

UNIVERSITY OF HAMBURG

MASTER THESIS

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## Masterthesis\_doc

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*in the*

Institute of Psychology  
Department of Psychology with focus on Quantitative Methods



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UNIVERSITY OF HAMBURG

## *Abstract*

Institute of Psychology

Department of Psychology with focus on Quantitative Methods

Master of Science

**Masterthesis\_doc**

by Lona Frießner

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# Table of contents

<b>Abstract</b>	iii
<b>1 Introduction</b>	1
<b>2 Theory</b>	3
<b>3 Methods</b>	5
3.1 Data generation . . . . .	5
3.2 Data-generating model . . . . .	5
3.3 Missing data generation . . . . .	5
3.4 Factors and simulation conditions . . . . .	5
3.5 Methods of missing data handling . . . . .	6
3.6 Execution of simulation . . . . .	6
<b>4 Results</b>	7
<b>5 Discussion</b>	15
<b>References</b>	17



# List of Figures



# List of Tables

4.1	Simulation results ( $N_2 = 15, \gamma_{01} = 0$ ) . . . . .	8
4.2	Simulation results ( $N_2 = 15, \gamma_{01} = 0.4$ ) . . . . .	9
4.3	Simulation results ( $N_2 = 30, \gamma_{01} = 0$ ) . . . . .	10
4.4	Simulation results ( $N_2 = 30, \gamma_{01} = 0.4$ ) . . . . .	11
4.5	Simulation results ( $N_2 = 60, \gamma_{01} = 0$ ) . . . . .	12
4.6	Simulation results ( $N_2 = 60, \gamma_{01} = 0.4$ ) . . . . .	13



## Chapter 1

# Introduction



## Chapter 2

# Theory



## Chapter 3

# Methods

### 3.1 Data generation

A simulation study was conducted to compare the methods of missing data handling.  
(erklären, was eine Simulationsstudie ist)

Data was generated from a parametric model with known parameters.

### 3.2 Data-generating model

The data-generating model was a two-level random intercept model:

$$Y_{ij} = \gamma_{10} (X_{ij} - \bar{X}_{\cdot j}) + \gamma_{01} \bar{X}_{\cdot j} + \gamma_{02} W_j + u_{0j} + e_{ij} \quad (3.1)$$

The random effects are normally distributed with  $u_{0j} \sim N(0, \psi^2)$  and  $e_{ij} \sim N(0, \sigma^2)$  and independent of each other.  $Y_{ij}$ ,  $X_{ij}$  and  $W_j$  are created as z-standardized variables, which means that they have a mean of zero and a variance of 1. First,

### 3.3 Missing data generation

### 3.4 Factors and simulation conditions

#### 3.4.1 Constants

#### 3.4.2 Level-2 sample size

As the small-sample performance of the methods is of interest, three different group sizes are used: - N2 = 15 - N2 = 30 - N2 = 60 These sizes are chosen to reflect McNeish's (2017) summary that group sizes below 25 almost certainly face issues and below 50 there is a susceptibility to small sample biases. These sample sizes should therefore cover problematic, likely problematic and not problematic magnitudes. ### Effect size of the group-level effect { 01} The effect size of the group-level effect of X is varied between 0.0 and 0.30. This is to investigate the performance both with a null effect of the parameter of interest as well as a substantive effect.

### **3.4.3 ICC of X and residual Y**

### **3.4.4 Missing data mechanism**

Missing data mechanism is set to either MCAR or MAR. For MAR, the strength of relationship between W and missing of X is set to 0.4, which corresponds to  $0.4^2 \%$  100% explanation of variance in missingness through W.

