# Mediation and Path Analysis

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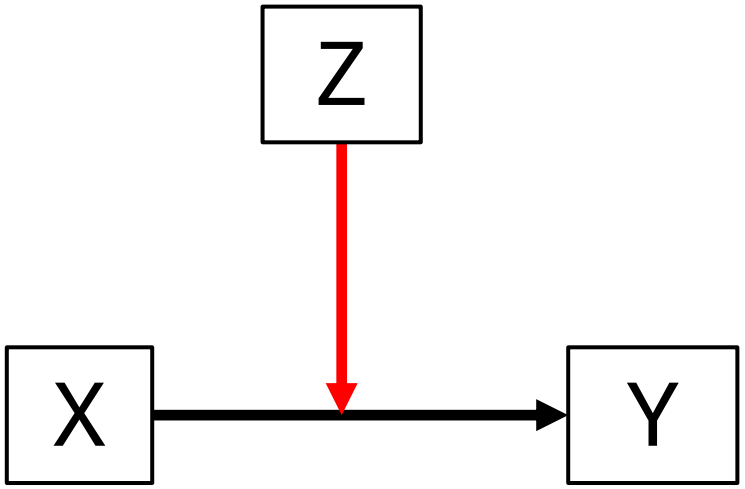
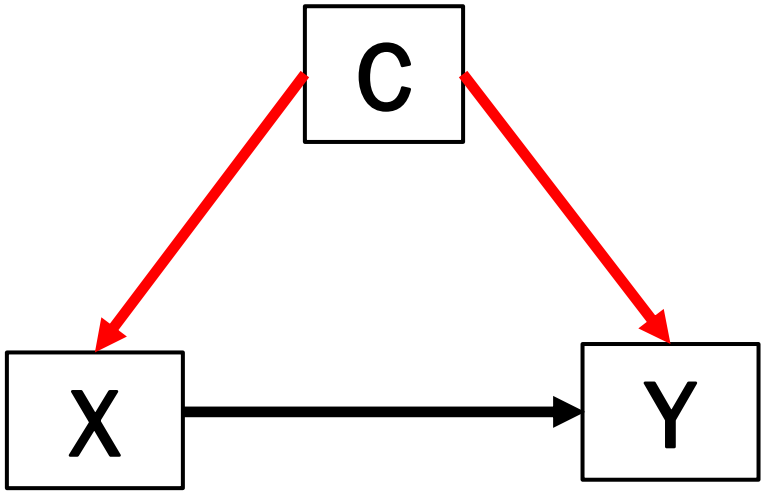
# Moderator, Confounder and Mediator

