Overview of type of available data and algorithms

Daniel Durstewitz, Georgia Koppe, Peter Kuppens, Manuel Brenner
Central Institute for Mental Health Mannheim
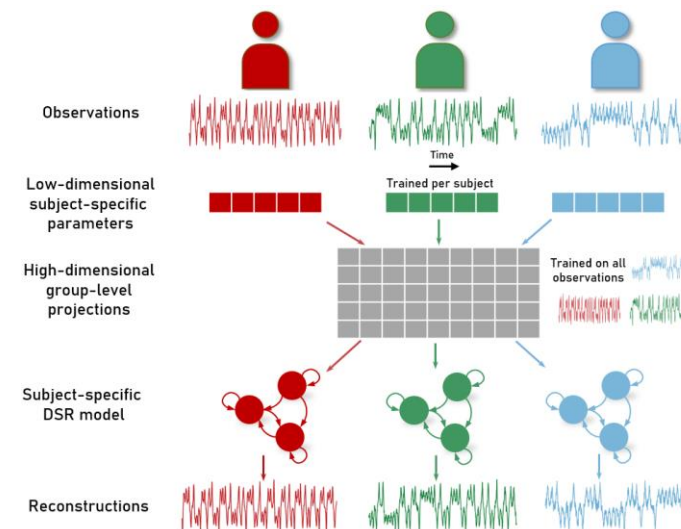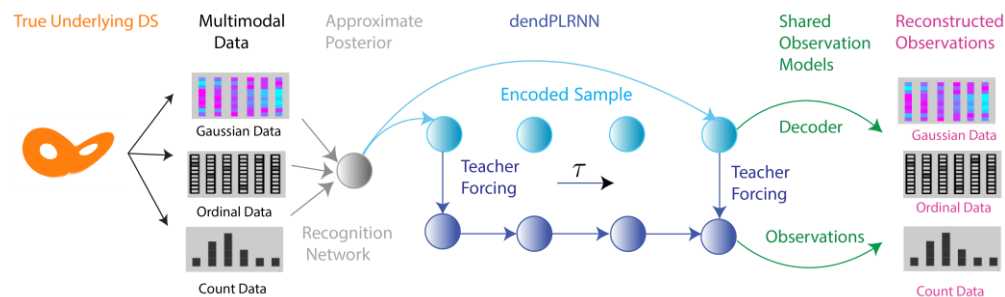
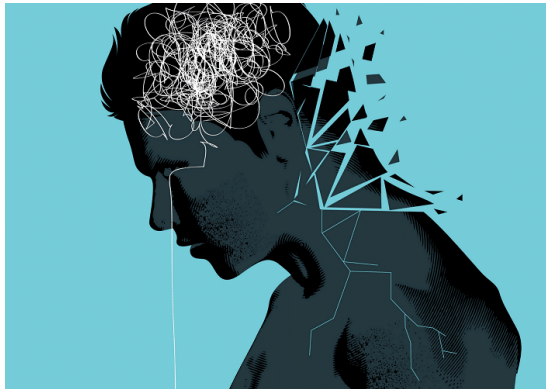**Steering Commitee Meeting Edinburgh, 17/11/23**

WP 4.2 – AI Algorithms

WP 4.2 – AI Algorithms:
→ Development of the
Multimodal Teacher Forcing Framework

WP 4.3 Big data integration framework
→ Development of Hierarchical Inference Framework
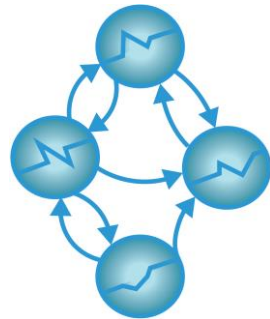
WP 4.2 – AI Algorithms

WP 4.2 – AI Algorithms

Multimodal **V**ariational **A**uto**E**ncoder+ **T**eacher **F**orcing (**MTF**)

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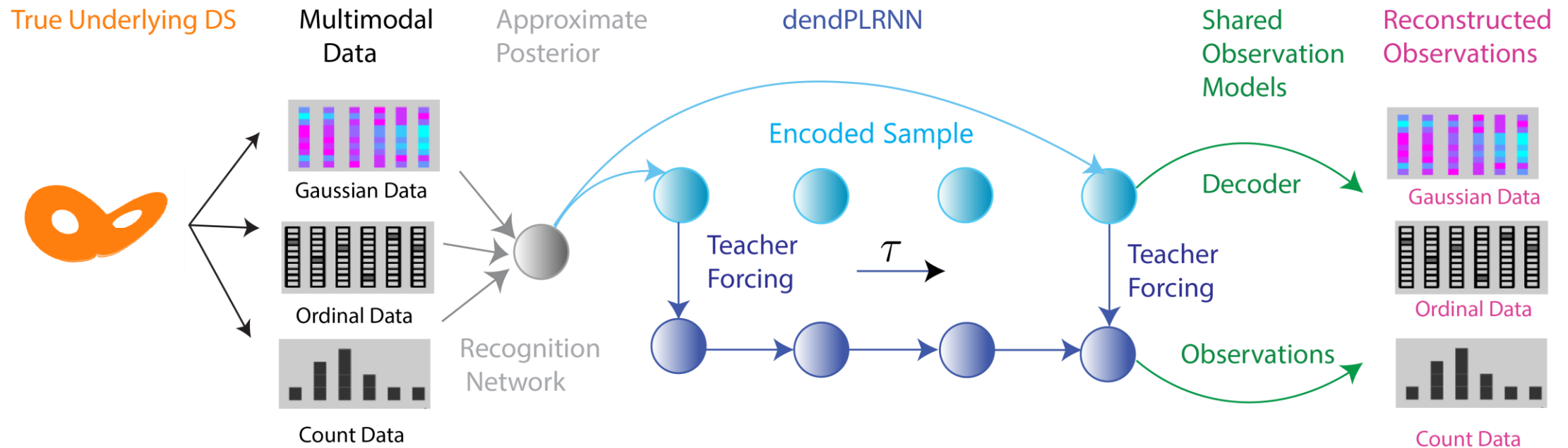
WP 4.2 – AI Algorithms

