Practice: Evaluation Research

Session 03 - **GCM and LCSM**

psy112 - Evaluation Research

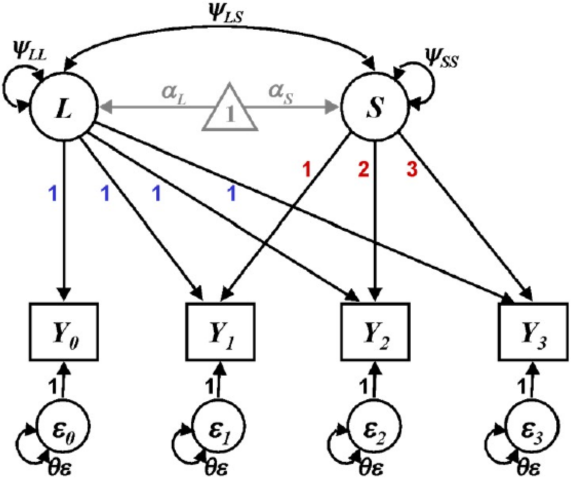
Faculty VI / UOL

Summer term 2025

Content

1. GCMs
2. LCSMs
3. Summary

Model 1: First-Order Linear Growth Curve Model (GCM)



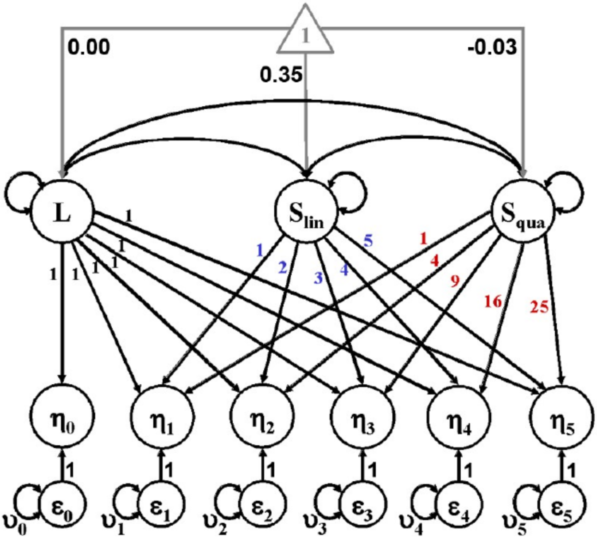
Model 1: Linear Growth Curve Model (GCM)

- **Description:** This is the most fundamental growth model. It captures a constant, straight-line pattern of change over time by estimating an initial level (Intercept, L) and a constant rate of change (Slope, S) for each individual.
- **Simple Equation:** The average score at time t is determined by the average starting point and the average slope.

$$E[Y_t] = \alpha_L + t \cdot \alpha_S$$

- **When to Use:** Use this model when your theory suggests that change should occur at a steady, constant rate over the entire measurement period.

Model 2: Quadratic (Second-Order) GCM



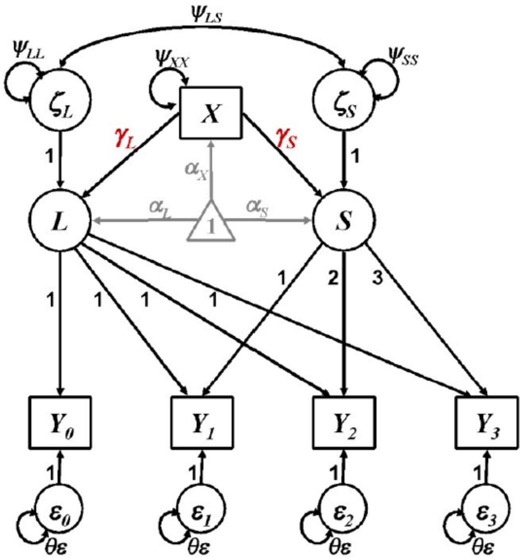
Model 2: Quadratic (Second-Order) GCM

- **Description:** This model captures non-linear change by adding a quadratic slope factor (S_{qua}). It allows for one curve in the trajectory, representing acceleration or deceleration in the rate of change.
- **Simple Equation:** The average score is now also a function of time squared.

$$E[Y_t] = \alpha_L + t \cdot \alpha_{S_{lin}} + t^2 \cdot \alpha_{S_{qua}}$$

- **When to Use:** Use this when you expect the rate of change to change over time. For example, learning might be rapid at first and then slow down.

Model 3: GCM with a Time-Invariant Covariate



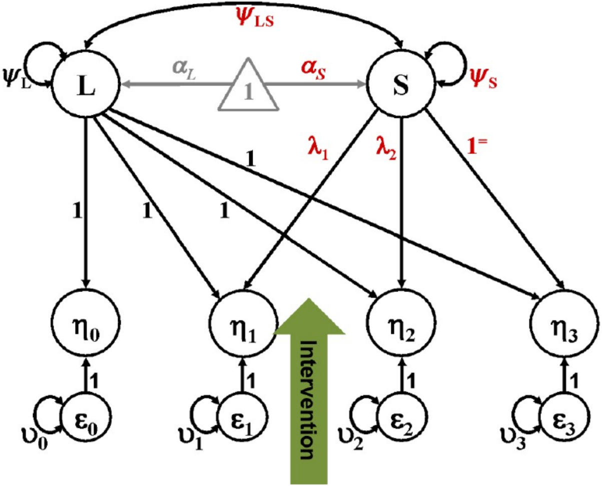
Model 3: GCM with a Time-Invariant Covariate

- **Description:** This model, also called a conditional GCM, explains individual differences in growth trajectories. It tests if a stable characteristic (X), like a personality trait or group membership, predicts the initial level (L) or rate of change (S).
- **Simple Equation:** The average Intercept and Slope now depend on the value of the covariate X.

$$E[L] = \alpha_L + \gamma_L X \quad | \quad E[S] = \alpha_S + \gamma_S X$$

- **When to Use:** Use this when your goal is to explain *why* individuals show different patterns of change.