Moderator




$Y = X + Z + \mathbf{XZ}$

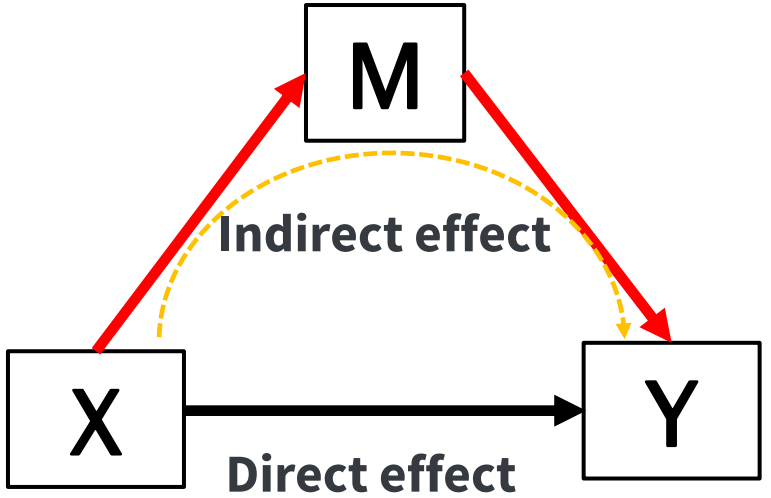
Confounder




$Y = X + C$

Direct effect of X on Y
*after controlling for* C

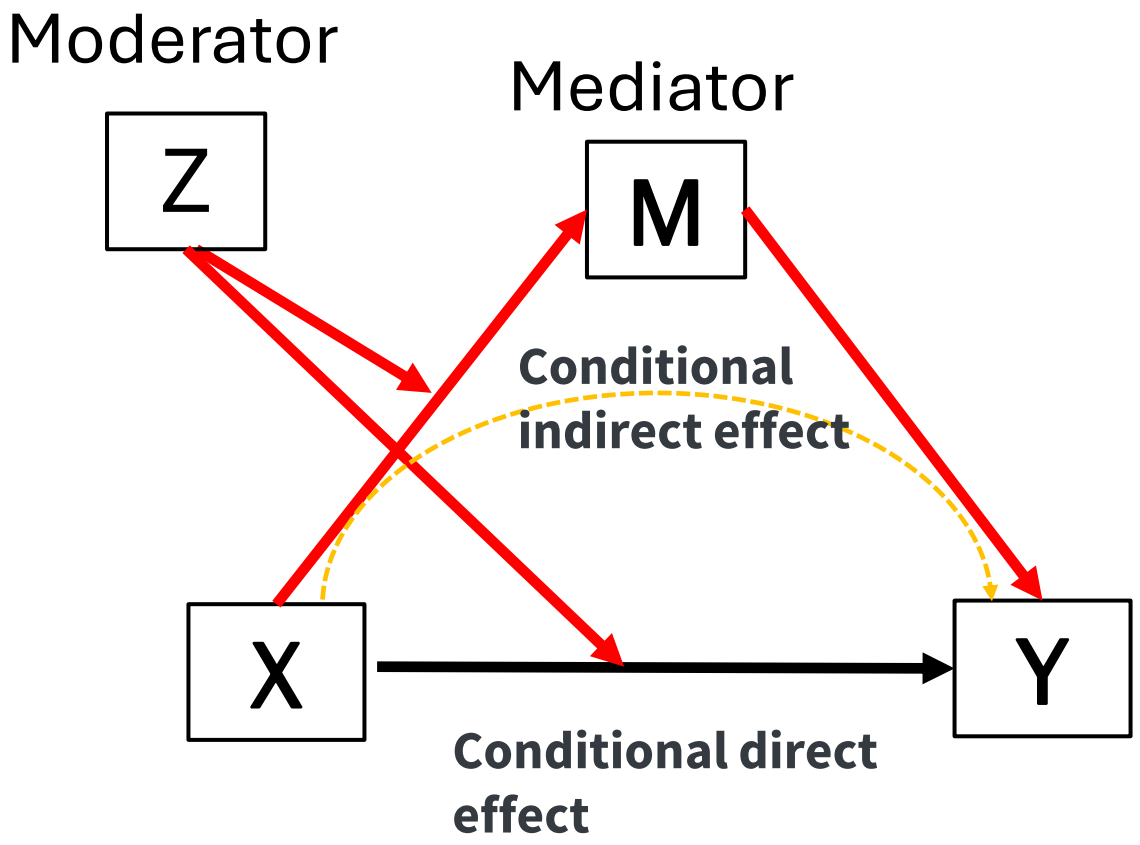
Mediator




$M = X$

$Y = X + M$

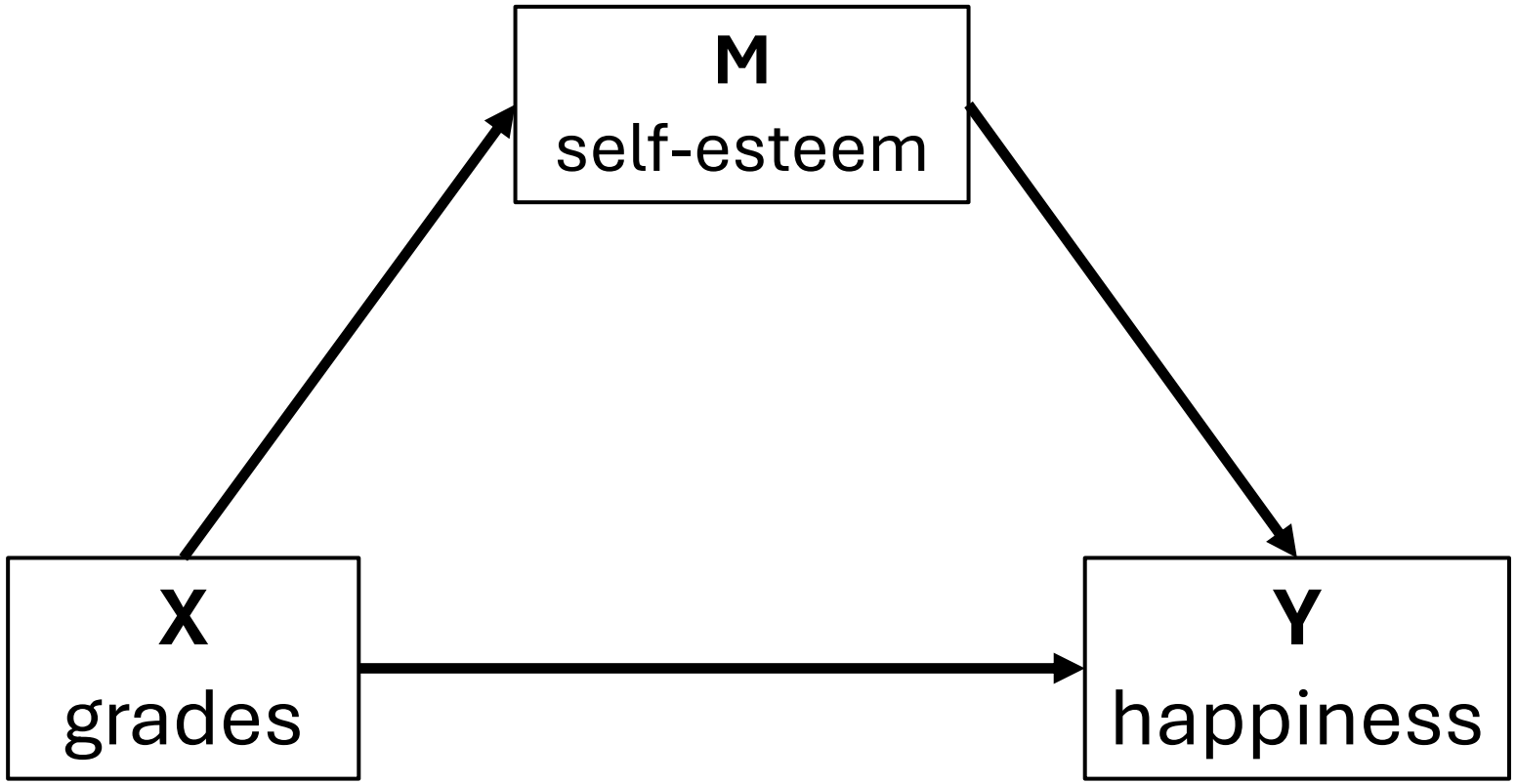
# Conditional mediation model



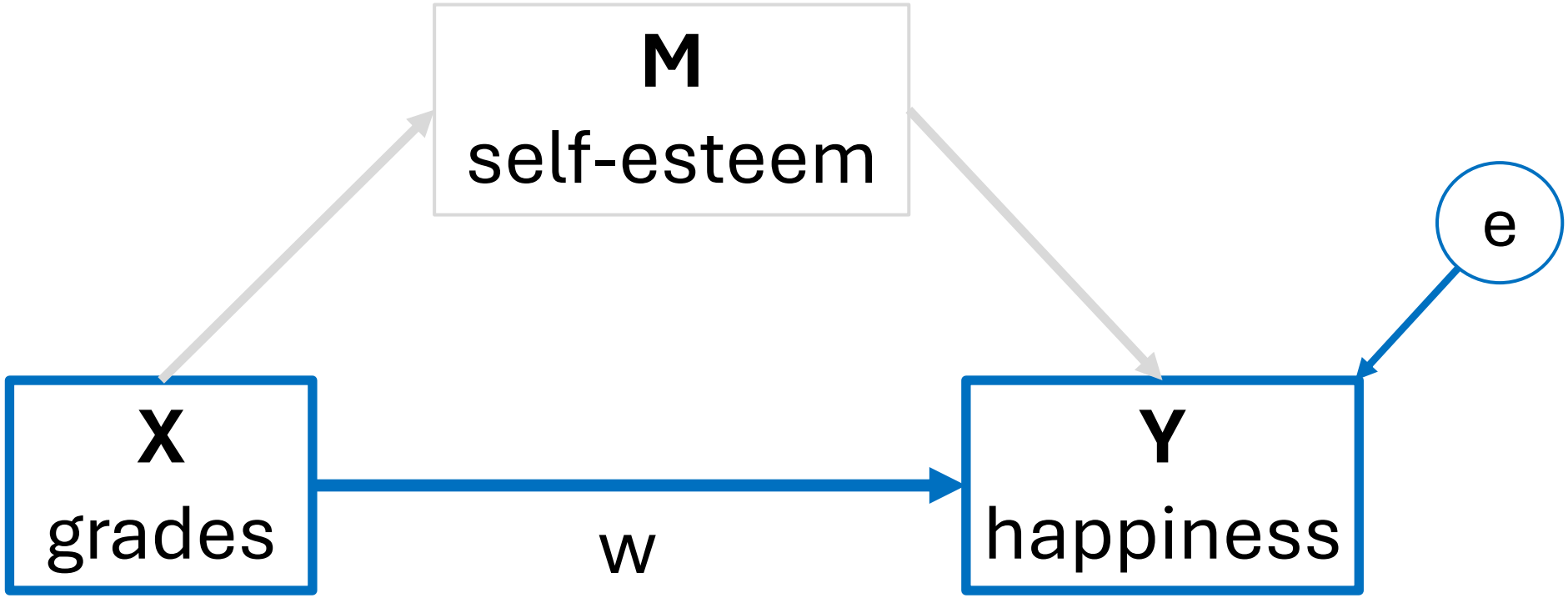

$$M = X + Z + XZ$$

$$Y = X + Z + XZ + M$$

# A single mediation analysis

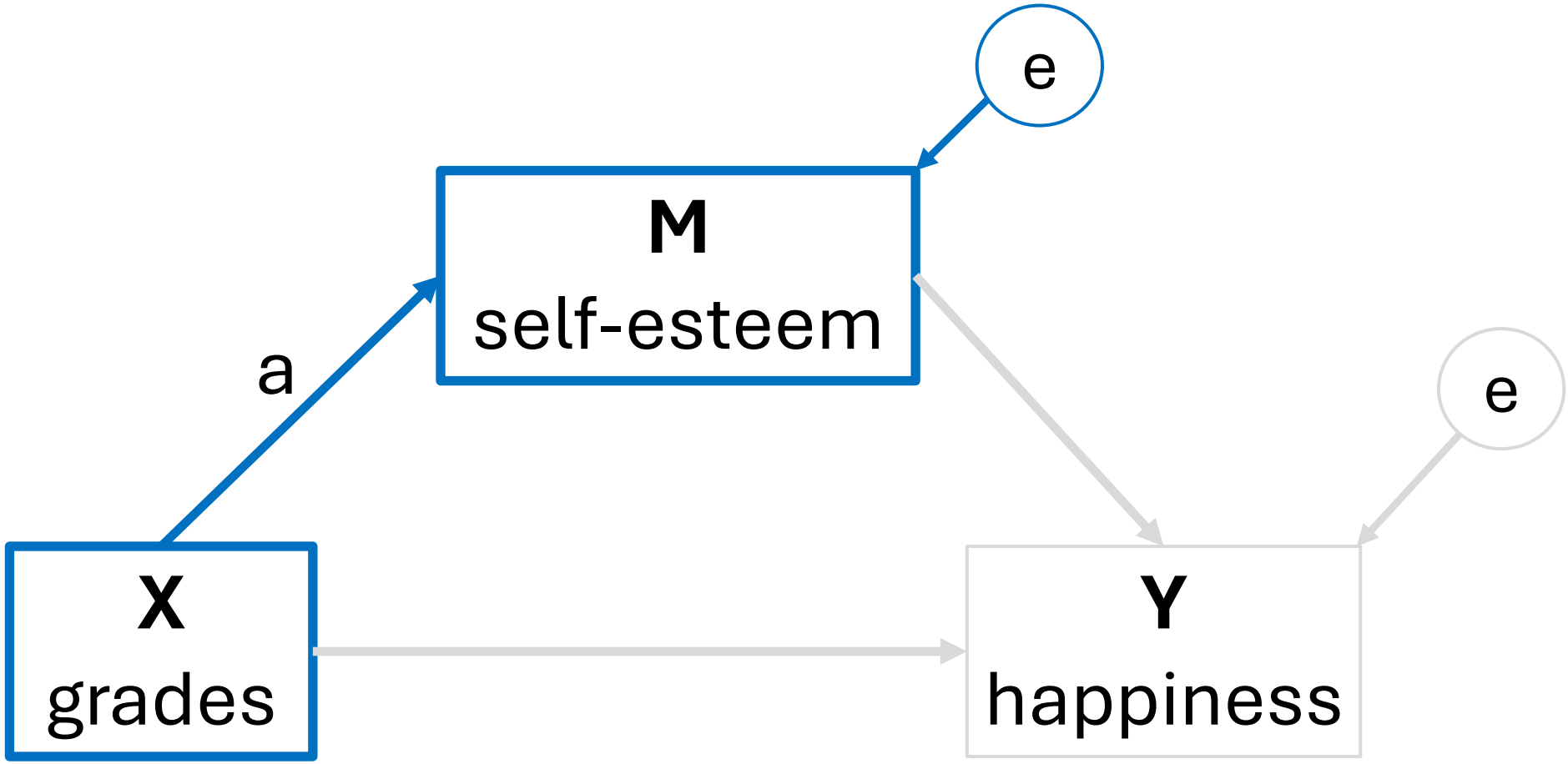


