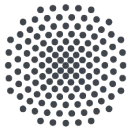


University of Stuttgart
Germany

Mixed-effects models in EEG

Statistically evaluating mixed-effects models for EEG analysis using large-scale simulations

June 30, 2022

About me

Luis
Lips

Education

- Information Systems B.Sc
- Computer Science M.Sc.

Journey to master thesis

- got in touch via Bene’s EEG course
- got excited and stayed for the FaPra

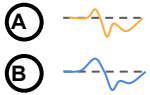
Agenda

Overview → Goals → Approach → Schedule

Overview

Number of subjects

Number of trials



Between-subject variability

Modelling Scheme

Analysis

Statistical Power

Modelling Schemes

Two-way approach

Meta-models

Mixed-effects models

Goals

Two-way approach

“Linear regression”

$\boldsymbol{y = X\beta + \varepsilon}$

$\boldsymbol{\varepsilon} \sim N(0,R)$

Meta-model

$y_{i\square} = \mu + \delta_{\square} + \varepsilon_{i\square}$

$\delta_{\square} \sim N(0,\tau^2)$

$\varepsilon_{i\square} \sim N(0,\sigma_{\square}^2)$

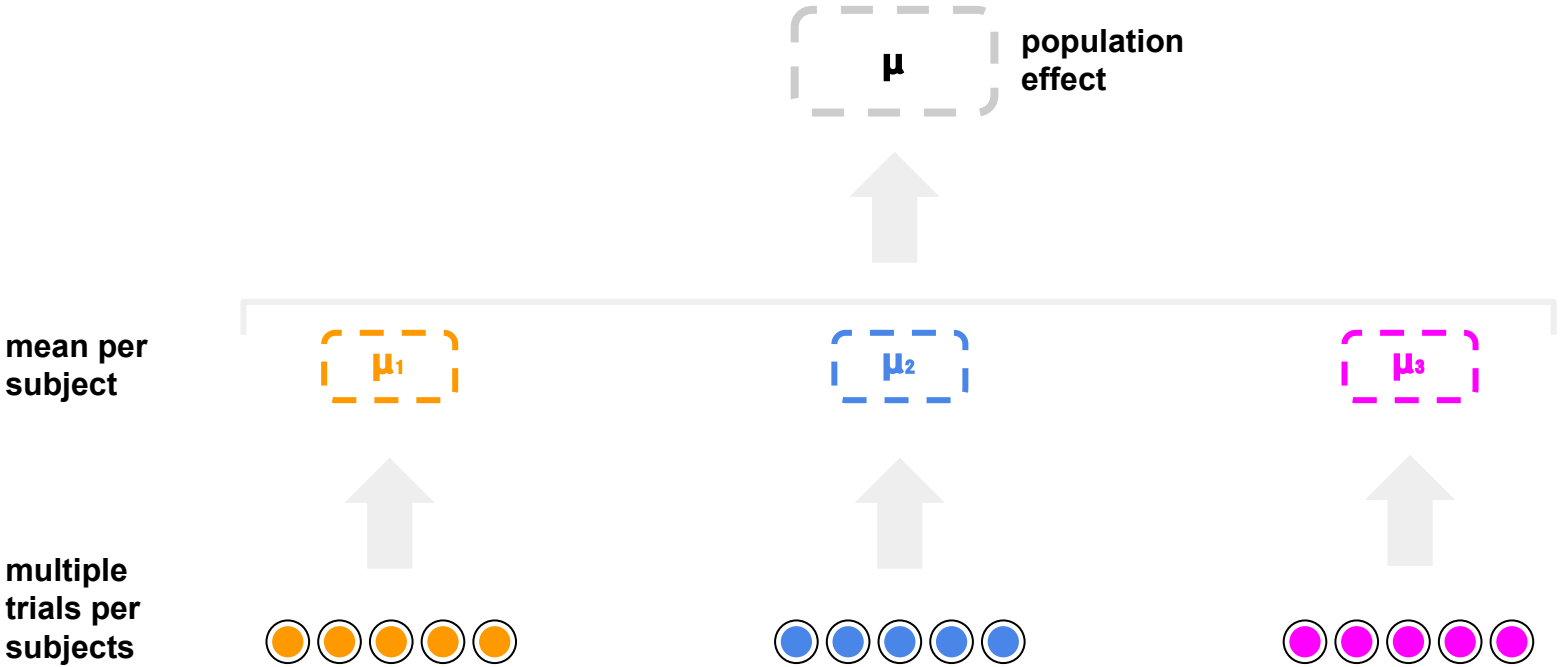
Mixed-effects model

$\boldsymbol{y = X\beta + Zu + \varepsilon}$

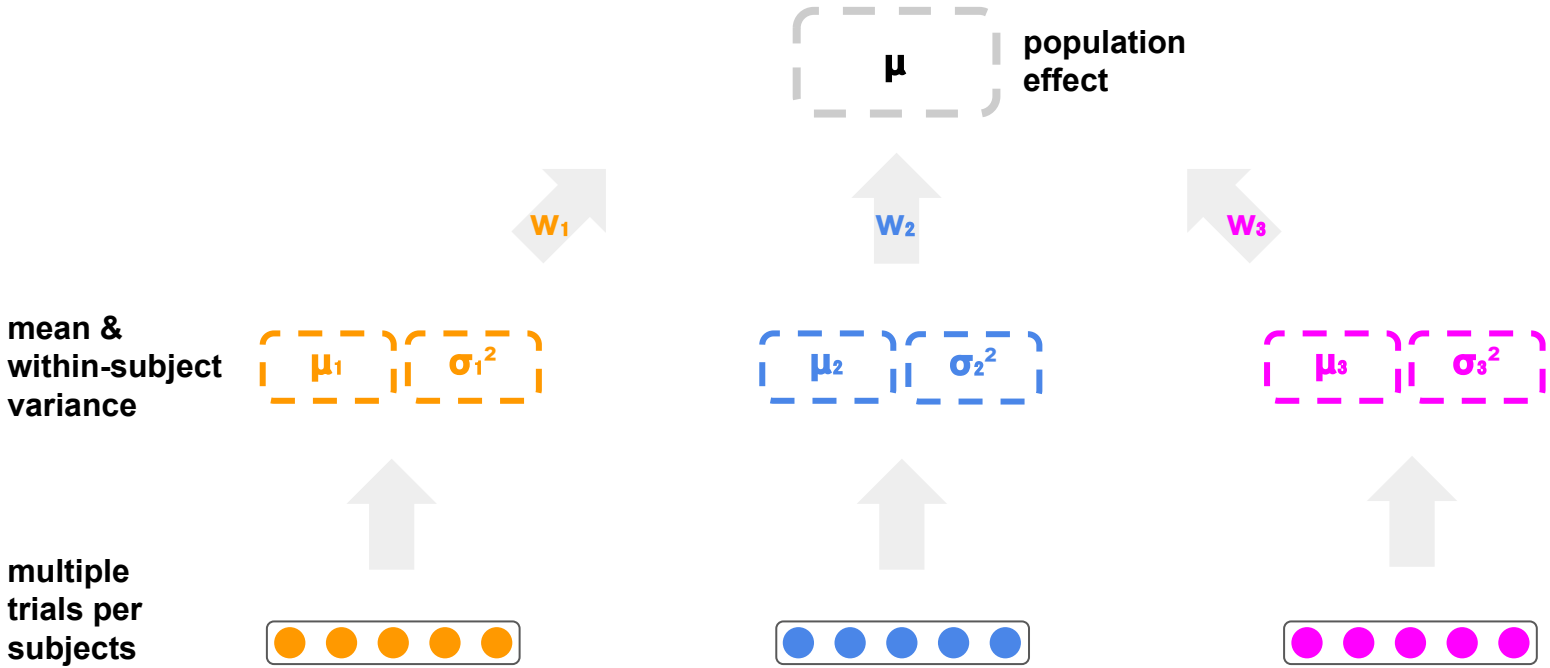
$\boldsymbol{u} \sim N(0,G)$

$\boldsymbol{\varepsilon} \sim N(0,R)$

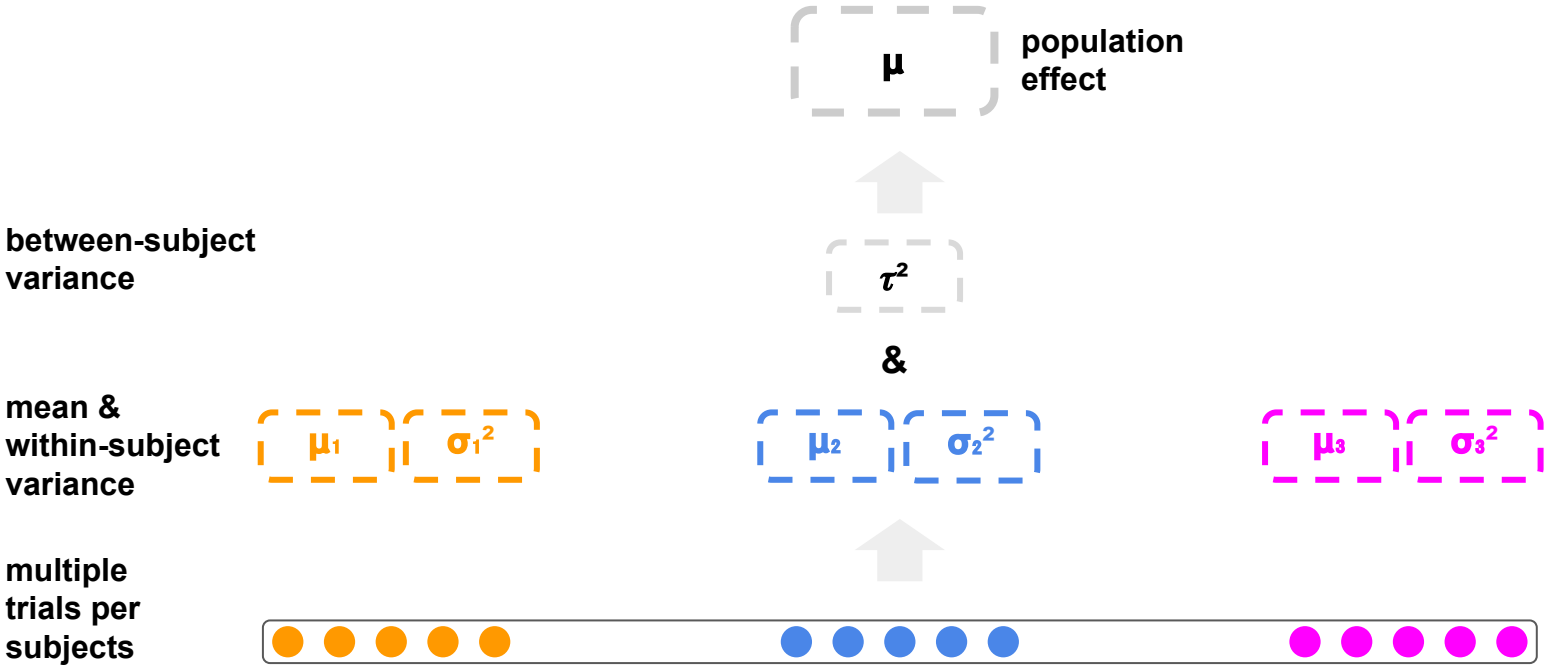
Two-way approach



Meta-model

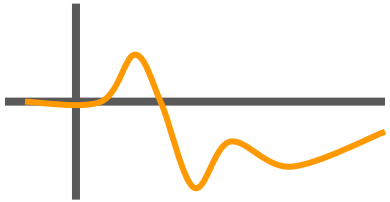

μ
population effect
w1
w2
w3
mean & within-subject variance
μ1
σ1²
μ2
σ2²
μ3
σ3²
multiple trials per subjects

Mixed-effects model

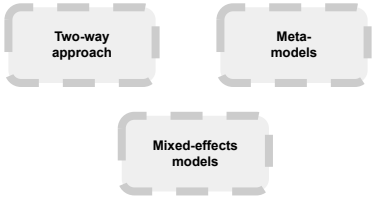


Goals

Simulation toolbox



Implementing of modelling-schemes



Comparison

Simulation toolbox

julia

MixedModels.jl

MixedModels Sim.jl

Simulating experimental conditions

1

Fit mixed model to dummy variables

2

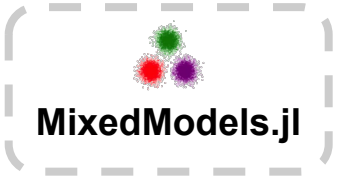
Change time-varying parameters

3

Add noise to simulated signal

4

Implementation of modelling-schemes



Implementing two-way approach	Implementing mixed-effects model	Implementing meta-model	Sanity check
1	2	3	4

