NCRM National Centre for Research Methods

Structural Equation Modeling: what is it and what can we use it for?

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E·S·R·C ECONOMIC & SOCIAL RESEARCH COUNCIL
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What is SEM?

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- It integrates a number of different multivariate techniques into one model fitting framework
- It is an integration of:
  - Measurement theory
  - Factor (latent variable) analysis
  - Path analysis
  - Regression
  - Simultaneous equations

Useful for Research Questions that..

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- Involve complex, multi-faceted constructs that are measured with error
- That specify ‘systems’ of relationships rather than a dependent variable and a set of predictors
- Focus on indirect (mediated) as well as direct effects of variables on other variables

Also Known as

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- Causal Modeling

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- Mplus, EQS, Amos, Calis, Mx, SEPATH, Tetrad, R, stata
- Some have downloadable student versions

SEM can be thought of as

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Latent Variables

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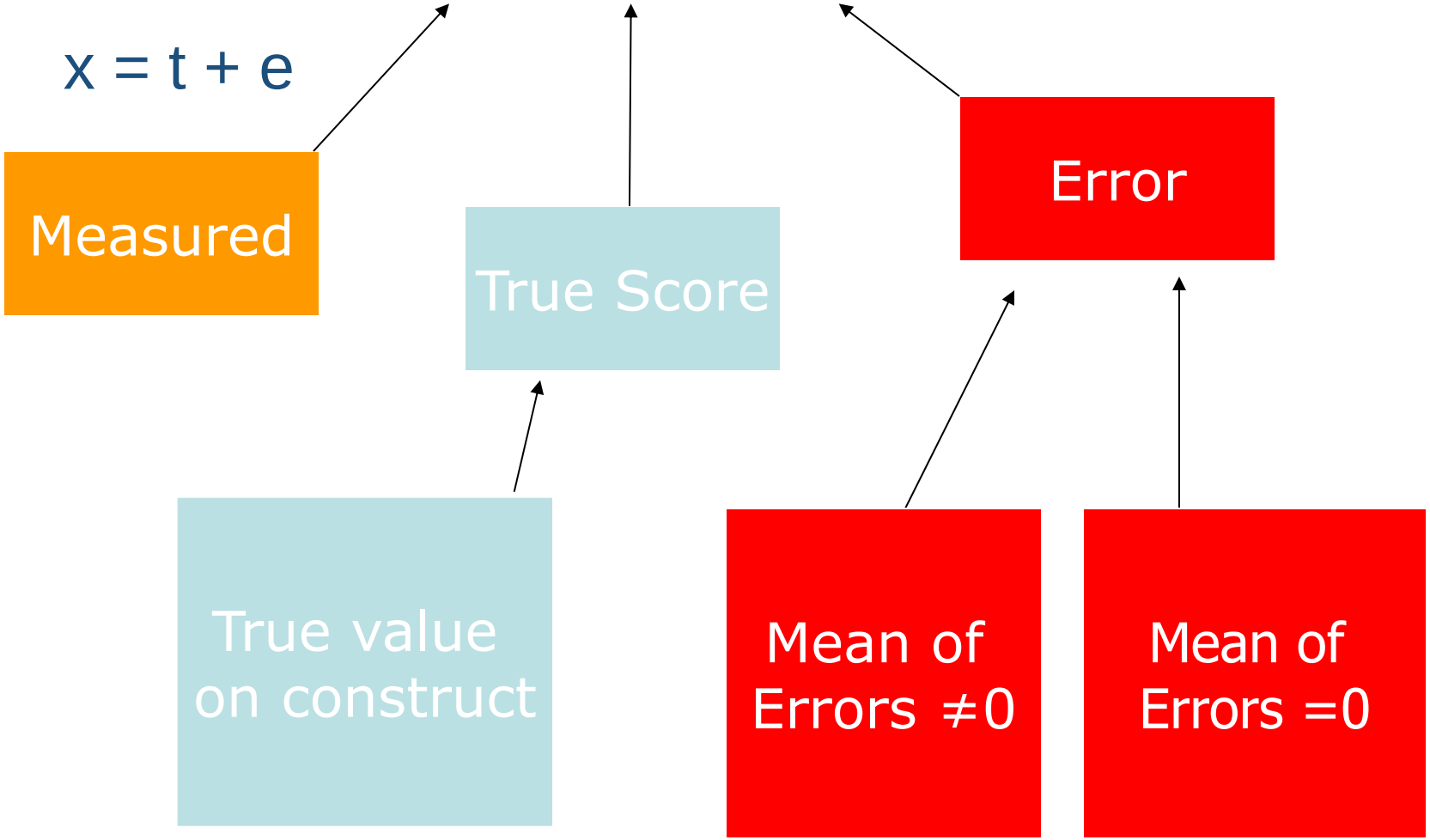
- We can measure latent variables using observable indicators
- We can think of the variance of a questionnaire item as being caused by:
  - The latent construct we want to measure
  - Other factors (error/unique variance)

True score and measurement error



$$X = t + e$$

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Observed item

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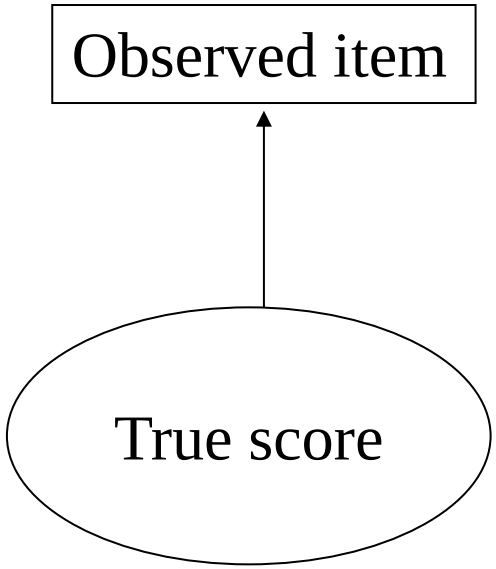