Observations

Gaussian Obs. **Ordinal Obs.** **Poisson Obs.**

$$Y = \{\{x_1, \cdots, x_T\}; \{o_1, \cdots, o_T\}; \{c_1, \cdots, c_T\}\}$$
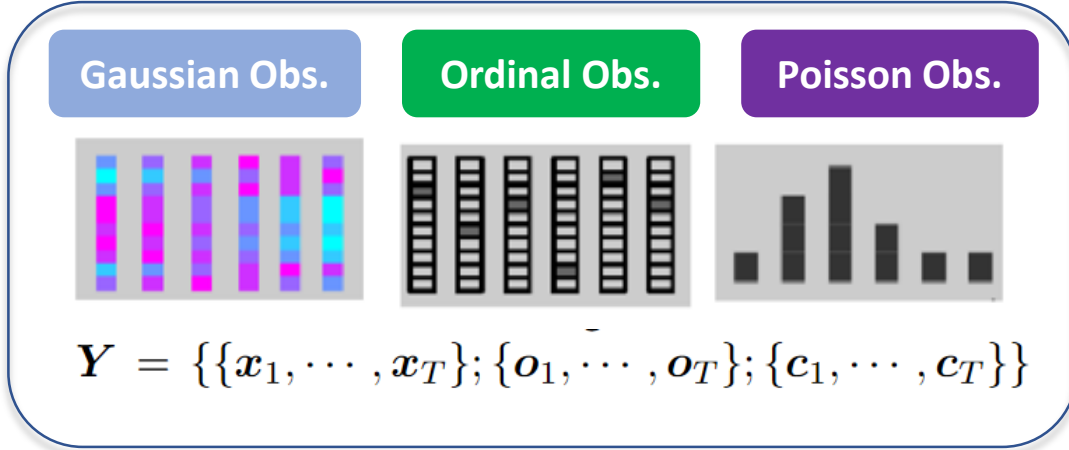
Encoder (CNN)

Approximate posterior

$$q_\phi(\tilde{Z}|Y) = \mathcal{N}(\mu_\phi(Y), \Sigma_\phi(Y))$$

ELBO Loss

$$\mathcal{L}(\phi, \theta; Y) = -\mathbb{E}_{q_\phi}[\log p_\theta(Y|\tilde{Z}) + \log p_\theta(\tilde{Z})] - \mathbb{H}_{q_\phi}(\tilde{Z} \mid Y)$$

Decoder

Observation Models

$$x_t \mid \tilde{z}_t \sim \mathcal{N}(B\tilde{z}_t, \Gamma)$$
$$o_t \mid \tilde{z}_t \sim \text{Ordinal}(\beta\tilde{z}_t, \epsilon)$$
$$c_t \mid \tilde{z}_t \sim \text{Poisson}(\lambda(\tilde{z}_t))$$

Data Likelihoods

$$\log p_\theta(Y|\tilde{Z}) =$$
$$\sum_{t=1}^{T}\left(\log p_\theta(x_t|\tilde{z}_t) + \log p_\theta(o_t|\tilde{z}_t) + \log p_\theta(c_t|\tilde{z}_t)\right)$$

WP 4.2 – AI Algorithms

Underlying DS

z_t

Noisy Gaussian Obs.

$$x_t | z_t \sim \mathcal{N}(z_t, \Gamma)$$

Ordinal Obs.

$$o_t | z_t \sim \text{Ordinal}(\beta z_t, \epsilon)$$

Poisson Obs.

$$p_t | z_t \sim \text{Poisson}(\lambda(z_t))$$
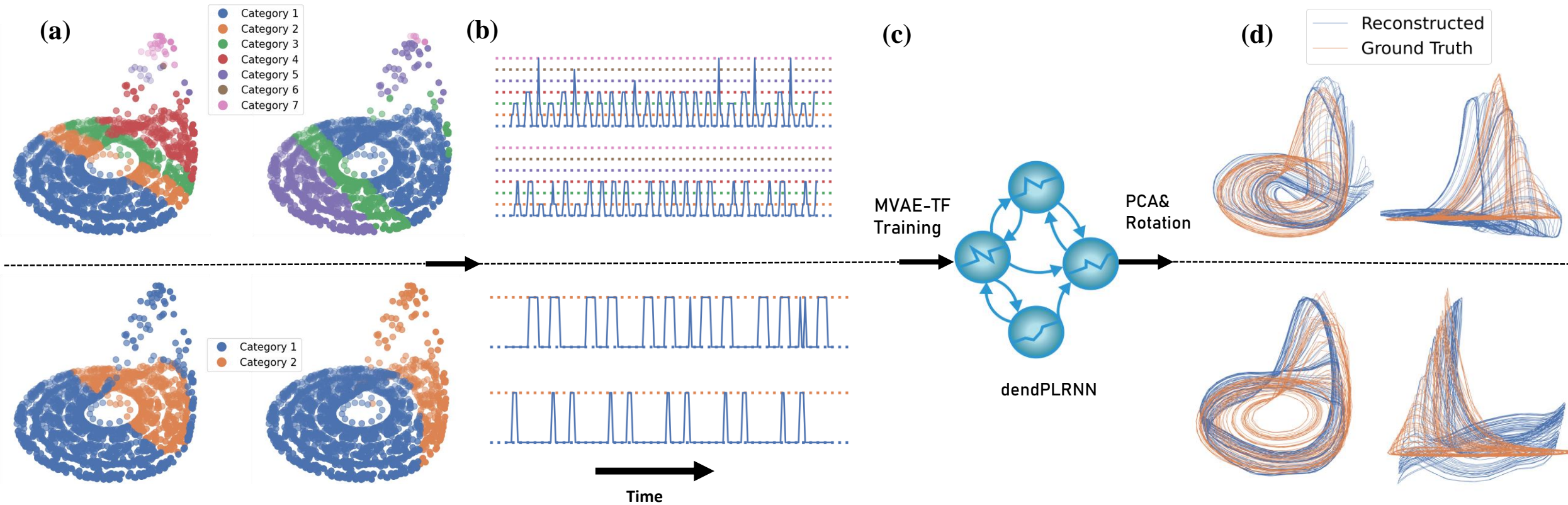
Geometric Agreement