# Step 1: Total effect



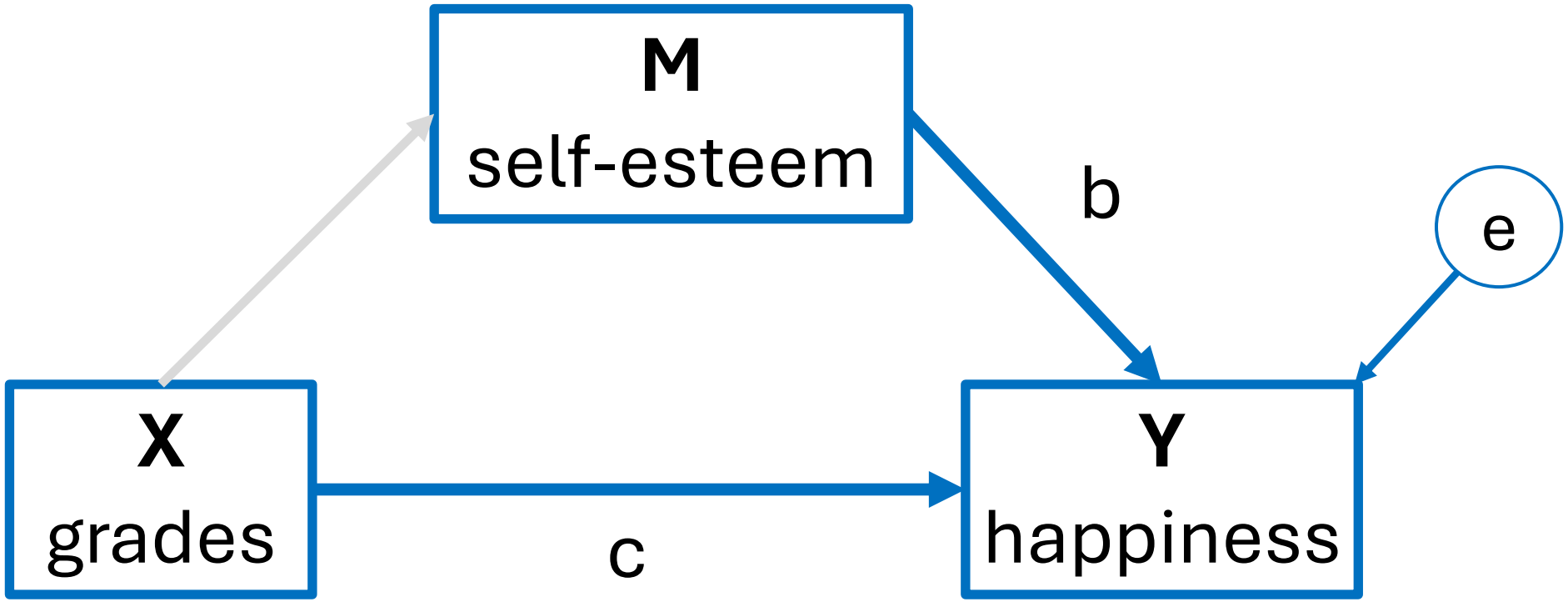

$$Y = \text{intercept} + w \cdot X + e$$

# Step 2: Association between X on M




$$M = \text{intercept} + a \cdot X + e$$

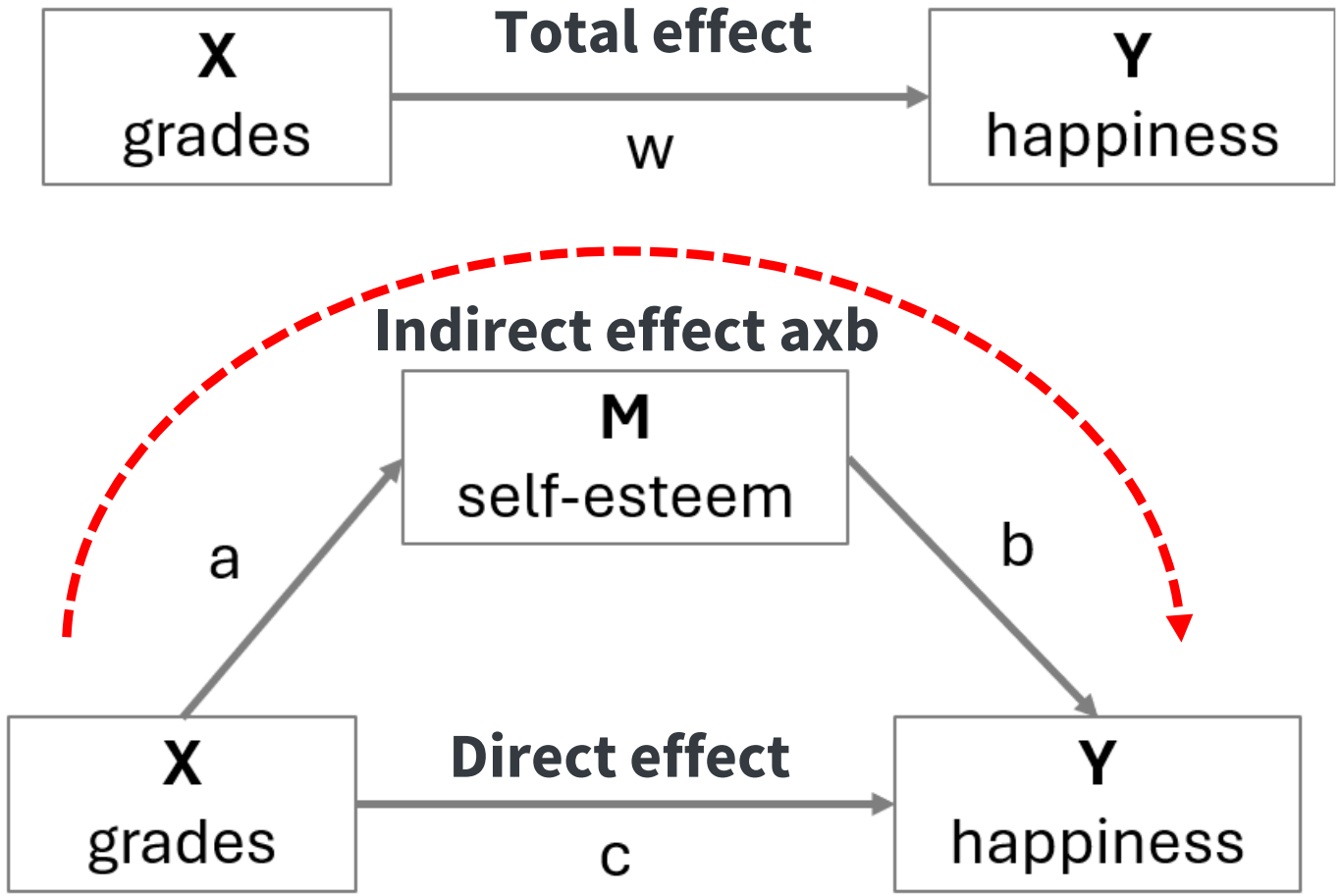
# Step 3: Effects of both X and M on Y




$$Y = \text{intercept} + c \cdot X + b \cdot M + e$$

# A single mediation analysis

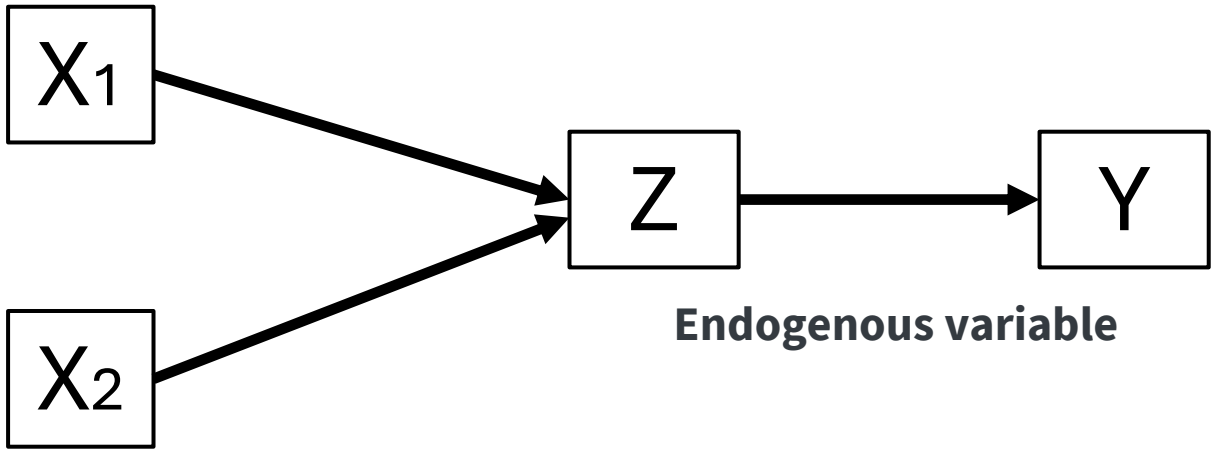