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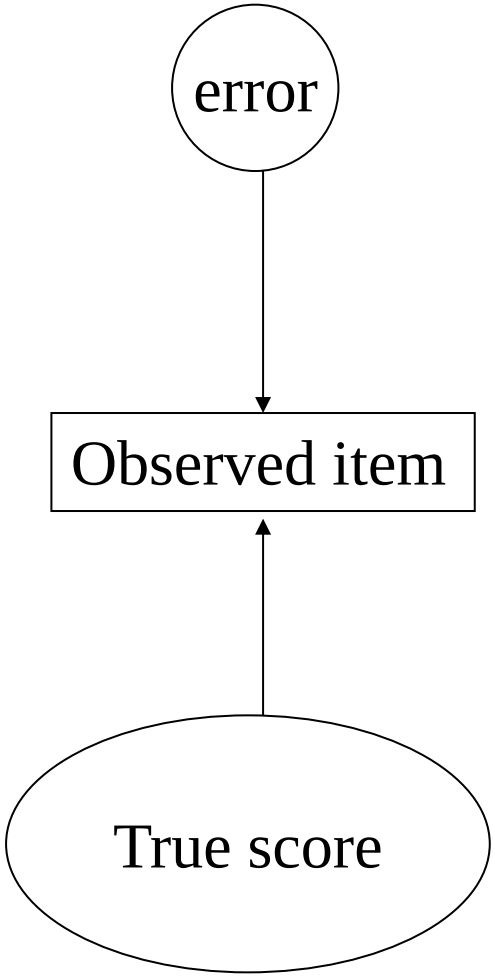

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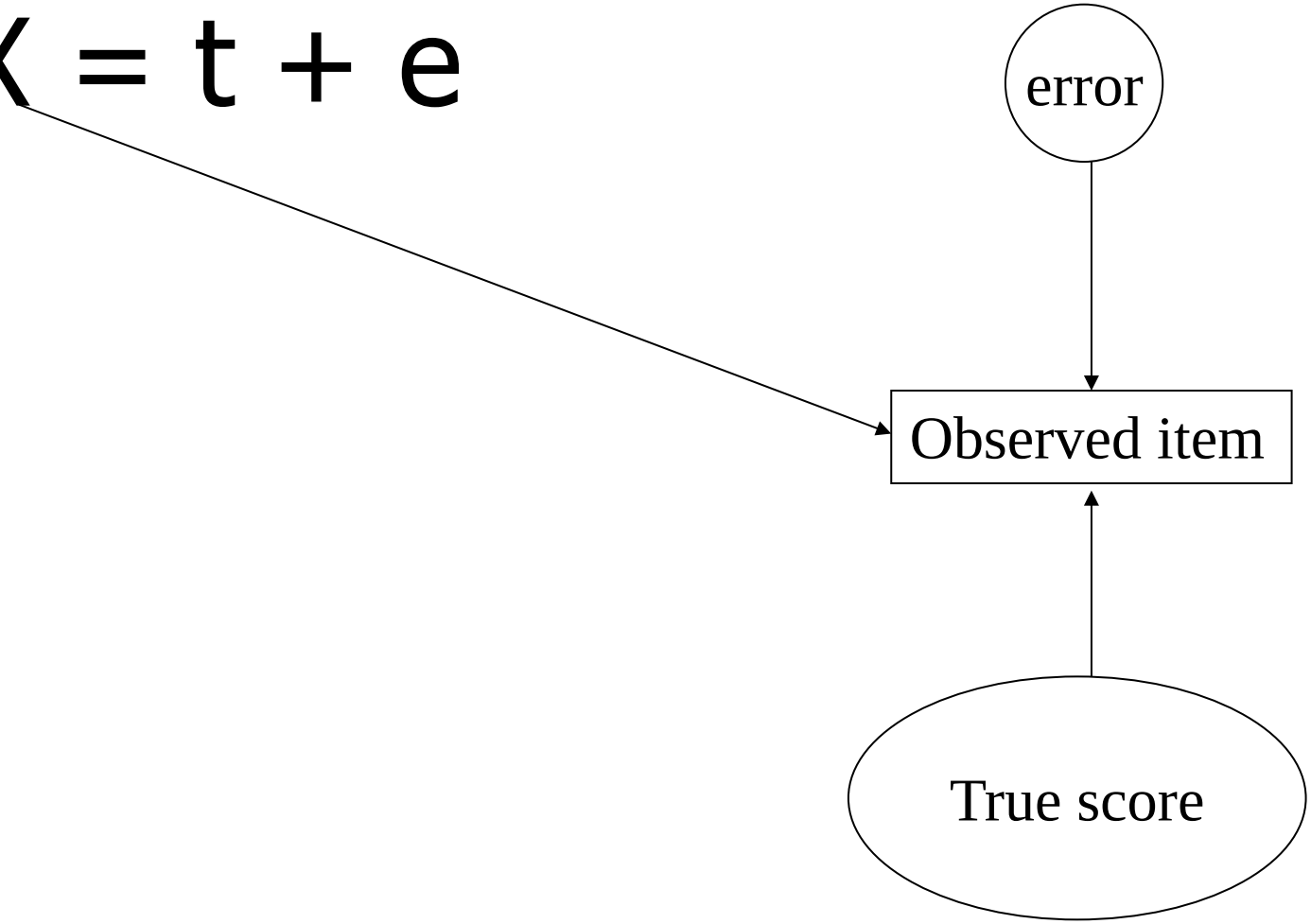

