Mixed-effects models in EEG

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

October 14, 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
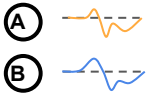
Agenda

Overview

Goals

State

Outlook

Overview

Number of subjects

Number of trials
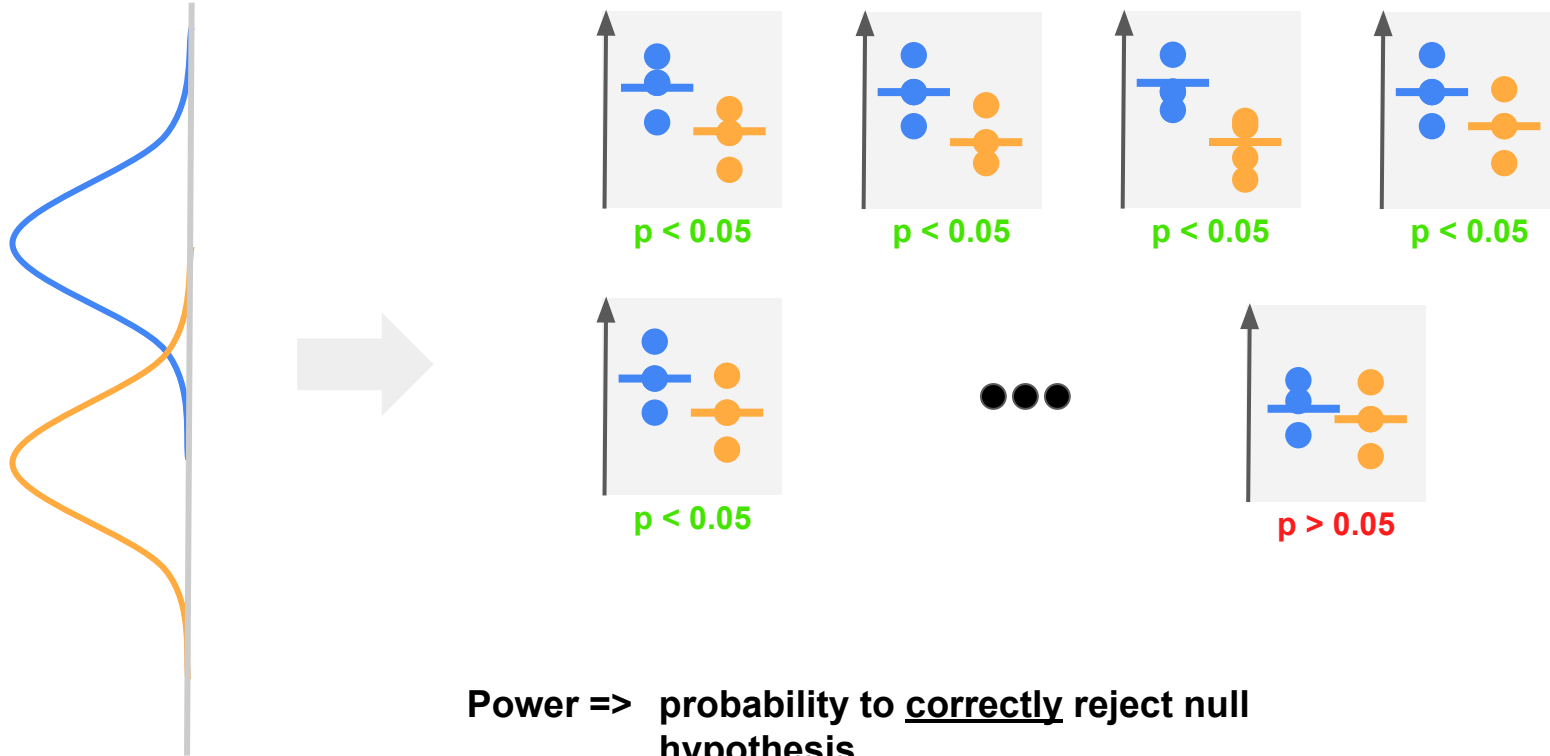
Between-subject variability
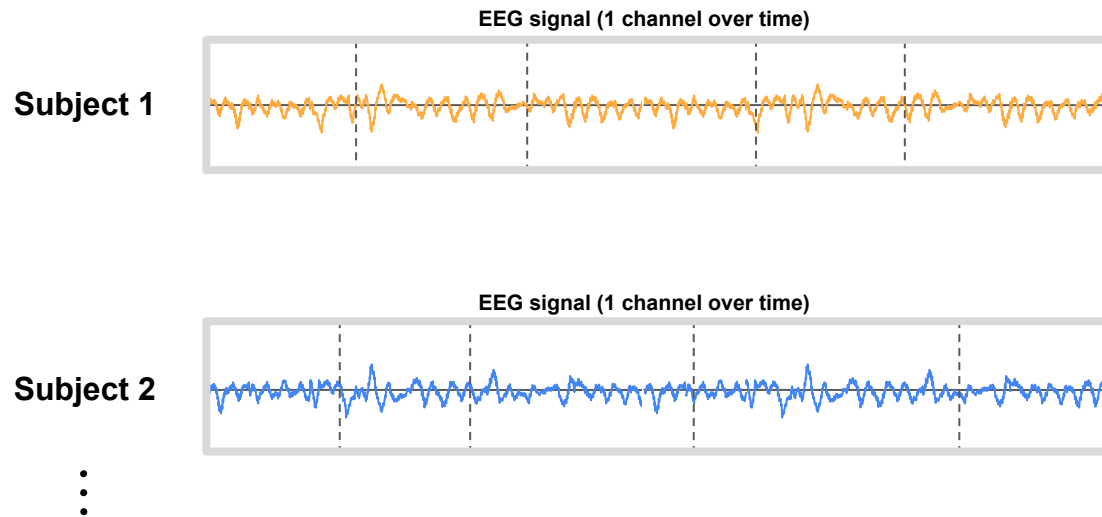
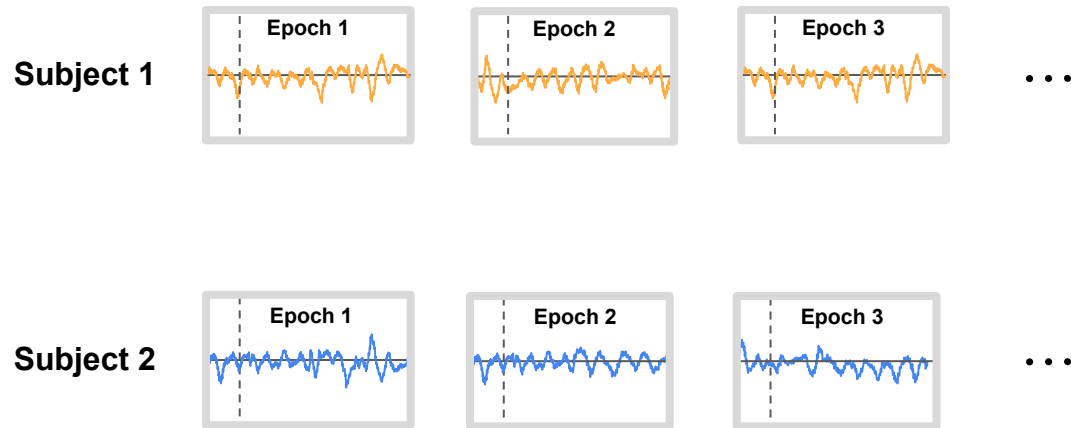Modelling Scheme