Temporal Agreement

WP 4.2 – AI Algorithms

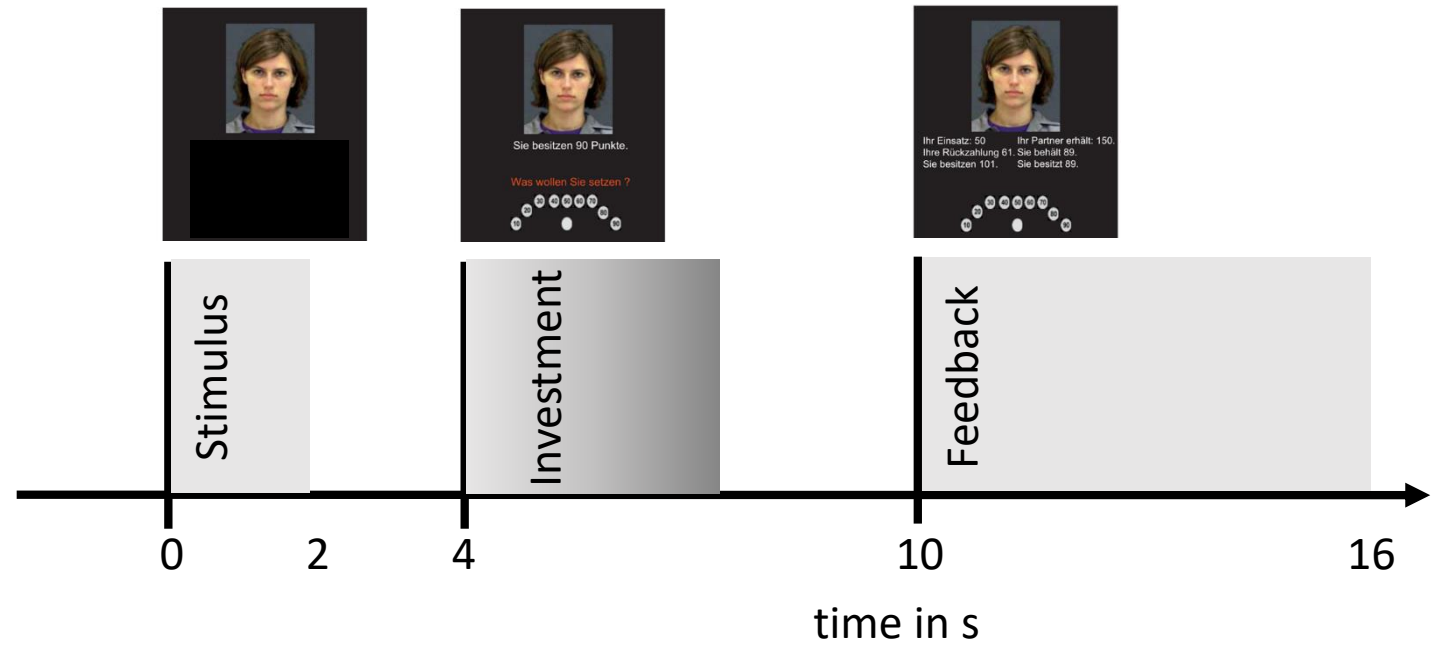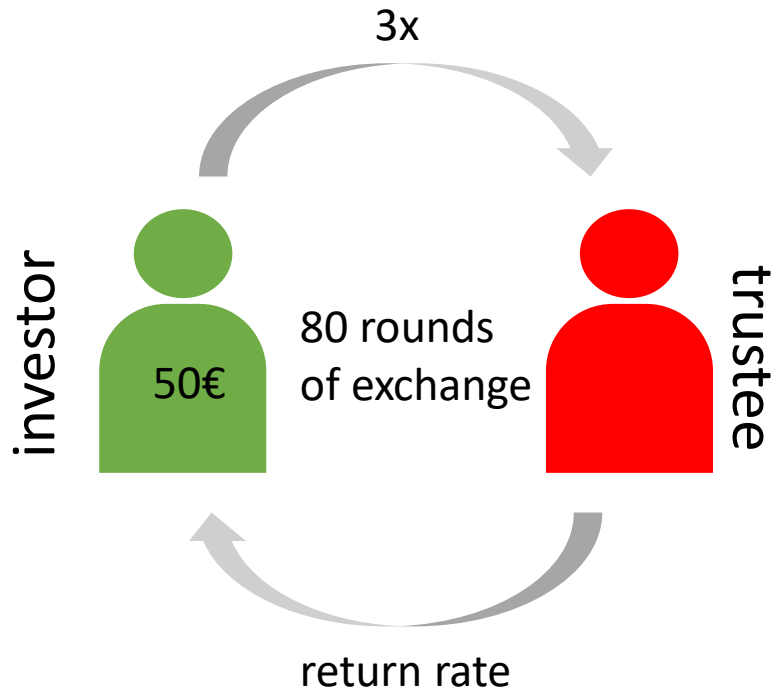## Reconstructed Dynamics from ordinal discretization

