FFA Rasch Modelling

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1 Setup

```
library(easystats)  # convinient stats
library(here)  # path hell
library(eRm)  # Rasch models
library(mirt)  # more IRT
library(MASS)  # stats
library(lordif)  # DIF
library(tidyverse)  # data wrangling
library(psych)  # factor analysis
library(lavaan)  # CFAs
library(semPlot)  # SEM plots
```

1.1 Import FFA data

```
d_filename <- "Achtsamkeit_Daten_FFAEichung_rekodiert_2.sav"

d <- data_read(here("raw-data", d_filename))
```

1.2 Median split

```
d2 <-
  d %>%
  filter(Geschlecht != "divers") %>%
  mutate(Geschlecht = as.character(Geschlecht)) %>%
  mutate(PHQ_medsplit = ifelse(PHQ_Sum >= median(PHQ_Sum), 1, 0),
         Alter_medsplit = ifelse(Alter >= median(Alter), 1, 0))
```

Yes, only two cases of sex “divers”.

1.3 Check

Can we drop “diverse” sex without loosing much data?

```
d %>%
  count(Geschlecht)
```

```
  Geschlecht   n
1   männlich 495
2   weiblich 515
3     divers   2
```

2 Prepare data

2.1 Select FFA items

```
ffa_items <-
  d2 %>%
  dplyr::select(starts_with("FFA_"))
```

2.2 Recode

```
ffa_items2 <-
  ffa_items %>%
  mutate(across(.cols = everything(),
              .fns = ~ case_when(. == "fast nie" ~ 0,
                                 . == "eher selten" ~ 1,
                                 . == "relativ oft" ~ 2,
                                 . == "fast immer" ~ 3)))
```

2.3 Check

```
ffa_items2 %>%
 describe_distribution()
```

```
Variable    | Mean |    SD | IQR |         Range |   Skewness | Kurtosis
|     n | n_Missing
---------------------------------------------------------------------
```

```
------------------
FFA_1      | 1.91 | 0.85 |   1 | [0.00, 3.00] |     -0.52 |    -0.24
| 1010 |        0
FFA_2      | 1.51 | 0.89 |   1 | [0.00, 3.00] | -7.47e-03 |    -0.73
| 1010 |        0
FFA_3      | 1.42 | 0.86 |   1 | [0.00, 3.00] |      0.02 |    -0.66
| 1010 |        0
FFA_4      | 1.89 | 0.85 |   2 | [0.00, 3.00] |     -0.40 |    -0.48
| 1010 |        0
FFA_5      | 1.84 | 0.83 |   1 | [0.00, 3.00] |     -0.44 |    -0.28
| 1010 |        0
FFA_6      | 1.80 | 0.82 |   1 | [0.00, 3.00] |     -0.29 |    -0.43
| 1010 |        0
FFA_7      | 1.78 | 0.84 |   1 | [0.00, 3.00] |     -0.39 |    -0.36
| 1010 |        0
FFA_8      | 1.84 | 0.77 |   1 | [0.00, 3.00] |     -0.29 |    -0.27
| 1010 |        0
FFA_9      | 1.71 | 0.84 |   1 | [0.00, 3.00] |     -0.26 |    -0.47
| 1010 |        0
FFA_10     | 1.72 | 0.85 |   1 | [0.00, 3.00] |     -0.29 |    -0.49
| 1010 |        0
FFA_11     | 1.74 | 0.84 |   1 | [0.00, 3.00] |     -0.28 |    -0.47
| 1010 |        0
FFA_12     | 1.54 | 0.86 |   1 | [0.00, 3.00] |     -0.07 |    -0.65
| 1010 |        0
FFA_13_rek | 1.67 | 0.90 |   1 | [0.00, 3.00] |     -0.15 |    -0.76
| 1010 |        0
FFA_14     | 1.60 | 0.84 |   1 | [0.00, 3.00] |     -0.14 |    -0.54
| 1010 |        0
```

2.4 FFA-13

```
ffa13_items <-
  ffa_items2 %>%
  dplyr::select(-FFA_13_rek)

dim(ffa13_items)
```

```
[1] 1010   13
```

3 IRT Models FFA13 - one factor model

3.1 Rating Scale Model (RSM)

```
ffa_rsm1 <- RSM(ffa_items2, se = FALSE)
ffa_rsm1_ppar <- person.parameter(ffa_rsm1)
```

This model does not run, throws error due to singularity in matrix.