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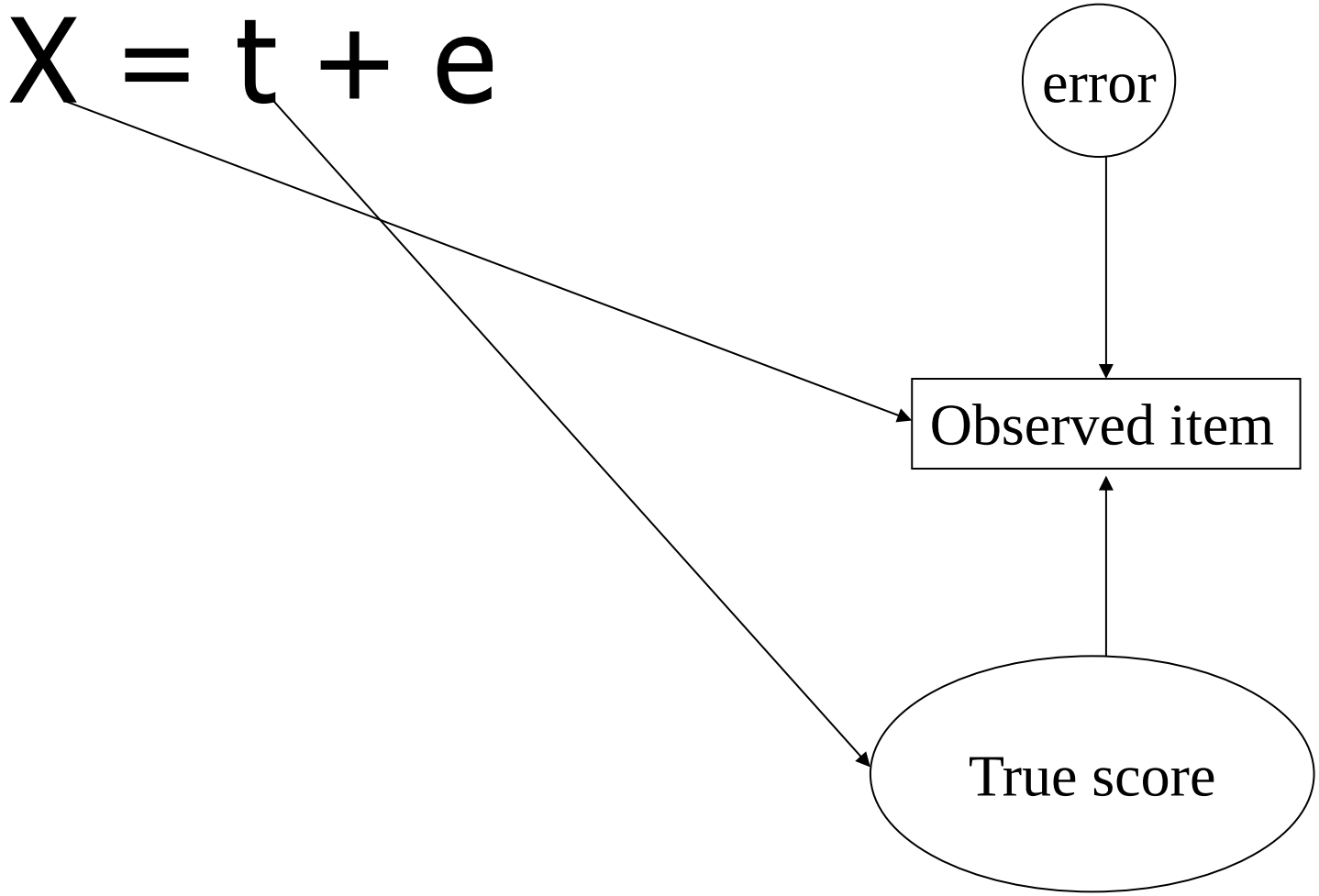

