

# Block-Wise Model Fit for Structural Equation Models with Experience Sampling Data

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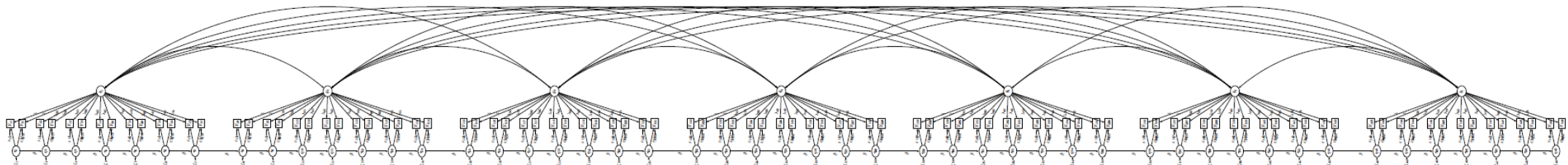
# SEM for Experience Sampling Data

**Starting point:** Research questions regarding the (in)stability of psychological constructs

⇒ Latent state trait (LST) theory

$$Y_{11} = \underbrace{\lambda_{T11} \cdot \theta}_{\text{Stable influence}} + \underbrace{\lambda_{O11} \cdot \zeta_1}_{\text{Situation-specific influence}} + \underbrace{\epsilon_{11}}_{\text{measurement error}}$$

⇒ Very large models with experience sampling data:



# Fit evaluation for Experience Sampling SEMs

**Problem:** Common fit indices in SEM are less reliable for models with many manifest variables

- $\chi^2$  estimated are inflated
- CFI and TLI tend to get worse
- RMSEA improves with more manifest variables

(e.g. Moshagen, 2012; Shi et al., 2019; Kenny & McCoach, 2003)

**Alternative:** Block-wise fit evaluation

- (Co)Variances of entire SEM are estimated together
- Smaller blocks of the covariance matrix (for each day) are used to calculate block-wise fit indices
- Advantages:
  - Model restrictions across days can be included
  - We can use common cut-offs to evaluate model fit

	day 1	day 2	day 3	...
day1	$\chi^2_1$ RMSEA <sub>1</sub> , CFI <sub>1</sub> , TLI <sub>1</sub>			
day2		$\chi^2_2$ , RMSEA <sub>2</sub> , CFI <sub>2</sub> , TLI <sub>2</sub>		
day3			$\chi^2_3$ , RMSEA <sub>3</sub> , CFI <sub>3</sub> , TLI <sub>3</sub>	
⋮				⋮

# Block-wise Fit Evaluation

- (1) Overall Model is estimated (with ML)
- (2) K blocks are extracted from the model-implied and empirical (co)variance Matrices  $\hat{\Sigma}$  and  $S$ .
  - K = Number of blocks, e.g. days in an Experience Sampling Study
- (3) Common fit indices are calculated with adjusted formulas for common indices

$$\chi^2 = (\log|\hat{\Sigma}| + \text{tr}(\hat{\Sigma}^{-1}S) - \log|S| - q + (\bar{x} - \hat{\mu})^T \hat{\Sigma}^{-1} (\bar{x} - \hat{\mu})) \cdot N$$



$$\chi_k^2 = (\log|\hat{\Sigma}_k| + \text{tr}(\hat{\Sigma}_k^{-1}S_k) - \log|S_k| - q_k + (\bar{x}_k - \hat{\mu}_k)^T \hat{\Sigma}_k^{-1} (\bar{x}_k - \hat{\mu}_k)) \cdot N$$

$q_k$  = number of observed variables per block

$$\text{RMSEA}_k = \frac{\sqrt{\chi_k^2 - \text{df}_k}}{\sqrt{\text{df}_k \cdot N}}$$