WP 4.2 – AI Algorithms

Negative Binomial Model

$$p_{\theta}\left(c_{lt} \mid z_t\right) = \frac{\Gamma(c_{lt} + \phi_l)}{\Gamma(\phi_l)c_{lt}!} \left(\frac{\phi_l}{\mu_{lt} + \phi_l}\right)^{\phi_l} \left(\frac{\mu_{lt}}{\mu_{lt} + \phi_l}\right)^{c_{lt}}$$
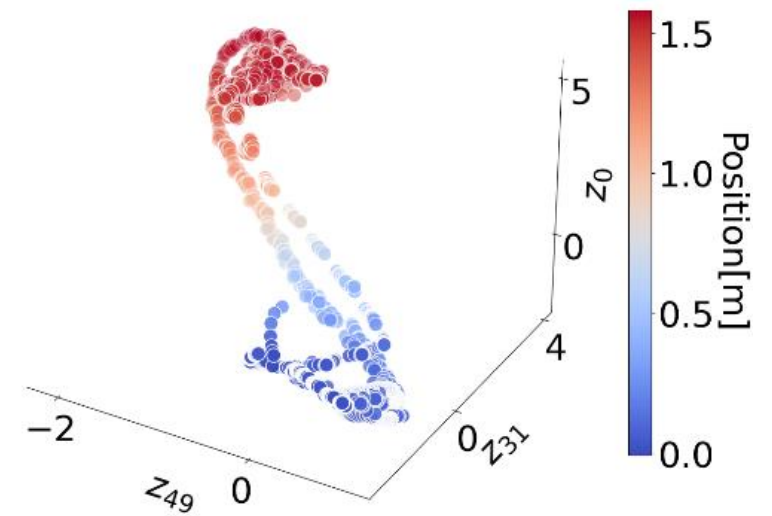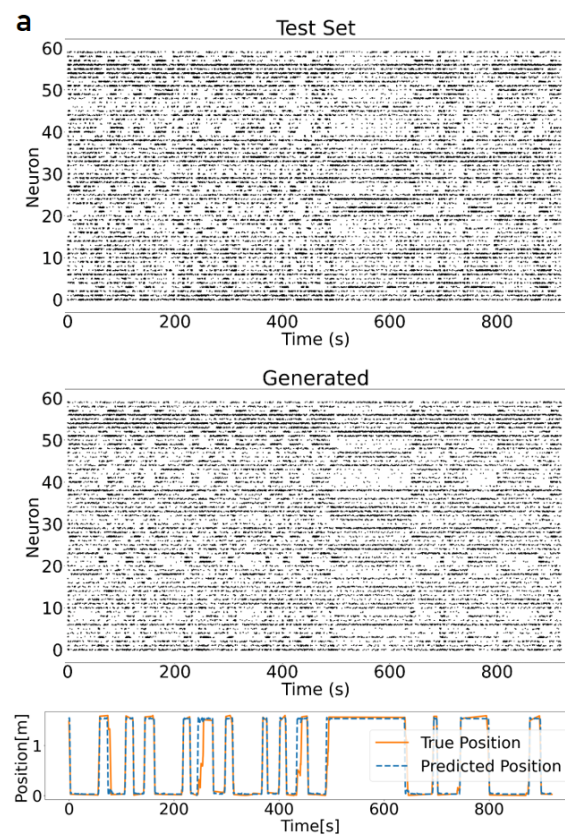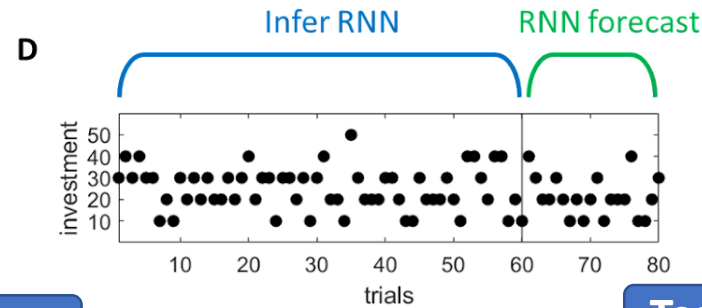
WP 4.2 – AI Algorithms
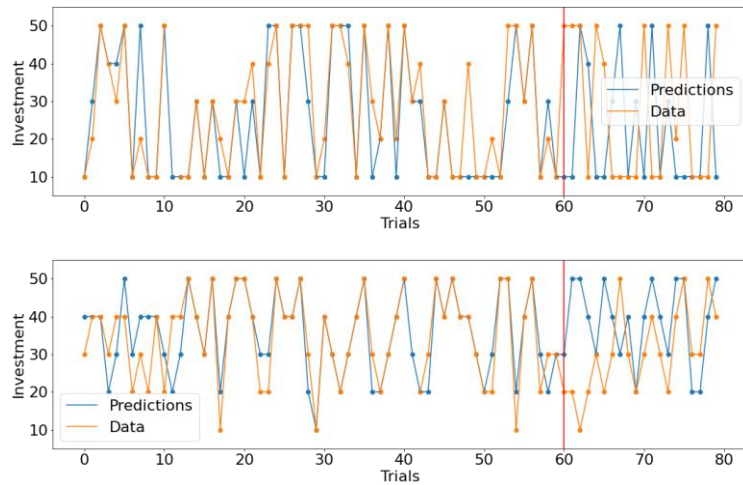
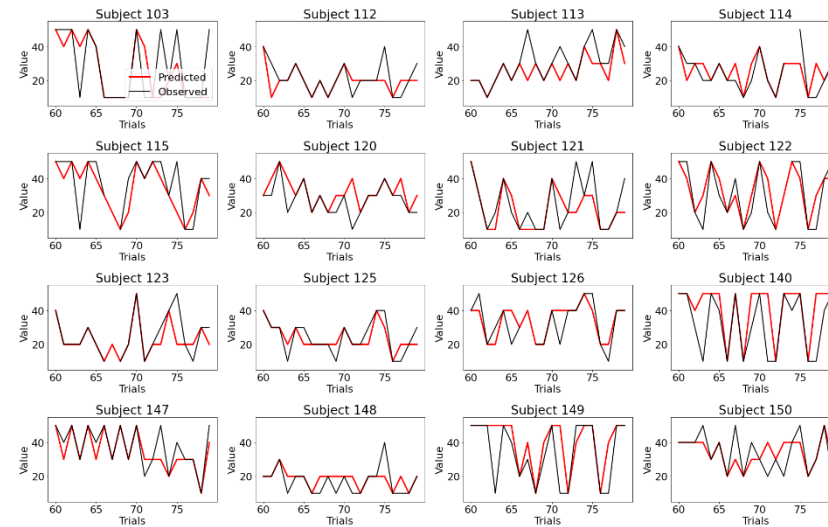## Validation on psychological data