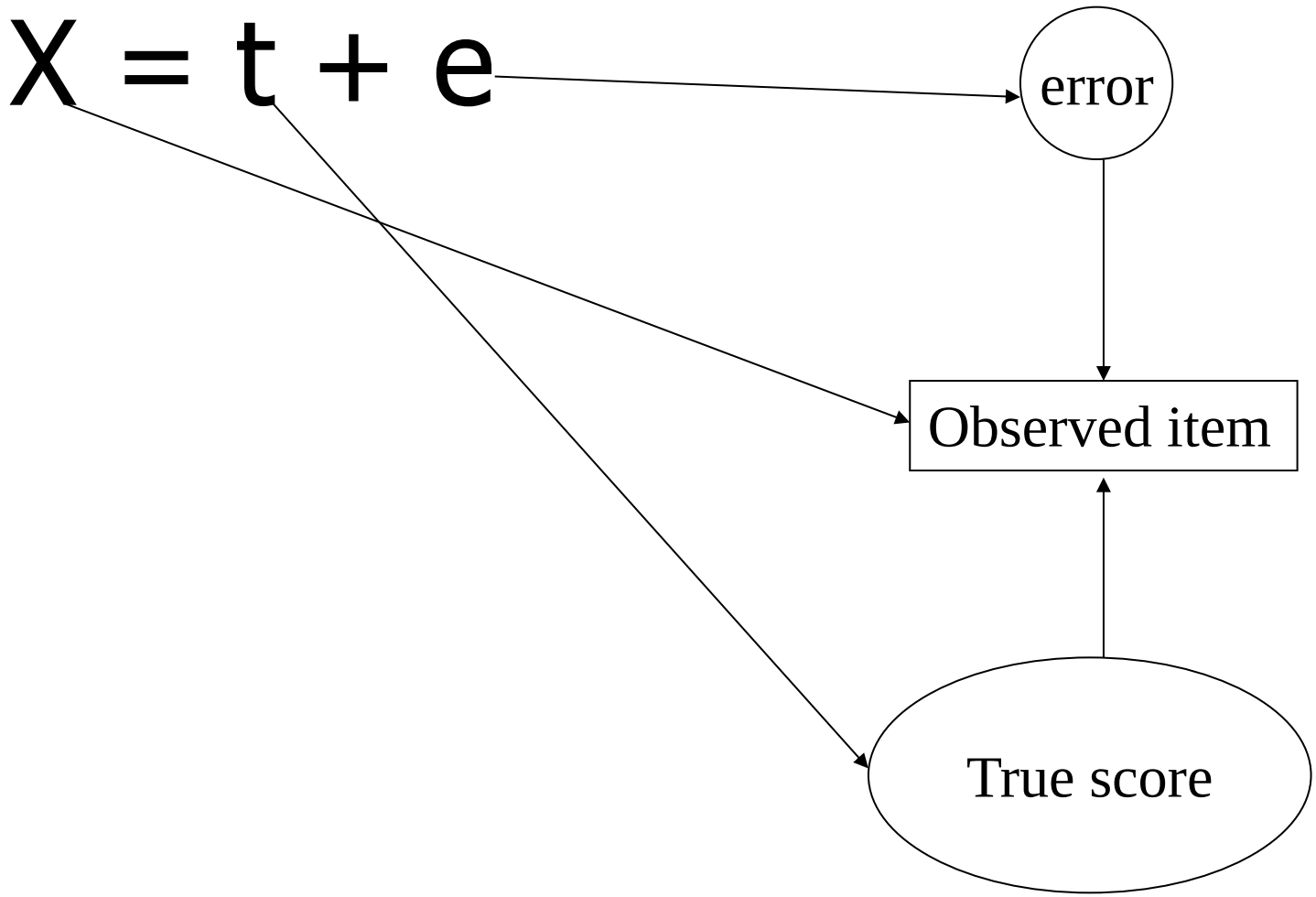
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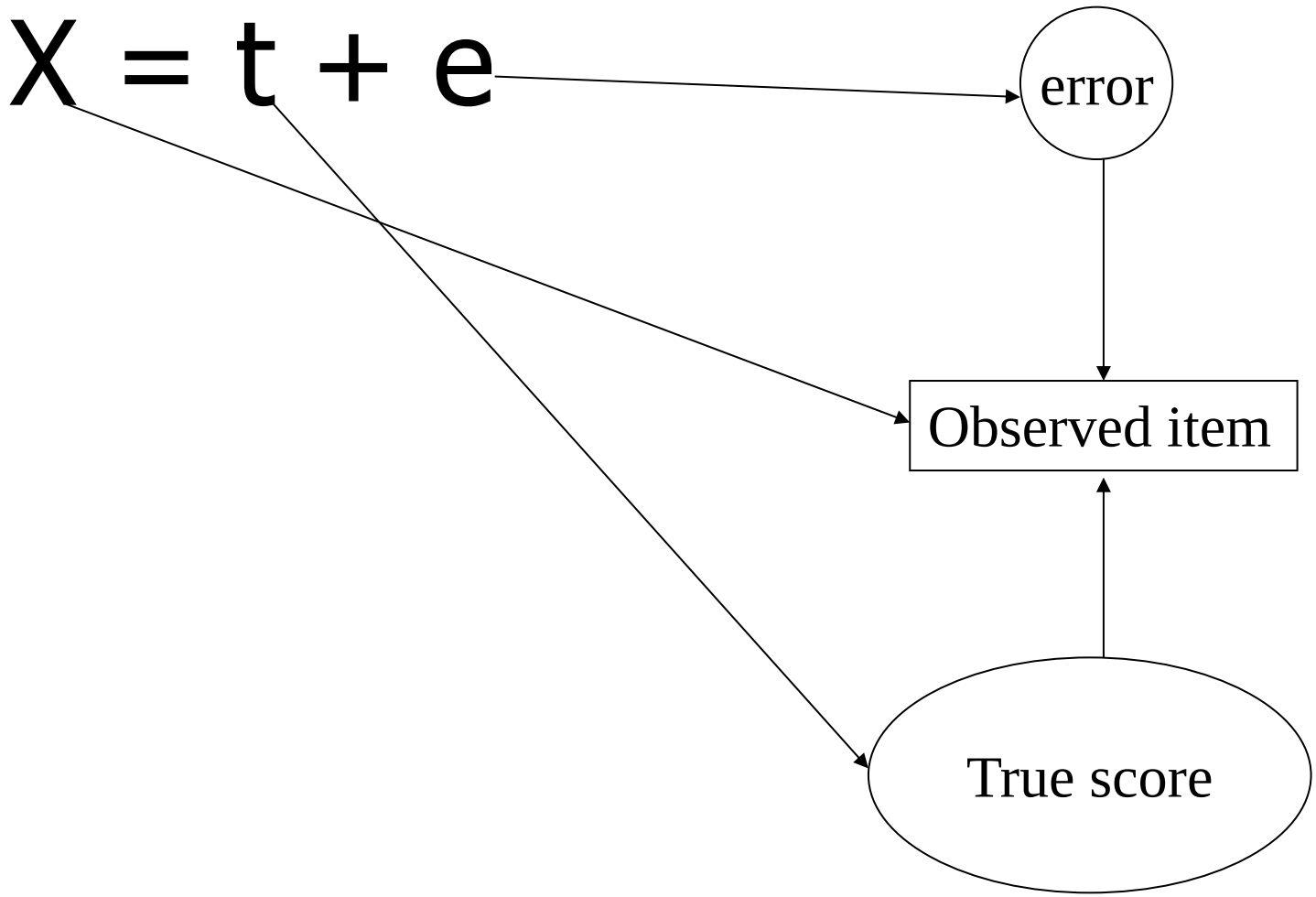
Observed item
True score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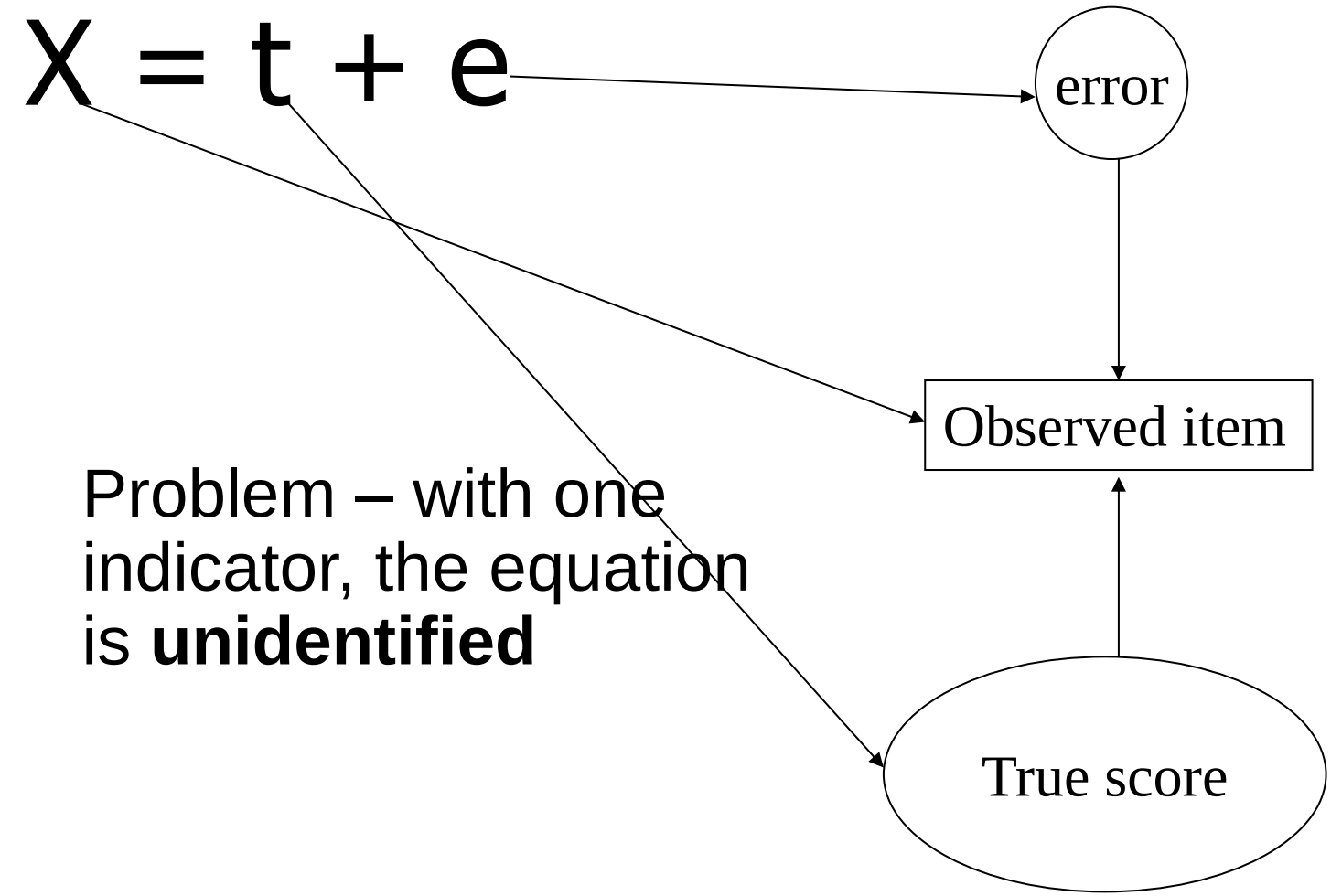