Analysis

Statistical Power

Statistical Power

Power => probability to <u>correctly</u> reject null hypothesis

Data

EEG signal (1 channel over time)

Subject 1

EEG signal (1 channel over time)

Subject 2

Data

Subject 1

Epoch 1	Epoch 2	Epoch 3	· · ·

Subject 2

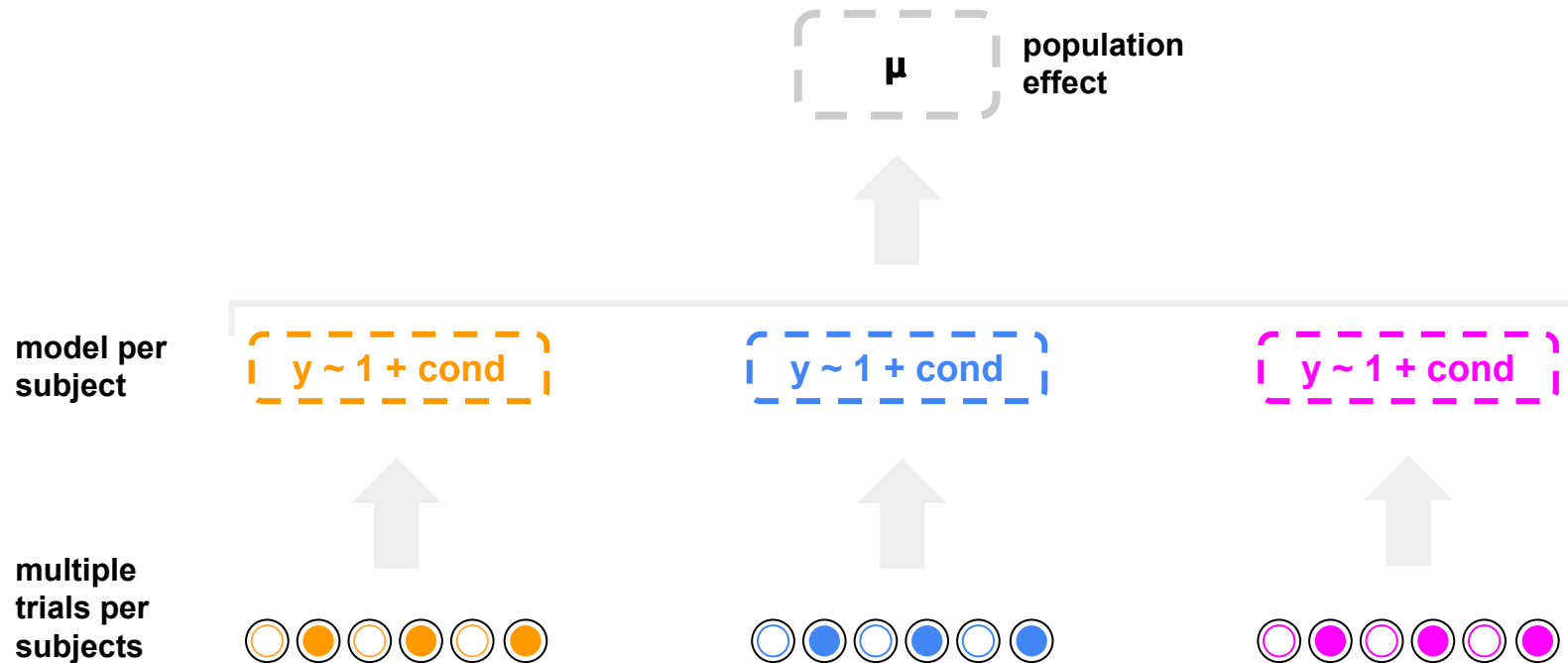| Epoch 1	Epoch 2	Epoch 3	· · ·

Modelling Schemes

Two-way approach

Mixed-effects models

Meta-model

Two-way approach

Mixed-effects model

μ   **population effect**

one model for all subjects   y ~ 1 + cond + (1 + cond | subj)