# Block-wise Fit Evaluation

Degrees of freedom = observed parameters – estimated parameters

Easy to split  
between blocks

Unclear how to split  
between blocks

Alternative: simulate block-wise  $df_k$

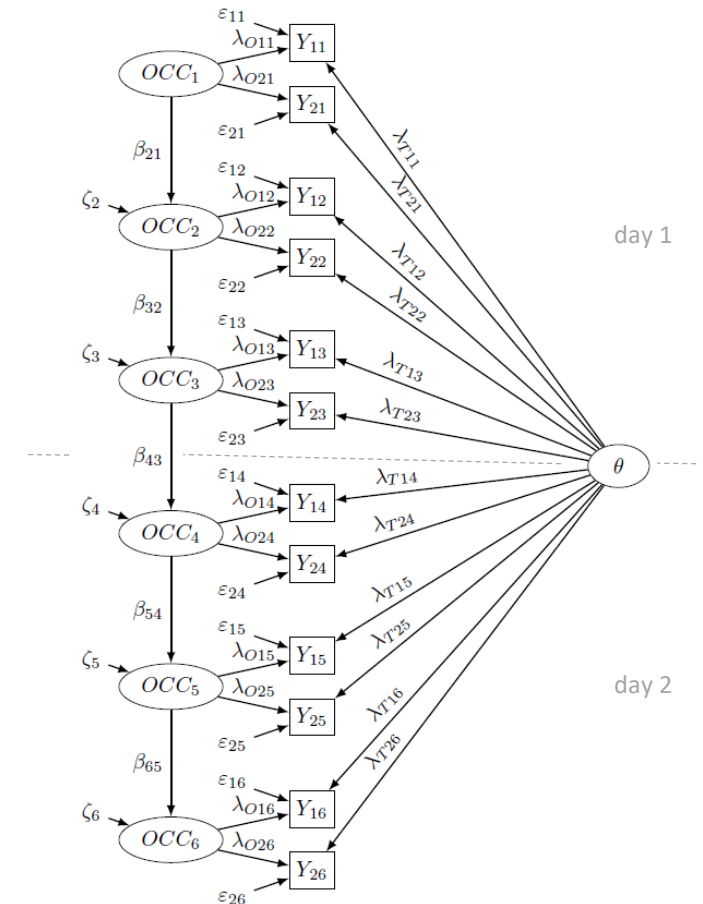
$$df = E(\chi^2)$$

⇒ Under  $H_0$ , the mean  $\chi^2$ -value should be equal to the df

⇒ We can compute block-wise  $\chi_k^2$

⇒ with many simulated datasets:  $df_k = M(\chi_k^2)$

⇒ simulation study:  $\chi_k^2$  are  $\chi^2$  distributed with  $df_k$  degrees of freedom



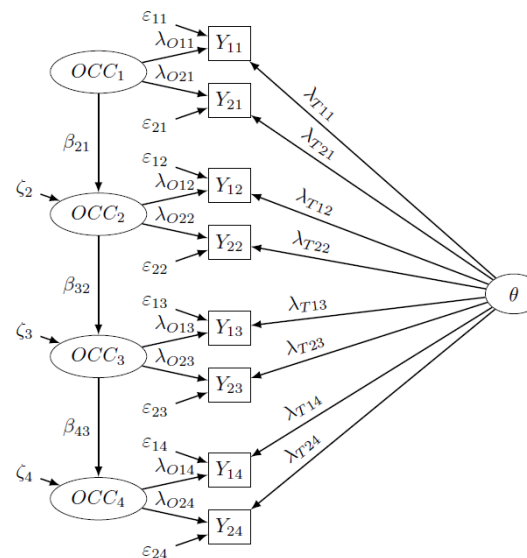
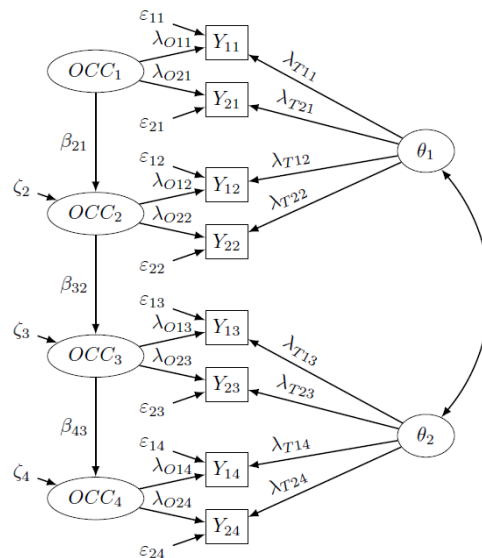
Multistate-Singletrait model with autoregressive paths