Problem – with one indicator, the equation is **unidentified**

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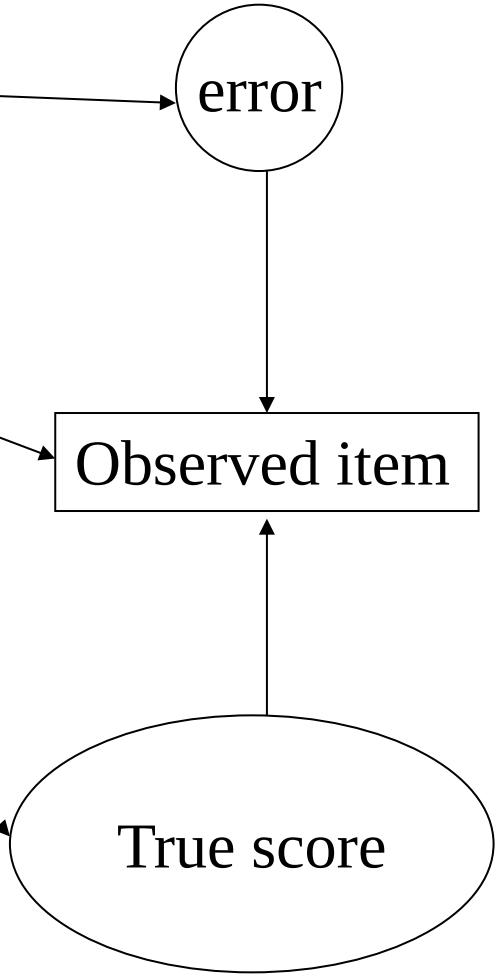

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We can't separate true score and error

Multiple Indicator Latent Variables

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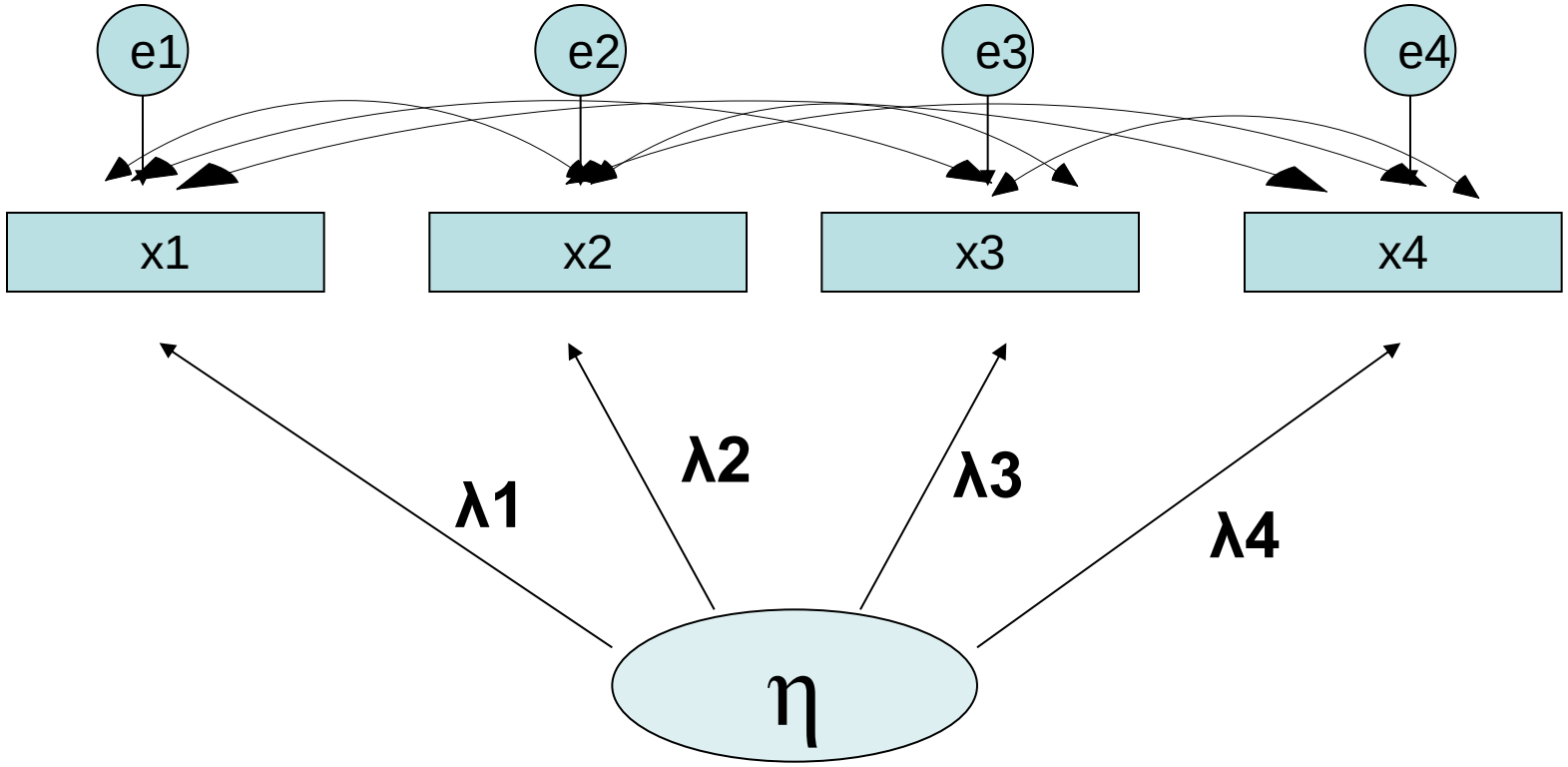
- With multiple indicators we can use a latent variable model to partition variance
- e.g. principal components analysis transforms correlated variables into uncorrelated components
- We can then use a reduced set of components to summarise the observed associations

A Common Factor Model



λ = Factor loadings = correlation between factor & indicator

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- Random error in dependent variables -> estimates unbiased but less precise
- Random error in independent variables -> attenuates regression coefficients toward zero

Remember

SEM can be thought of as

Path Analysis

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We now know about latent variables, what about path analysis?