## **3.5 Methods of missing data handling**

### **3.5.1 Estimands**

### **3.5.2 Performance measures**

## **3.6 Execution of simulation**

## Chapter 4

# Results

Results text

TABLE 4.1: Simulation results ( $N_2 = 15$ ,  $\gamma_{01} = 0$ )

	CD			LD			MI-R			MI-a			Bayes		
	Bias	Cov	SD												
<b>MCAR</b>															
<b>ICC = 0.1</b>															
$\gamma_{01}$	0.002	0.942	0.284	0.037	0.941	0.300	0.005	0.966	0.252	0.005	0.986	0.252	0.003	0.980	0.291
$\gamma_{10}$	-0.006	0.951	0.084	-0.006	0.944	0.104	-0.008	0.943	0.103	-0.008	0.944	0.103	-0.010	0.946	0.100
<b>ICC = 0.3</b>															
$\gamma_{01}$	0.000	0.960	0.272	0.012	0.953	0.280	-0.001	0.942	0.278	-0.001	0.972	0.278	-0.003	0.980	0.288
$\gamma_{10}$	0.001	0.942	0.089	0.000	0.931	0.111	-0.005	0.938	0.108	-0.005	0.939	0.108	-0.006	0.934	0.108
<b>MAR</b>															
<b>ICC = 0.1</b>															
$\gamma_{01}$	-0.002	0.949	0.283	0.031	0.947	0.284	0.007	0.970	0.247	0.007	0.985	0.247	0.001	0.987	0.289
$\gamma_{10}$	0.000	0.942	0.087	-0.002	0.954	0.106	-0.007	0.949	0.104	-0.007	0.950	0.104	-0.007	0.954	0.102
<b>ICC = 0.3</b>															
$\gamma_{01}$	-0.016	0.943	0.279	0.007	0.949	0.279	-0.014	0.943	0.275	-0.014	0.968	0.275	-0.016	0.975	0.291
$\gamma_{10}$	0.001	0.941	0.087	-0.001	0.948	0.105	-0.004	0.943	0.102	-0.004	0.945	0.102	-0.005	0.949	0.101

TABLE 4.2: Simulation results ( $N_2 = 15$ ,  $\gamma_{01} = 0.4$ )

	CD			LD			MI-R			MI-a			Bayes		
	Bias	Cov	SD												
<b>MCAR</b>															
<b>ICC = 0.1</b>															
$\gamma_{01}$	-0.008	0.953	0.275	-0.038	0.968	0.269	-0.075	0.965	0.239	-0.075	0.981	0.239	-0.036	0.985	0.281
$\gamma_{10}$	0.000	0.952	0.083	0.000	0.952	0.102	-0.001	0.950	0.101	-0.001	0.953	0.101	-0.003	0.954	0.099
<b>ICC = 0.3</b>															
$\gamma_{01}$	0.003	0.955	0.272	-0.013	0.949	0.272	-0.016	0.951	0.275	-0.016	0.967	0.275	-0.008	0.971	0.290
$\gamma_{10}$	0.002	0.949	0.083	0.003	0.935	0.106	-0.001	0.944	0.103	-0.001	0.948	0.103	-0.003	0.942	0.101
<b>MAR</b>															
<b>ICC = 0.1</b>															
$\gamma_{01}$	-0.004	0.959	0.276	-0.050	0.942	0.283	-0.078	0.965	0.238	-0.078	0.977	0.238	-0.039	0.982	0.276
$\gamma_{10}$	-0.007	0.954	0.084	-0.005	0.952	0.105	-0.007	0.956	0.102	-0.007	0.959	0.102	-0.010	0.952	0.101
<b>ICC = 0.3</b>															
$\gamma_{01}$	0.006	0.962	0.269	-0.019	0.956	0.275	-0.020	0.947	0.271	-0.020	0.976	0.271	-0.008	0.977	0.290
$\gamma_{10}$	-0.001	0.945	0.086	0.000	0.948	0.105	-0.003	0.946	0.102	-0.003	0.948	0.102	-0.006	0.951	0.102

TABLE 4.3: Simulation results ( $N_2 = 30, \gamma_{01} = 0$ )

