

MODULE 8

MULTILEVEL MEDIATION

OUTLINE

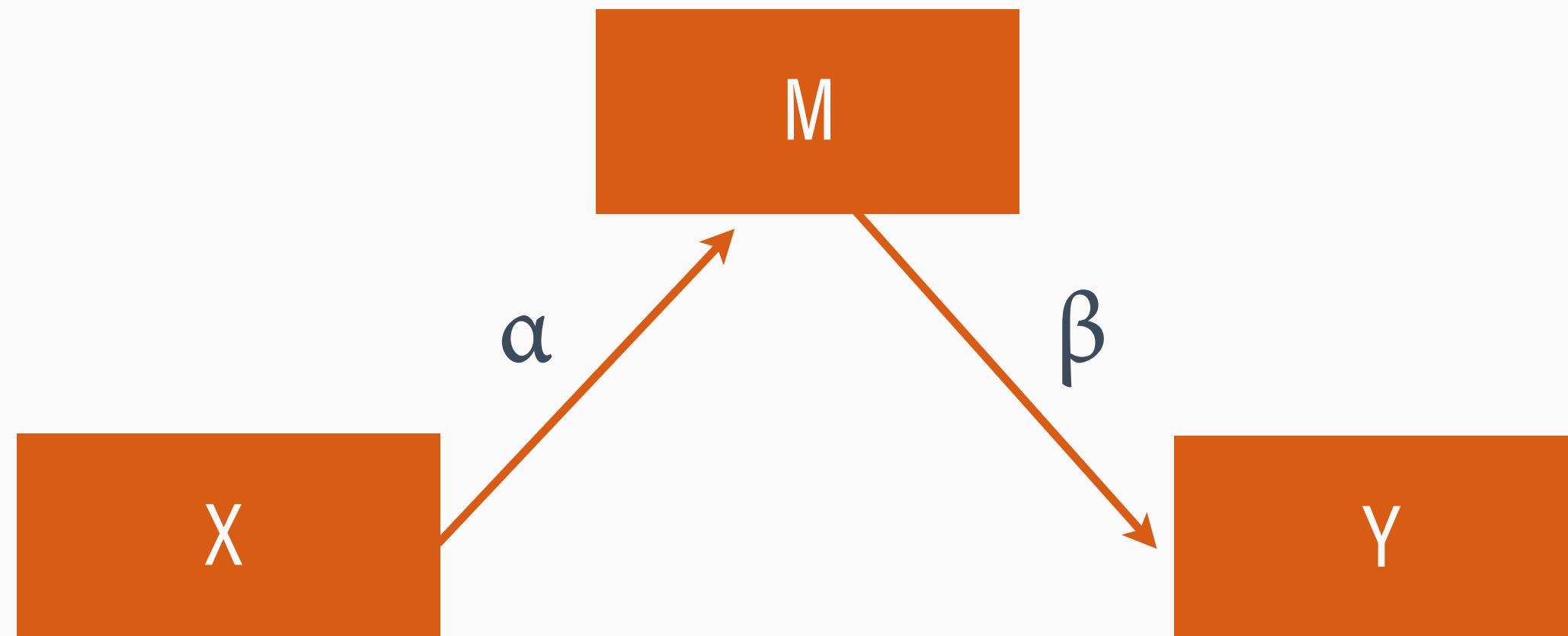
- 1 Mediation Overview
- 2 1-1-1 Model With Random Intercepts
- 3 1-1-1 Model With Random Slopes
- 4 Moderation on the α or β paths

MEDIATION

- A mediation analysis attempts to clarify the mechanism through which two variables are related
- A typical model features an explanatory variable affecting an intervening variable (the mediator) that, in turn, transmits the predictor's influence to the outcome

PATH DIAGRAMS

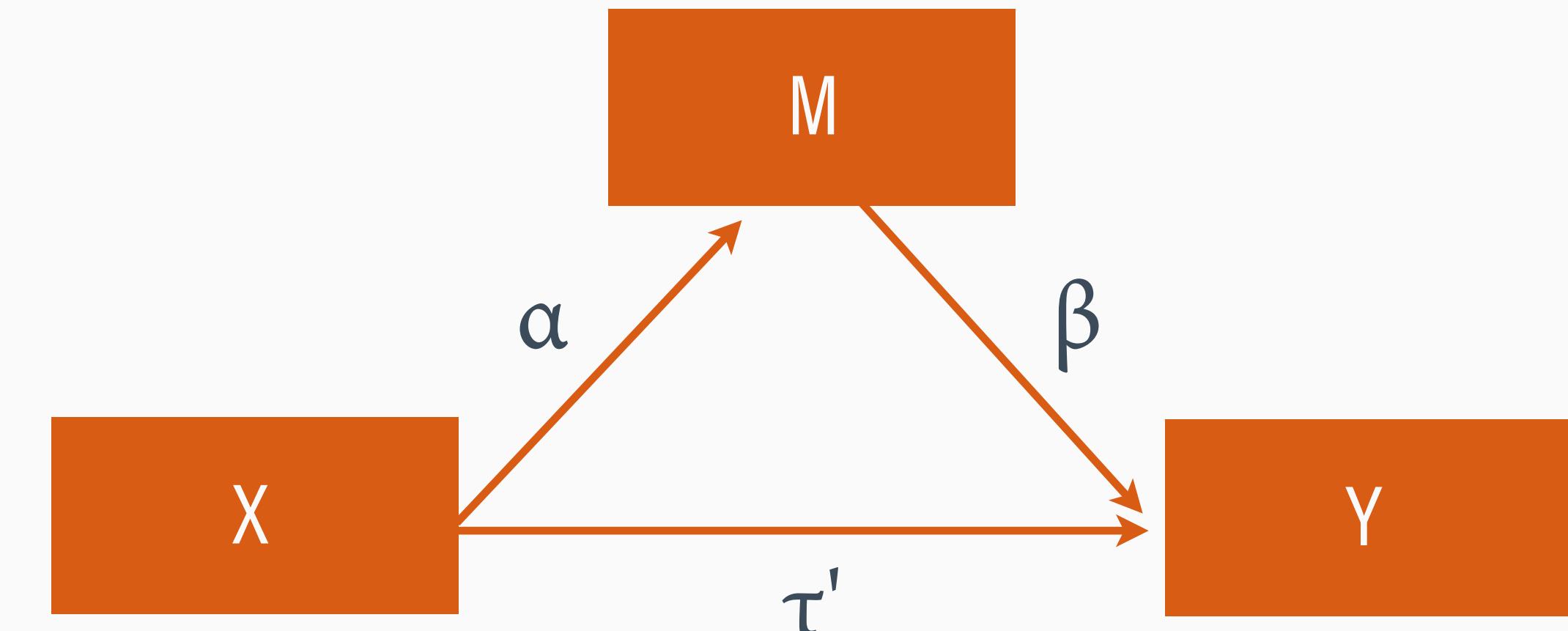
X-Y relation completely explained by indirect effect via M



$$M_i = I_M + \alpha(X_i) + \varepsilon_{Mi}$$

$$Y_i = I_Y + \beta(M_i) + \varepsilon_{Yi}$$

X-Y relation comprised of indirect and direct effect

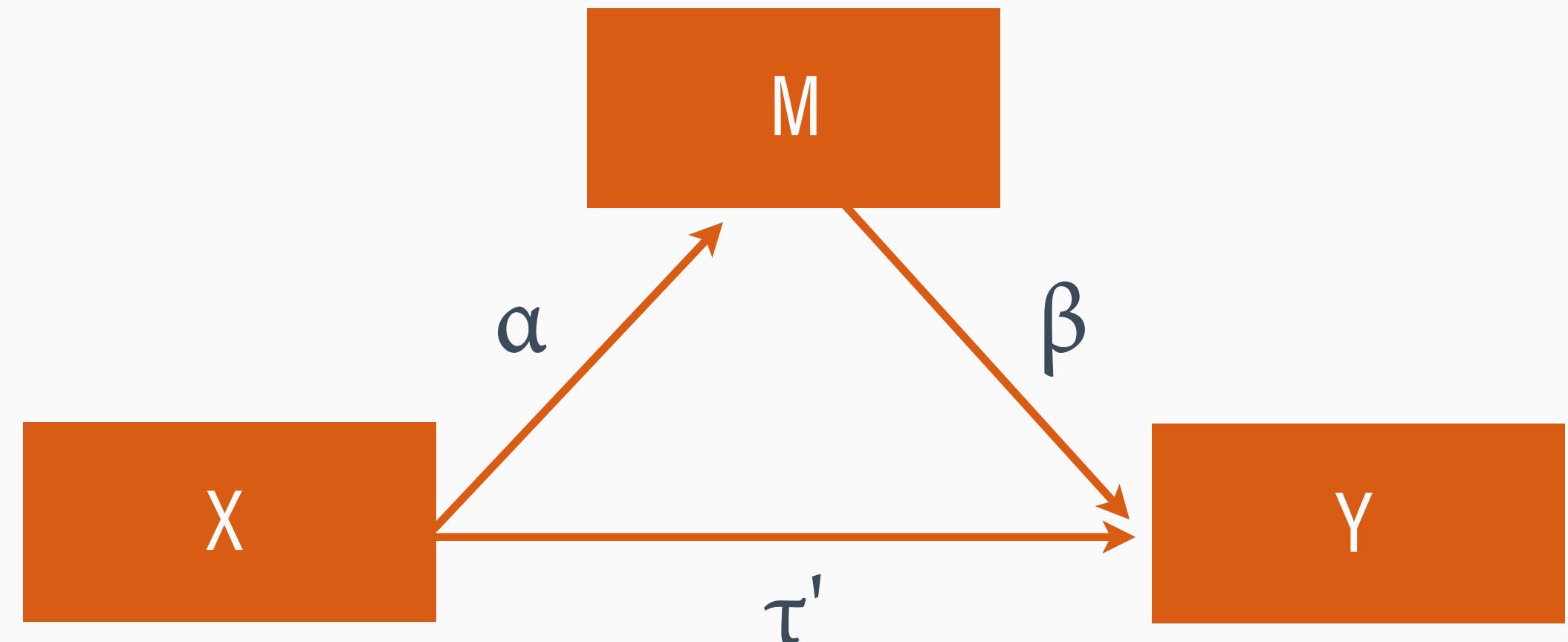


$$M_i = I_M + \alpha(X_i) + \varepsilon_{Mi}$$

$$Y_i = I_Y + \beta(M_i) + \tau'(X_i) + \varepsilon_{Yi}$$

PRODUCT OF COEFFICIENTS ESTIMATOR

- Multiplying the α and β slopes (i.e., the indirect pathways) defines the so-called product of coefficients estimator
- The $\alpha\beta$ product quantifies the influence of X on Y via the mediator M
- The total $X-Y$ association is $\alpha\beta + \tau'$



MEDIATION INFERENCE

- Mediation inference is challenging because the sampling distribution of $\alpha\beta$ can be quite nonnormal
- Using familiar test statistics to get a p-value can lead to incorrect conclusions about the mediated effect
- Bootstrap confidence intervals or MCMC are recommended because they can be asymmetric around the point estimate

MULTILEVEL MEDIATION

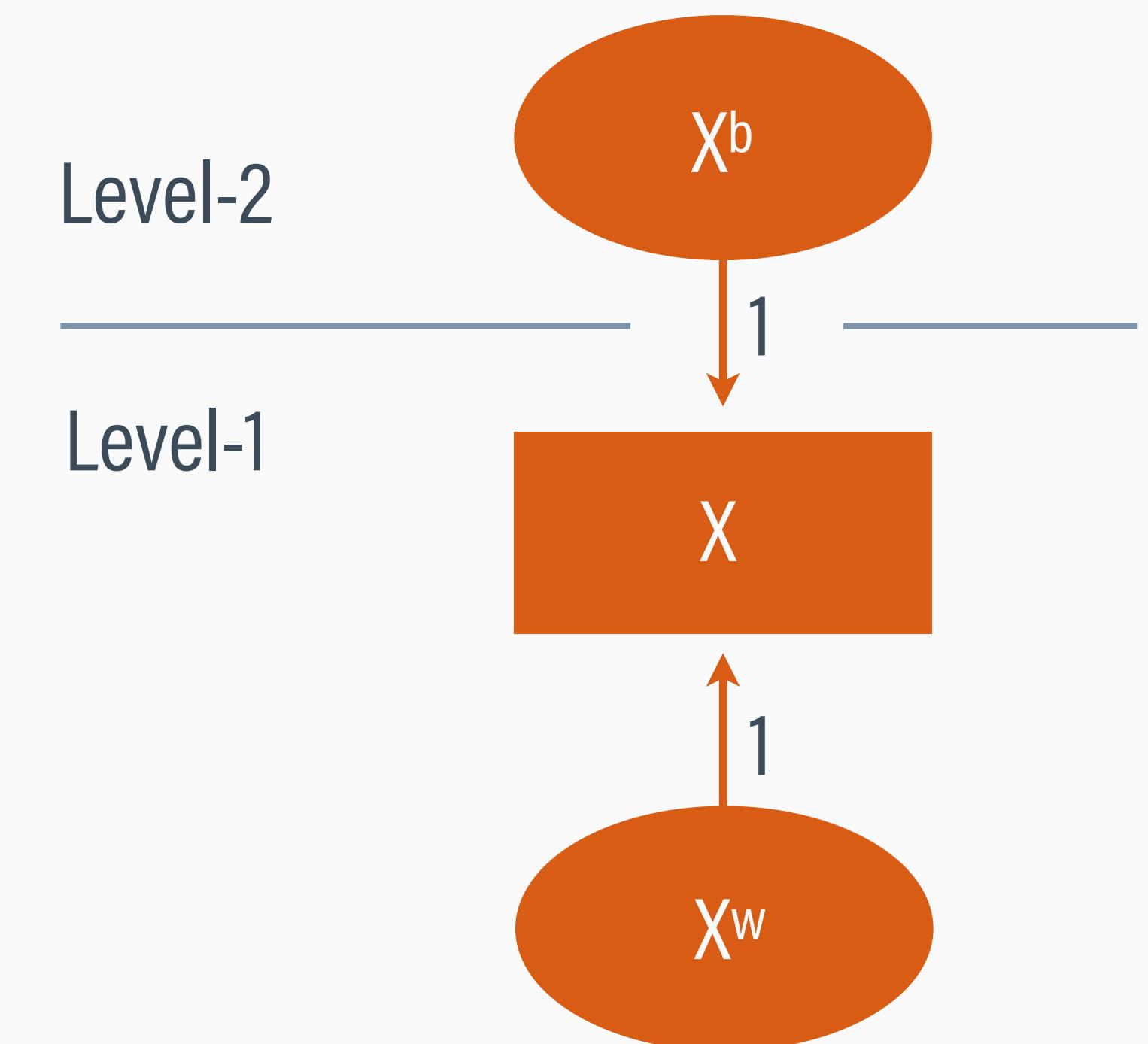
- Multilevel mediation incorporates associations at multiple levels of the data hierarchy
- Variables measured at level-1 have two sources of variation, and mediation can occur at the within and between levels
- Variables measured at level-2 have only level-2 associations

DISAGGREGATION PATH DIAGRAM

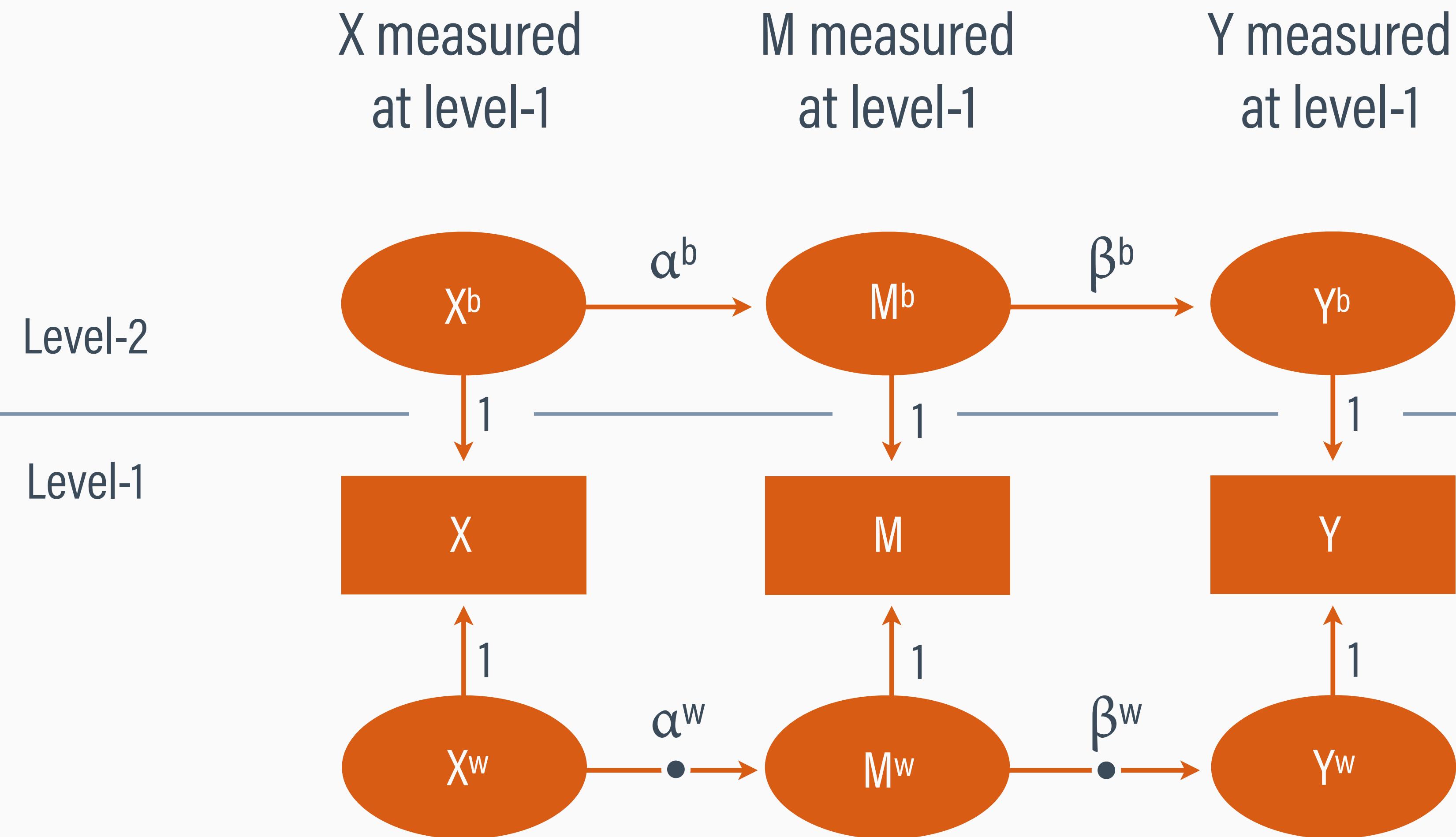
- A variable X is disaggregated into the sum of a cluster mean and within-cluster deviation

$$X_{ij} = X_j^b + X_{ij}^w = \text{cluster mean} + \text{within-cluster deviation}$$