Comparison

julia

Plots.jl

Simulating data

1

Analyse data via different modelling schemes

2

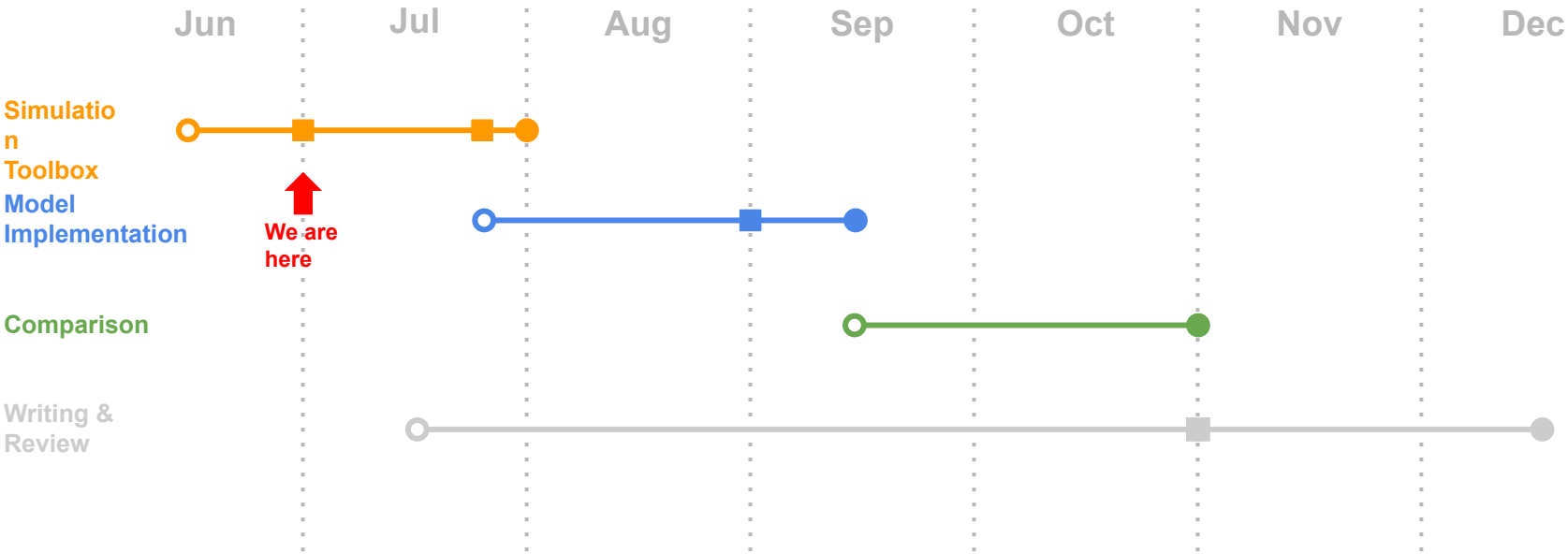
Plot power contour plots

3

(Multiple comparison correction)

4

Timeline


Jun
Jul
Aug
Sep
Oct
Nov
Dec
Simulation Toolbox
Model Implementation
We are here
Comparison
Writing & Review