Mediation analysis decomposes the total effect X → Y (**w**) into a direct effect (c) and an indirect effect through a **mediator** variable M, which is the product of **a** and **b** (**axb**).



# Path analysis

**Exogenous variables:** Independent variables that are influenced by factors outside the model and, in turn, influence endogenous variables. In path diagrams, **arrows originate from exogenous** variables but do not point to them.

**Endogenous variables:** Dependent variables that are explained by exogenous variables in the model. **Arrows point toward them** and these represent causal paths. Note that an endogenous variable may also be specified as the predictor of another endogenous variable

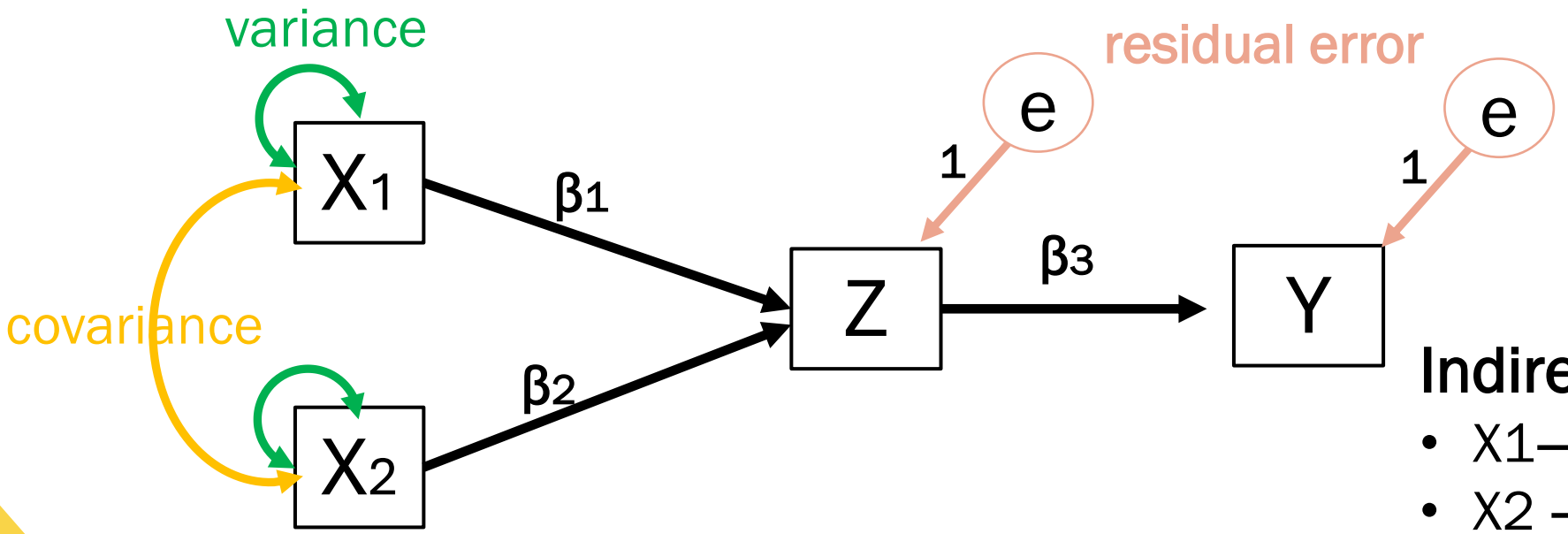


# Path analysis (direct and indirect effects)

**Path coefficients** are regression coefficients (typically denoted as β1–β3, or sometimes as p1–p3) that represent **direct effects** of one variable on another. Indirect effects of paths are calculated as the **product** of direct effects of the paths: $\beta_1 * \beta_3$ and $\beta_2 * \beta_3$.

**Variances** are typically represented as curved double-sided arrows, where both arrows point to the same variable. **Covariances** are also represented as double-sided arrows in which the arrows connect two distinct variables.

