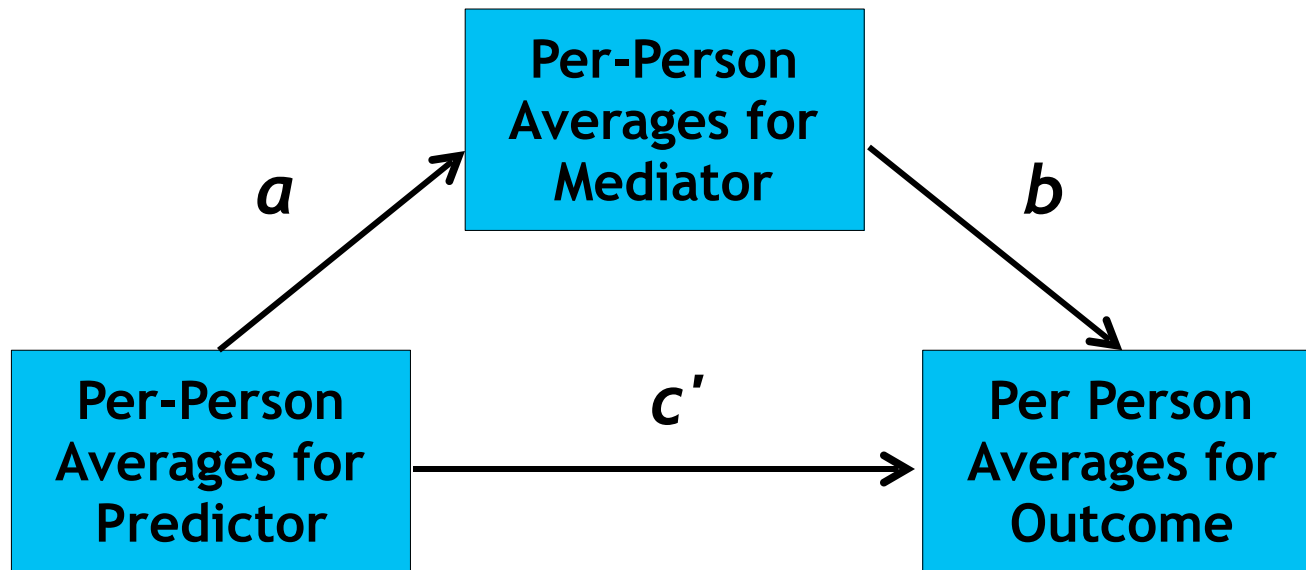
$$\text{Indirect effect} = \text{Mean}(a_i \times b_i)$$

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An OK Way to Do Multilevel Mediation

USE AGGREGATE REPEATED MEASURES FOR EACH PARTICIPANT



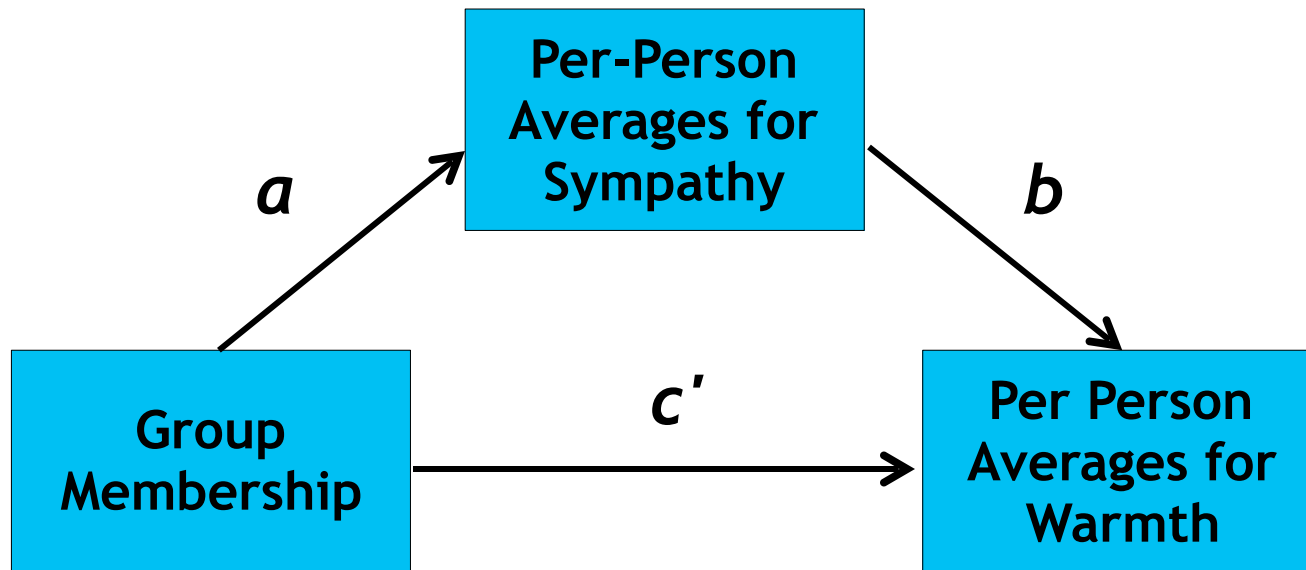
(Unbiased) Indirect effect = $a \times b$