- The rectangle represents the original variable, circles are the disaggregated components, and the 1s on the arrows convey that X^b and X^w contribute equally to X

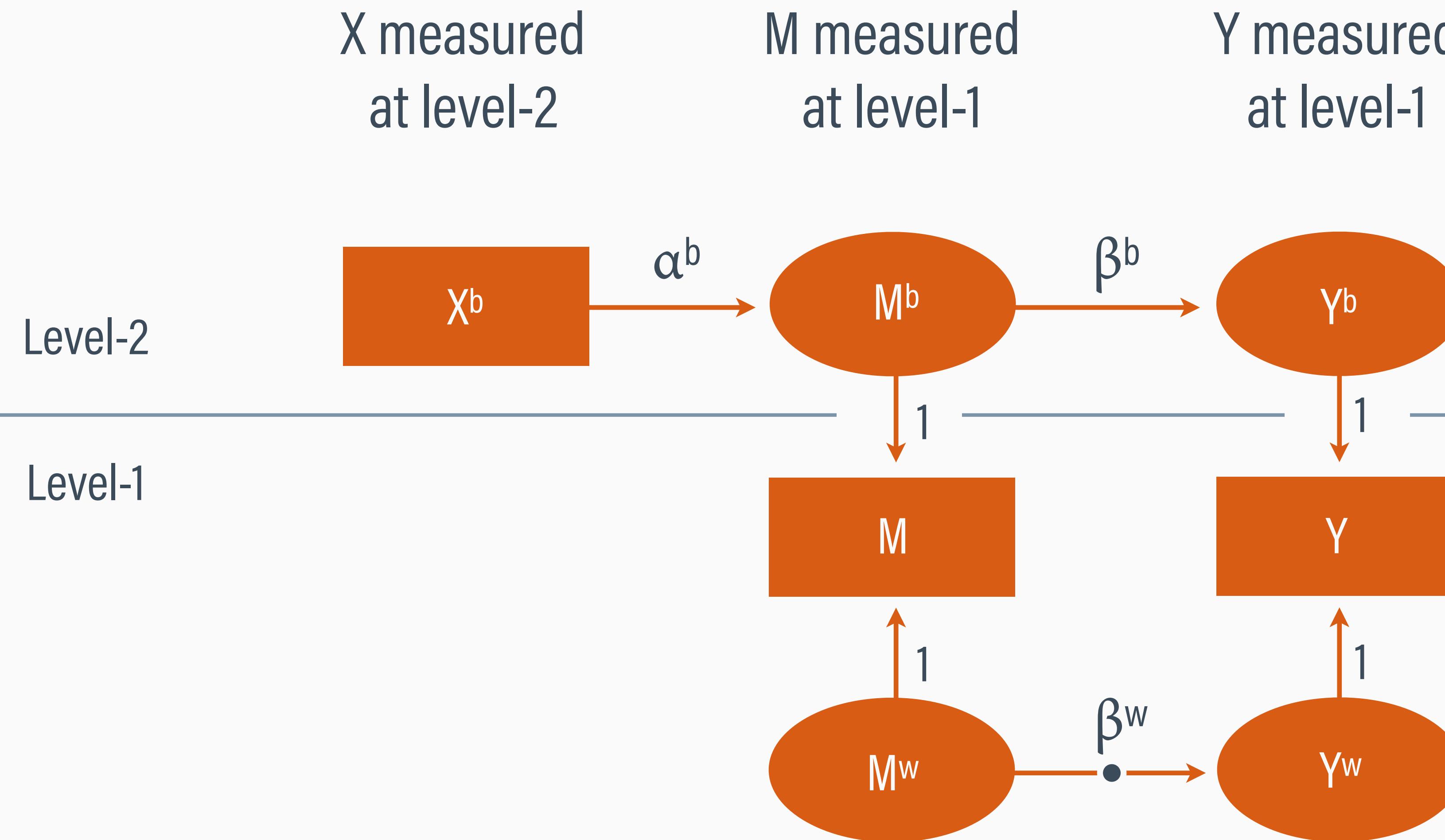


1-1-1 PATH DIAGRAM



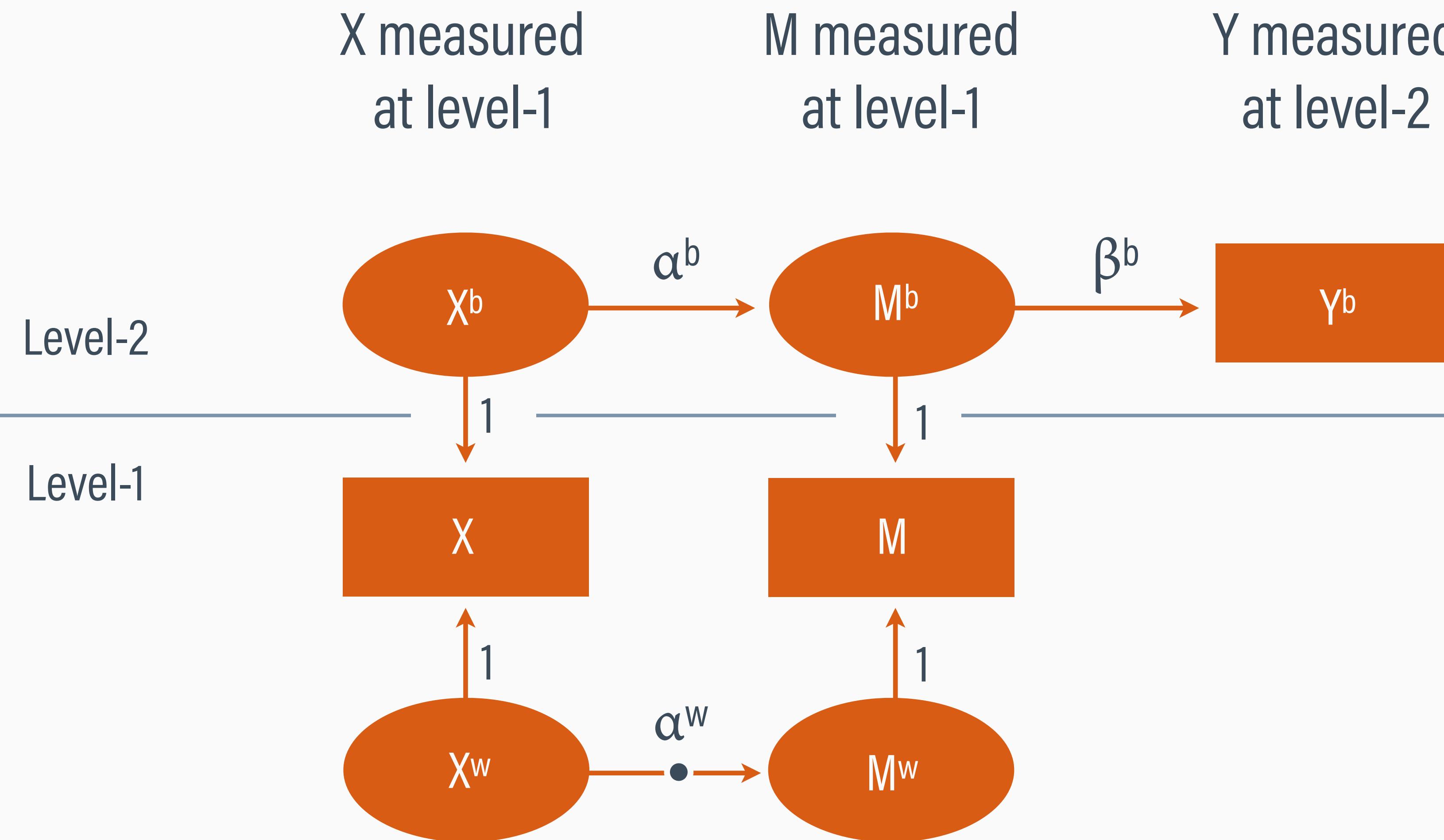
- level-1 slopes may or may not be random

2-1-1 PATH DIAGRAM



- level-1 slopes may or may not be random

1-1-2 PATH DIAGRAM



- level-1 slopes may or may not be random

MLM MEDIATION INFERENCE

- Bootstrapping is complex with multilevel data because there are multiple approaches to resampling
- Resample only level-2 units; resample level-2 units, then resample level-1 units within each chosen level-2 unit
- Bayesian MCMC estimation automatically provides appropriate asymmetric 95% limits

RANDOM SLOPE VARIATION

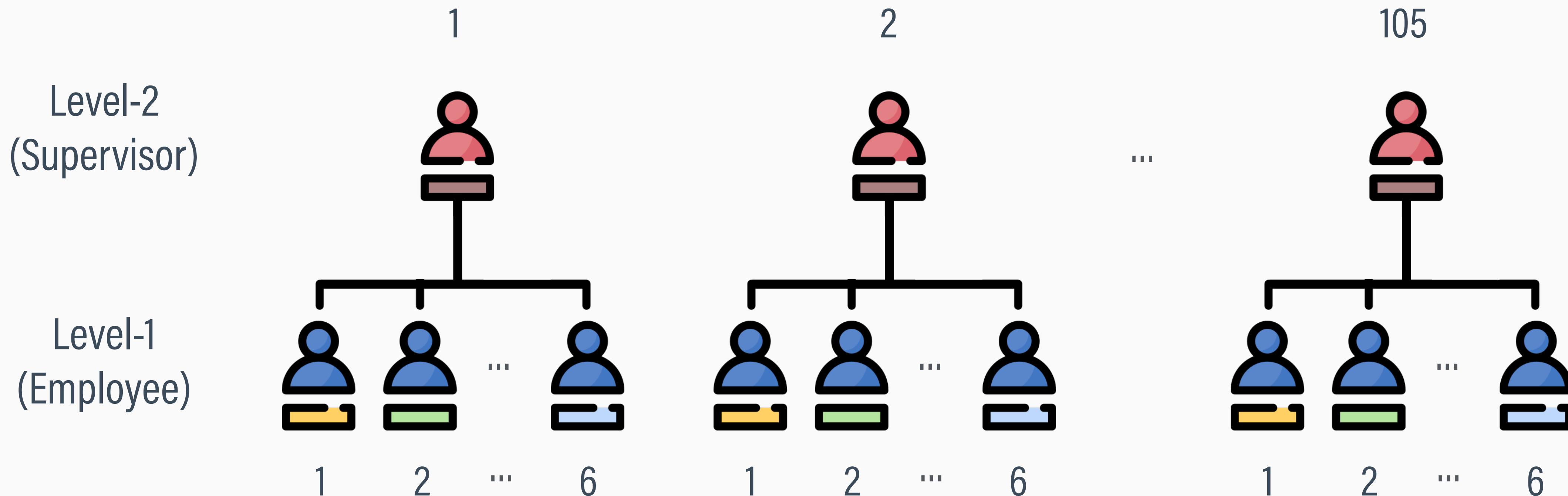
- Cluster-specific α and β paths (i.e., random slopes in the M and Y models) imply that $\alpha\beta$ can vary across level-2 units
- The product of coefficients estimator changes when both α and β have random slope variation
- We need to use multilevel structural equation modeling ...

OUTLINE

- 1 Mediation Overview
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ORGANIZATIONAL APPLICATION

- $n_j = 6$ employees at level-1 nested within $J = 105$ teams or workgroups at level-2 ($N = 630$ data records in total)



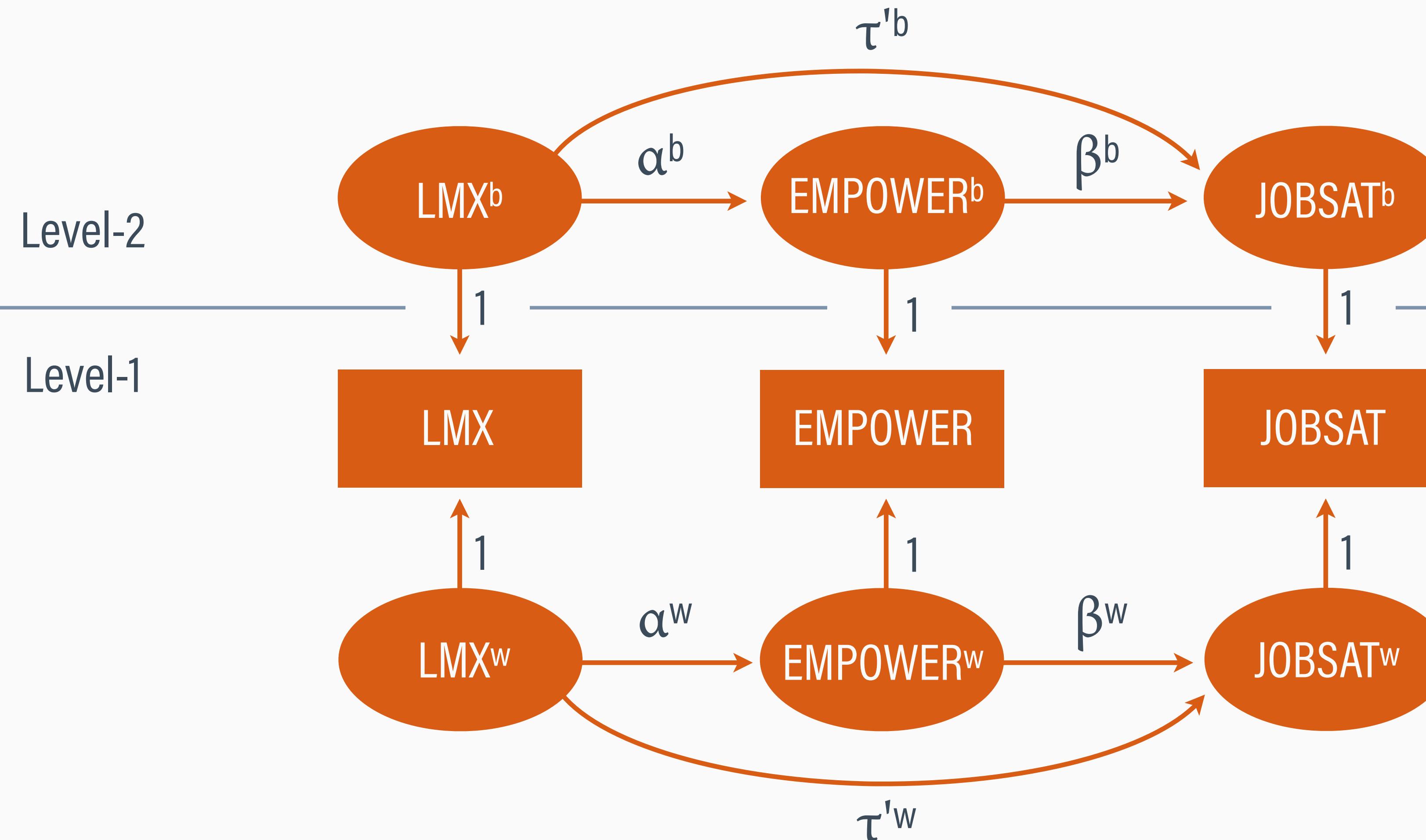
VARIABLE INFORMATION

- Predictor
- Mediator
- Outcome

Variable	Definition	Level	Scale
Team	Team-level (level-2) identifier	2	Integers (1 to 105)
LMX	Leader-member exchange (relationship quality)	1	Numeric (0 to 17)
Empower	Employee empowerment	1	Numeric (14 to 42)
Jobsat	Job satisfaction rating	1	Numeric (0 to 17)