multiple trials per subjects
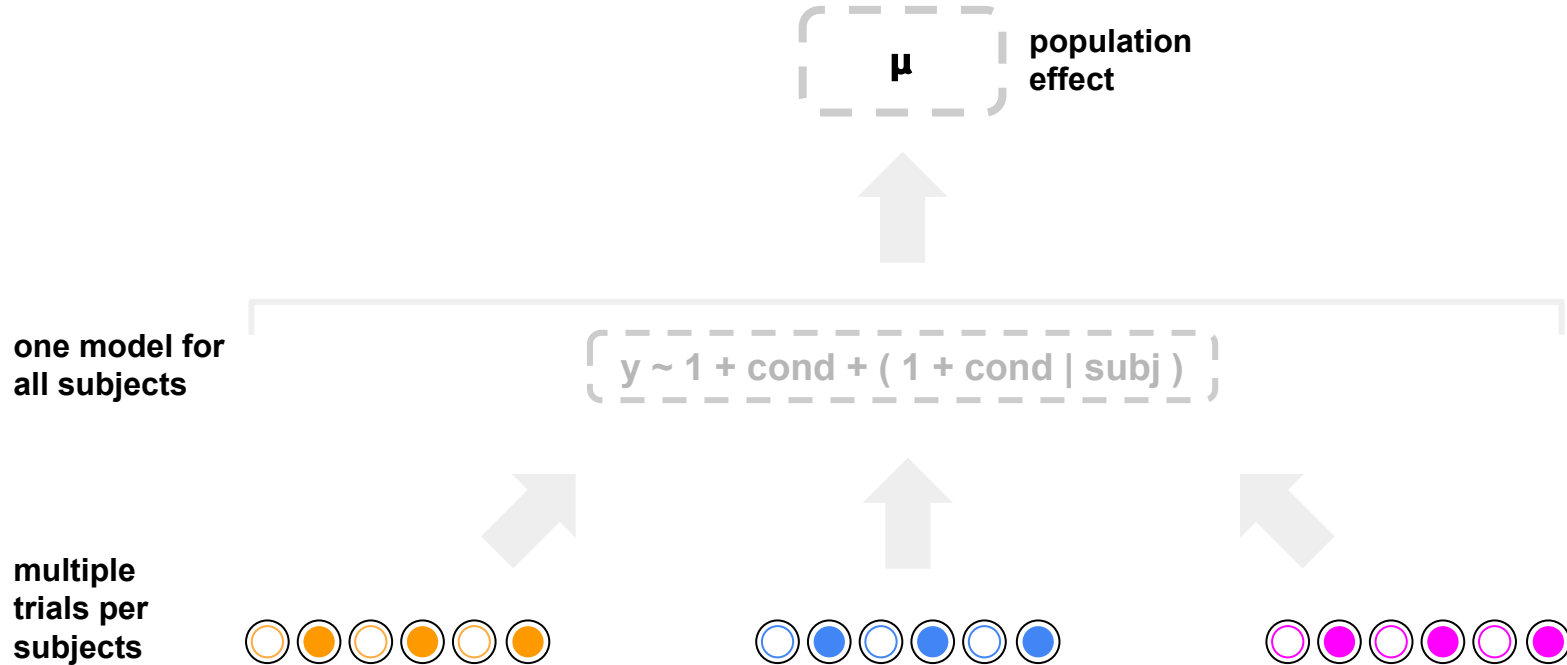
Goals
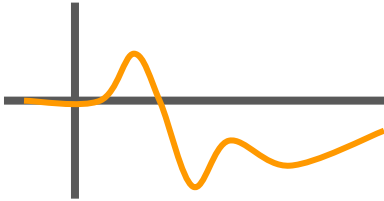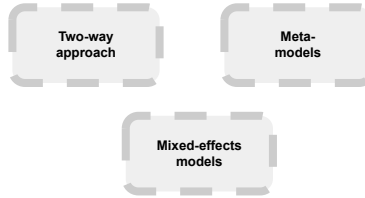
Simulation toolbox

[Demo!](#)

Some preliminary results…

Power two-stage approach
(β=[2.0, 0.5], σranef=[[0.5, 0.2], [0.0]], σres=0.0001, noiselevel=2)