# Simulation Study 1: Method

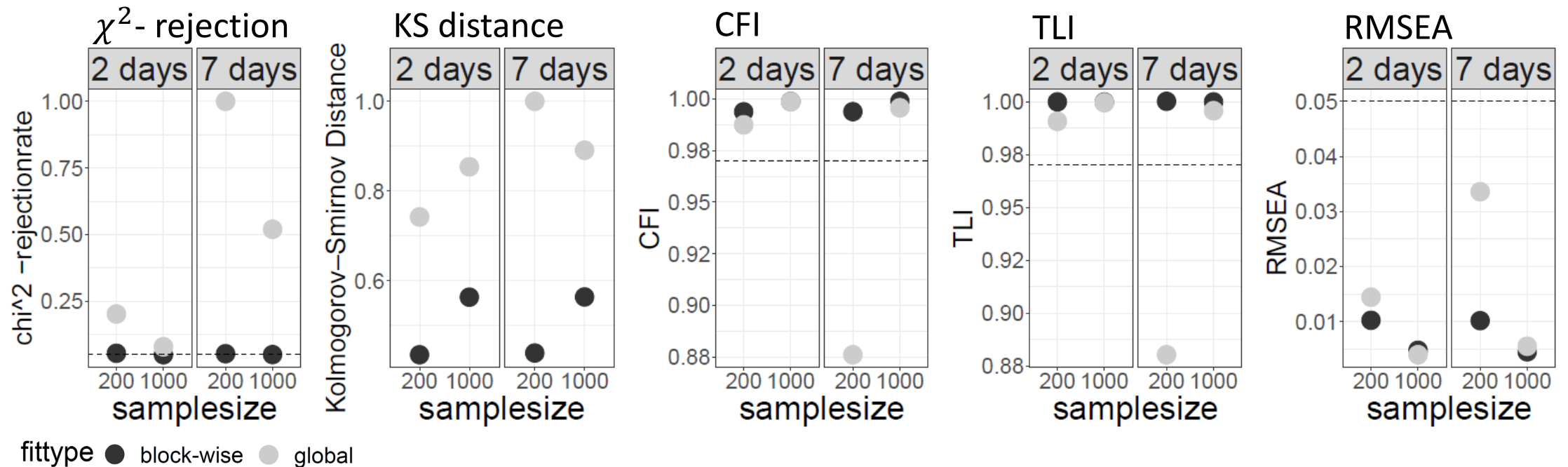
Can block-wise fit evaluation better identify correctly specified models than global fit evaluation?

Design:

- 2 model sizes: 2 days (28 manifest variables), 7 days (98 manifest variables)
- 2 sample sizes: 200, 1000
- 2 models: day-specific traits LST model, singletrait LST model



# Simulation Study 1: Results



Most likely experience sampling scenario: 7 days, N = 200

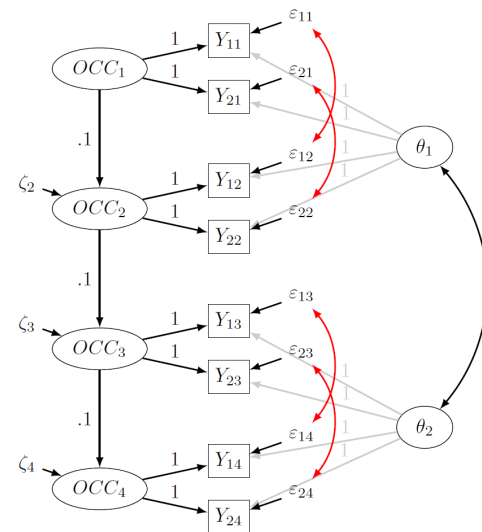
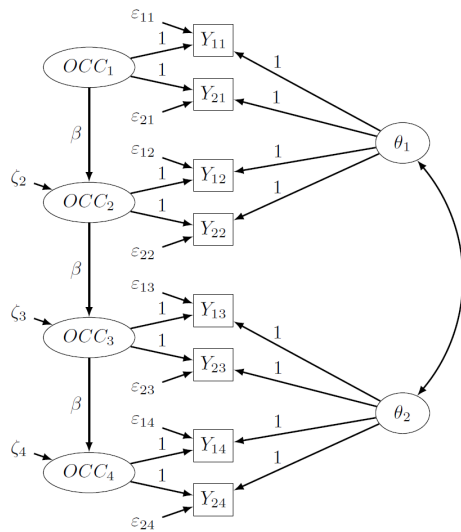
⇒ global indices reject perfect models

⇒ block-wise fit correctly identifies perfect models

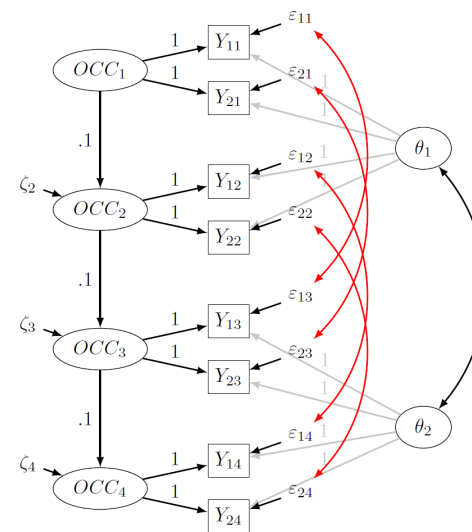
# Simulation Study 2: Method

Can block-wise fit evaluation correctly identify misspecified models?