WP 4.2 – AI Algorithms

Validation on psychological data
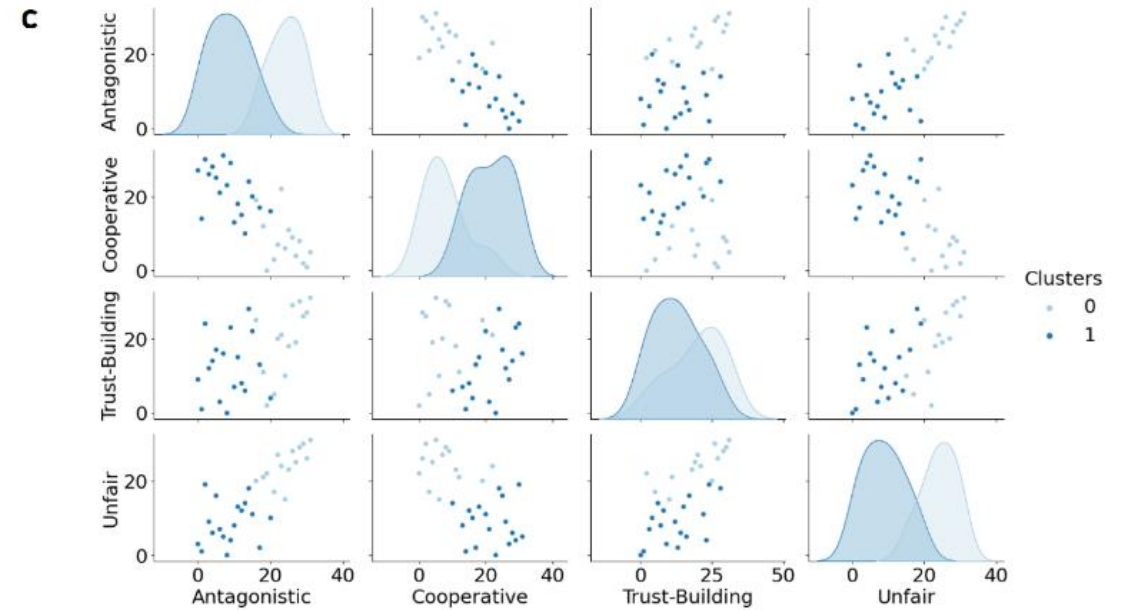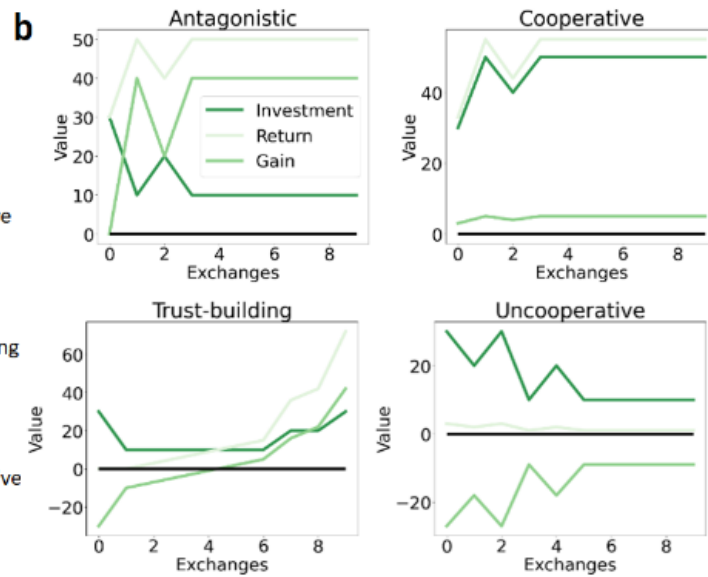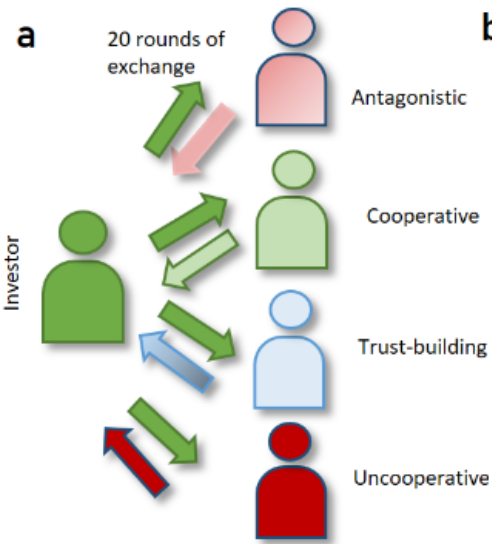