(Unbiased) Total effect = Indirect effect + c'



An OK Way to Do Multilevel Mediation

USE AGGREGATE REPEATED MEASURES FOR EACH PARTICIPANT



(Unbiased) Indirect effect = $a \times b$

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How do we determine the robustness of our effects?

- There have been approaches put forward, but...



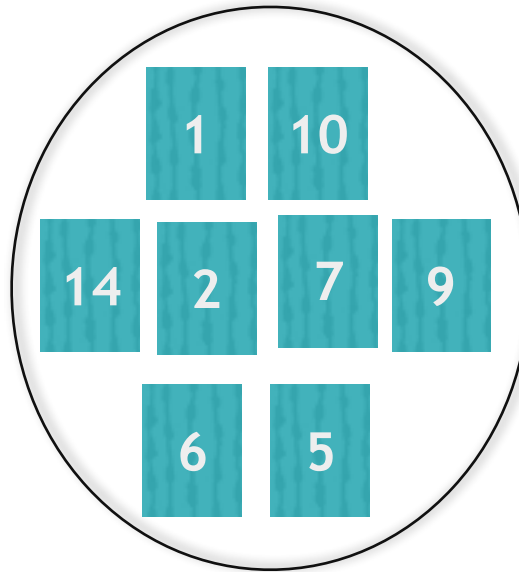
How do we determine the robustness of our effects?

- There have been approaches put forward, but...
- Bootstrapping is ideal because
 - It does not require the assumption that the random effects are normally distributed.
 - It is already ubiquitous in social psychology (especially in mediation analysis)



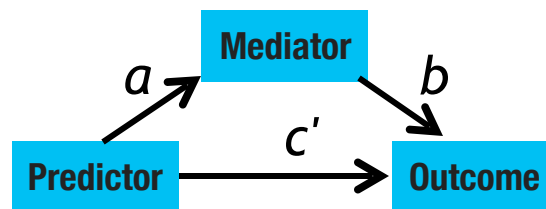
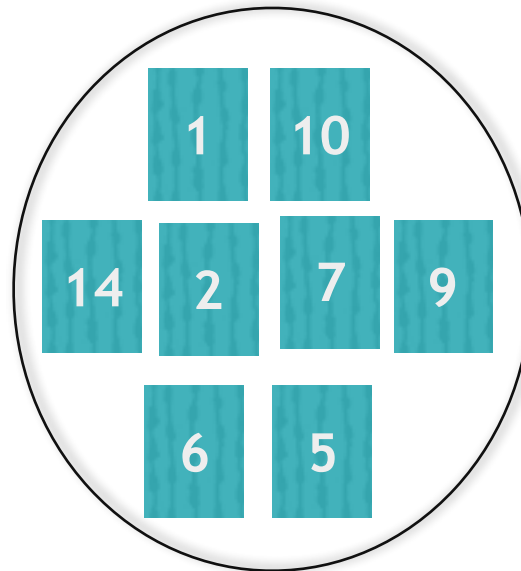
Bootstrapping for confidence intervals