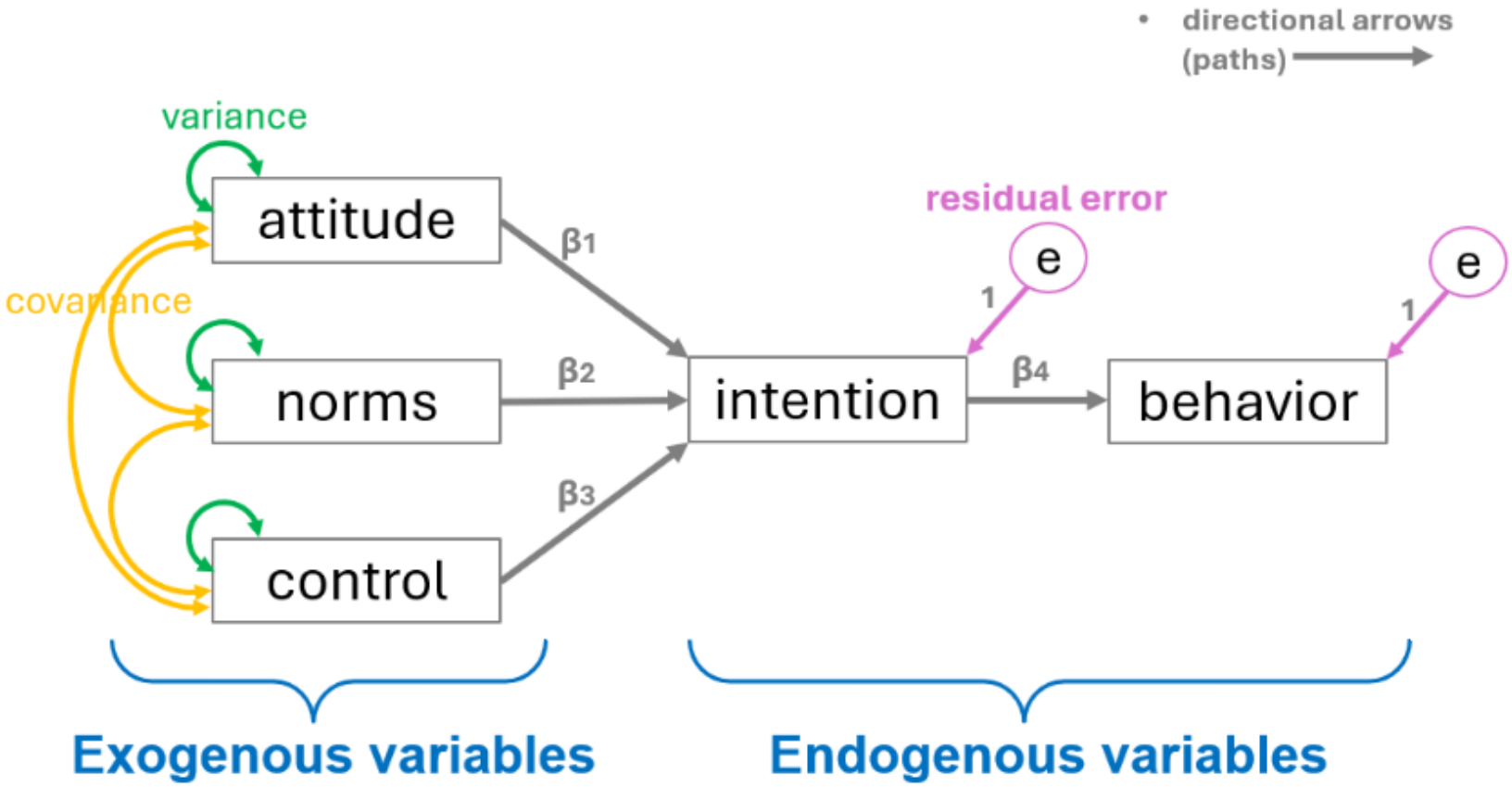
**(Residual) error terms** are added to **endogenous variables**.




**Indirect effects:**

- X1→ Z → Y, (β1*β3)
- X2 → Z → Y, (β2*β3)

# Path analysis




$$intention = intercept + \beta_1 attitude + \beta_2 norms + \beta_3 control + e$$

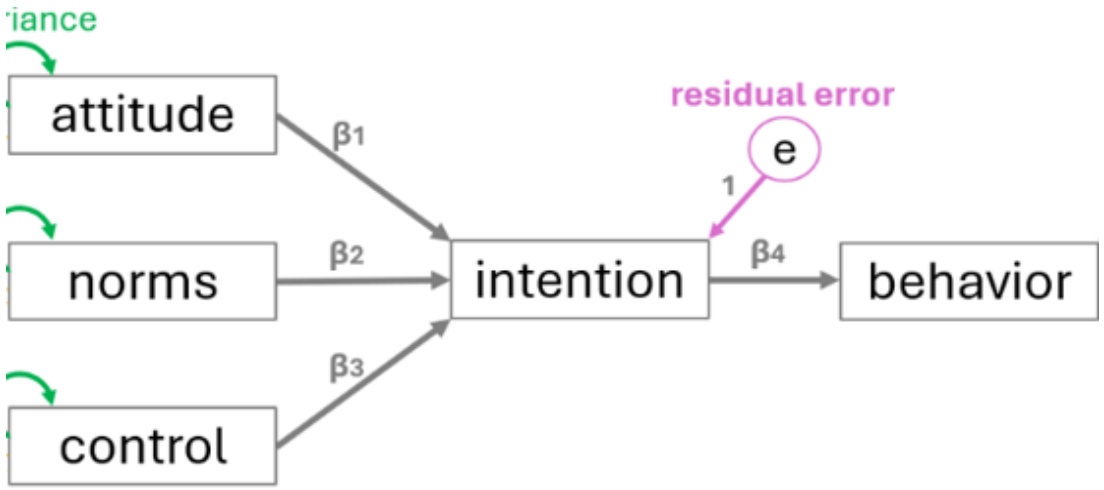
$$behavior = intercept + \beta_4 intention + e$$