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- Regression equations specified between measured variables
- ‘Effects’ of predictor variables on criterion/dependent variables can be:
  - Direct
  - Indirect
  - Total

Path Diagram notation

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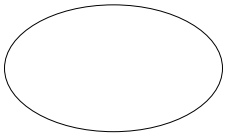
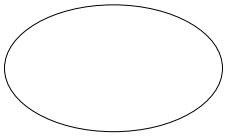


Measured latent variable

Observed / manifest variable

Path Diagram notation



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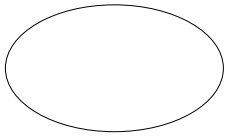

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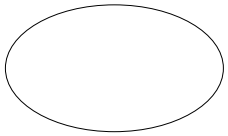

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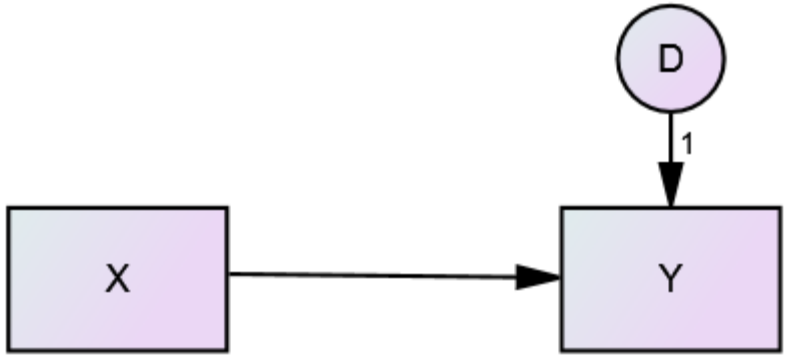
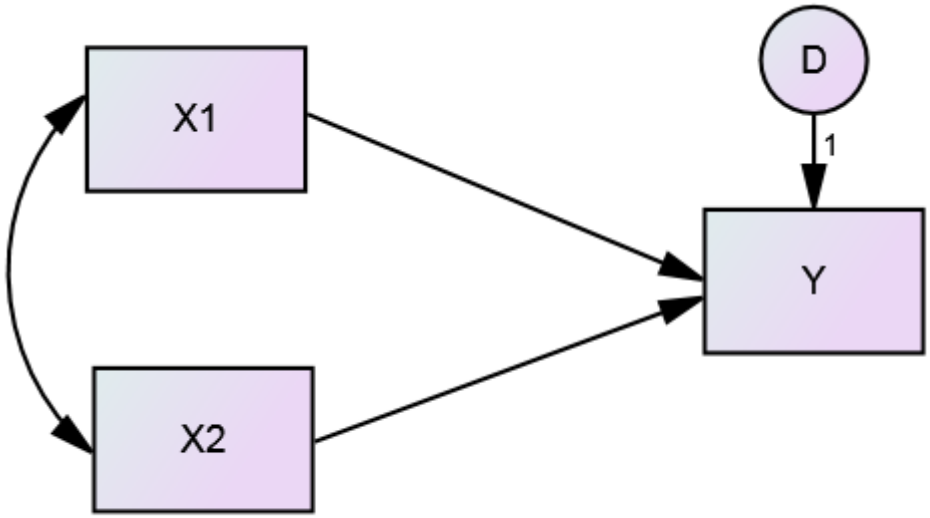
Regression / directional path

PD1: Single Cause



Two correlated causes



Indirect Effect

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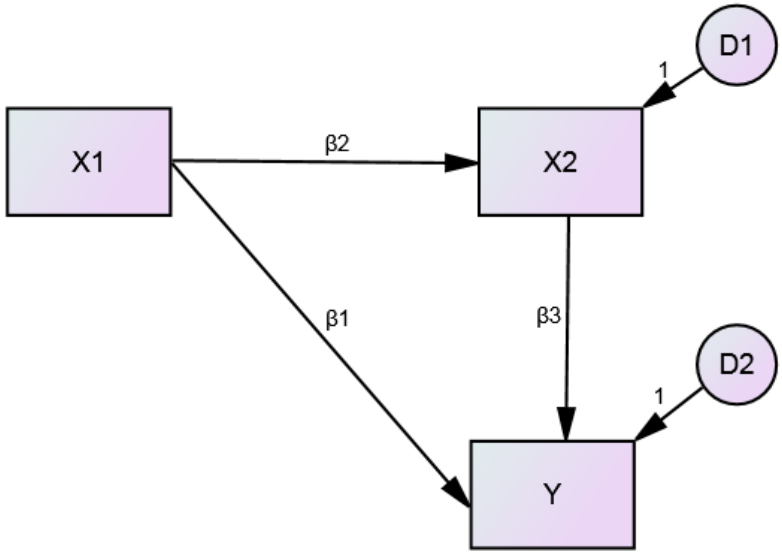

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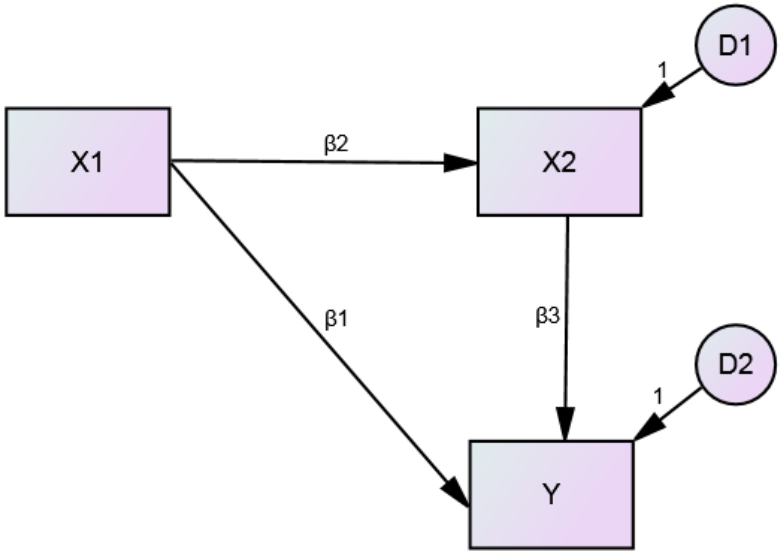
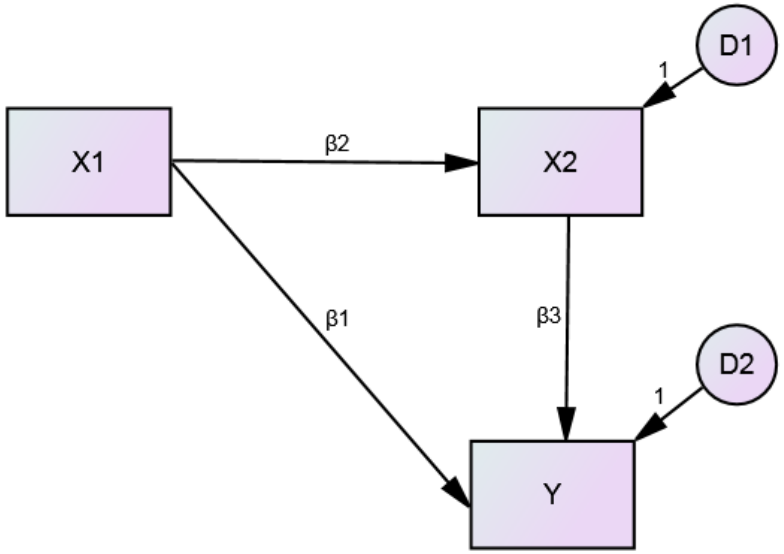