Original Sample



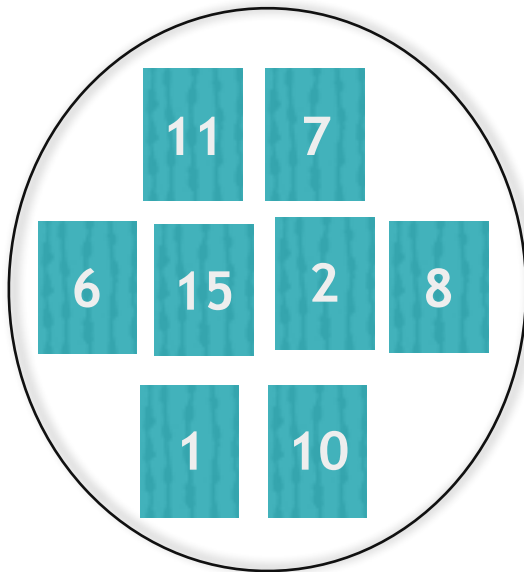
Bootstrapping for confidence intervals

Original Sample

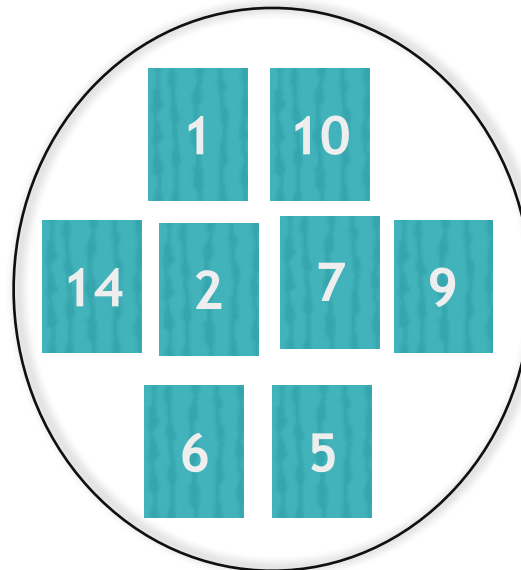


Bootstrapping for confidence intervals

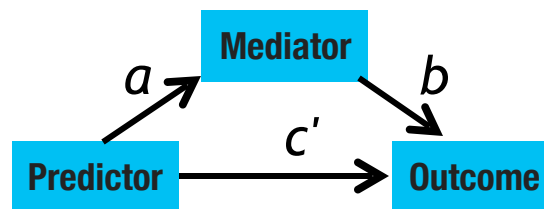
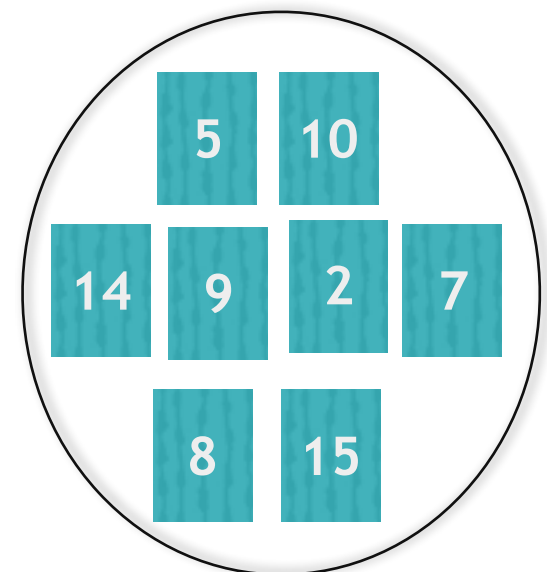
Resample 1