# Direct effects

β1, β2, β3, β4

Parameter Estimates

| Dep | Pred | Estimate | SE | 95% Confidence Intervals Lower | Upper | β | z | p |
|---|---|---|---|---|---|---|---|---|
| behavior | intention | 0.4534 | 0.0646 | 0.3267 | 0.5801 | 0.4452 | 7.0143 | < .001 |
| intention | control | 0.2750 | 0.0580 | 0.1613 | 0.3887 | 0.2908 | 4.7396 | < .001 |
| intention | norms | 0.1525 | 0.0592 | 0.0365 | 0.2685 | 0.1516 | 2.5765 | 0.010 |
| intention | attitude | 0.3523 | 0.0581 | 0.2385 | 0.4661 | 0.3702 | 6.0676 | < .001 |




Intercepts

| Variable | Intercept | SE | 95% Confidence Intervals Lower | Upper | z | p |
|---|---|---|---|---|---|---|
| behavior | 1.743 | 0.203 | 1.345 | 2.140 | 8.595 | 0.000 |
| intention | 0.586 | 0.237 | 0.121 | 1.051 | 2.470 | 0.014 |
| attitude | 3.179 | 0.000 | 3.179 | 3.179 | | |
| norms | 2.903 | 0.000 | 2.903 | 2.903 | | |
| control | 3.095 | 0.000 | 3.095 | 3.095 | | |

$$intention = 0.586 + 0.352 \cdot attitude + 0.153 \cdot norms + 0.275 \cdot control$$

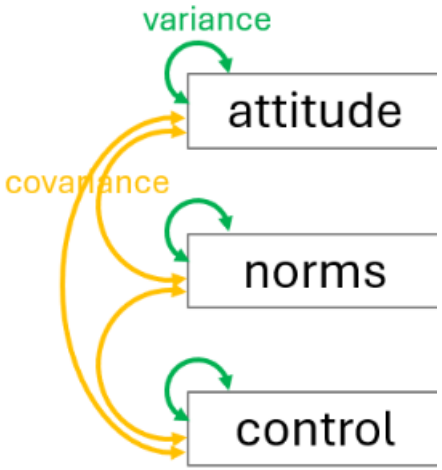
$$behavior = 1.743 + 0.453 \cdot intention$$

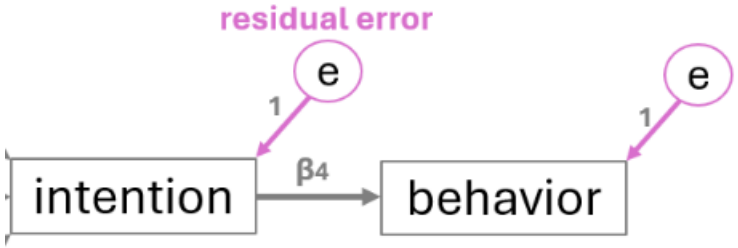
# Indirect effects

Defined Parameters

| Label | Description | Parameter | Estimate | SE | 95% Confidence Intervals | | β | z | p |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | Lower | Upper | | | |
| IE1 | control ⇒ intention ⇒ behavior | p2*p1 | 0.1247 | 0.0318 | 0.0625 | 0.1869 | 0.1295 | 3.9271 | < .001 |
| IE2 | norms ⇒ intention ⇒ behavior | p3*p1 | 0.0691 | 0.0286 | 0.0131 | 0.1252 | 0.0675 | 2.4185 | 0.016 |
| IE3 | attitude ⇒ intention ⇒ behavior | p4*p1 | 0.1597 | 0.0348 | 0.0915 | 0.2280 | 0.1648 | 4.5890 | < .001 |

# Variances and covariances




Variances and Covariances

| | | | | 95% Confidence Intervals | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Variable 1 | Variable 2 | Estimate | SE | Lower | Upper | β | z | p | Method | Type |
| behavior | behavior | 0.6987 | 0.0700 | 0.5614 | 0.8359 | 0.8018 | 9.9750 | < .001 | Estim | Residuals |
| intention | intention | 0.5302 | 0.0532 | 0.4261 | 0.6344 | 0.6310 | 9.9750 | < .001 | Estim | Residuals |
| control | control | 0.9393 | 0.0000 | 0.9393 | 0.9393 | 1.0000 | | | Sample | Variables |
| control | norms | 0.2201 | 0.0000 | 0.2201 | 0.2201 | 0.2492 | | | Sample | Variables |
| control | attitude | 0.3337 | 0.0000 | 0.3337 | 0.3337 | 0.3575 | | | Sample | Variables |
| norms | norms | 0.8304 | 0.0000 | 0.8304 | 0.8304 | 1.0000 | | | Sample | Variables |
| norms | attitude | 0.1996 | 0.0000 | 0.1996 | 0.1996 | 0.2274 | | | Sample | Variables |
| attitude | attitude | 0.9278 | 0.0000 | 0.9278 | 0.9278 | 1.0000 | | | Sample | Variables |

# Path diagram