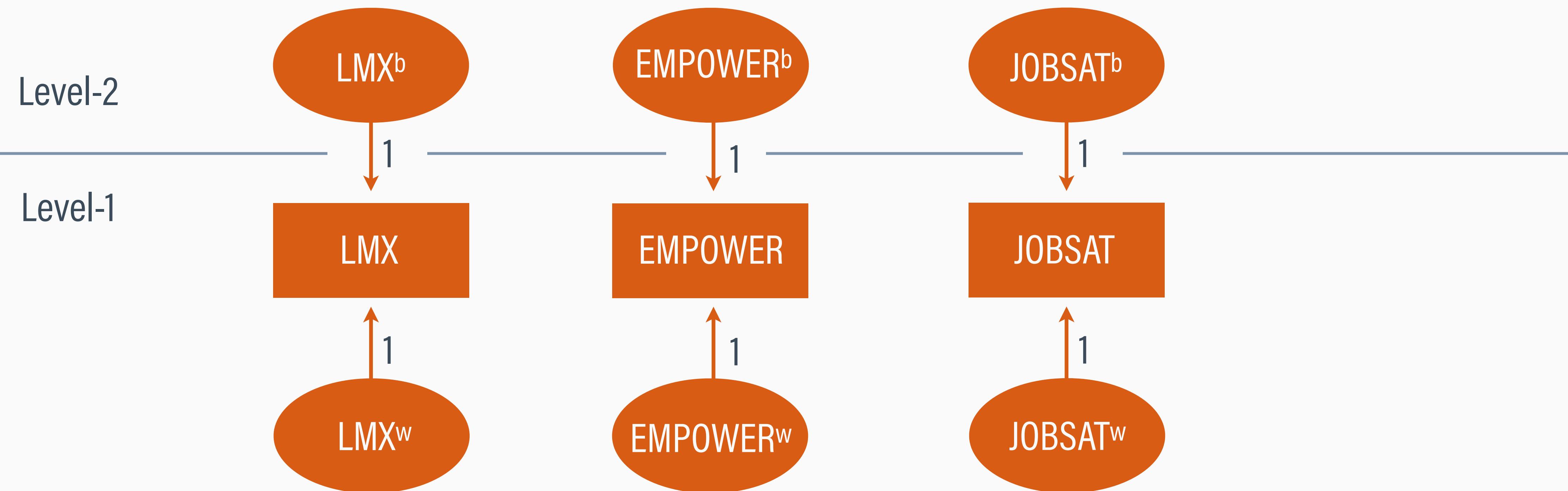
PATH DIAGRAM

- Within- and between-cluster mediation at level-1 and level-2



STARTING SIMPLE: EMPTY MODELS

- Disaggregated level-1 variables with no associations



WITHIN-CLUSTER (LEVEL-1) MODELS

- Each level-1 score is the sum of a level-2 cluster (team) average and a within-cluster residual

$$lmx_{ij} = lmx_j^b + \varepsilon_{ij}(lmx)$$

$$\text{empower}_{ij} = \text{empower}_j^b + \varepsilon_{ij}(\text{empower})$$

$$\text{jobsat}_{ij} = \text{jobsat}_j^b + \varepsilon_{ij}(\text{jobsat})$$

- The cluster means are level-2 latent variables (i.e., random intercepts or random effects) instead of arithmetic means

BLIMP SCRIPT 7.1 EXCERPT

$$lmx_{ij} = lmx_j^b + \varepsilon_{ij}(lmx)$$

$$empower_{ij} = empower_j^b + \varepsilon_{ij}(empower)$$

$$jobsat_{ij} = jobsat_j^b + \varepsilon_{ij}(jobsat)$$

CLUSTERID: Team;

LATENT: Team = LMX_b Empower_b JobSat_b; # define team-level latent variables

MODEL:

LMX ~ intercept@LMX_b; # set level-1 equation's intercept to the level-2 cluster mean

Empower ~ intercept@Empower_b;

JobSat ~ intercept@JobSat_b;

BETWEEN-CLUSTER (LEVEL-2) MODELS

- Each level-2 cluster mean is the sum of a grand mean and a level-2 residual

$$lmx_j^b = \beta_0(lmx) + u_{0j}(lmx)$$

$$empower_j^b = \beta_0(empower) + u_{0j}(empower)$$

$$jobsat_j^b = \beta_0(jobsat) + u_{0j}(jobsat)$$

- The cluster means are normally distributed level-2 latent variables (i.e., random intercepts or random effects)

BLIMP SCRIPT 7.1 EXCERPT

$$lmx_j^b = \beta_0(lmx) + u_{0j}(lmx)$$

$$empower_j^b = \beta_0(empower) + u_{0j}(empower)$$

$$jobsat_j^b = \beta_0(jobsat) + u_{0j}(jobsat)$$

CLUSTERID: Team;

LATENT: Team = LMX_b Empower_b JobSat_b; # define team-level latent variables

MODEL:

LMX_b ~ intercept; # empty level-2 equations

Empower_b ~ intercept;

JobSat_b ~ intercept;

LMX ~ intercept@LMX_b; # set level-1 equation's intercept to the level-2 cluster mean

Empower ~ intercept@Empower_b;

JobSat ~ intercept@JobSat_b;

OUTPUT HOUSEKEEPING

CLUSTERID: Team;

LATENT: Team = LMX_b Empower_b JobSat_b; # define team-level latent variables

MODEL:

level2: # arbitrary label that groups summary tables for a set of models

LMX_b ~ intercept;

Empower_b ~ intercept;

JobSat_b ~ intercept;

level1: # arbitrary label that groups summary tables for a set of models

LMX ~ intercept@LMX_b;

Empower ~ intercept@Empower_b;

JobSat ~ intercept@JobSat_b;

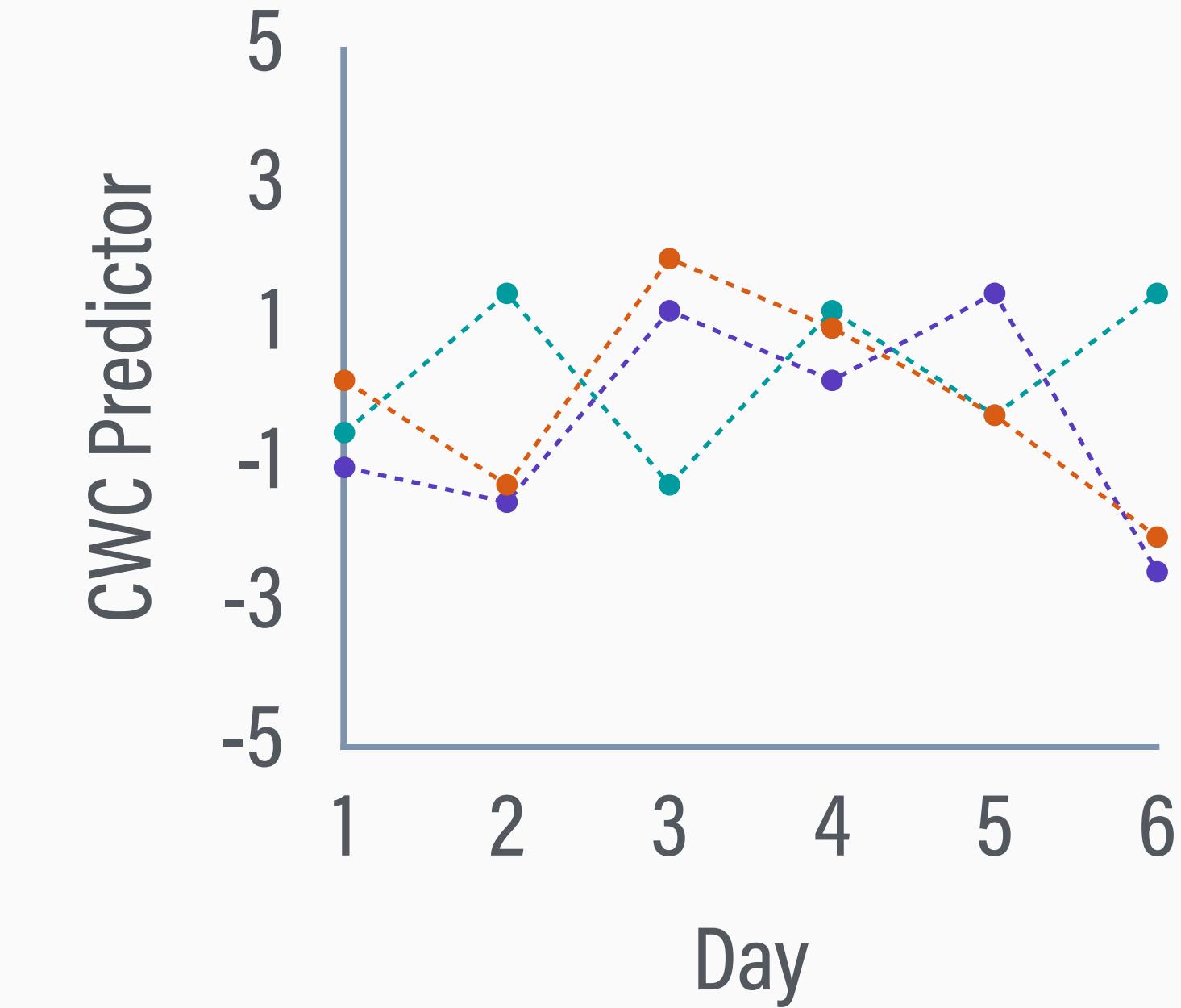
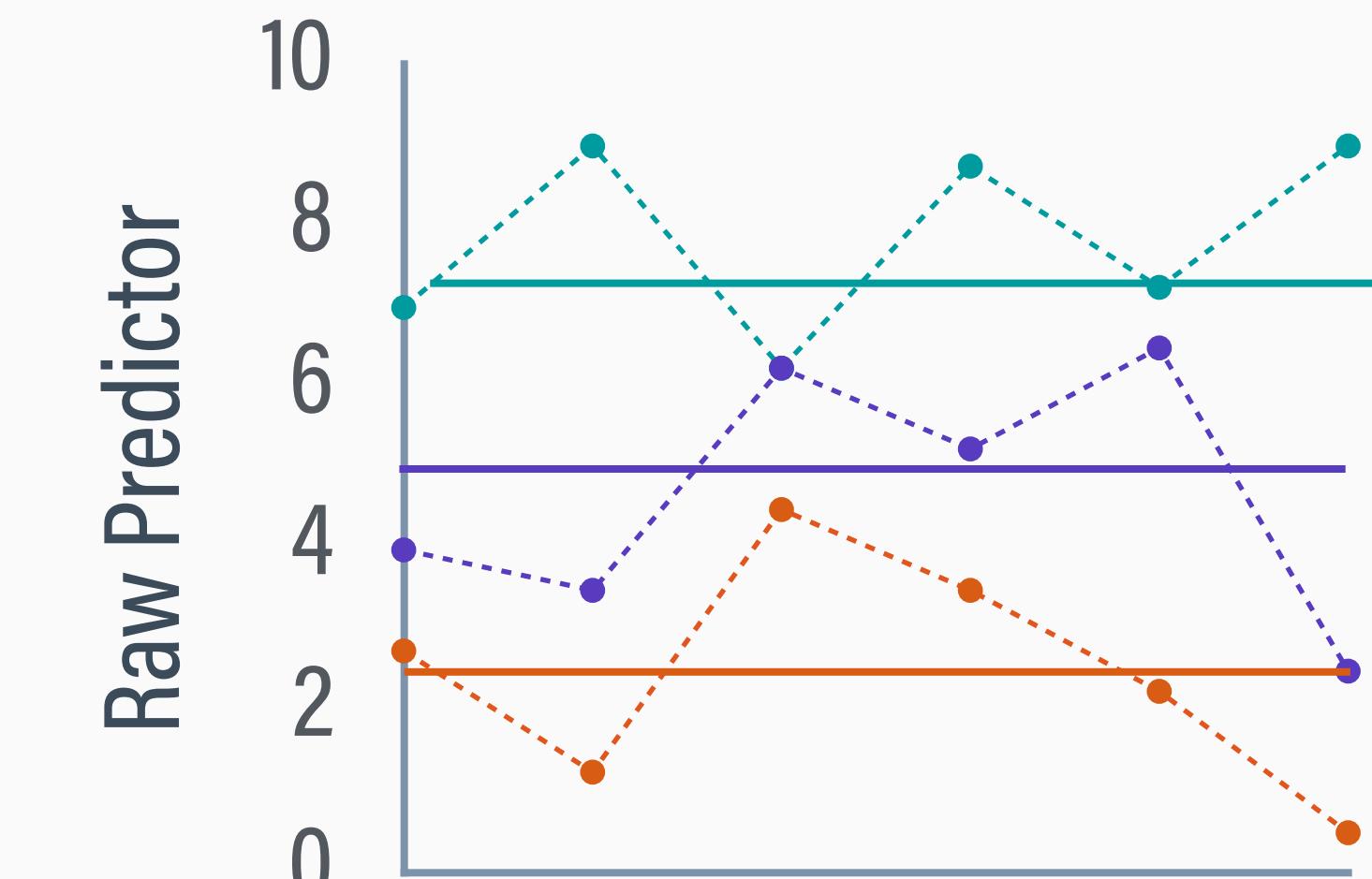
CENTERING LEVEL-1 PREDICTORS

- Pure within-cluster predictors are created by deviating (centering) each person's score at its level-2 team mean

$$lmx_{ij}^w = lmx_{ij} - lmx_j^b$$

$$\text{empower}_{ij}^w = \text{empower}_{ij} - \text{empower}_j^b$$

- The resulting deviation scores contain only within-team (level-1) variation



BLIMP SCRIPT 7.1 EXCERPT

$$lmx_{ij}^w = lmx_{ij} - lmx_j^b$$

$$empower_{ij}^w = empower_{ij} - empower_j^b$$

CLUSTERID: Team;

LATENT: Team = LMX_b Empower_b JobSat_b;

MODEL:

LMX_w = LMX - LMX_b; # text substitution alias to simplify the equations

Empower_w = Empower - Empower_b; # text substitution alias to simplify the equations

level2:

LMX_b ~ intercept;

Empower_b ~ intercept;

JobSat_b ~ intercept;

level1:

LMX ~ intercept@LMX_b;

Empower ~ intercept@Empower_b;

JobSat ~ intercept@JobSat_b;

WITHIN-CLUSTER MEDIATION MODELS

- Level-1 slopes represent “pure’ within-team associations

$$lmx_{ij} = lmx_j^b + \varepsilon_{ij}(lmx)$$

$$empower_{ij} = empower_j^b + \alpha^w(lmx_{ij}^w) + \varepsilon_{ij}(empower)$$

$$jobsat_{ij} = jobsat_j^b + \tau'^w(lmx_{ij}^w) + \beta^w(empower_{ij}^w) + \varepsilon_{ij}(jobsat)$$

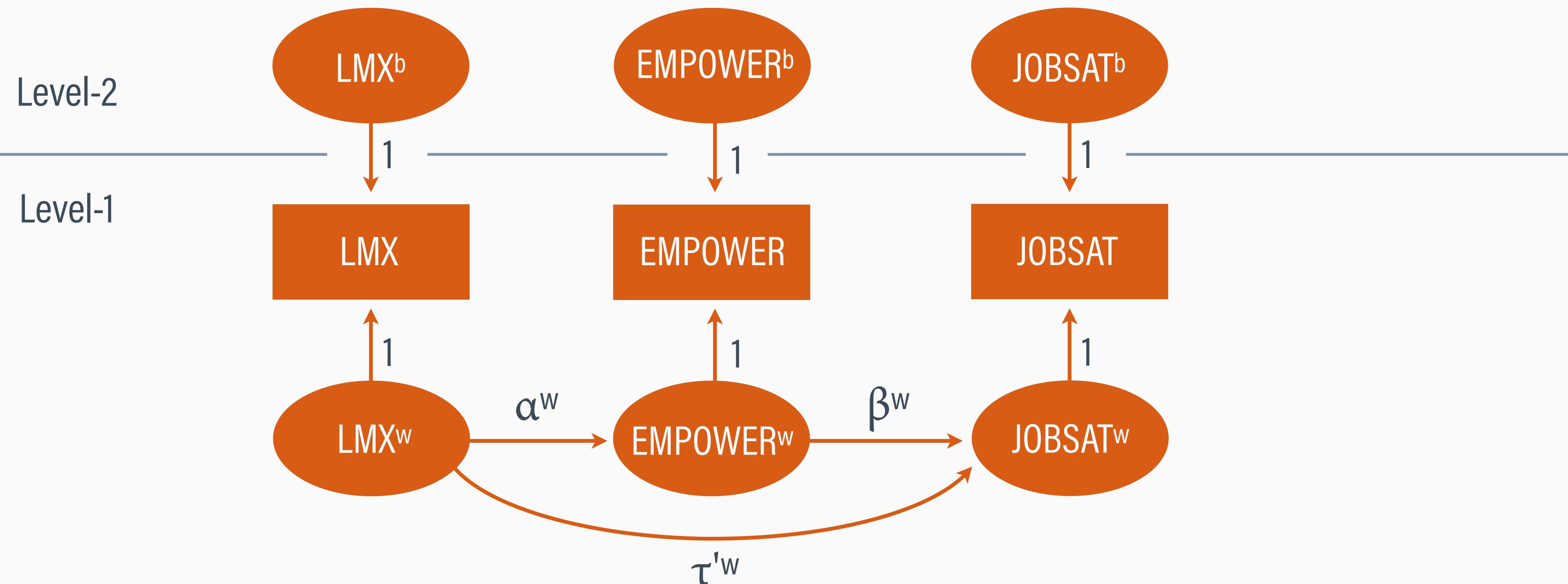
- The random intercepts (team averages) vary across teams