Original Sample

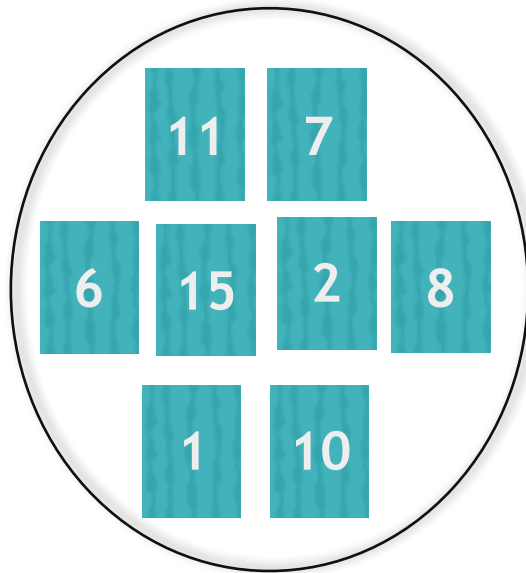


Resample 2

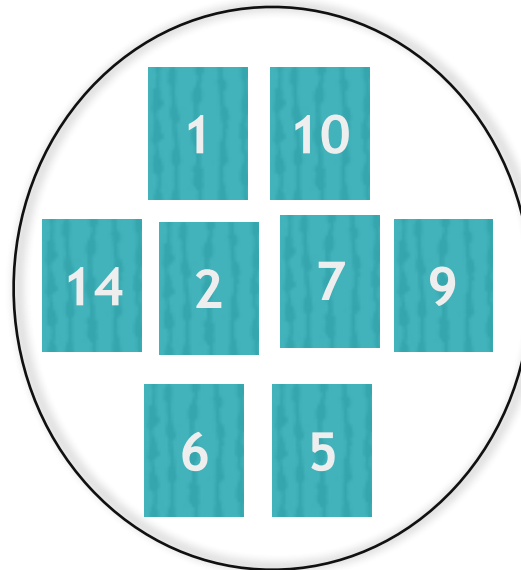


Bootstrapping for confidence intervals

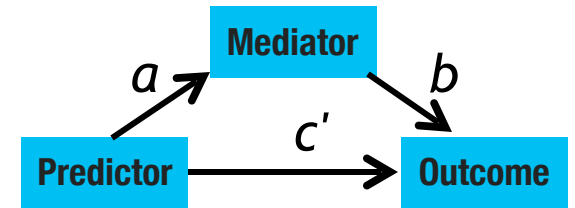
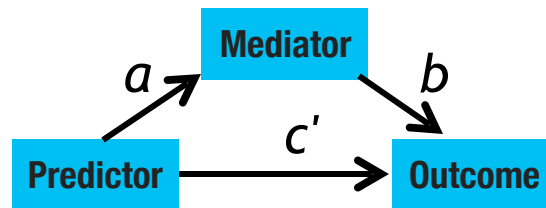
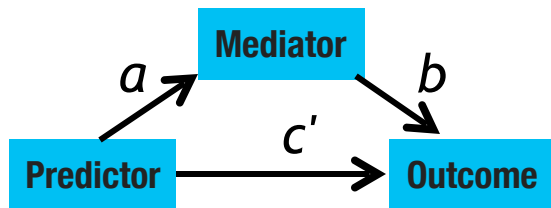
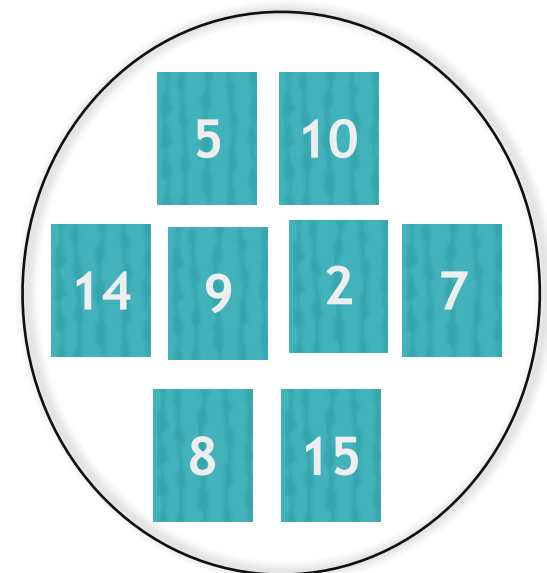
Resample 1



Original Sample



Resample 2



Goals of Current Demonstration

- Demonstrate how you can calculate unbiased indirect and total effects in multilevel mediation models.
- Demonstrate how you can use a bootstrapping approach to estimate confidence intervals for your effects.



Research Questions

- Will people rate their target in-group more warmly than target outgroups?
- Can this be explained by greater sympathy toward the target in-group (i.e., an indirect effect).