Model 4: Nonlinear GCM (Latent Basis)



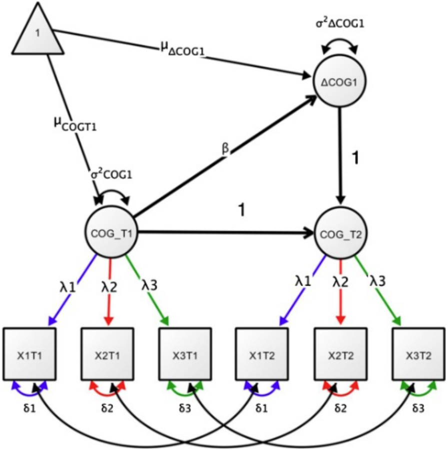
Model 4: Nonlinear GCM (Latent basis)

- **Description:** This model offers flexibility by letting the data determine the shape of the trajectory. Instead of fixing all slope loadings (e.g., 0, 1, 2, 3), some are freely estimated (λ_1, λ_2), allowing the model to capture unspecified non-linear patterns.
- **Simple Equation:** The average score's change depends on the estimated time loadings (λ_t).

$$E[Y_t] = \alpha_L + \lambda_t \cdot \alpha_S$$

- **When to Use:** Ideal for exploring the shape of change when theory is unclear, or for modeling abrupt shifts, such as those caused by an intervention.

Model 5: Latent Change Score (LCS) Model



Kievit et al. (2018)

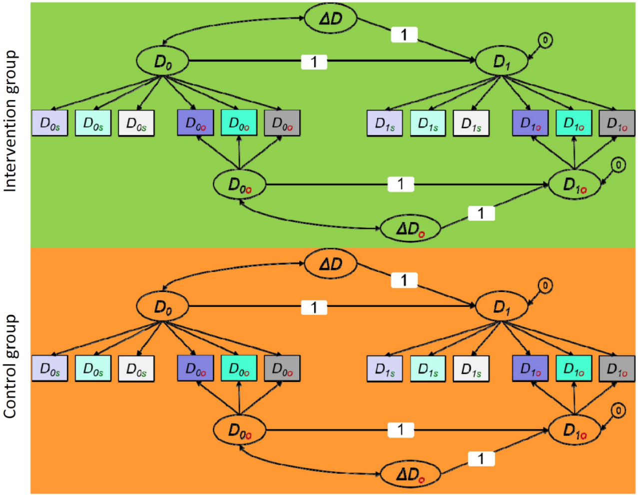
Model 5: Latent Change Score (LCS) Model

- **Description:** Unlike GCMs which model the overall trajectory, the LCS model focuses directly on the **change** between consecutive time points. It models the state at Time 2 as a function of the state at Time 1 plus a latent change score (Δ).
- **Simple Equation:** The score at the next time point is the score from the previous time point plus the estimated change.

$$E[\text{State}_{t+1}] = E[\text{State}_t] + E[\Delta_{\text{change}}]$$

- **When to Use:** When your research question is about the dynamics of change itself, such as what influences the transition from one state to the next.

Model 6: Multigroup LCS Model



Model 6: Multigroup LCS Model

- **Description:** This extends the LCS model to compare the dynamics of change between two or more distinct groups (e.g., an intervention group vs. a control group). The entire model is estimated separately for each group.
- **Simple Equation:** Equations are estimated for each group to test for differences in key parameters.

$$E[\Delta D_{\text{Intervention}}] \quad \text{vs.} \quad E[\Delta D_{\text{Control}}]$$

- **When to Use:** This is a powerful tool for randomized controlled trials (RCTs) to test if an intervention caused a different process of change compared to a control condition.

Summary of Model Differences

Model Name	Primary Focus	Key Feature	Best Use Case
Linear GCM	Overall Trajectory	Assumes a constant, linear rate of change.	Testing hypotheses about steady growth or decline.
Quadratic GCM	Overall Trajectory	Models one curve in the trajectory (acceleration/deceleration).	When the rate of change is expected to change over time.
Conditional GCM	Explaining Differences	Uses a time-invariant covariate to predict intercept and/or slope.	Understanding *why* individuals or groups show different growth patterns.
Latent Basis GCM	Exploring Shape	Freely estimates some slope loadings to let the data define the shape.	When theory is unclear about the shape of change, or for modeling interventions.
LCS Model	Dynamics of Change	Directly models the change between consecutive time points.	Investigating the process of change itself and what influences transitions.
Multigroup LCS	Comparing Dynamics	Estimates separate LCS models for different groups.	Testing if an intervention or group membership alters the process of change.

Next session

Topic: Causality

daniel.kristanto@uni-oldenburg.de & andrea.hildebrandt@uni-oldenburg.de