PATH DIAGRAM

$$lmx_{ij} = lmx_j^b + \varepsilon_{ij}(lmx)$$

$$\text{empower}_{ij} = \text{empower}_j^b + \alpha^w(lmx_{ij}^w) + \varepsilon_{ij}(\text{empower})$$

$$\text{jobsat}_{ij} = \text{jobsat}_j^b + \tau'^w(lmx_{ij}^w) + \beta^w(\text{empower}_{ij}^w) + \varepsilon_{ij}(\text{jobsat})$$



BLIMP SCRIPT 7.1 EXCERPT

CLUSTERID: Team;

LATENT: Team = LMX_b Empower_b JobSat_b;

MODEL:

LMX_w = LMX - LMX_b; # text substitution alias to simplify the equations

Empower_w = Empower - Empower_b; # text substitution alias to simplify the equations

level2:

...

level1:

LMX ~ intercept@LMX_b;

Empower ~ intercept@Empower_b LMX_w@apath_w; # @ labels the within-cluster slopes

JobSat ~ intercept@JobSat_b LMX_w@tpath_w Empower_w@bpath_w; # @ labels the within-cluster slopes

$$lmx_{ij} = lmx_j^b + \varepsilon_{ij}(lmx)$$

$$empower_{ij} = empower_j^b + \alpha^w(lmx_{ij}^w) + \varepsilon_{ij}(empower)$$

$$jobsat_{ij} = jobsat_j^b + \tau'^w(lmx_{ij}^w) + \beta^w(empower_{ij}^w) + \varepsilon_{ij}(jobsat)$$

BETWEEN-CLUSTER MEDIATION MODELS

- Level-1 slopes represent “pure’ within-team associations

$$lmx_j^b = \beta_0(lmx) + u_{0j}(lmx)$$

$$empower_j^b = \beta_0(empower) + \alpha^b(lmx_j^b) + u_{0j}(empower)$$

$$jobsat_j^b = \beta_0(jobsat) + \tau'^b(lmx_j^b) + \beta^b(empower_j^b) + u_{0j}(jobsat)$$

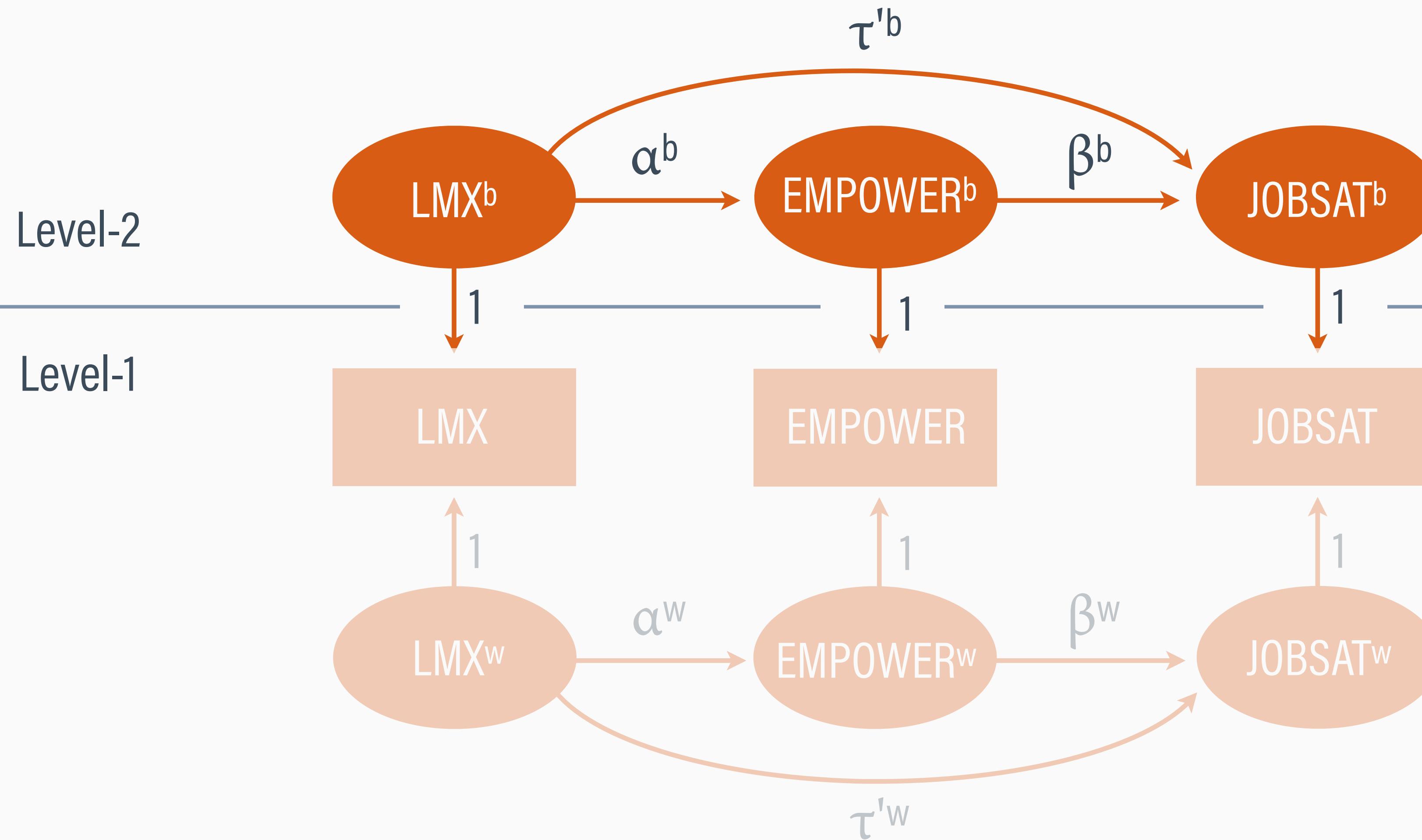
- The random intercepts (team averages) vary across teams

PATH DIAGRAM

$$lmx_j^b = \beta_0(lmx) + u_{0j}(lmx)$$

$$empower_j^b = \beta_0(empower) + \alpha^b(lmx_j^b) + u_{0j}(empower)$$

$$jobsat_j^b = \beta_0(jobsat) + \tau'^b(lmx_j^b) + \beta^b(empower_j^b) + u_{0j}(jobsat)$$



BLIMP SCRIPT 7.1 EXCERPT

CLUSTERID: Team;

LATENT: Team = LMX_b Empower_b JobSat_b;

MODEL:

...

level2:

LMX_b ~ intercept;

Empower_b ~ intercept LMX_b@apath_b; # @ labels the between-cluster slopes

JobSat_b ~ intercept LMX_b@tpath_b Empower_b@bpath_b; # @ labels the between-cluster slopes

level1:

...

$$lmx_j^b = \beta_0(lmx) + u_{0j}(lmx)$$

$$empower_j^b = \beta_0(empower) + \alpha^b(lmx_j^b) + u_{0j}(empower)$$

$$jobsat_j^b = \beta_0(jobsat) + \tau'^b(lmx_j^b) + \beta^b(empower_j^b) + u_{0j}(jobsat)$$

INDIRECT EFFECT ESTIMATES

- An indirect effect is the product of its component slopes

$$\text{Between-cluster indirect effect} = \alpha^b \times \beta^b$$

$$\text{Within-cluster indirect effect} = \alpha^w \times \beta^w$$

- The indirect effect is not an estimated parameter, but rather a deterministic function of two estimated slopes
- MCMC produces a distribution of the indirect effect

BLIMP SCRIPT 7.1 EXCERPT

MODEL:

```
LMX_w = LMX - LMX_b; # text substitution alias to simplify the equations  
Empower_w = Empower - Empower_b;  
level2: # arbitrary label that groups summary tables for a set of models  
LMX_b ~ intercept;  
Empower_b ~ intercept LMX_b@apath_b; # @ labels the between-cluster slopes  
JobSat_b ~ intercept LMX_b@tpath_b Empower_b@bpath_b;  
level1: # arbitrary label that groups summary tables for a set of models  
LMX ~ intercept@LMX_b;  
Empower ~ intercept@Empower_b LMX_w@apath_w; # @ labels the within-cluster slopes  
JobSat ~ intercept@JobSat_b LMX_w@tpath_w Empower_w@bpath_w;
```

PARAMETERS:

```
ab_w = apath_w * bpath_w; # use slope labels to define the indirect effect estimates  
ab_b = apath_b * bpath_b;
```

RBLIMP SCRIPT 7 (MODEL 1) EXCERPT

```
model1 <- rblimp(...  
  latent = 'Team = LMX_b Empower_b JobSat_b',  
  model = '  
    LMX_w = LMX - LMX_b; # text substitution alias to simplify the equations  
    Empower_w = Empower - Empower_b;  
    level2: # arbitrary label that groups summary tables for a set of models  
    LMX_b ~ intercept;  
    Empower_b ~ intercept LMX_b@apath_b; # @ labels the between-cluster slopes  
    JobSat_b ~ intercept LMX_b@tpath_b Empower_b@bpath_b;  
    level1: # arbitrary label that groups summary tables for a set of models  
    LMX ~ intercept@LMX_b;  
    Empower ~ intercept@Empower_b LMX_w@apath_w; # @ labels the within-cluster slopes  
    JobSat ~ intercept@JobSat_b LMX_w@tpath_w Empower_w@bpath_w;',  
  parameters = '  
    ab_w = apath_w * bpath_w; # use slope labels to define the indirect effect estimates  
    ab_b = apath_b * bpath_b; ...)  
output(model1)  
plot_posterior(model1, 'ab_w') # plot distribution of indirect effect parameter  
plot_posterior(model1, 'ab_b')
```

WITHIN-CLUSTER α^w PATH

 = level-2 estimate
 = level-1 estimate

Outcome Variable: Empower

Parameters	Estimate	StdDev	2.5%	97.5%	ChiSq	PValue	N_Eff
<hr/>							
Variances:							
Residual Var.	14.436	0.899	12.820	16.320	---	---	6508.903
<hr/>							
Coefficients:							
Empower_b	@ 1.000	---	---	---	---	---	---
LMX_w	0.687	0.059	0.570	0.801	135.816	0.000	5674.431
<hr/>							
Standardized Coefficients:							
LMX_w	0.453	0.033	0.385	0.515	186.307	0.000	4602.107
<hr/>							
Proportion Variance Explained							
by Coefficients	0.205	0.030	0.148	0.265	---	---	4523.272
by Residual Variation	0.795	0.030	0.735	0.852	---	---	4523.272

WITHIN-CLUSTER β^w AND τ'^w PATHS

 = level-2 estimate
 = level-1 estimate

Outcome Variable: JobSat

Parameters	Estimate	StdDev	2.5%	97.5%	ChiSq	PValue	N_Eff
<hr/>							
Variances:							
Residual Var.	1.173	0.071	1.043	1.322	---	---	6223.732
<hr/>							
Coefficients:							
JobSat_b	@ 1.000	---	---	---	---	---	---
LMX_w	0.161	0.019	0.124	0.198	72.366	0.000	8556.982
Empower_w	0.019	0.012	-0.005	0.044	2.486	0.115	8322.604
<hr/>							
Standardized Coefficients:							
LMX_w	0.380	0.041	0.297	0.458	84.752	0.000	8271.061
Empower_w	0.069	0.044	-0.016	0.155	2.502	0.114	8480.419
<hr/>							
Proportion Variance Explained							
by Coefficients	0.175	0.029	0.120	0.233	---	---	5032.537
by Residual Variation	0.825	0.029	0.767	0.880	---	---	5032.537

INTERPRETATIONS

- $\alpha^w = 0.69$ is the expected empowerment difference between two people *from the same team* with LMX scores that differ by one point
- $\beta^w = 0.02$ is the expected job satisfaction difference between two people from the same team with empowerment scores that differ by one point, holding constant LMX at any value

BETWEEN-CLUSTER α^b PATH

█ = level-2 estimate
█ = level-1 estimate

Latent Variable: Empower_b

Parameters	Estimate	StdDev	2.5%	97.5%	ChiSq	PValue	N_Eff
<hr/>							
Variances:							
Residual Var.	2.400	0.832	1.018	4.255	---	---	542.191
Coefficients:							
Intercept	29.167	3.379	23.373	36.720	75.607	0.000	522.201
LMX_b	-0.057	0.351	-0.846	0.546	0.053	0.817	520.579
Standardized Coefficients:							
LMX_b	-0.040	0.226	-0.520	0.353	0.056	0.813	477.866
Proportion Variance Explained							
by Coefficients	0.024	0.077	0.000	0.273	---	---	498.597
by Residual Variation	0.976	0.077	0.727	1.000	---	---	498.597