Method: Sample

- N = 340 (community members)
- 62% female, 38% male
- Age range: 16-75
- Ethnicity: 33% White, 28% East Asian, 28% South Asian, 5% Black, 3% Arab, 2% Latino



Method: Questionnaire

- Demographic information (e.g., ethnicity).
- Sympathy (0 = not at all sympathetic to 10 = very sympathetic) toward 7 target ethnic groups.
- Warmth (0 = cold to 10 = warm) toward 7 target ethnic groups.

Arabic

Black

East
Asian

First
Nation

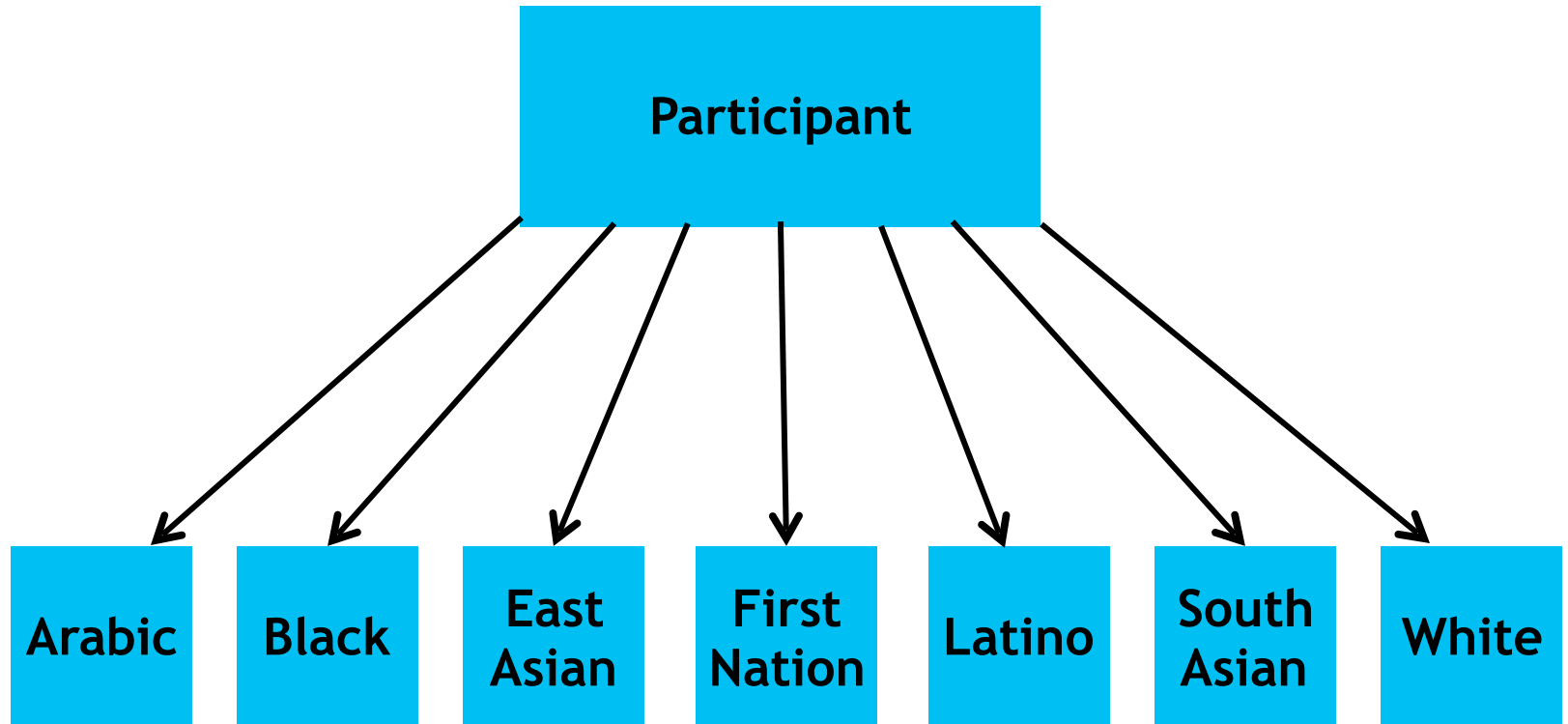
Latino

South
Asian

White



Analytic Approach



Bootstrap Analysis in R:

- Created a function “indirect.mlm”
 - Runs the relevant multilevel models in each resample
 - Multiplies together the random a and b slopes and takes
the mean of these products
- Use the “boot” package to do the multilevel mediation



Analytic Approach

Between-Person Effects:

- Indirect effect = $a \times b$
- Total effect = Indirect effect + c'

Within-Person Effects:

- Unbiased Indirect effect = $\text{Mean}(a_i \times b_i)$
- Unbiased Total effect = $\text{Mean}(\text{Indirect effect}_i + c')$



Analytic Approach

```
boot(data=data.set, R=1000,  
      strata=ID,  
      statistic=indirect.mlm,  
      y="warmth", x="target",  
      mediator="sympathy", group.id="ID")
```



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      between.m=T,  
      uncentered.x=F)
```



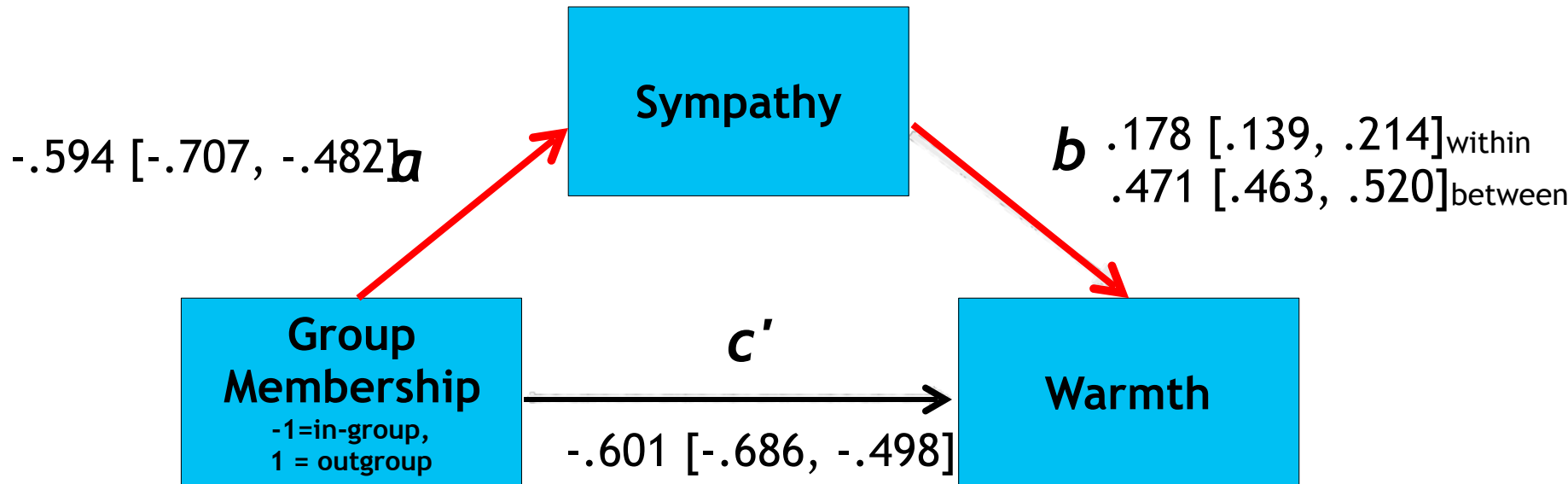
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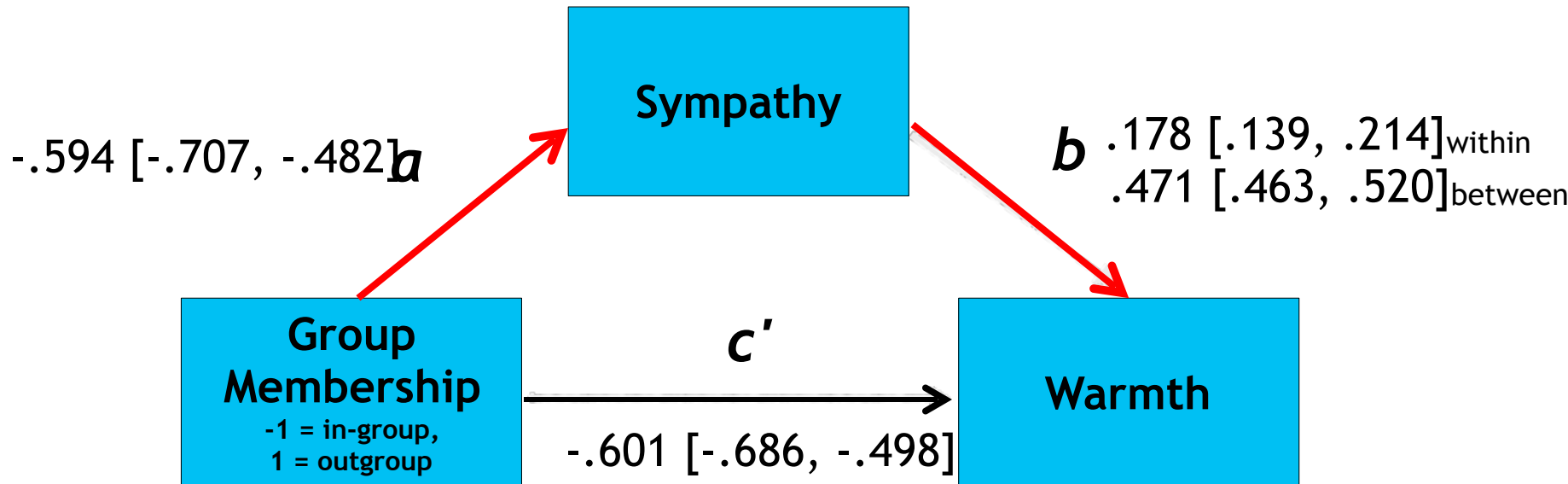
Results (unbiased)

ab_{within} $-.131$ $[-.180, -.103]$
 ab_{between} $-.280$ $[-.352, -.236]$



Results (biased)

$ab_{\text{within}} \text{ } -.106 \text{ } [-.138, -.176]$
 $ab_{\text{between}} \text{ } -.280 \text{ } [-.352, -.236]$



Total effect = $-.784 \text{ } [-.871, -.696]$



Results

Bias in indirect effect:

Biased: $ab_{\text{within}} = -.106 [-.138, -.076]$

Unbiased: $ab_{\text{within}} = -.131 [-.180, -.103]$

Difference = $.025 [.015, .058] = \sigma_{ab}$

Bauer et al. (2006)



Results

Bias in indirect effect:

Biased: $ab_{\text{within}} = -.106 [-.138, -.076]$

Unbiased: $ab_{\text{within}} = -.131 [-.180, -.103]$