3.2 Partial Credit Model (PCM)

3.2.1 Estimate parameters

3.2.1.1 FFA-14: 14 items

```
ffa_pcm1 <- PCM(ffa_items2)
thresholds(ffa_pcm1)
```

```
Design Matrix Block 1:
           Location Threshold 1 Threshold 2 Threshold 3
FFA_1       0.26067    -0.94317    -0.22598     1.95115
FFA_2       0.91626    -0.67573     0.88345     2.54106
FFA_3       1.12831    -0.57636     0.99342     2.96786
FFA_4       0.22817    -1.21454     0.03671     1.86234
FFA_5       0.36060    -1.02959    -0.07687     2.18827
FFA_6       0.34979    -1.37675     0.17527     2.25084
FFA_7       0.48002    -0.93762     0.05186     2.32582
FFA_8       0.22446    -1.71550     0.02947     2.35943
FFA_9       0.58029    -1.04322     0.30623     2.47786
FFA_10      0.58014    -0.92527     0.26003     2.40568
FFA_11      0.50785    -1.09032     0.25214     2.36172
FFA_12      0.88470    -0.77655     0.76261     2.66804
FFA_13_rek  0.62526    -0.85574     0.59710     2.13443
FFA_14      0.76323    -0.99528     0.59661     2.68836
```

```
ffa_pcm1_ppar <- person.parameter(ffa_pcm1)
ffa_pcm1_ppar
```

```
Person Parameters:

 Raw Score    Estimate Std.Error
         3 -2.47563019 0.6110641
         4 -2.14746247 0.5393721
         5 -1.88288301 0.4918666
         6 -1.65803307 0.4580168
         7 -1.46010308 0.4327927
         8 -1.28138631 0.4134650
         9 -1.11680549 0.3984023
        10 -0.96292147 0.3865766
        11 -0.81719887 0.3772888
        12 -0.67766802 0.3700483
        13 -0.54286015 0.3645077
        14 -0.41157499 0.3604056
        15 -0.28277307 0.3575391
        16 -0.15562456 0.3557542
        17 -0.02941778 0.3549217
        18  0.09649900 0.3549390
        19  0.22270913 0.3557148
        20  0.34973478 0.3571744
        21  0.47802889 0.3592494
        22  0.60799865 0.3618793
        23  0.74004711 0.3650126
        24  0.87456811 0.3686113
        25  1.01192106 0.3726488
        26  1.15244051 0.3771211
        27  1.29648521 0.3820526
        28  1.44448274 0.3875043
        29  1.59695652 0.3935906
        30  1.75455113 0.4004877
        31  1.91808584 0.4084536
        32  2.08866648 0.4178543
        33  2.26786312 0.4292056
        34  2.45792067 0.4432464
        35  2.66204174 0.4610582
        36  2.88497992 0.4843112
        37  3.13422277 0.5157722
        38  3.42238345 0.5604822
        39  3.77318878 0.6289827
        40  4.23992101 0.7486760
        41  4.99249392 1.0290806
        42  5.81436949        NA
```

```
ffa_pcm1_itemfit <- eRm::itemfit(ffa_pcm1_ppar)
ffa_pcm1_itemfit
```

```
Itemfit Statistics:
              Chisq   df p-value Outfit MSQ Infit MSQ Outfit t Infit
t Discrim
FFA_1      1012.904 1002   0.398      1.010     0.979    0.231
-0.458   0.522
FFA_2      1074.782 1002   0.054      1.072     1.051    1.684
1.226   0.492
FFA_3      1066.561 1002   0.077      1.063     1.064    1.504
1.535   0.470
FFA_4       849.198 1002   1.000      0.847     0.850   -3.647
-3.707   0.614
FFA_5       758.503 1002   1.000      0.756     0.767   -5.965
-5.809   0.667
FFA_6       784.800 1002   1.000      0.782     0.798   -5.439
-5.081   0.646
FFA_7       746.182 1002   1.000      0.744     0.762   -6.368
-6.000   0.677
FFA_8       959.878 1002   0.826      0.957     0.952   -0.985
-1.113   0.517
FFA_9       796.610 1002   1.000      0.794     0.799   -5.140
-5.073   0.648
FFA_10      770.208 1002   1.000      0.768     0.777   -5.836
-5.705   0.665
FFA_11      749.025 1002   1.000      0.747     0.756   -6.436
-6.277   0.676
FFA_12      795.992 1002   1.000      0.794     0.799   -5.295
-5.210   0.650
FFA_13_rek 2651.416 1002   0.000      2.643     1.855   27.010
16.750  -0.021
FFA_14      979.859 1002   0.686      0.977     0.951   -0.536
-1.184   0.538
```