β1=direct effect of X1 on Y

Indirect Effect



β1=direct effect of X1 on Y

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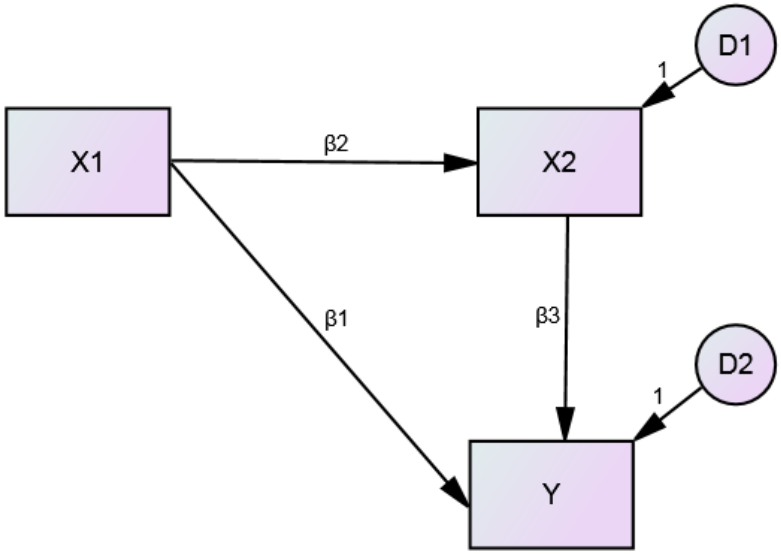
Indirect Effect



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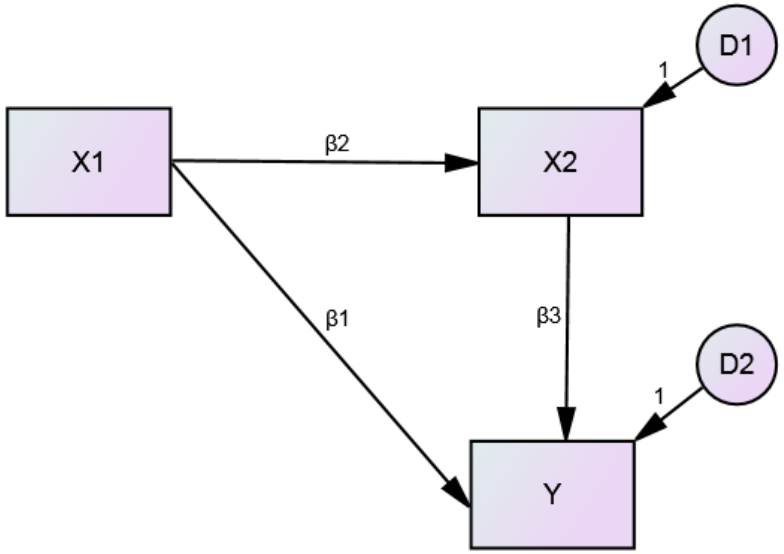

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β3=direct effect of X2 on Y

β2*β3=indirect effect of X1 on Y

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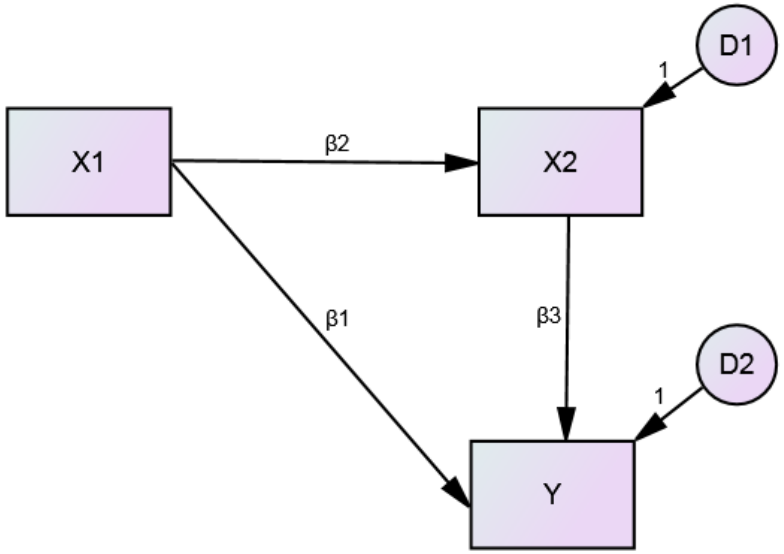