BETWEEN-CLUSTER β^b AND τ'^b PATHS

 = level-2 estimate
 = level-1 estimate

Latent Variable: JobSat_b

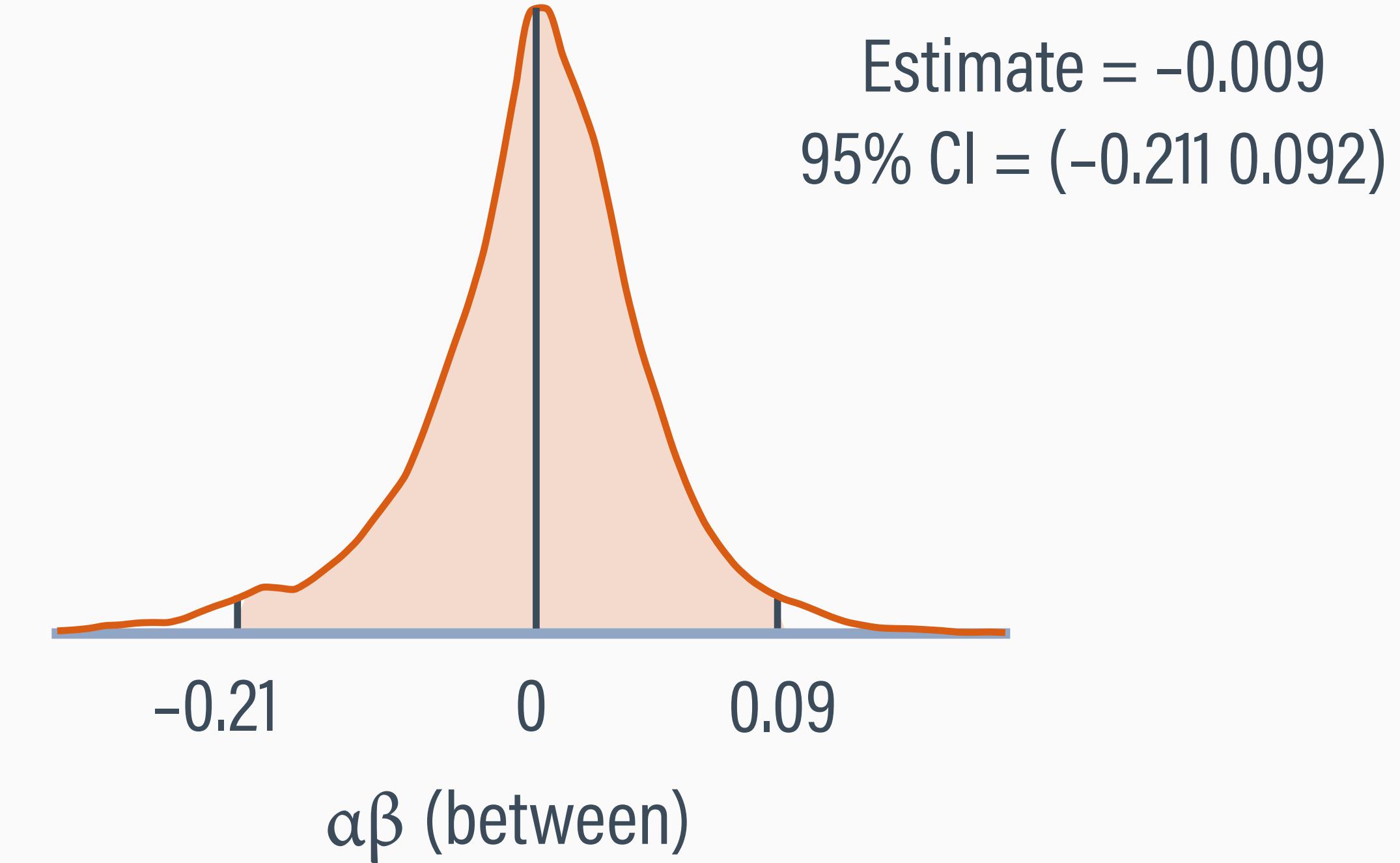
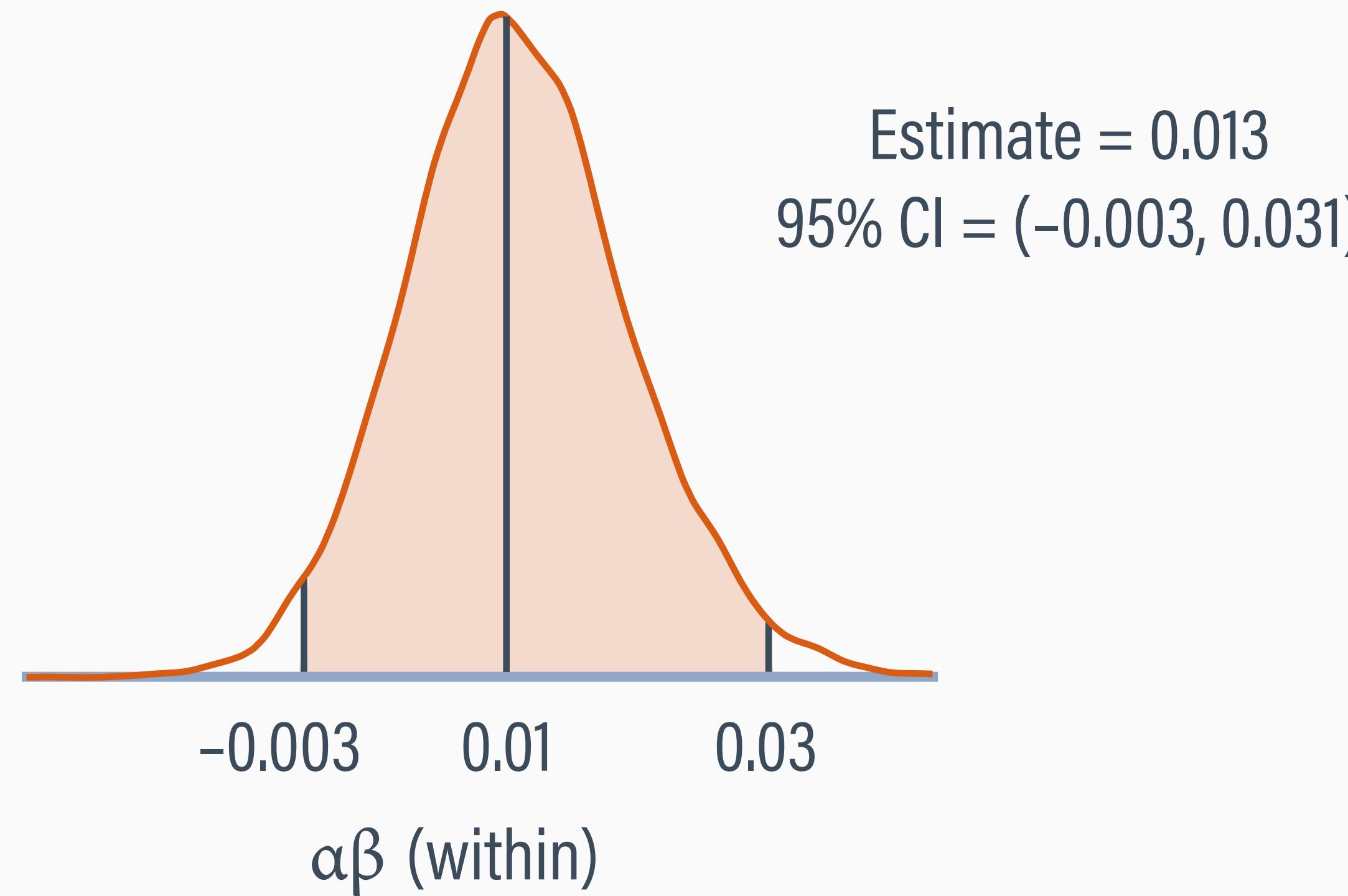
Parameters	Estimate	StdDev	2.5%	97.5%	ChiSq	PValue	N_Eff
<hr/>							
Variances:							
Residual Var.	0.059	0.044	0.003	0.168	---	---	239.018
<hr/>							
Coefficients:							
Intercept	-2.992	2.347	-9.284	0.381	2.021	0.155	196.419
LMX_b	0.205	0.091	0.053	0.414	5.423	0.020	345.646
Empower_b	0.178	0.066	0.078	0.344	7.973	0.005	195.484
<hr/>							
Standardized Coefficients:							
LMX_b	0.514	0.184	0.145	0.878	7.743	0.005	414.852
Empower_b	0.649	0.165	0.293	0.949	15.207	0.000	230.355
<hr/>							
Proportion Variance Explained							
by Coefficients	0.669	0.200	0.243	0.984	---	---	186.171
by Residual Variation	0.331	0.200	0.016	0.757	---	---	186.171

INTERPRETATIONS

- $\alpha^b = 0.06$ is the expected empowerment mean difference between two teams with average LMX values that differ by one point, controlling for team-average LMX
- $\beta^b = 0.18$ is the expected job satisfaction mean difference between two teams with average empowerment values that differ by one point, controlling for team-average LMX

DISTRIBUTIONS OF INDIRECT EFFECTS

- Indirect effects are computed at each MCMC iteration, producing a distribution of plausible mediated effects at each level



INDIRECT EFFECTS OUTPUT

□ = level-2 estimate

■ = level-1 estimate

GENERATED PARAMETERS:

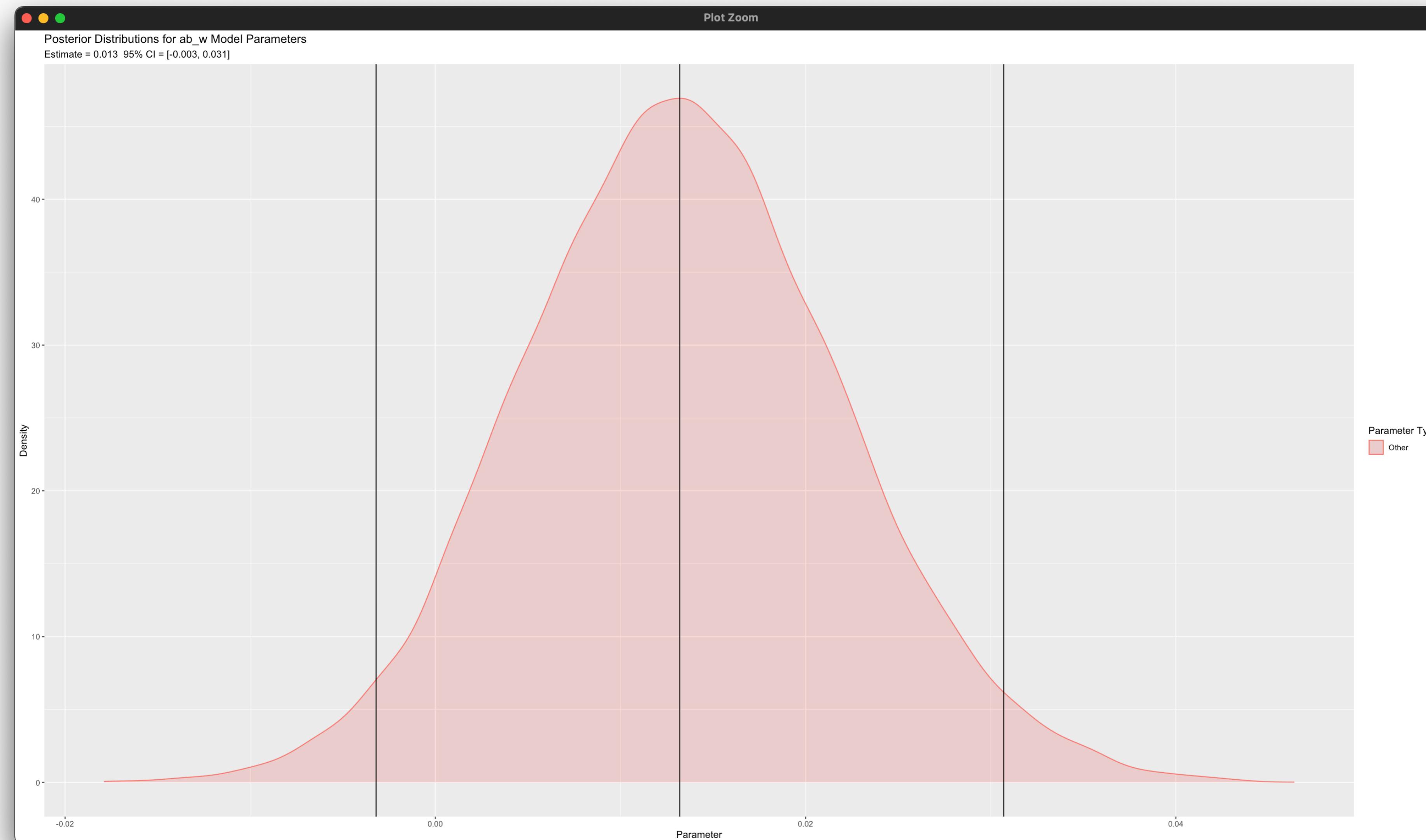
Standard test statistics are inappropriate
for evaluating mediated effects!

Summaries based on 20000 iterations using 2 chains.

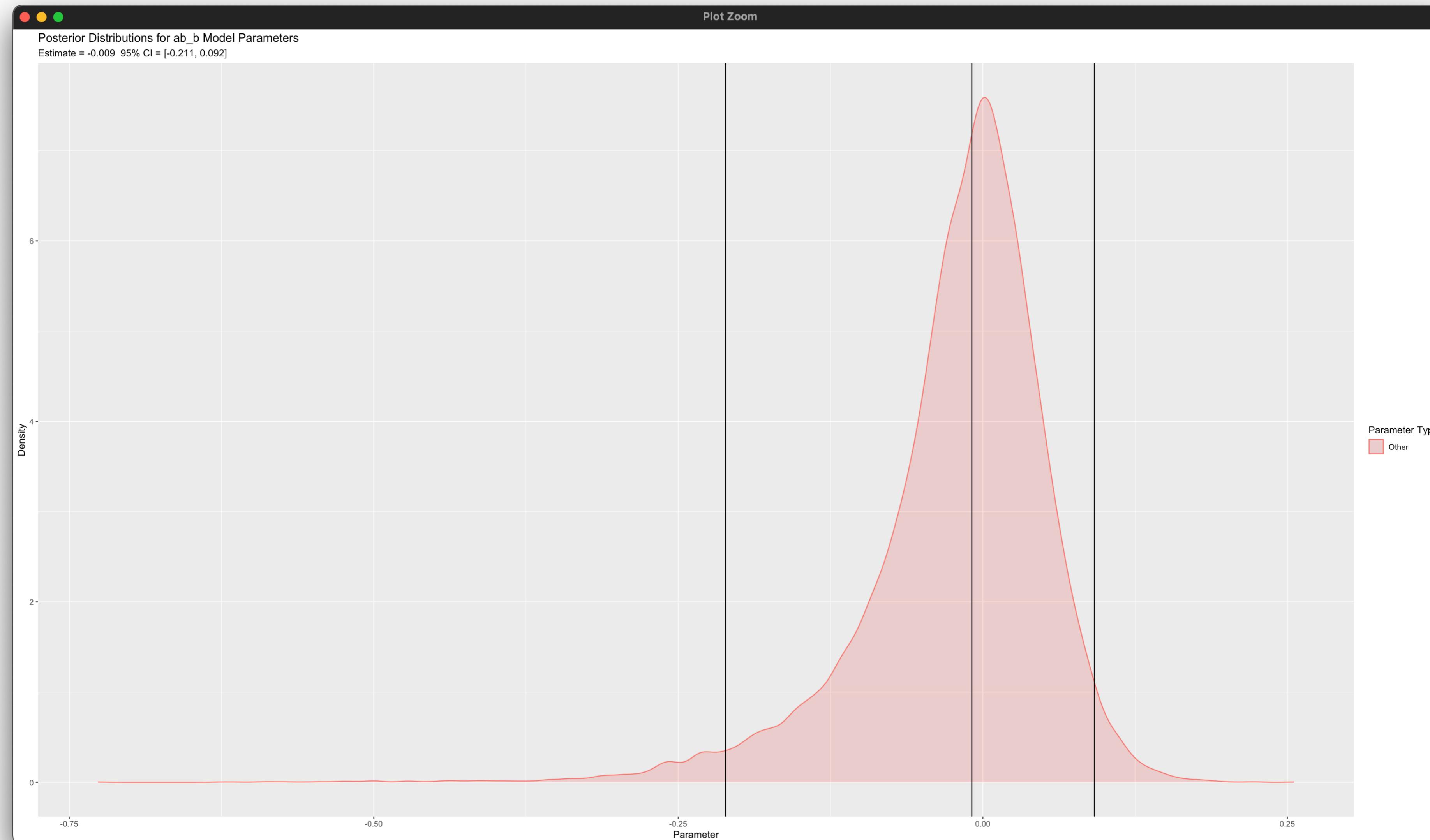
NOTE: Estimate column based on posterior median.

Parameters	Estimate	StdDev	2.5%	97.5%	ChiSq	PValue	N_Eff
ab_w	0.013	0.009	-0.003	0.031	2.4	.120	8417.097
ab_b	-0.009	0.075	-0.211	0.092	0.0	.776	368.719

DISTRIBUTION OF $\alpha\beta^w$ (RBLIMP ONLY)



DISTRIBUTION OF $\alpha\beta^b$ (RBLIMP ONLY)

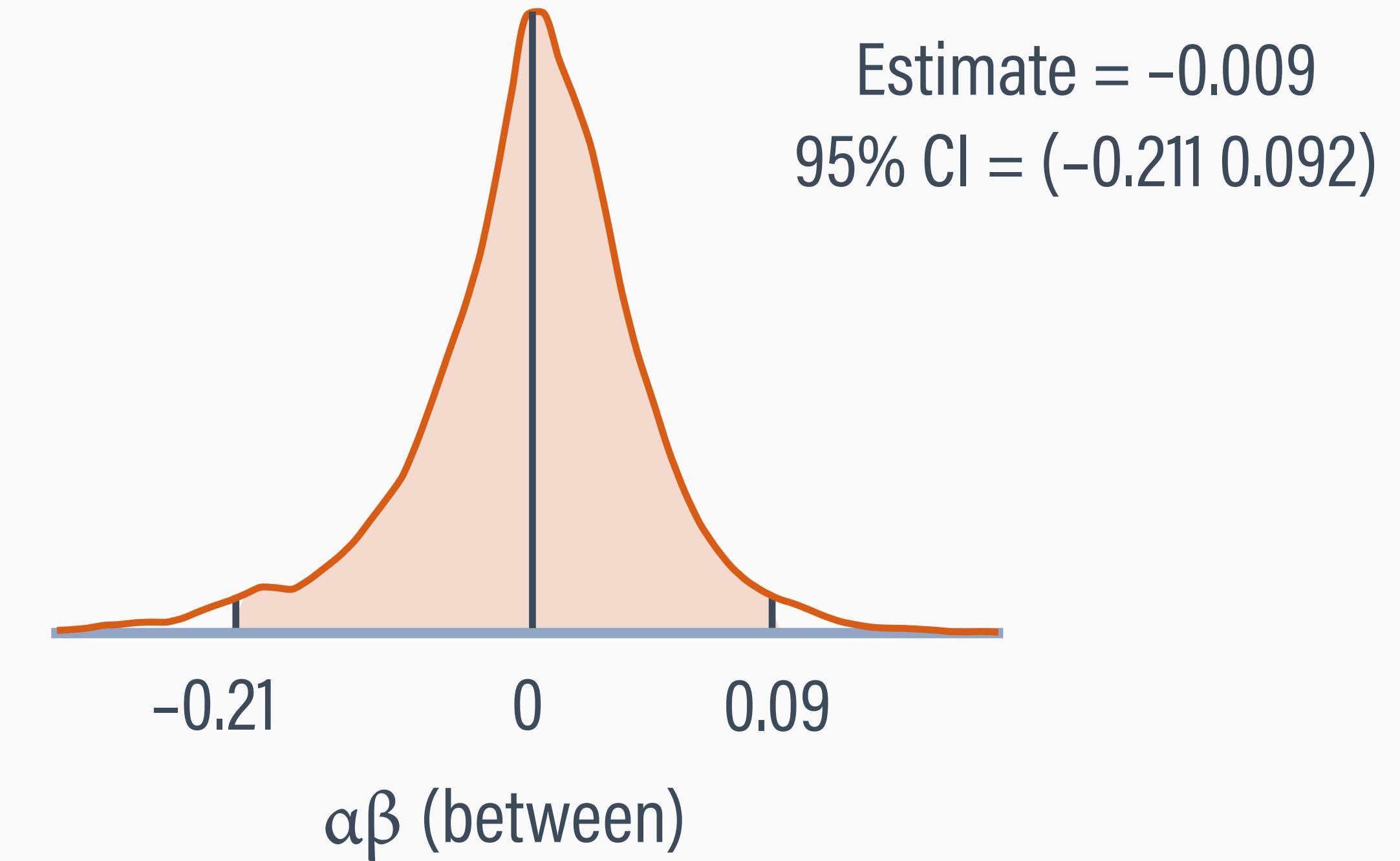
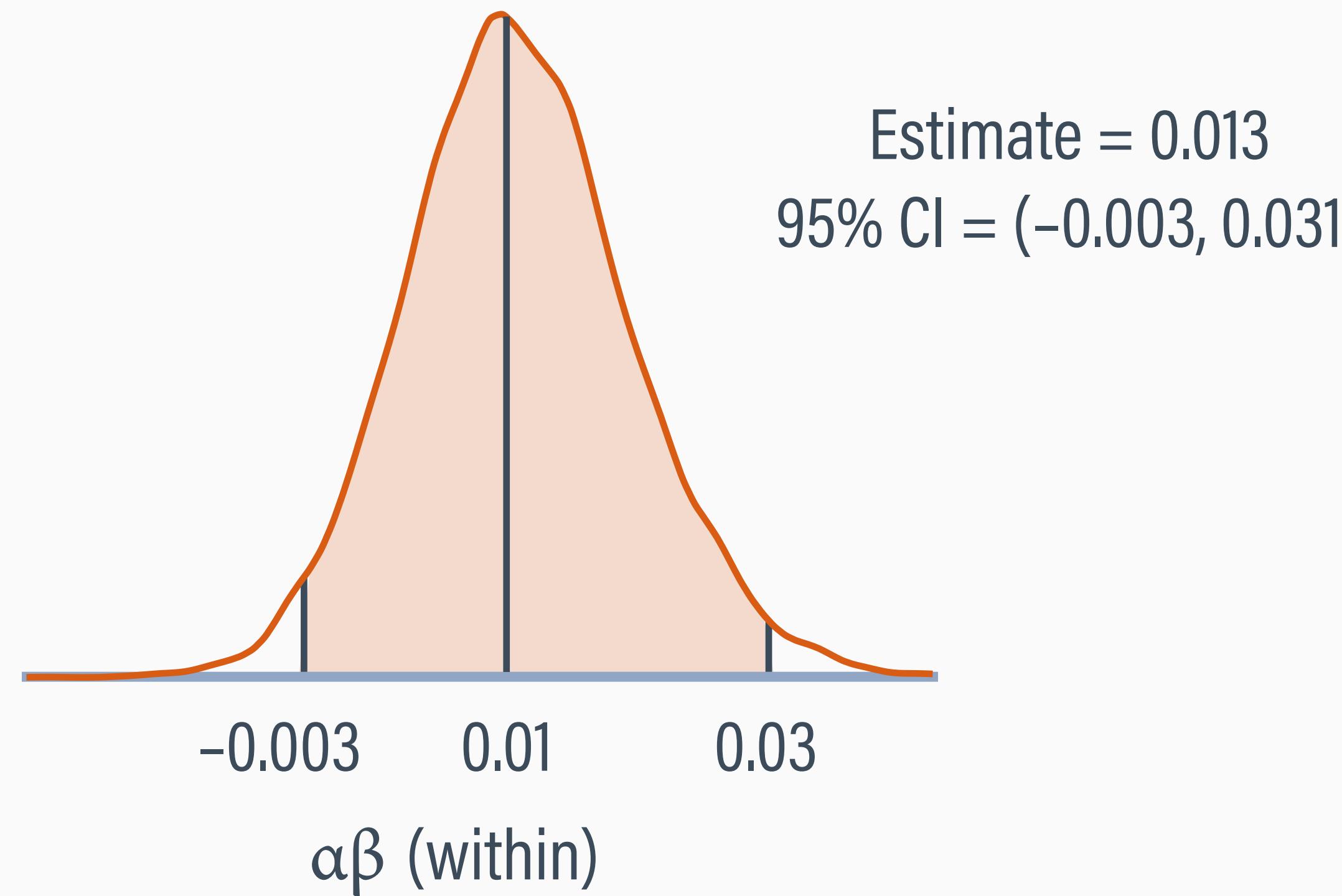