Power contour

$\sigma_w = 10, \sigma_b = 2$

(h)

14
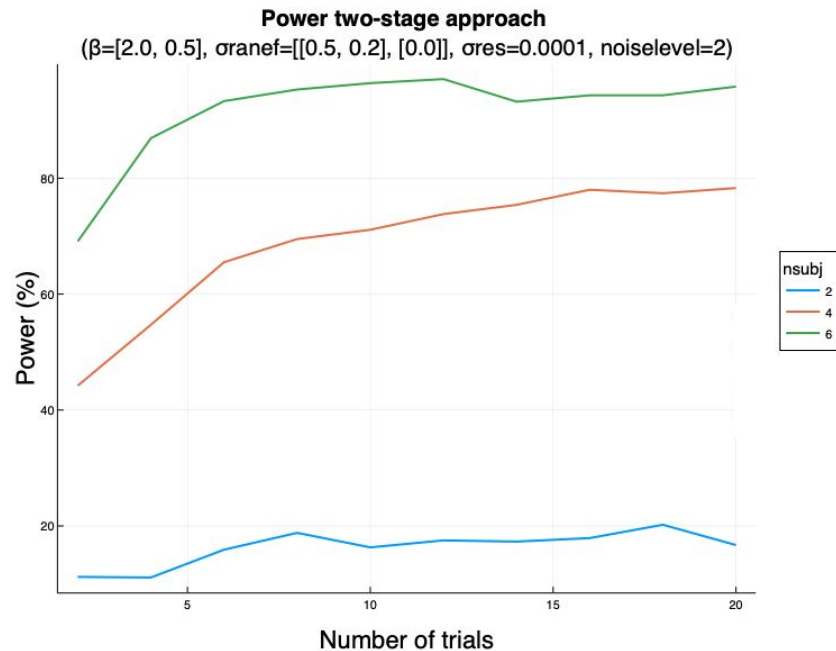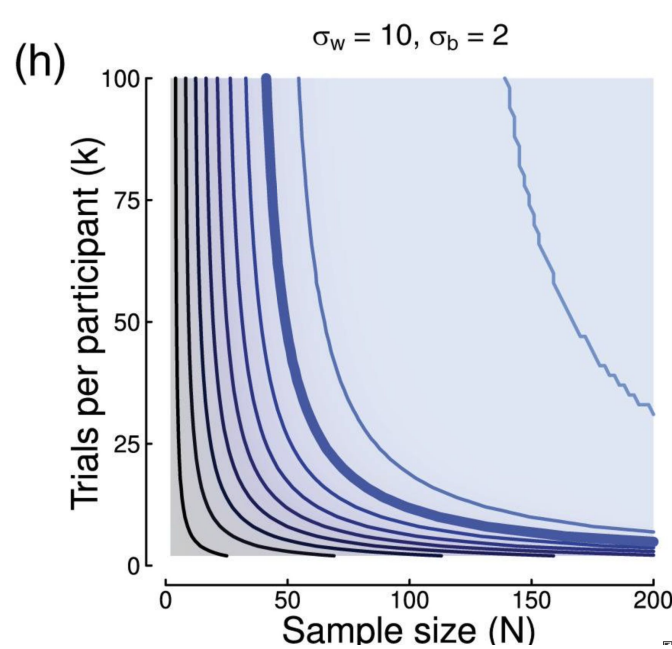
What's done? What's left?