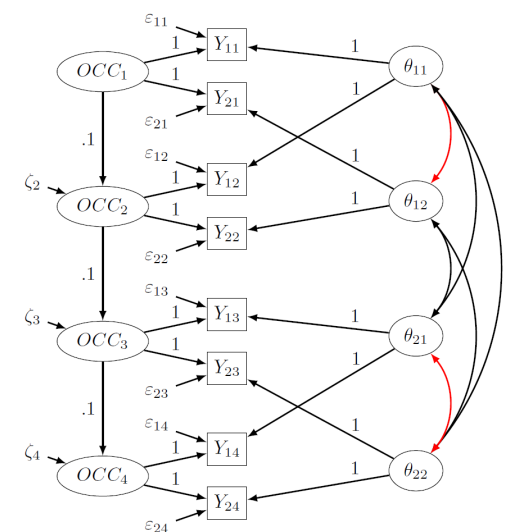
Design: 2 (model size) x 2 (sample size) x 2 (model) x 6 (misspecifications)



residual correlations  
between days ( $r = .15; r = .40$ )



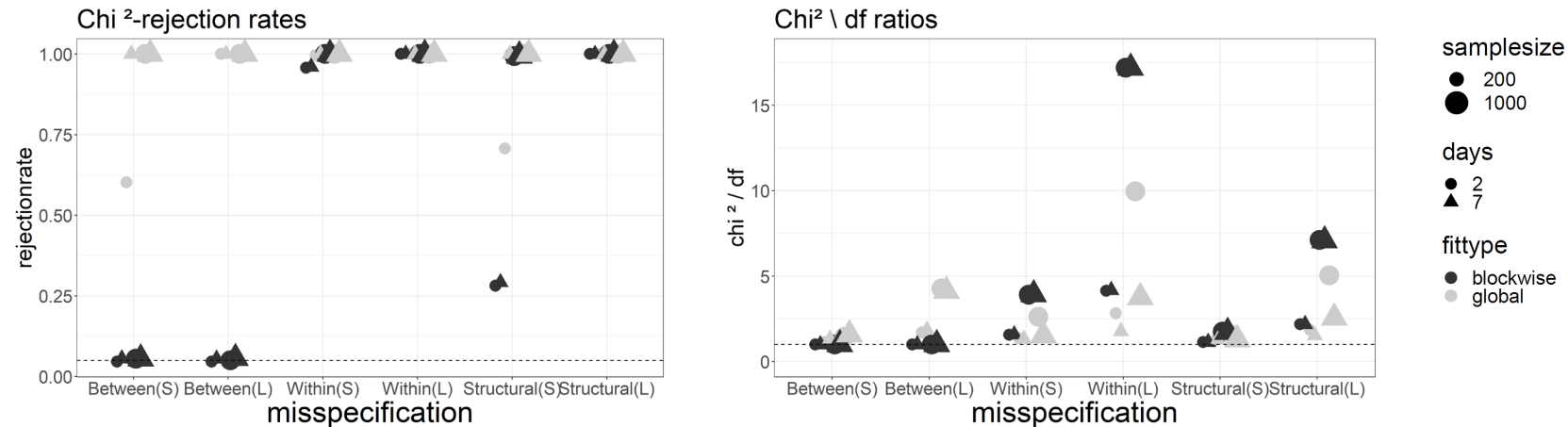
residual correlations  
within days ( $r = .15; r = .40$ )



Structural misspecification  
( $r = .90; r = .60$ )