References

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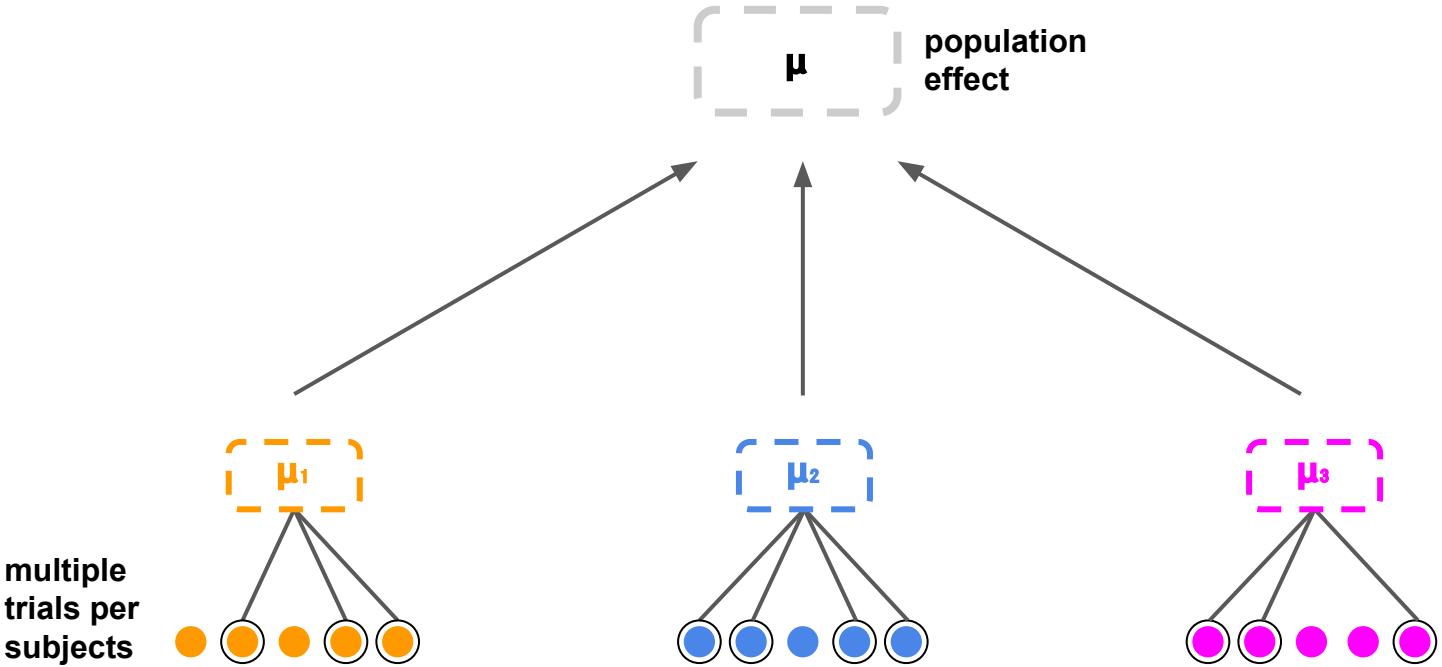
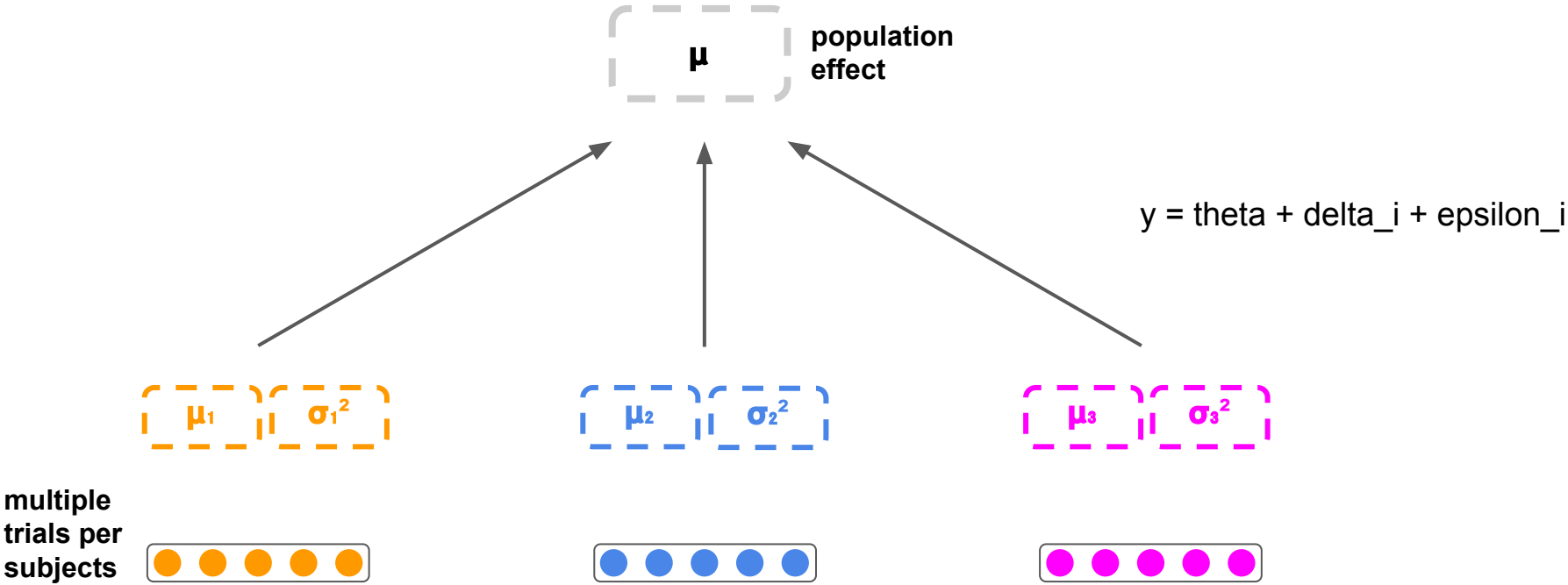
Discussion