Train&Test Set Predictions

Test Set Predictions

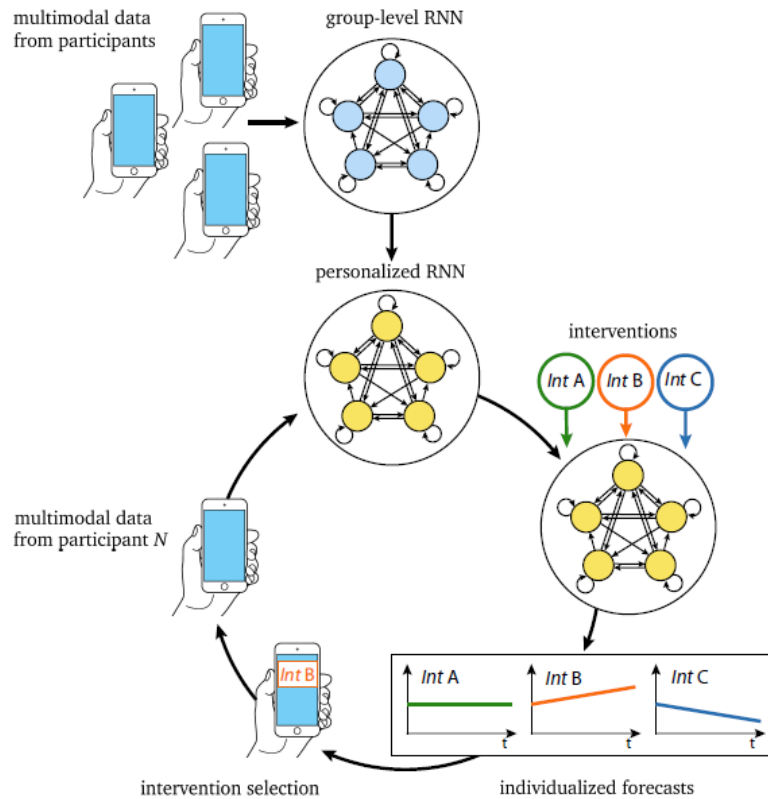# WP 4.2 – AI Algorithms

Simulation of novel/generative dynamics

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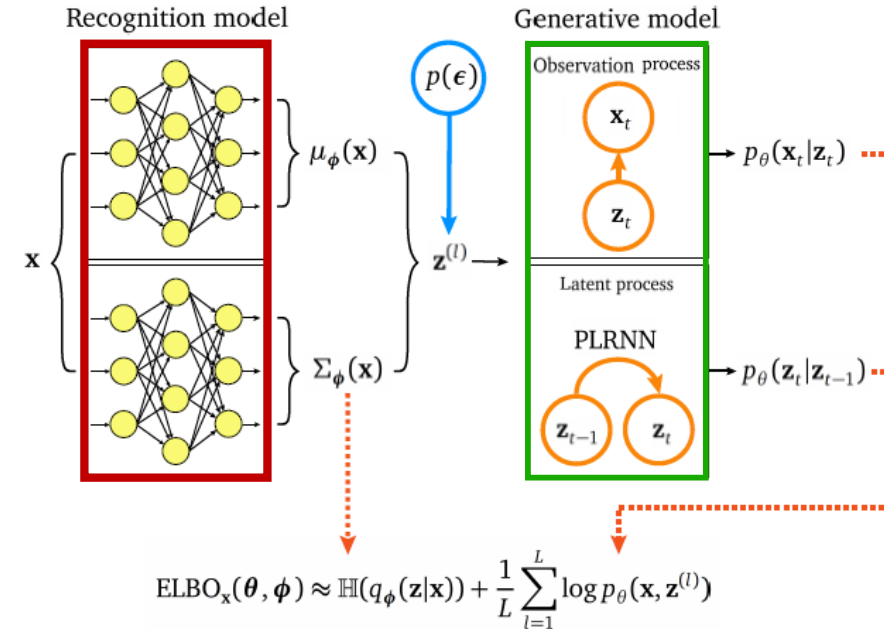
WP 4.3 Big data integration framework