	CD			LD			MI-R			MI-a			Bayes		
	Bias	Cov	SD												
<b>MCAR</b>															
<b>ICC = 0.1</b>															
$\gamma_{01}$	0.003	0.945	0.188	0.042	0.939	0.186	0.014	0.962	0.173	0.014	0.976	0.173	0.009	0.963	0.199
$\gamma_{10}$	-0.005	0.953	0.059	-0.006	0.953	0.073	-0.007	0.954	0.073	-0.007	0.954	0.073	-0.008	0.950	0.072
<b>ICC = 0.3</b>															
$\gamma_{01}$	-0.004	0.957	0.185	0.010	0.964	0.185	-0.003	0.955	0.190	-0.003	0.964	0.190	-0.003	0.965	0.192
$\gamma_{10}$	0.001	0.942	0.063	0.000	0.943	0.077	-0.003	0.939	0.077	-0.003	0.940	0.077	-0.003	0.943	0.076
<b>MAR</b>															
<b>ICC = 0.1</b>															
$\gamma_{01}$	0.006	0.941	0.191	0.039	0.947	0.192	0.010	0.965	0.177	0.010	0.972	0.177	0.003	0.965	0.203
$\gamma_{10}$	0.000	0.944	0.061	-0.002	0.945	0.075	-0.003	0.950	0.074	-0.003	0.951	0.074	-0.004	0.948	0.073
<b>ICC = 0.3</b>															
$\gamma_{01}$	0.008	0.969	0.179	0.027	0.956	0.183	0.011	0.958	0.186	0.011	0.968	0.186	0.010	0.967	0.188
$\gamma_{10}$	0.000	0.944	0.062	0.000	0.948	0.076	-0.003	0.954	0.075	-0.003	0.954	0.075	-0.003	0.946	0.074

TABLE 4.4: Simulation results ( $N_2 = 30$ ,  $\gamma_{01} = 0.4$ )

	CD			LD			MI-R			MI-a			Bayes		
	Bias	Cov	SD												
<b>MCAR</b>															
<b>ICC = 0.1</b>															
$\gamma_{01}$	0.005	0.950	0.189	-0.034	0.956	0.187	-0.052	0.956	0.175	-0.052	0.966	0.175	-0.009	0.970	0.204
$\gamma_{10}$	0.000	0.966	0.056	-0.001	0.967	0.068	0.001	0.966	0.066	0.001	0.969	0.066	-0.003	0.967	0.065
<b>ICC = 0.3</b>															
$\gamma_{01}$	0.007	0.943	0.188	-0.008	0.941	0.191	-0.002	0.938	0.194	-0.002	0.953	0.194	0.004	0.951	0.201
$\gamma_{10}$	0.000	0.963	0.057	0.003	0.956	0.069	0.001	0.950	0.067	0.001	0.954	0.067	0.000	0.954	0.067
<b>MAR</b>															
<b>ICC = 0.1</b>															
$\gamma_{01}$	0.005	0.948	0.191	-0.033	0.944	0.190	-0.057	0.952	0.174	-0.057	0.963	0.174	-0.015	0.958	0.204
$\gamma_{10}$	0.001	0.947	0.060	0.001	0.946	0.073	0.003	0.948	0.073	0.003	0.950	0.073	0.000	0.946	0.071
<b>ICC = 0.3</b>															
$\gamma_{01}$	0.002	0.941	0.182	-0.014	0.947	0.180	-0.006	0.942	0.185	-0.006	0.951	0.185	0.000	0.954	0.191
$\gamma_{10}$	-0.002	0.948	0.059	-0.001	0.947	0.075	-0.003	0.950	0.072	-0.003	0.951	0.072	-0.004	0.948	0.072

TABLE 4.5: Simulation results ( $N_2 = 60$ ,  $\gamma_{01} = 0$ )