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β3=direct effect of X2 on Y

β2*β3=indirect effect of X1 on Y

β1+(β2*β3)=total effect of X1 on Y

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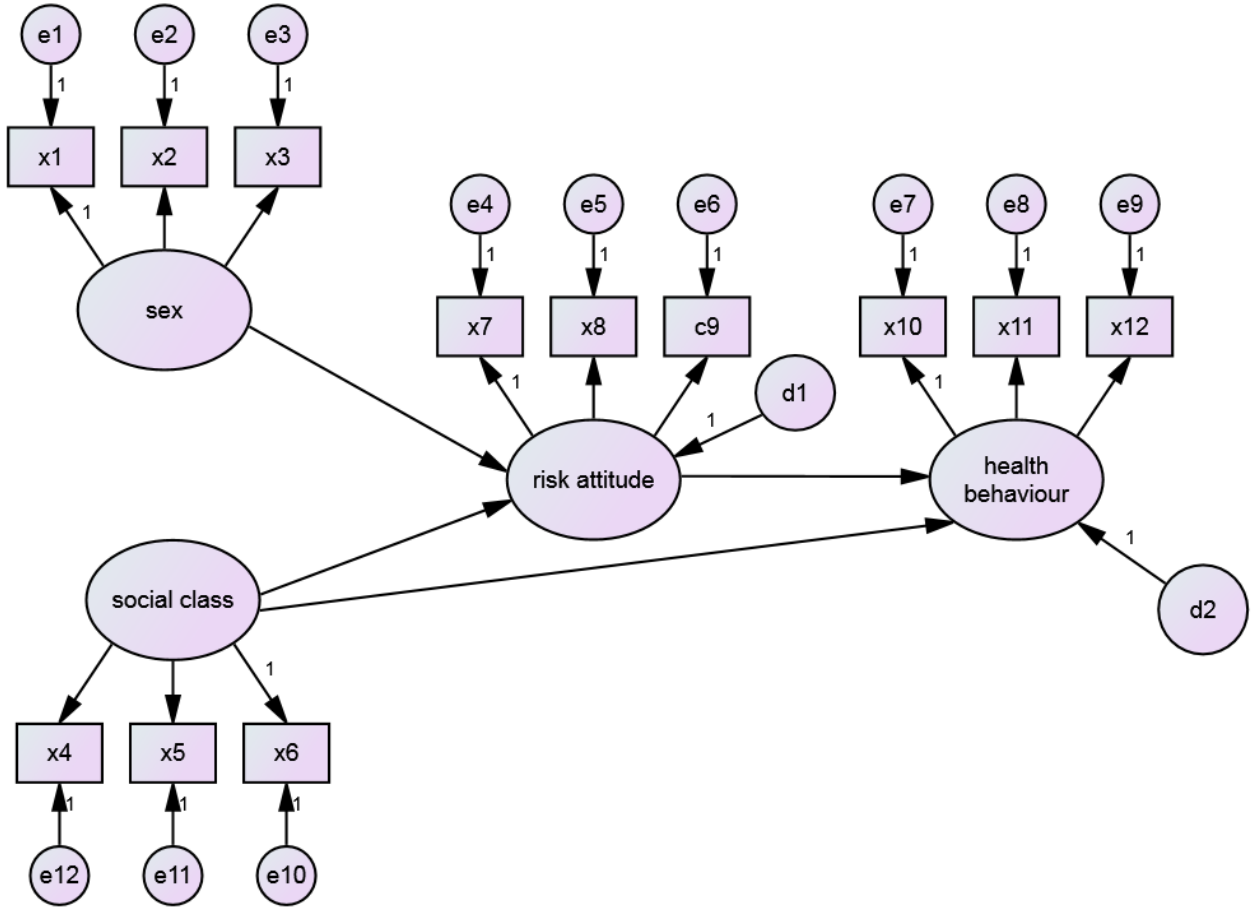

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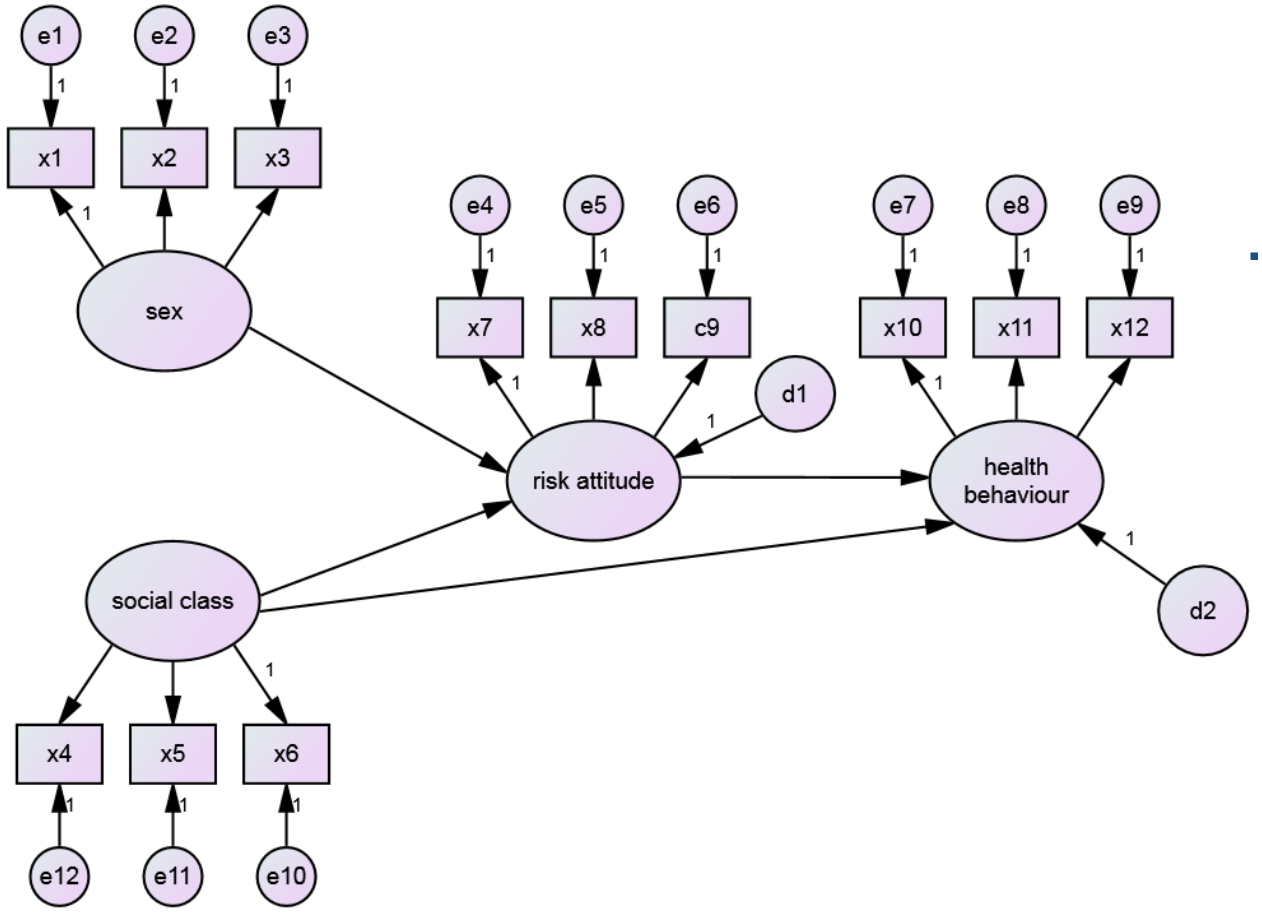

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For more information contact

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