INTERPRETATIONS

- $\alpha\beta^w = .013$ is the effect of a one-point within-team difference on LMX that gets transmitted to job satisfaction via a one-point within-team difference in empowerment (the mediator)
- $\alpha\beta^b = -0.01$ is the effect of a one-point between-team mean difference on LMX that gets transmitted to job satisfaction via a one-point mean difference in empowerment (the mediator)

95% ASYMMETRIC INTERVALS

- Zero is inside both 95% intervals (just barely at level-1), implying that the data could have originated from a population with no mediation



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WITHIN-CLUSTER MEDIATION MODELS

- Level-1 slopes represent “pure’ within-team associations

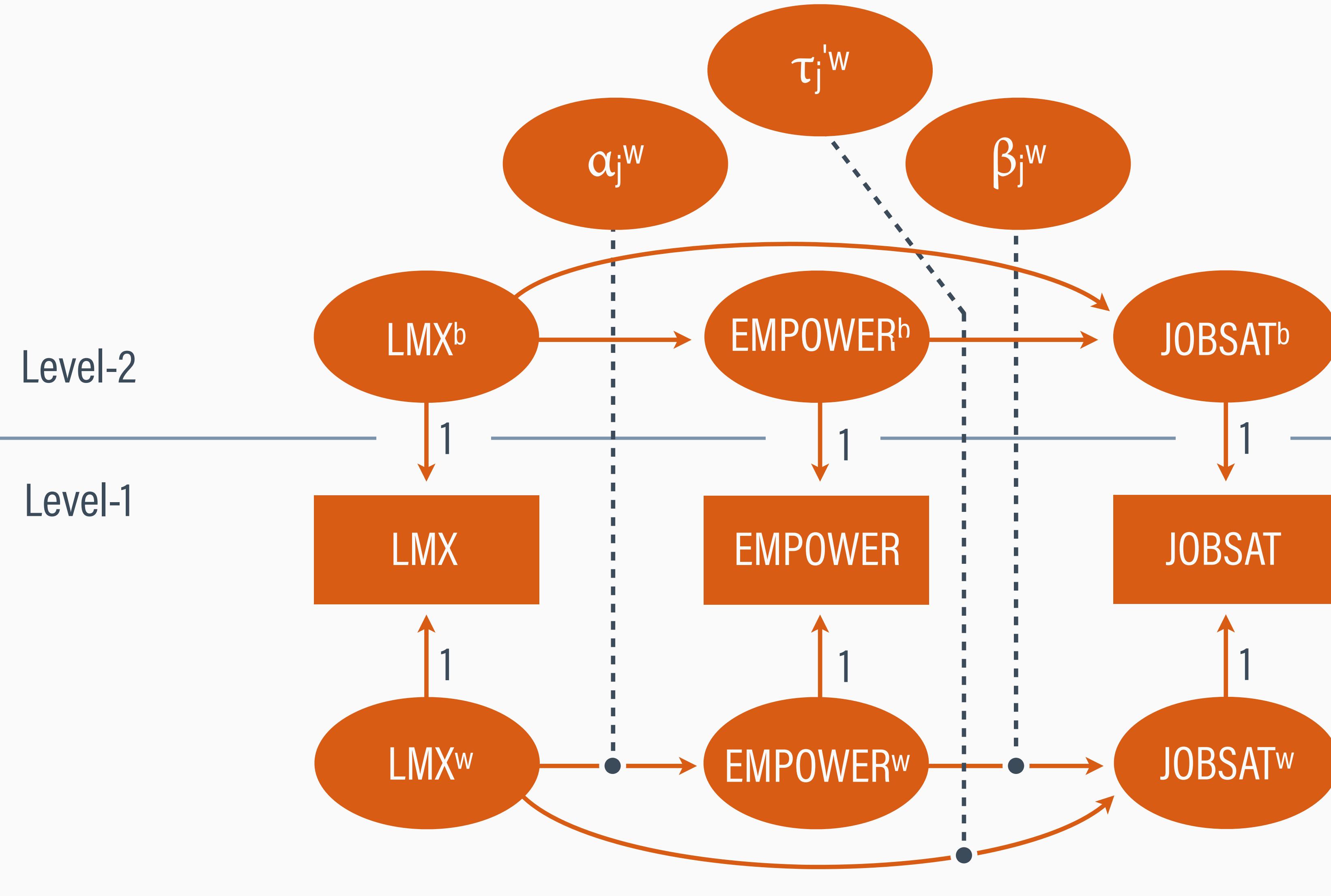
$$lmx_{ij} = lmx_j^b + \varepsilon_{ij}(lmx)$$

$$\text{empower}_{ij} = \text{empower}_j^b + \alpha_j^w(lmx_{ij}^w) + \varepsilon_{ij}(\text{empower})$$

$$\text{jobsat}_{ij} = \text{jobsat}_j^b + \tau_j^w(lmx_{ij}^w) + \beta_j^w(\text{empower}_{ij}^w) + \varepsilon_{ij}(\text{jobsat})$$

- Intercepts (team averages) and slopes vary across teams

PATH DIAGRAM



INDIRECT EFFECT ESTIMATES

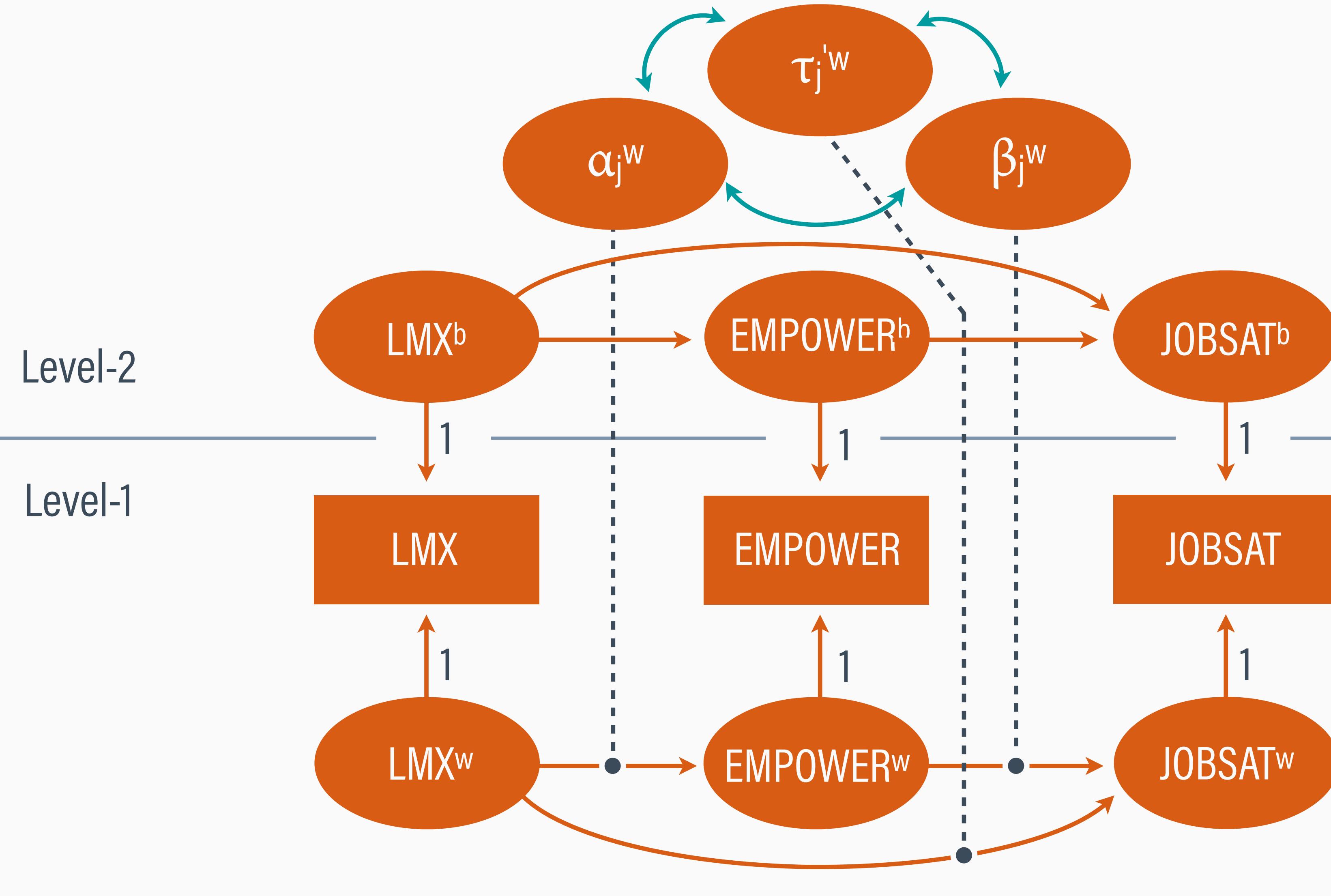
- In a model with random slopes, the within-cluster indirect effect equals the product of α^w and β^w *plus* the covariance (unstandardized correlation) between the random slopes

$$\text{Between-cluster indirect effect} = \alpha^b \times \beta^b$$

$$\text{Within-cluster indirect effect} = \alpha^w \times \beta^w + \text{cov}(\alpha^w, \beta^w)$$

- Correlating slopes in a multilevel SEM is vital for obtaining unbiased indirect effects (Kenny, Korchmaros, & Bolger, 2003)

PATH DIAGRAM



BLIMP SCRIPT 7.2 EXCERPT

LATENT: Team = LMX_b Empower_b JobSat_b apath_w bpath_w tpath_w; # define random slope latent variables

MODEL:

...

level2:

LMX_b ~ intercept;

Empower_b ~ intercept LMX_b@apath_b;

JobSat_b ~ intercept LMX_b@tpath_b Empower_b@bpath_b;

apath_w ~ intercept@apathw_mean; # random slope latent variables with their means labeled

bpath_w ~ intercept@bpathw_mean;

tpath_w ~ intercept;

apath_w ~~ bpath_w@ab_corr; # correlate random a and b paths and attach a label;

apath_w bpath_w ~~ tpath_w; # correlate remaining random slopes

...

BLIMP SCRIPT 7.2 EXCERPT

LATENT: Team = LMX_b Empower_b JobSat_b apath_w bpath_w tpath_w; # define random slope latent variables

MODEL:

```
...  
apath_w ~ intercept@apathw_mean;  
bpath_w ~ intercept@bpathw_mean;  
tpath_w ~ intercept;  
apath_w ~~ bpath_w@ab_corr; # correlate random a and b paths and attach a label;  
apath_w bpath_w ~~ tpath_w; # correlate remaining random slopes
```

level1:

```
LMX ~ intercept@LMX_b;
```

```
Empower ~ intercept@Empower_b LMX_w@apath_w; # @ sets the LMX_w slope to its level-2 latent variable
```

```
JobSat ~ intercept@JobSat_b LMX_w@tpath_w Empower_w@bpath_w; # @ sets slopes to their latent variables
```

$$\text{empower}_{ij} = \text{empower}_j^b + \alpha_j^w(\text{LMX}_{ij}^w) + \varepsilon_{ij}(\text{empower})$$

$$\text{jobsat}_{ij} = \text{jobsat}_j^b + \tau_j^w(\text{LMX}_{ij}^w) + \beta_j^w(\text{empower}_{ij}^w) + \varepsilon_{ij}(\text{jobsat})$$

BLIMP SCRIPT 7.2 EXCERPT

MODEL:

```
...  
level2:  
LMX_b ~ intercept;  
Empower_b ~ intercept LMX_b@apath_b;  
JobSat_b ~ intercept LMX_b@tpath_b Empower_b@bpath_b;  
apath_w ~ intercept@apathw_mean;  
bpath_w ~ intercept@bpathw_mean;  
tpath_w ~ intercept;  
apath_w ~~ bpath_w@ab_corr; # correlate random a and b paths and attach a label;  
apath_w bpath_w ~~ tpath_w; # correlate remaining random slopes
```

...