# Simulation study 2: Results



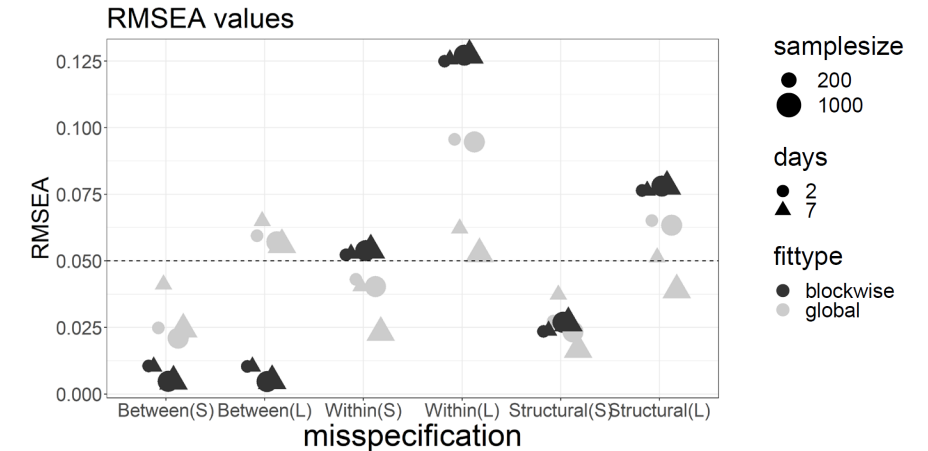
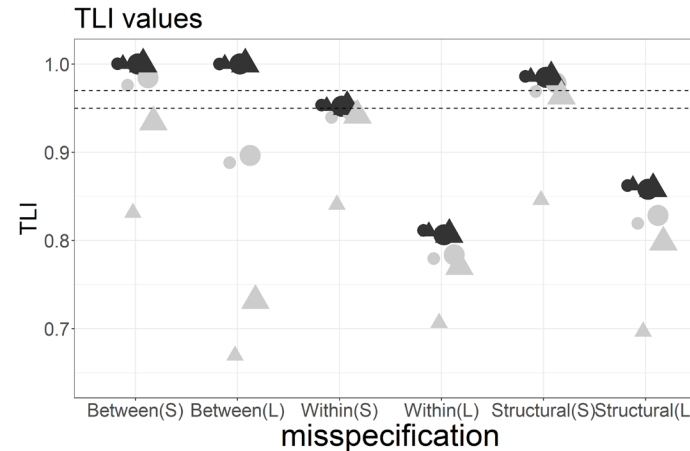
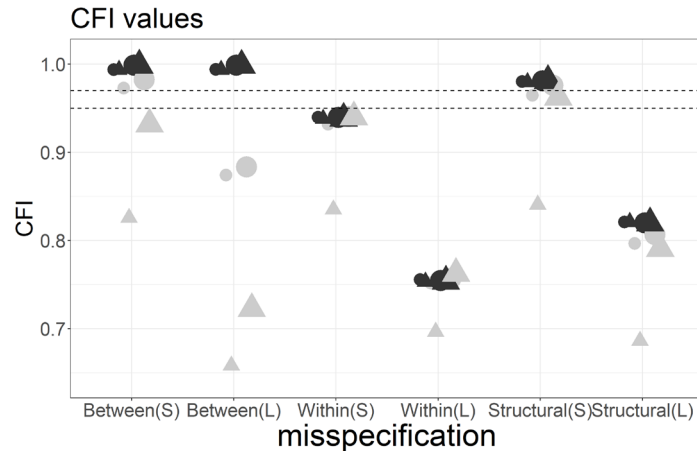
## Global $\chi^2$ and block-wise $\chi_k^2$

- High rejection rates
- No effect of the number of days

## Block-wise $\chi_k^2$ (and other indices)

- Cannot detect misspecification between days

# Simulation Study 2: Results



## Global CFI and TLI

- Strongly affected by number of days ( $d = 0.87$ )
- values for 7 days and  $N = 200$  systematically lower

## Block-wise $CFI_k$ and $TLI_k$

- Not affected by numbers of days ( $p = .51$ )

## Global RMSEA

- Would let us conclude that (strongly) misspecified models are acceptable

## Block-wise $RMSEA_k$

- Generally indicates worse fit

# Discussion

For typical experience sampling data (e.g. 7 days,  $N = 200$ ), block-wise fit

- can better identify well-fitting models than global evaluation
  - is not affected by the number of days, i.e. manifest variables
- ⇒ For LST models (and other SEM) with experience sampling data, we recommend block-wise fit evaluation

## Limitations and Future Research

- Block-wise fit cannot detect misspecification purely between days
- Missing data is common, FIML should be implemented for block-wise fit calculation

Thank you for your attention!