

Practice: Evaluation Research

Session 02 - MLM and CSM

psy112 - Evaluation Research

Faculty VI / UOL

Summer term 2025

Content

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- 2 Mixed ANOVA
- 3 Multi-level Modeling section
- 4 Change Score Model

Setting Up Environment

- The book for this course is available [here](#)
- We will use the environment from psy126 ([check here](#)) or the one we set up during the first practical session.
- Importantly, we will use rpy2 package in python to run R script in python environment. To check that your environment works, please try to run the jupyter book (test.ipynb) uploaded in StudIP.
- If there is an error, please refer to book from psy126 ([click here](#)), especially in the part of Potential Issues

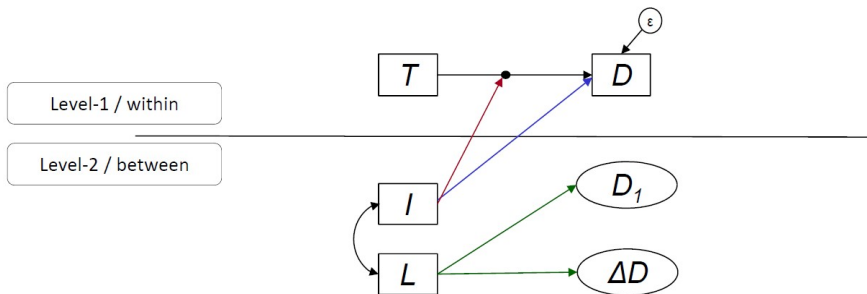
Mixed ANOVA

Building on purely between-subjects and within-subjects analyses, we now introduce **Mixed ANOVA**.

- **Core Idea:** Mixed ANOVA is used for research designs that include **both**:
 - ▶ A **Between-Subjects Factor**: Comparing two or more *independent* groups of participants (e.g., treatment vs. control group).
 - ▶ A **Within-Subjects Factor**: Measuring the *same* participants multiple times or under multiple conditions (e.g., pre-test vs. post-test; this is the repeated measures component).
- **Purpose:** It allows us to simultaneously investigate:
 - ▶ Differences *between* the groups (main effect of the between-subjects factor).
 - ▶ Changes *within* individuals over time/conditions (main effect of the within-subjects factor).
 - ▶ The **interaction** between these factors: Does the within-person change differ depending on which group a person belongs to?

Multilevel model

- Between-person IV: Intervention (I) no/yes = 0/1
- Within-person IV : Time (T) pre/post = 0/1
- DV: Depression (D)
- Covariate: Loneliness (L)



Exercise: Write the equation for the multilevel regression model and interpret the 5 regression coefficients (colored + black) estimated in the model.

Multilevel Model Equation

This model predicts Depression score (D) based on Time (T), Intervention group (I), Loneliness (L), and their interactions.

Variables:

- D : Depression score (Level 1 DV)
- T : Time (Level 1 IV, coded 0=pre, 1=post)
- I : Intervention group (Level 2 IV, coded 0=control, 1=intervention)
- L : Loneliness (Level 2 Covariate)

Model Equation:

$$D_{ti} = b_0 + b_1 \cdot T_{ti} + b_2 \cdot I_i + b_3 \cdot (T_{ti} \cdot I_i) + b_4 \cdot L_i + b_5 \cdot (T_{ti} \cdot L_i) + (\text{error terms})$$

Interpretation of Coefficients

$$D_{ti} = b_0 + b_1 \cdot T_{ti} + b_2 \cdot I_i + b_3 \cdot (T_{ti} \cdot I_i) + b_4 \cdot L_i + b_5 \cdot (T_{ti} \cdot L_i) + (\text{error terms}_{ti})$$

***b*₀: (Intercept)**

Path: Baseline value (no specific arrow).

Interpretation: Estimated average D at pre-test ($T = 0$) for the control group ($I = 0$) when Loneliness is 0 ($L = 0$).

***b*₁: (Main Effect of Time T)**

Path: Black arrow ($T \rightarrow D$), slope for ref. group.

Interpretation: Estimated average change in D from pre- to post-test ($T = 0$ to $T = 1$) for the control group ($I = 0$) when Loneliness is 0 ($L = 0$).

***b*₂: (Main Effect of Intervention I)**

Path: Blue arrow ($I \rightarrow D$).

Interpretation: Estimated average difference in D between intervention ($I = 1$) and control ($I = 0$) groups at pre-test ($T = 0$), holding L constant.