This model shows a bad fit.

3.2.1.2 FFA-13: 13 item

```
ffa_pcm2 <- PCM(ffa13_items)
ffa_pcm2_ppar <- person.parameter(ffa_pcm2)
```

```
ffa_pcm2_itemfit2 <- eRm::itemfit(ffa_pcm2_ppar)
ffa_pcm2_itemfit2
```

```
Itemfit Statistics:
          Chisq  df p-value Outfit MSQ Infit MSQ Outfit t Infit t
Discrim
FFA_1  1128.015 985   0.001      1.144     1.062    3.009   1.371
0.492
FFA_2  1147.431 985   0.000      1.164     1.111    3.635   2.568
0.472
FFA_3  1134.305 985   0.001      1.150     1.129    3.355   2.973
0.446
FFA_4   952.263 985   0.768      0.966     0.935   -0.761  -1.540
0.579
FFA_5   805.340 985   1.000      0.817     0.822   -4.313  -4.279
0.644
FFA_6   837.713 985   1.000      0.850     0.859   -3.613  -3.399
0.619
FFA_7   776.805 985   1.000      0.788     0.800   -5.089  -4.886
0.662
FFA_8  1041.978 985   0.101      1.057     1.030    1.280   0.687
0.482
FFA_9   868.430 985   0.997      0.881     0.878   -2.820  -2.931
0.611
FFA_10  804.569 985   1.000      0.816     0.829   -4.447  -4.193
0.643
FFA_11  822.820 985   1.000      0.835     0.833   -3.987  -4.085
0.638
FFA_12  838.186 985   1.000      0.850     0.856   -3.665  -3.579
0.625
FFA_14 1042.183 985   0.100      1.057     1.019    1.309   0.457
0.509
```

3.2.2 Overall Goodness of Fit

```
#gofIRT(ffa_pcm2_ppar)  # not implemented for polytomuous models yet
#item_info(ffa_pcm2)
```

3.2.3 Andersen test

Significant results indicate that the exercise parameter differ significantly between the two groups.

```
LRtest(ffa_pcm2)  # nicht so gut
```

```
Andersen LR-test:
LR-value: 168.57
Chi-square df: 35
p-value:  0
```

```
LRtest(ffa_pcm2, d2$Evang)  # ok
```

```
Andersen LR-test:
LR-value: 57.32
Chi-square df: 38
p-value:  0.023
```

```
LRtest(ffa_pcm2, d2$Theorie)  # nicht so gut
```

```
Andersen LR-test:
LR-value: 119.295
Chi-square df: 38
p-value:  0
```

```
LRtest(ffa_pcm2, d2$PHQ_medsplit)  # nicht so gut
```

```
Andersen LR-test:
LR-value: 253.068
Chi-square df: 38
p-value:  0
```