Pre-training and hierarchisation framework

1. **Group level parameter**
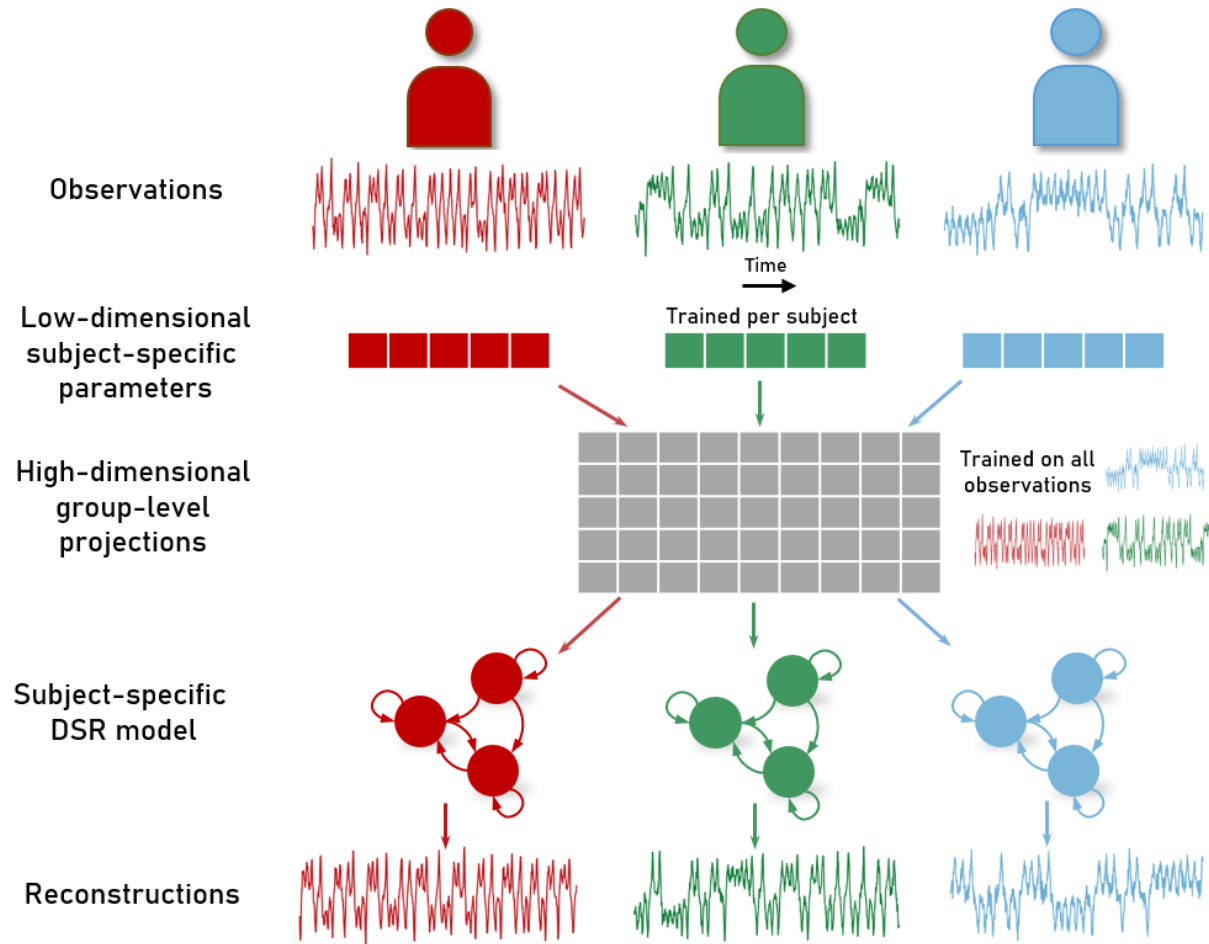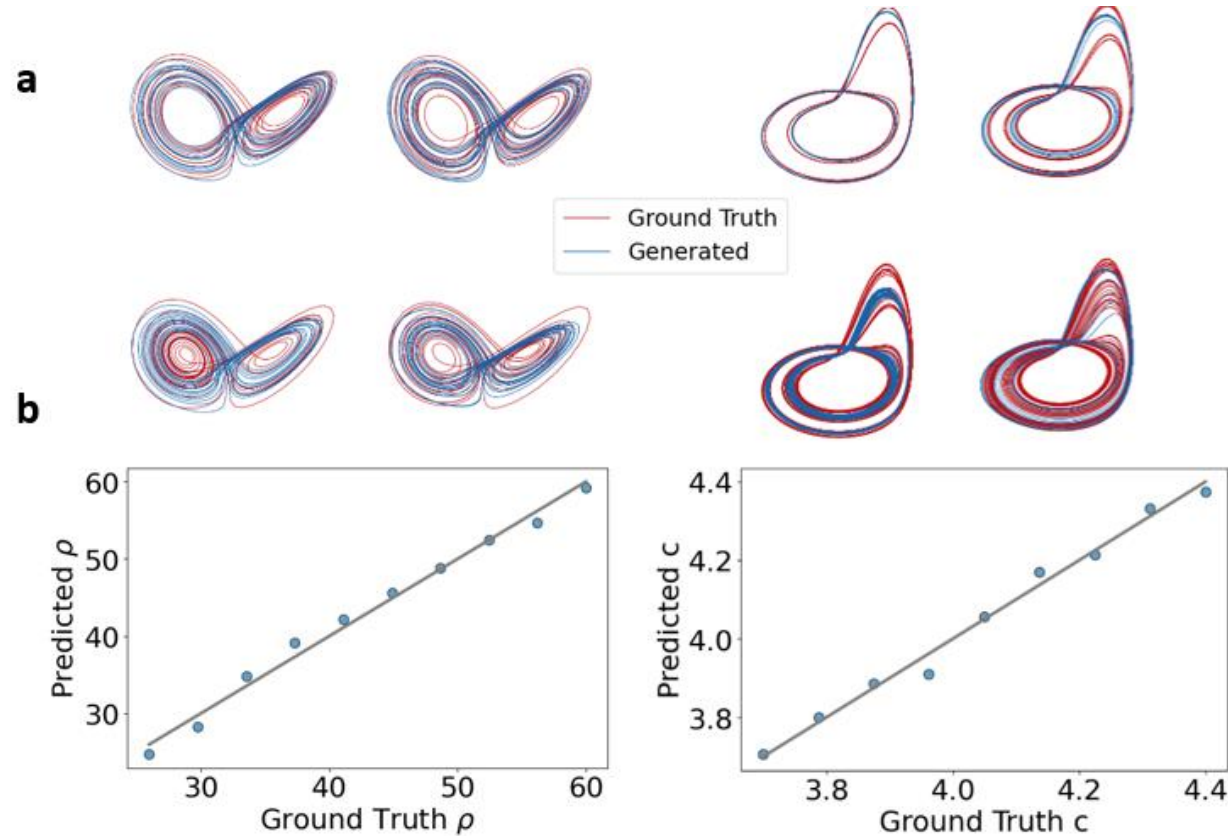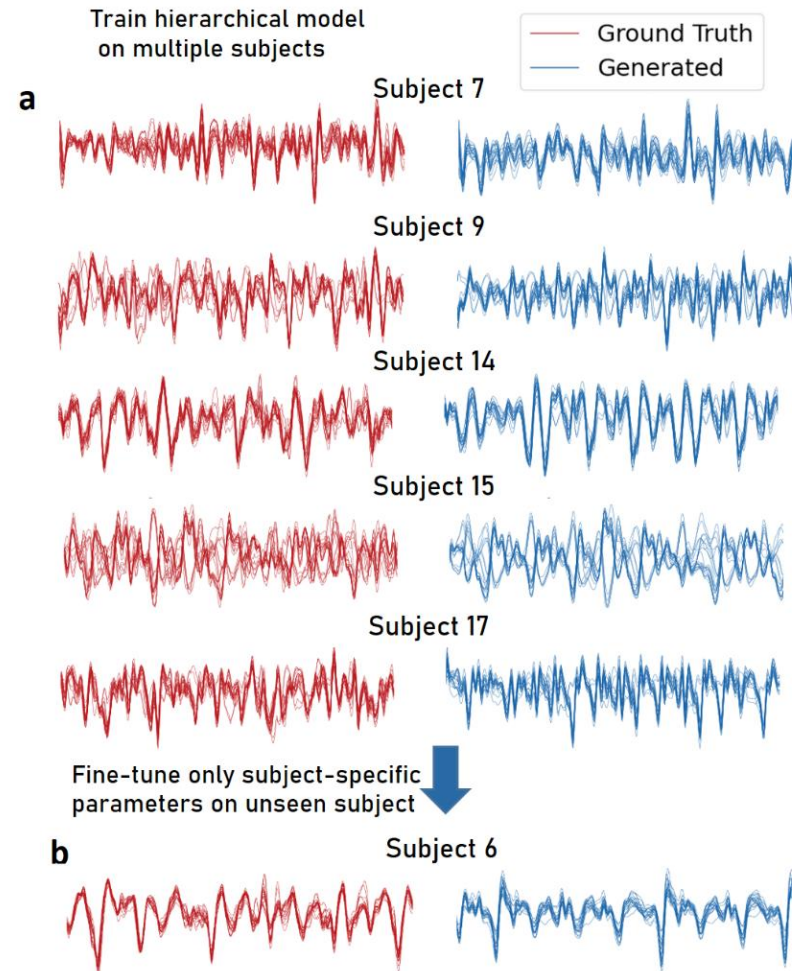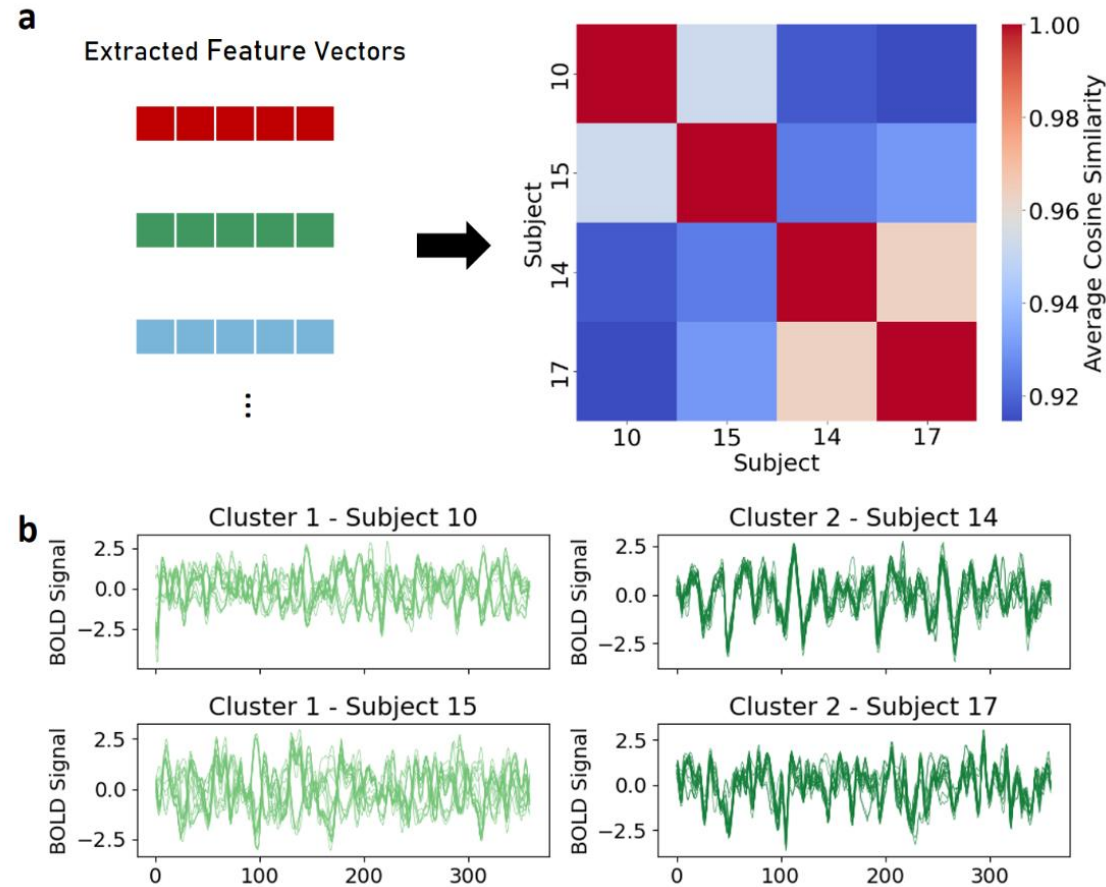2. **Subject level parameter**

Unai Fischer Abaigar, MSc

WP 4.3 Big data integration framework

WP 4.3 Big data integration framework

WP 4.3 Big data integration framework

WP 4.3 Big data integration framework

Extraction of interpretable structure from experimental data