PARAMETERS:

```
ab_cov = ab_corr * sqrt(apath_w.totalvar * bpath_w.totalvar); # covariance between random slopes uses .totalvar to get the variance  
ab_w = apathw_mean * bpathw_mean + ab_cov;  
ab_b = apath_b * bpath_b;
```

WITHIN-CLUSTER α^w PATH

 = level-2 estimate

 = level-1 estimate

Latent Variable: apath_w

Parameters	Estimate	StdDev	2.5%	97.5%	ChiSq	PValue	N_Eff
<hr/>							
Variances:							
Residual Var.	0.182	0.077	0.068	0.367	---	---	689.181
<hr/>							
Coefficients:							
Intercept	0.662	0.073	0.515	0.803	81.727	0.000	1491.264
<hr/>							
Proportion Variance Explained							
by Coefficients	0.000	0.000	0.000	0.000	---	---	nan
by Residual Variation	1.000	0.000	1.000	1.000	---	---	nan

WITHIN-CLUSTER β^w PATH

- = level-2 estimate
- = level-1 estimate

Latent Variable: bpath_w

Parameters	Estimate	StdDev	2.5%	97.5%	ChiSq	PValue	N_Eff
<hr/>							
Variances:							
Residual Var.	0.005	0.003	0.001	0.012	---	---	196.246
<hr/>							
Coefficients:							
Intercept	0.025	0.015	-0.005	0.053	2.730	0.098	348.833
<hr/>							
Proportion Variance Explained							
by Coefficients	0.000	0.000	0.000	0.000	---	---	nan
by Residual Variation	1.000	0.000	1.000	1.000	---	---	nan

INTERPRETATIONS

- $\alpha^w = 0.66$ is the expected empowerment difference between two people *from the same team* with LMX scores that differ by one point
- $\beta^w = 0.03$ is the expected job satisfaction difference between two people from the same team with empowerment scores that differ by one point, holding constant LMX at any value

BETWEEN-CLUSTER α^b PATH

 = level-2 estimate
 = level-1 estimate

Latent Variable: Empower_b

Parameters	Estimate	StdDev	2.5%	97.5%	ChiSq	PValue	N_Eff
<hr/>							
Variances:							
Residual Var.	2.457	0.810	1.049	4.233	---	---	526.462
Coefficients:							
Intercept	28.583	3.322	22.984	36.210	75.351	0.000	593.906
LMX_b	0.005	0.346	-0.790	0.585	0.004	0.948	585.287
Standardized Coefficients:							
LMX_b	0.003	0.226	-0.515	0.377	0.005	0.945	423.151
Proportion Variance Explained							
by Coefficients	0.022	0.077	0.000	0.272	---	---	273.546
by Residual Variation	0.978	0.077	0.728	1.000	---	---	273.546

BETWEEN-CLUSTER β^b AND τ'^b PATHS

 = level-2 estimate
 = level-1 estimate

Latent Variable: JobSat_b

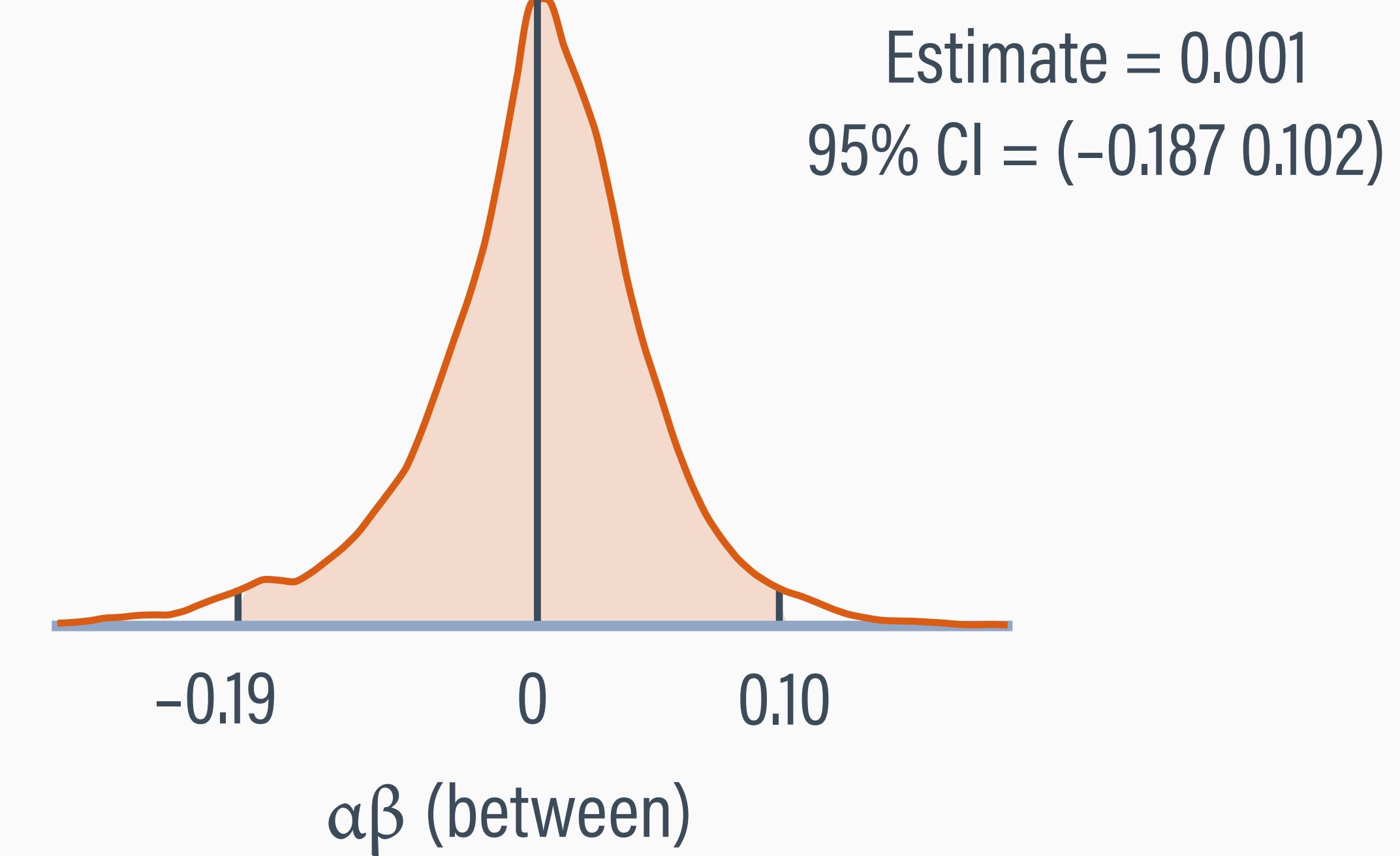
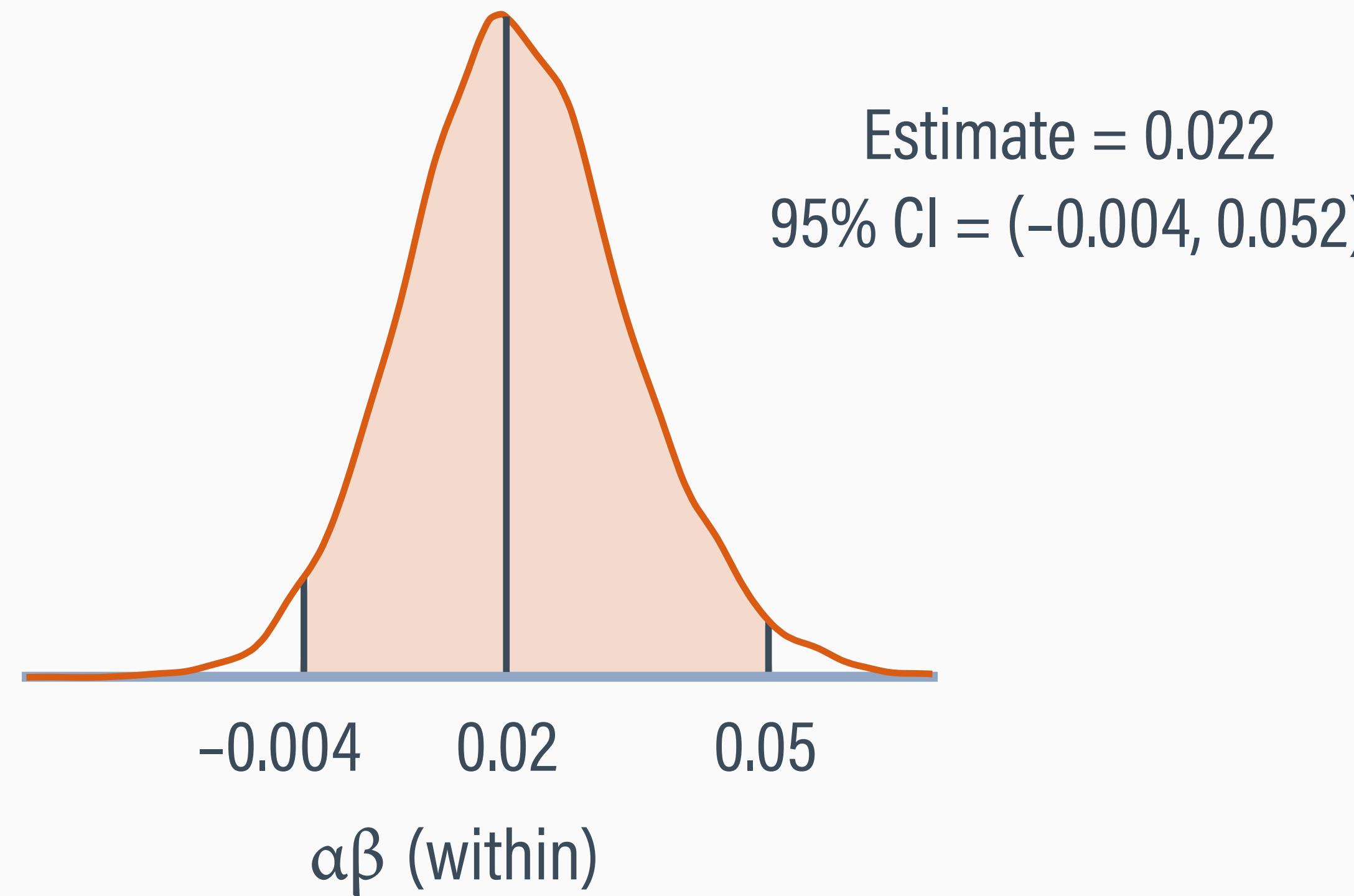
Parameters	Estimate	StdDev	2.5%	97.5%	ChiSq	PValue	N_Eff
<hr/>							
Variances:							
Residual Var.	0.064	0.045	0.005	0.171	---	---	274.358
<hr/>							
Coefficients:							
Intercept	-2.843	2.350	-8.407	0.697	1.731	0.188	194.582
LMX_b	0.199	0.090	0.046	0.399	5.199	0.023	318.385
Empower_b	0.173	0.067	0.070	0.329	7.183	0.007	209.485
<hr/>							
Standardized Coefficients:							
LMX_b	0.501	0.187	0.121	0.851	7.063	0.008	325.075
Empower_b	0.628	0.167	0.277	0.912	13.785	0.000	277.072
<hr/>							
Proportion Variance Explained							
by Coefficients	0.661	0.206	0.205	0.974	---	---	240.927
by Residual Variation	0.339	0.206	0.026	0.795	---	---	240.927

INTERPRETATIONS

- $\alpha^b = 0.005$ is the expected empowerment mean difference between two teams with average LMX values that differ by one point, controlling for team-average LMX
- $\beta^b = 0.17$ is the expected job satisfaction mean difference between two teams with average empowerment values that differ by one point, controlling for team-average LMX

DISTRIBUTIONS OF INDIRECT EFFECTS

- Indirect effects are computed at each MCMC iteration, producing a distribution of plausible mediated effects at each level



INDIRECT EFFECTS OUTPUT

■ = level-2 estimate
□ = level-1 estimate

GENERATED PARAMETERS:

Standard test statistics are inappropriate
for evaluating mediated effects!

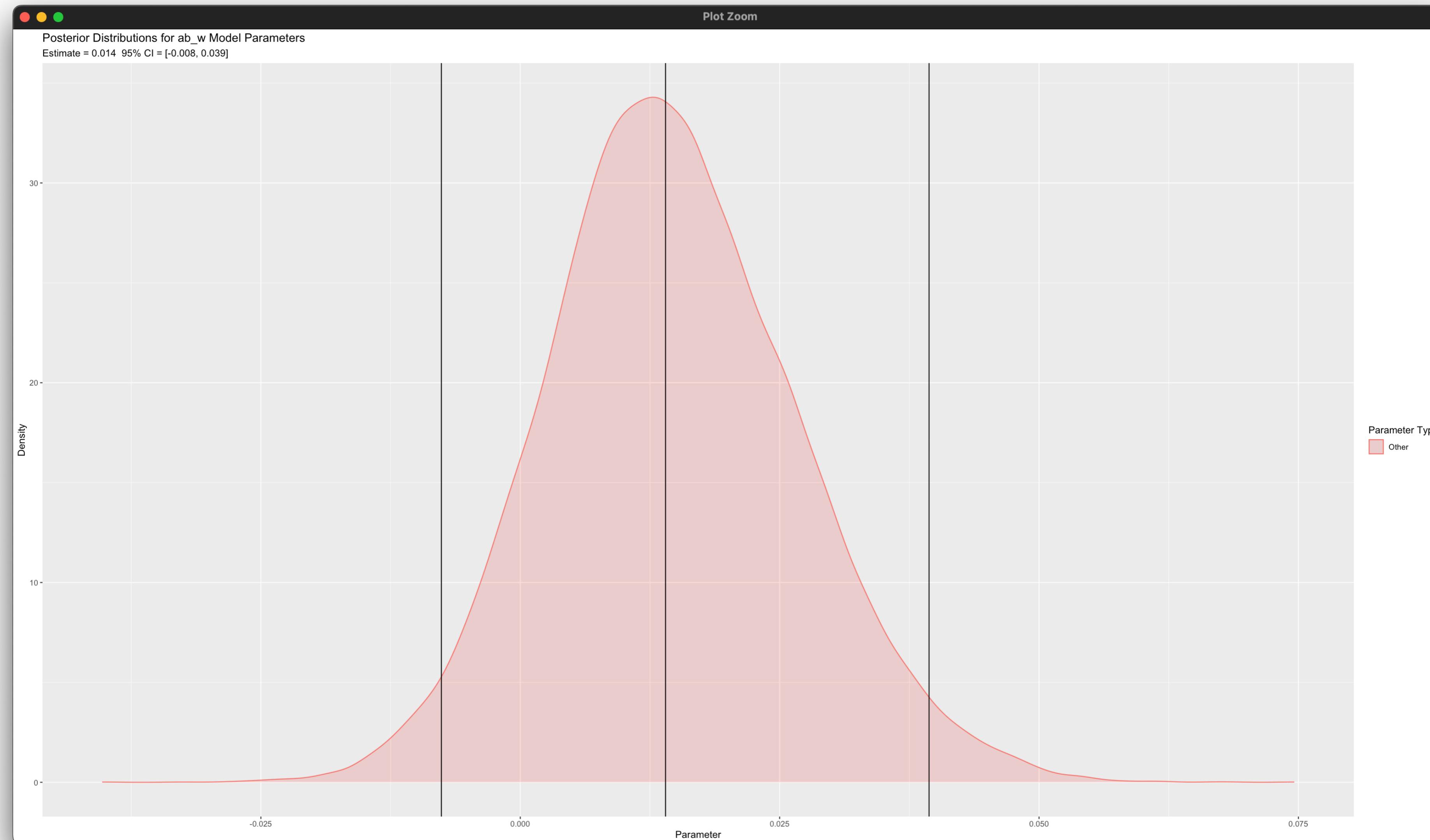
Summaries based on 20000 iterations using 2 chains.

NOTE: Estimate column based on posterior median.

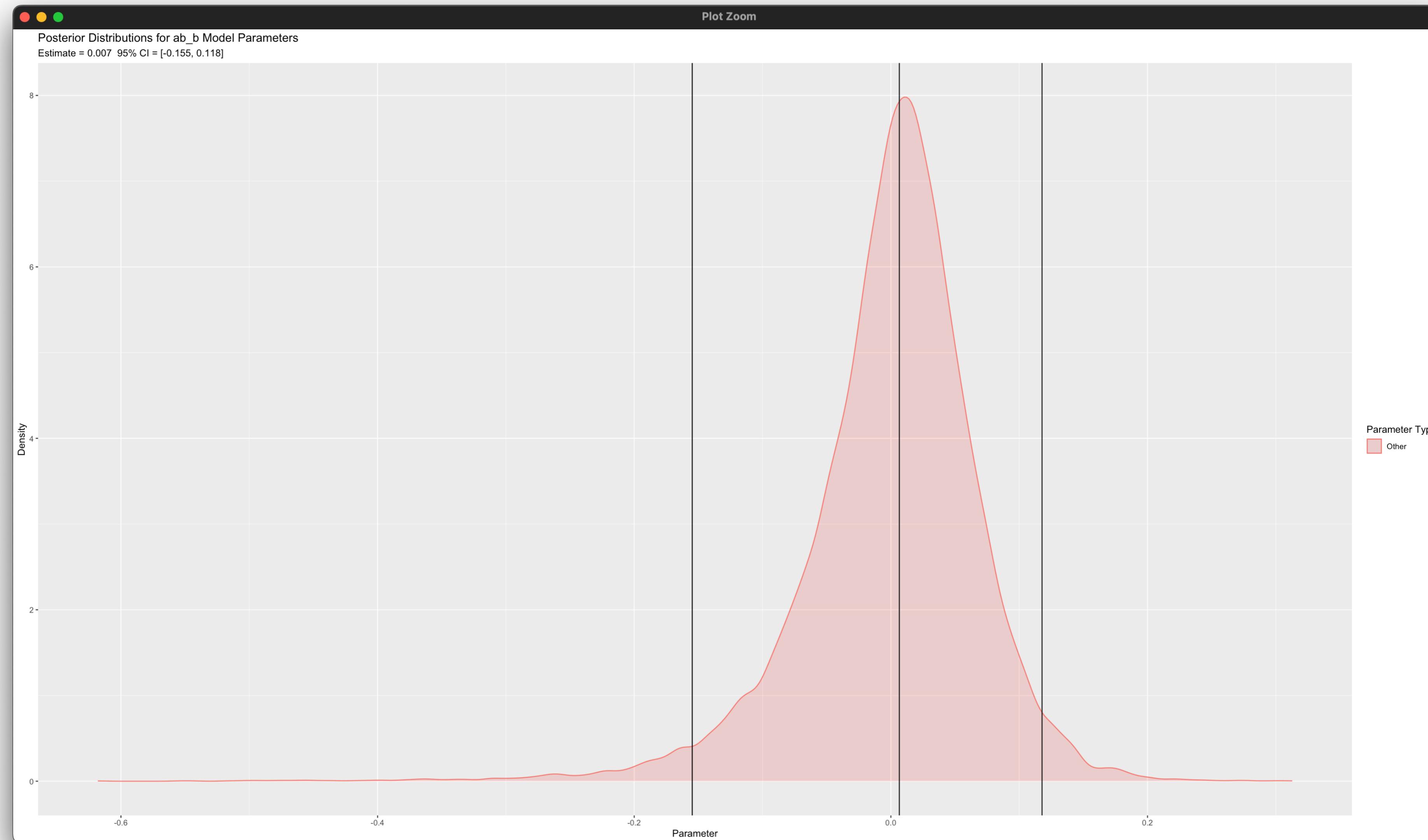
Parameters	Estimate	StdDev	2.5%	97.5%	ChiSq	PValue	N_Eff
<hr/>							
ab_cov	0.007	0.010	-0.012	0.027	0.4	.494	320.266
ab_w	0.022	0.014	-0.004	0.052	2.6	.105	243.150
ab_b	0.001	0.073	-0.187	0.102	0.0	.895	261.393
<hr/>							