3.2.4 Wald Test

```
Waldtest(ffa_pcm2)
```

```
Wald test on item level (z-values):
```

```
                 z-statistic p-value
beta FFA_1.c1          4.506   0.000
beta FFA_1.c2          3.313   0.001
beta FFA_1.c3          1.406   0.160
beta FFA_2.c1          1.703   0.089
beta FFA_2.c2         -0.342   0.732
beta FFA_2.c3          0.099   0.921
beta FFA_3.c1          3.435   0.001
beta FFA_3.c2          2.098   0.036
beta FFA_3.c3          0.842   0.400
beta FFA_4.c1         -0.097   0.922
beta FFA_4.c2         -0.894   0.371
beta FFA_4.c3         -1.318   0.187
beta FFA_5.c1          0.021   0.984
beta FFA_5.c2         -1.239   0.215
beta FFA_5.c3         -2.135   0.033
beta FFA_7.c1         -0.063   0.950
beta FFA_7.c2         -1.739   0.082
beta FFA_7.c3         -2.886   0.004
beta FFA_8.c1          4.104   0.000
beta FFA_8.c2          2.937   0.003
beta FFA_8.c3          2.192   0.028
beta FFA_9.c1          1.163   0.245
beta FFA_9.c2         -0.938   0.348
beta FFA_9.c3         -1.972   0.049
beta FFA_10.c1         2.395   0.017
beta FFA_10.c2         0.048   0.962
beta FFA_10.c3        -0.583   0.560
beta FFA_11.c1         1.771   0.077
beta FFA_11.c2        -0.710   0.478
beta FFA_11.c3        -1.462   0.144
beta FFA_12.c1        -1.497   0.134
beta FFA_12.c2        -3.005   0.003
beta FFA_12.c3        -3.033   0.002
beta FFA_14.c1         2.537   0.011
beta FFA_14.c2         1.072   0.284
beta FFA_14.c3         0.952   0.341
```

```r
Waldtest(ffa_pcm2, d2$PHQ_medsplit)
```

```
Wald test on item level (z-values):
```

```
                z-statistic p-value
beta FFA_1.c1         0.280   0.779
beta FFA_1.c2         1.678   0.093
beta FFA_1.c3         2.732   0.006
beta FFA_2.c1        -4.512   0.000
beta FFA_2.c2        -5.186   0.000
beta FFA_2.c3        -6.045   0.000
beta FFA_3.c1        -5.622   0.000
beta FFA_3.c2        -7.385   0.000
beta FFA_3.c3        -6.354   0.000
beta FFA_4.c1         0.652   0.514
beta FFA_4.c2         2.637   0.008
beta FFA_4.c3         3.856   0.000
beta FFA_5.c1        -1.845   0.065
beta FFA_5.c2        -1.191   0.234
beta FFA_5.c3        -1.043   0.297
beta FFA_6.c1         0.561   0.575
beta FFA_6.c2         1.790   0.074
beta FFA_6.c3         1.669   0.095
beta FFA_7.c1        -2.465   0.014
beta FFA_7.c2        -1.011   0.312
beta FFA_7.c3         0.112   0.911
beta FFA_8.c1         0.129   0.897
beta FFA_8.c2        -0.393   0.694
beta FFA_8.c3         0.431   0.667
beta FFA_9.c1         0.605   0.545
beta FFA_9.c2         3.150   0.002
beta FFA_9.c3         4.208   0.000
beta FFA_10.c1       -2.569   0.010
beta FFA_10.c2       -1.876   0.061
beta FFA_10.c3       -1.783   0.075
beta FFA_11.c1        0.270   0.787
beta FFA_11.c2        2.763   0.006
beta FFA_11.c3        3.017   0.003
beta FFA_12.c1        1.119   0.263
beta FFA_12.c2        2.903   0.004
beta FFA_12.c3        2.149   0.032
beta FFA_14.c1        1.156   0.248
beta FFA_14.c2        2.015   0.044
beta FFA_14.c3        0.817   0.414
```