Interpretation of Coefficients

$$D_{ti} = b_0 + b_1 \cdot T_{ti} + b_2 \cdot I_i + b_3 \cdot (T_{ti} \cdot I_i) + b_4 \cdot L_i + b_5 \cdot (T_{ti} \cdot L_i) + (\text{error terms}_{ti})$$

b3: (Interaction Effect $T \times I$)

Path: Red arrow (I modifying $T \rightarrow D$).

Interpretation: Estimates how much the change in D over time differs for the intervention group ($I = 1$) compared to the control group ($I = 0$), holding L constant.

b4: (Main Effect of Loneliness L)

Path: Green arrow (top) ($L \rightarrow D$).

Interpretation: Estimated difference in D at pre-test ($T = 0$) associated with a one-unit increase in L , holding I constant.

b5: (Interaction Effect $T \times L$)

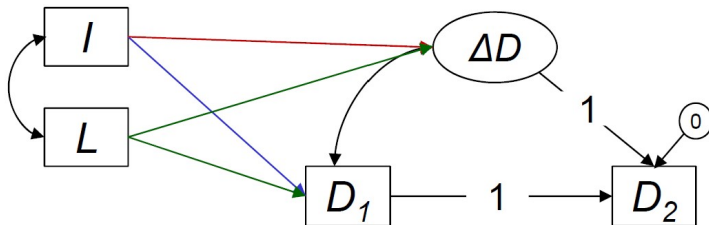
Path: Green arrow (bottom) (L modifying $T \rightarrow D$).

Interpretation: Estimates how much the change in D over time differs for each one-unit increase in L , holding I constant.

Note: The curved arrow between I and L represents their correlation, not a coefficient in this model predicting D .

Difference Score Model (Path modeling)

- Between-person IV: Intervention (I) no/yes = 0/1
- Within-person IV : Time (T) pre/post = 0/1
- DV: Depression (D)
- Covariate: Loneliness (L)



Exercise: Write the path model equations and interpret the 4 regression coefficients (colored) estimated in the model.

Difference Score Path Model: Equations

This path model analyzes the predictors of baseline depression (D_1) and the change in depression (ΔD) from pre-test (T=0) to post-test (T=1). The change score is defined as $\Delta D = D_2 - D_1$.

Variables:

- D_1 : Depression score at Time 1 (Pre-test)
- D_2 : Depression score at Time 2 (Post-test)
- ΔD : Change in Depression ($D_2 - D_1$)
- I : Intervention group (0=control, 1=intervention) - Level 2
- L : Loneliness (Level 2 Covariate)

Path Model Equations:

$$D_{1i} = b_{0D1} + b_1 \cdot I_i + b_2 \cdot L_i + e_{D1i}$$

$$\Delta D_i = b_{0\Delta D} + b_3 \cdot I_i + b_4 \cdot L_i + e_{\Delta D_i}$$

$$D_{2i} = D_{1i} + \Delta D_i \quad (\text{Implied by diagram})$$

Where i denotes the individual, b_1, b_2, b_3, b_4 correspond to the colored

Interpretation of Path Coefficients

$$D_{1i} = b0_{D1} + b1 \cdot I_i + b2 \cdot L_i + e_{D1i}$$
$$\Delta D_i = b0_{\Delta D} + b3 \cdot I_i + b4 \cdot L_i + e_{\Delta D i}$$

b1: (Effect of I on D_1)

Path: Blue arrow ($I \rightarrow D_1$).

Interpretation: Estimated average difference in baseline depression (D_1) between intervention ($I = 1$) and control ($I = 0$) groups, holding L constant.

b2: (Effect of L on D_1)

Path: Green arrow (bottom) ($L \rightarrow D_1$).

Interpretation: Estimated average difference in baseline depression (D_1) for a one-unit increase in L , holding I constant.

Interpretation of Path Coefficients

$$D_{1i} = b_{0D1} + b_1 \cdot I_i + b_2 \cdot L_i + e_{D1i}$$
$$\Delta D_i = b_{0\Delta D} + b_3 \cdot I_i + b_4 \cdot L_i + e_{\Delta D i}$$

b3: (Effect of I on ΔD)

Path: Red arrow ($I \rightarrow \Delta D$).

Interpretation: Estimated average difference in the *change* in depression (ΔD) between intervention ($I = 1$) and control ($I = 0$) groups, holding L constant.

b4: (Effect of L on ΔD)

Path: Green arrow (top) ($L \rightarrow \Delta D$).

Interpretation: Estimated average difference in the *change* in depression (ΔD) for a one-unit increase in L , holding I constant.

Note: The curved arrow between I and L represents their correlation. The black arrows define $\Delta D = D_2 - D_1$.

Next session

Topic: Latent Change Score Model

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