Simulation toolbox		Methods		Comparison	
Experiment Design	✅	Two-stage	✅	Simulate data	◔
LMM Parameterization	✅	LMM	✅	Experiments	◔
Time-varying parameters	✅	MEMA	○	Plots	○
Noise	✅	Sanity check	◔		

Challenges

Research

Statistics

Estimating Time

Timeline

References

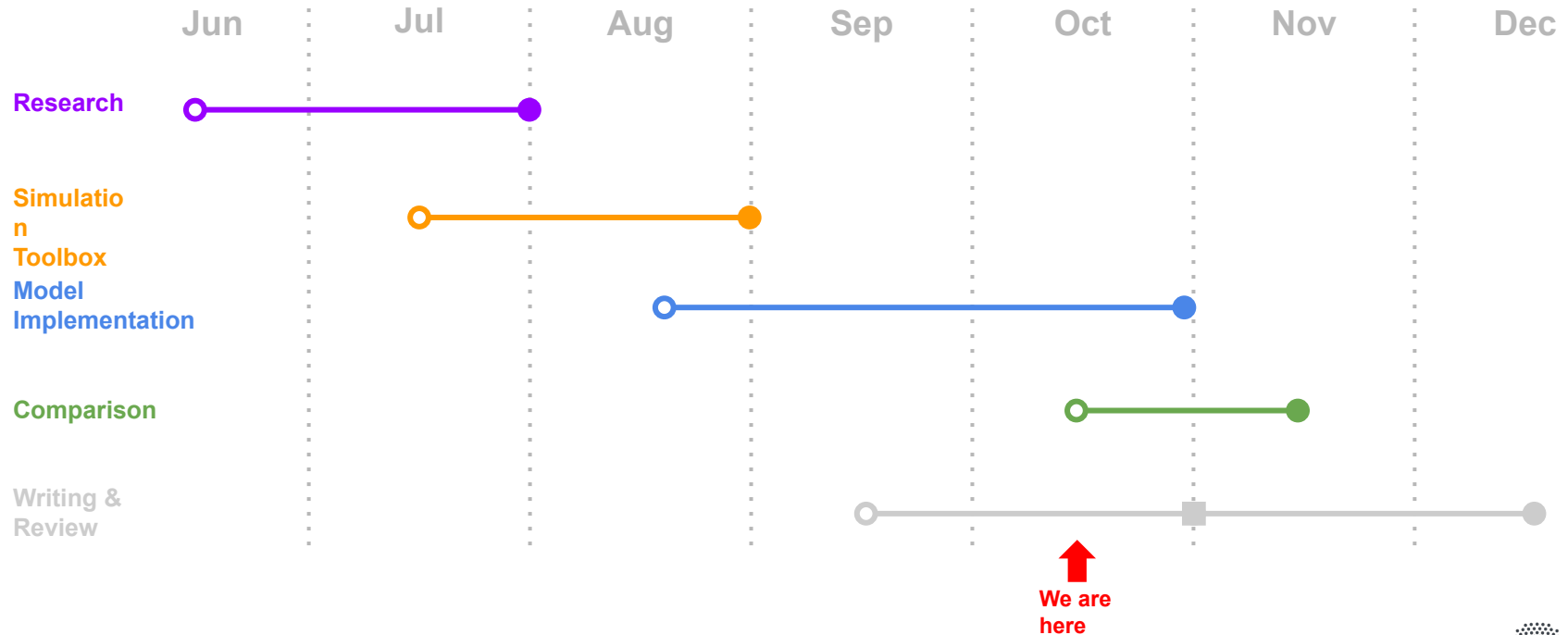Phillip Alday, Douglas Bates, Lisa DeBruine, PhD José Bayoán Santiago Calderón, and Lisa Schwetlick. Repsychling/mixedmodelssim.jl: v0.2.6, October 2021. URL https://doi.org/10.5281/zenodo.5543934.