DISTRIBUTION OF $\alpha\beta^w$ (RBLIMP ONLY)



DISTRIBUTION OF $\alpha\beta^b$ (RBLIMP ONLY)

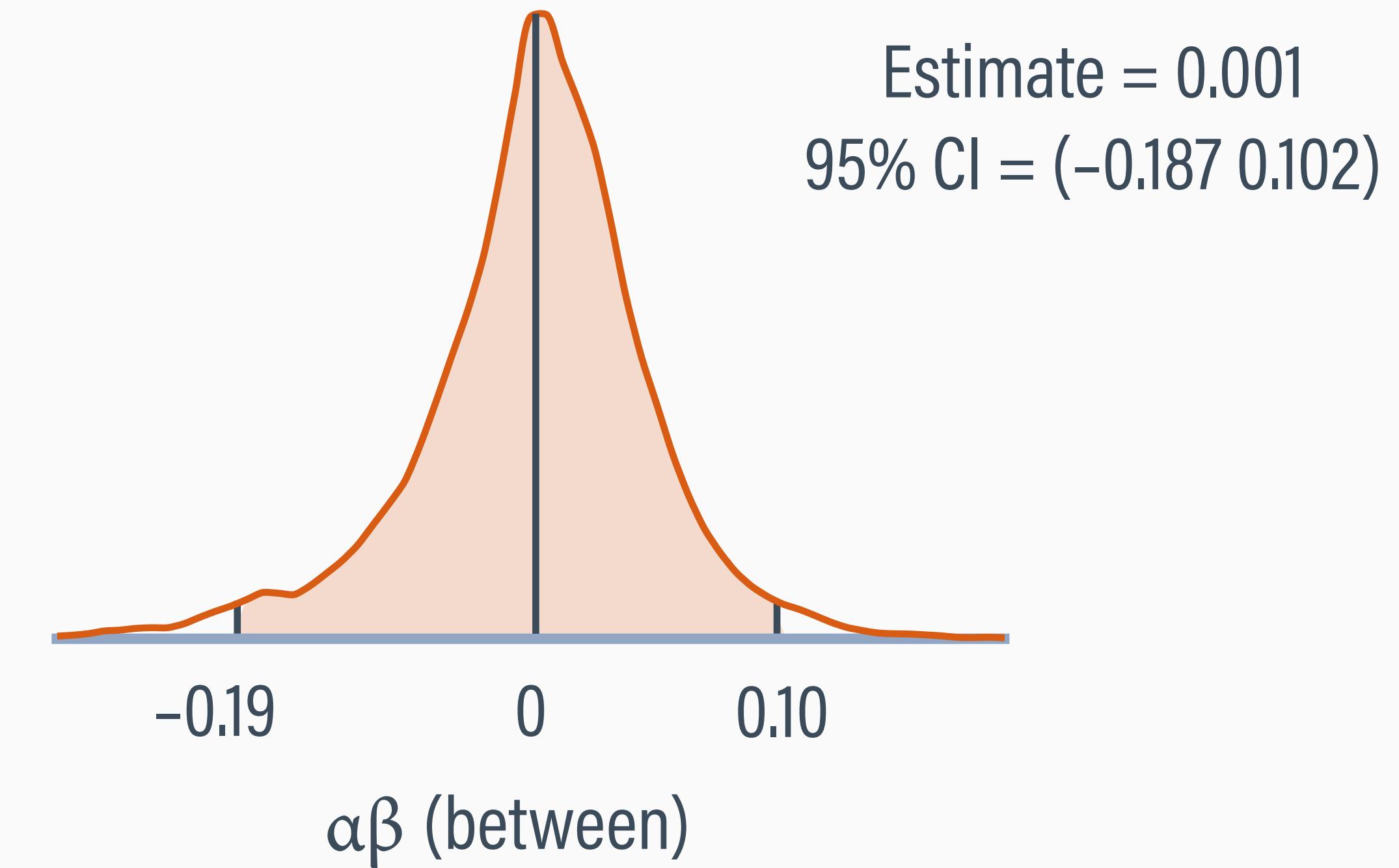
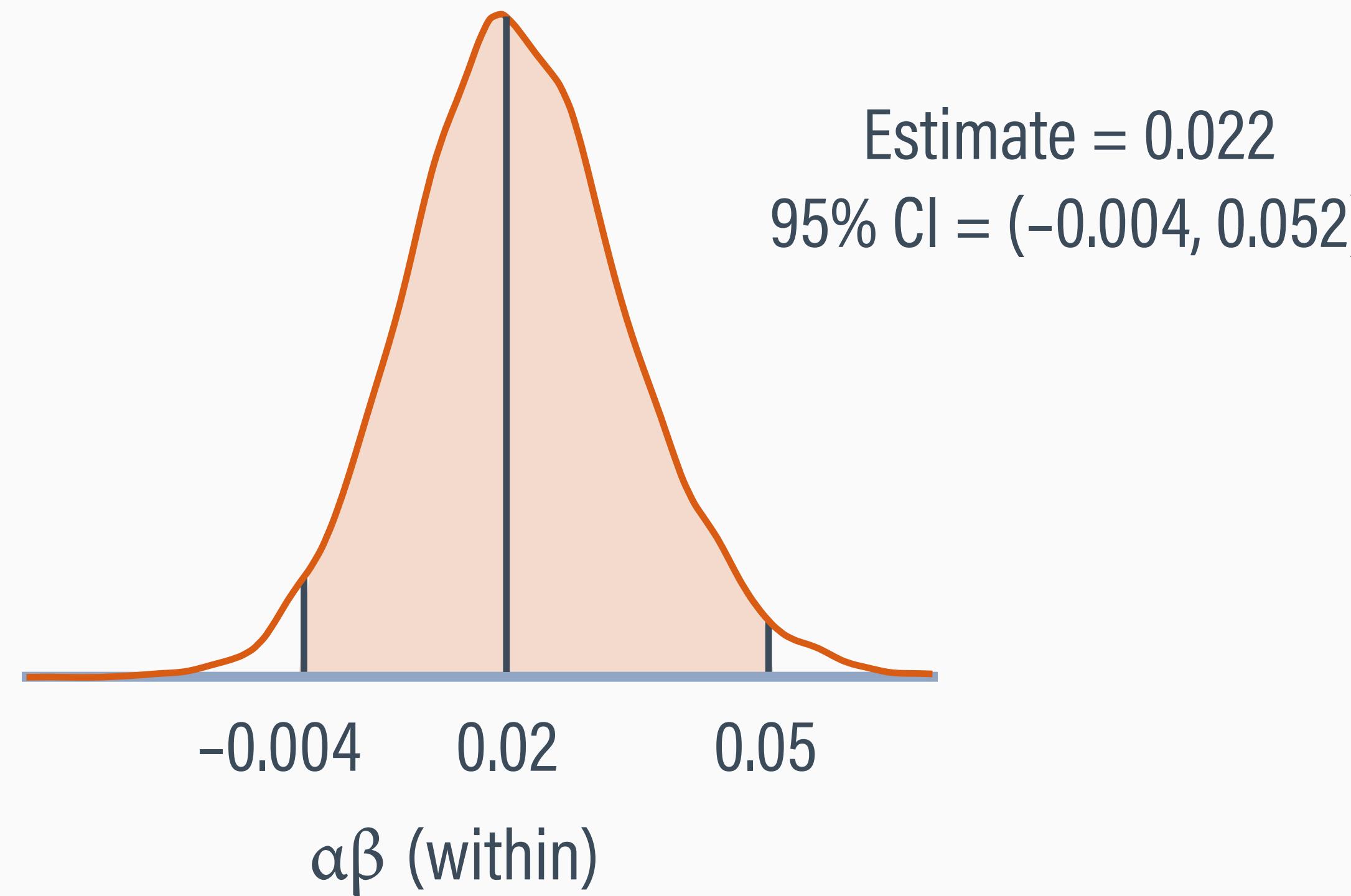


INTERPRETATIONS

- $\alpha\beta^w = .022$ is the effect of a one-point within-team difference on LMX that gets transmitted to job satisfaction via a one-point within-team difference in empowerment (the mediator)
- $\alpha\beta^b = 0.001$ is the effect of a one-point between-team mean difference on LMX that gets transmitted to job satisfaction via a one-point mean difference in empowerment (the mediator)

95% ASYMMETRIC INTERVALS

- Zero is inside both 95% intervals (just barely at level-1), implying that the data could have originated from a population with no mediation

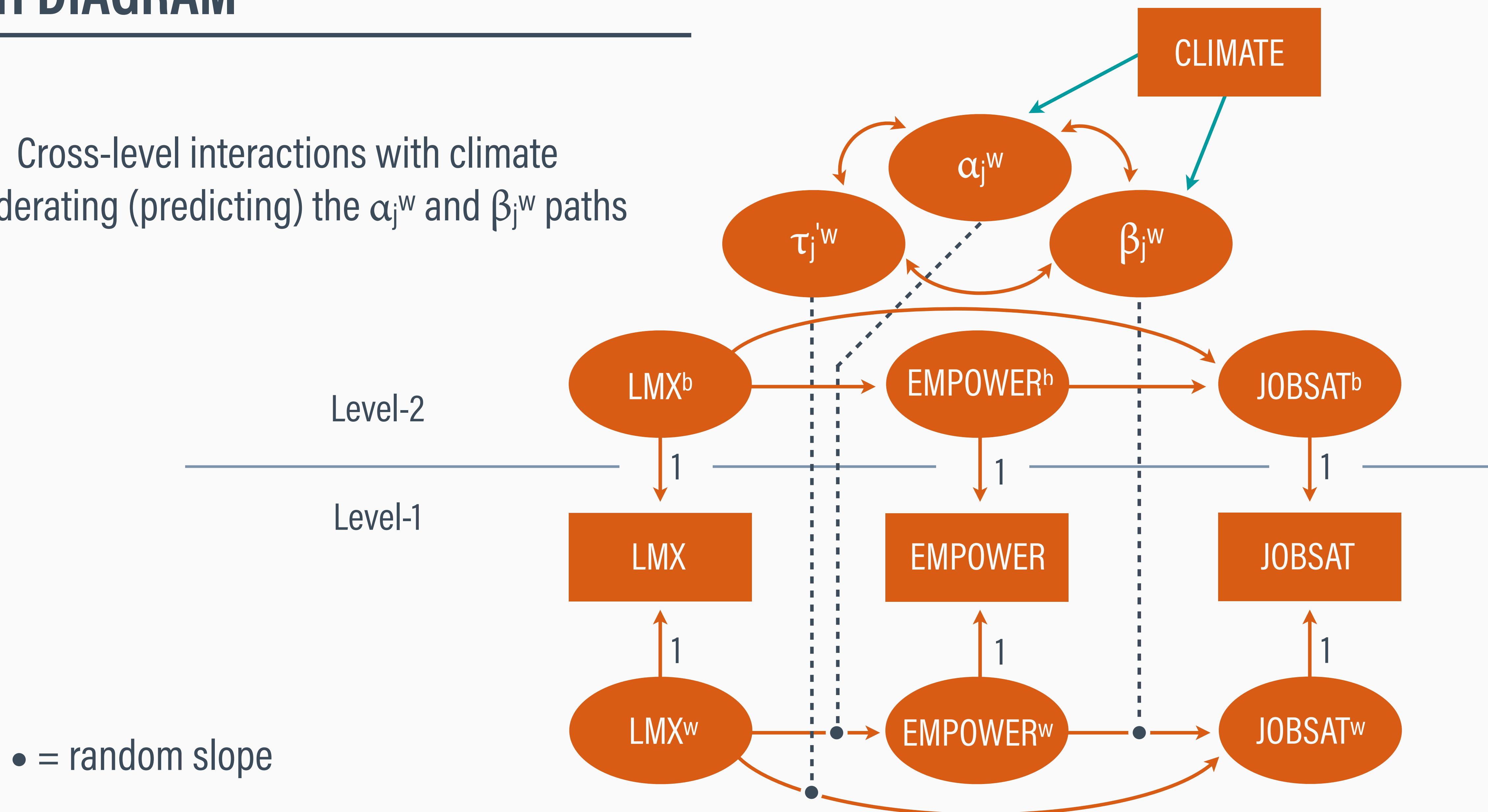


OUTLINE

- 1 Mediation Overview
- 2 1-1-1 Model With Random Intercepts
- 3 1-1-1 Model With Random Slopes
- 4 Moderation on the α or β paths

PATH DIAGRAM

Cross-level interactions with climate
moderating (predicting) the α_j^w and β_j^w paths



BLIMP SCRIPT 7.3 EXCERPT

LATENT: Team = LMX_b Empower_b JobSat_b apath_w bpath_w tpath_w;

CENTER: grandmean = Climate;

MODEL:

...

level2:

Climate ~ intercept;

LMX_b ~ intercept;

Empower_b ~ intercept LMX_b@apath_b Climate;

JobSat_b ~ intercept LMX_b@tpath_b Empower_b@bpath_b Climate;

apath_w ~ intercept@apathw_mean climate@apathw_mod; # random slope predicted by level-2 moderator

bpath_w ~ intercept@bpathw_mean climatebpathw_mod; # random slope predicted by level-2 moderator

tpath_w ~ intercept;

apath_w ~~ bpath_w@ab_corr; # correlate random a and b paths and attach a label;

apath_w bpath_w ~~ tpath_w; # correlate remaining random slopes

...

BLIMP SCRIPT 7.3 EXCERPT

Conditional mediated effects and different values of the moderator (team-level climate)

PARAMETERS:

```
ab_cov = ab_corr * sqrt(apath_w.totalvar * bpath_w.totalvar); # covariance between random slopes  
a_hi = apathw_mean + apathw_mod*sqrt(climate.totalvar); # a path at different values of the moderator  
a_mean = apathw_mean;  
a_lo = apathw_mean - apathw_mod*sqrt(climate.totalvar);  
b_hi = bpathw_mean + bpathw_mod*sqrt(climate.totalvar); # b path at different values of the moderator  
b_mean = bpathw_mean;  
b_lo = bpathw_mean - bpathw_mod*sqrt(climate.totalvar);  
ab_w_hi = a_hi*b_hi + ab_cov; # within-cluster mediated effect at different values of the moderator  
ab_w_mean = a_mean*b_mean + ab_cov;  
ab_w_lo = a_lo*b_lo + ab_cov;  
ab_b = apath_b*bpath_b; # between-cluster mediated effect
```

INDIRECT EFFECTS OUTPUT

■ = level-2 estimate
□ = level-1 estimate

GENERATED PARAMETERS:

Summaries based on 20000 iterations using 2 chains.

NOTE: Estimate column based on posterior median.

Standard test statistics are inappropriate
for evaluating mediated effects!

Parameters	Estimate	StdDev	2.5%	97.5%	ChiSq	PValue	N_Eff
<hr/>							
ab_cov	0.008	0.010	-0.012	0.028	0.651	0.420	526.299
a_hi	0.849	0.103	0.651	1.053	67.974	0.000	723.826
a_mean	0.655	0.073	0.510	0.797	80.705	0.000	830.976
a_lo	0.462	0.104	0.254	0.663	19.685	0.000	863.252
b_hi	0.019	0.019	-0.018	0.058	0.934	0.341	311.687
b_mean	0.025	0.016	-0.004	0.058	2.712	0.096	359.128
b_lo	0.033	0.020	-0.005	0.073	2.600	0.103	566.367
ab_w_hi	0.024	0.020	-0.013	0.064	1.505	0.220	463.559
ab_w_mean	0.025	0.015	-0.003	0.055	2.930	0.087	494.087
ab_w_lo	0.023	0.015	-0.004	0.054	2.577	0.108	539.407
ab_b	0.008	0.066	-0.158	0.108	0.000	0.991	513.172

DISTRIBUTION OF $\alpha\beta^w$ (RBLIMP ONLY)

Conditional mediated effect at +1 SD
above team-level climate mean



DISTRIBUTION OF $\alpha\beta^w$ (RBLIMP ONLY)

Conditional mediated effect at the team-level climate mean



DISTRIBUTION OF $\alpha\beta^w$ (RBLIMP ONLY)

Conditional mediated effect at -1 SD
above team-level climate mean