Difference = $.025 [.015, .058] = \sigma_{ab}$

- Difference between biased and unbiased effects is equal to covariance between random slopes for paths a and b .

Bauer et al. (2006)



Results

Bias in total effect:

Biased: $c = -.784 [-.871, -.696]$

Unbiased: $c = -.733 [-.823, -.643]$

Difference = $-.052 [-.086, -.020]$

Bauer et al. (2006)



Results

Bias in total effect:

Biased: $c = -.784 [-.871, -.696]$

Unbiased: $c = -.733 [-.823, -.643]$

Difference = $-.052 [-.086, -.020]$

- Difference between biased and unbiased total effect is equal to

$$ab_{unbiased} - ab_{biased} + \sigma_{ab}$$

Bauer et al. (2006)



Discussion

- Download R script to run this analysis
 - www.page-gould.com/r/indirectmlm



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 - We are creating a web application for non-R users



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Take Home Message

- Proof of concept
 - You can bootstrap indirect effects in multilevel mediation analysis.

www.page-gould.com/r/indirectmlm



Thank you!

Co-author

Elizabeth Page-Gould



Awarded to Page-Gould:

- ▢ Lab and Research Assistants
- ▢ Social Psychophysiology and Quantitative Methods Lab (SPRQL)

▢ Funding Sources

▢ Awarded to Sharples:

▢ Ontario Graduate Scholarship

▢ Canada Research Chairs

▢ Canada Foundation for Innovation

▢ Connaught Fund New Researcher Award

▢ Ontario Ministry of Research & Innovation

▢ Social Sciences and Humanities Research Council (SSHRC)
Insight Grants



Questions directed to any speaker?