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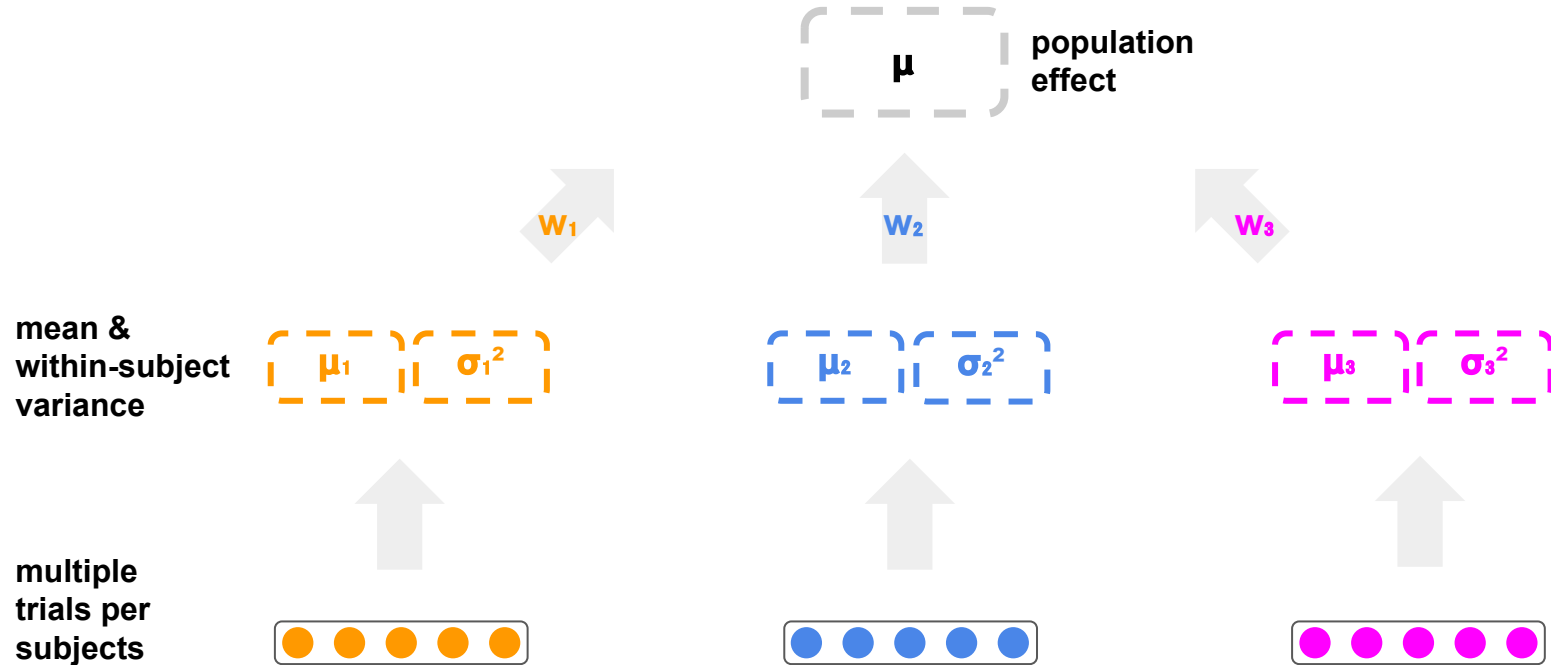Gang Chen, Ziad S. Saad, Jennifer C. Britton, Daniel S. Pine, and Robert W. Cox. Linear mixed-effects modeling approach to FMRI group analysis. NeuroImage, 73:176–190, June 2013. ISSN 10538119. doi: 10.1016/j.neuroimage.2013.01.047. URL https://linkinghub.elsevier.com/retrieve/pii/S1053811913000943.

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Discussion

Meta-model

population effect μ

w_1 w_2 w_3

mean & within-subject variance: μ_1 σ_1^2 | μ_2 σ_2^2 | μ_3 σ_3^2

multiple trials per subjects

Simulation toolbox

Simulating experimental conditions

1

Fit mixed model to dummy variables

2

Change time-varying parameters

3

Add noise to simulated signal

4

DONE   **IN PROGRESS**

Implementation of modelling-schemes

Implementing two-way approach

1

Implementing mixed-effects model

2

Implementing meta-model

3

Sanity check

4

DONE   IN PROGRESS

Comparison

Simulating data

Analyse data via different modelling schemes

Plot power contour plots

(Multiple comparison correction)

1

2

3

4

DONE   **IN PROGRESS**