	CD			LD			MI-R			MI-a			Bayes		
	Bias	Cov	SD												
<b>MCAR</b>															
<b>ICC = 0.1</b>															
$\gamma_{01}$	-0.006	0.955	0.130	0.027	0.954	0.128	-0.002	0.971	0.124	-0.002	0.979	0.124	-0.010	0.961	0.139
$\gamma_{10}$	0.000	0.944	0.043	-0.001	0.953	0.053	-0.002	0.939	0.053	-0.002	0.940	0.053	-0.002	0.945	0.052
<b>ICC = 0.3</b>															
$\gamma_{01}$	-0.002	0.946	0.127	0.017	0.955	0.127	0.001	0.949	0.132	0.001	0.954	0.132	0.000	0.954	0.133
$\gamma_{10}$	0.000	0.947	0.042	0.002	0.947	0.052	0.000	0.948	0.051	0.000	0.948	0.051	0.000	0.946	0.051
<b>MAR</b>															
<b>ICC = 0.1</b>															
$\gamma_{01}$	0.000	0.951	0.131	0.037	0.949	0.129	0.008	0.960	0.126	0.008	0.965	0.126	0.001	0.953	0.142
$\gamma_{10}$	-0.001	0.954	0.043	0.000	0.954	0.052	-0.001	0.956	0.051	-0.001	0.957	0.051	-0.001	0.953	0.050
<b>ICC = 0.3</b>															
$\gamma_{01}$	0.005	0.948	0.131	0.021	0.949	0.131	0.003	0.946	0.137	0.003	0.949	0.137	0.003	0.956	0.137
$\gamma_{10}$	0.001	0.954	0.041	0.000	0.949	0.052	-0.001	0.947	0.052	-0.001	0.947	0.052	-0.001	0.944	0.051

TABLE 4.6: Simulation results ( $N_2 = 60$ ,  $\gamma_{01} = 0.4$ )

	CD			LD			MI-R			MI-a			Bayes		
	Bias	Cov	SD												
<b>MCAR</b>															
<b>ICC = 0.1</b>															
$\gamma_{01}$	0.001	0.946	0.126	-0.039	0.939	0.124	-0.044	0.955	0.121	-0.044	0.960	0.121	-0.008	0.952	0.136
$\gamma_{10}$	0.001	0.960	0.041	0.001	0.961	0.050	0.004	0.954	0.049	0.004	0.955	0.049	0.001	0.958	0.049
<b>ICC = 0.3</b>															
$\gamma_{01}$	-0.002	0.952	0.129	-0.021	0.947	0.128	-0.007	0.954	0.132	-0.007	0.957	0.132	-0.005	0.962	0.133
$\gamma_{10}$	-0.001	0.954	0.040	-0.001	0.956	0.049	-0.002	0.956	0.048	-0.002	0.956	0.048	-0.002	0.961	0.048
<b>MAR</b>															
<b>ICC = 0.1</b>															
$\gamma_{01}$	0.000	0.954	0.129	-0.035	0.943	0.128	-0.044	0.960	0.125	-0.044	0.962	0.125	-0.008	0.957	0.144
$\gamma_{10}$	0.002	0.926	0.043	0.001	0.942	0.051	0.003	0.941	0.050	0.003	0.942	0.050	0.001	0.941	0.050
<b>ICC = 0.3</b>															
$\gamma_{01}$	-0.005	0.950	0.127	-0.022	0.956	0.125	-0.009	0.958	0.130	-0.009	0.961	0.130	-0.008	0.962	0.132
$\gamma_{10}$	-0.001	0.953	0.042	-0.002	0.944	0.051	-0.003	0.944	0.050	-0.003	0.945	0.050	-0.003	0.942	0.050



## Chapter 5

# Discussion



# References

- McNeish, D. (2017). Small Sample Methods for Multilevel Modeling: A Colloquial Elucidation of REML and the Kenward-Roger Correction. *Multivariate Behavioral Research*, 52(5), 661–670. <https://doi.org/10.1080/00273171.2017.1344538>