Two-way approach



Meta-model


μ
population effect
y = theta + delta_i + epsilon_i
μ1
σ1²
μ2
σ2²
μ3
σ3²
multiple trials per subjects

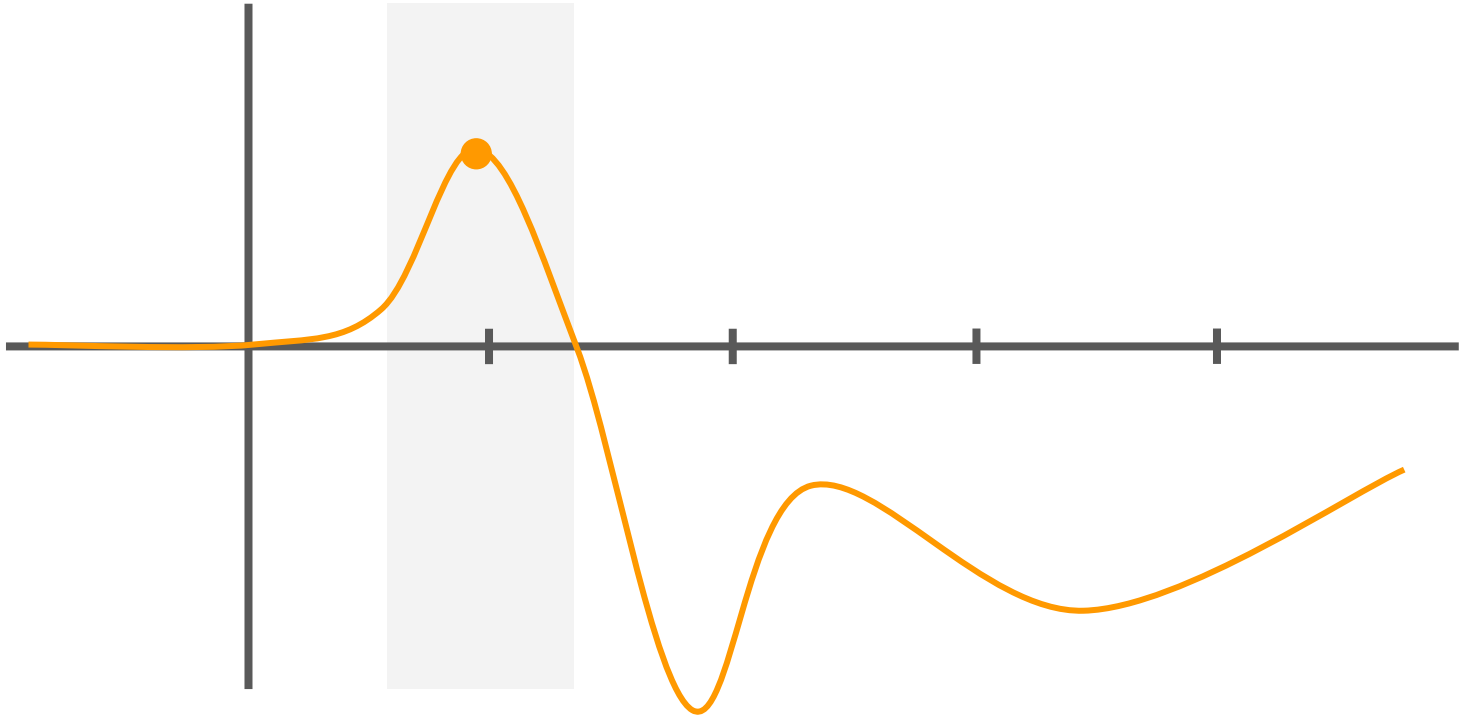
Mixed-effects model

μ **population effect**

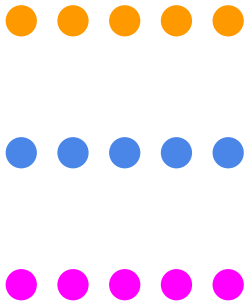
$y = X*b + Z*u + epsilon\_ij$

μ_1 μ_2 μ_3

1 Subject, 1 Trial, 1 Measure



Multiple subjects, multiple trials



Repeated measures !

Data

Data