3.2.5 MLoef Test

```
MLoef(ffa_pcm2)  # good
```

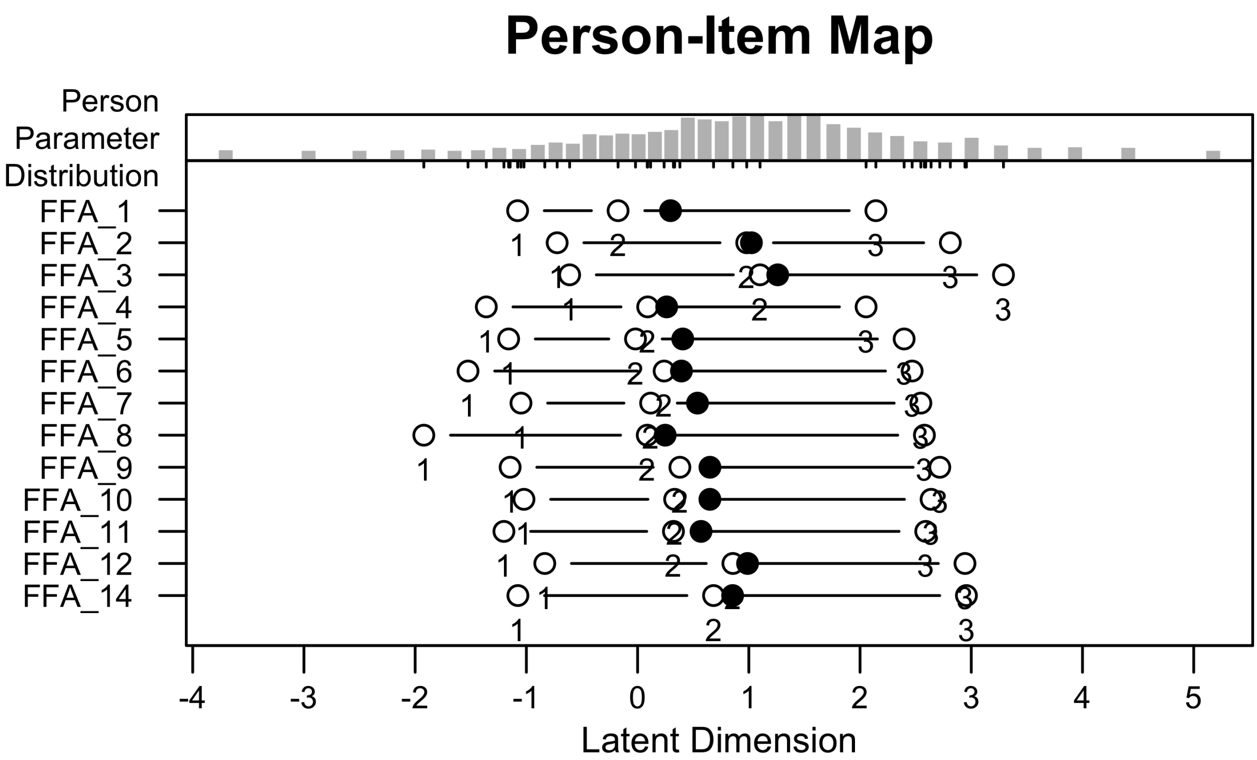
```
Martin-Loef-Test (split criterion: median)
LR-value: 378.543
Chi-square df: 377
p-value: 0.468
```

3.2.6 Item information

```
plotINFO(ffa_pcm2, legpos = FALSE)
```

```
Error in plot.new(): figure margins too large
```

```
plotPImap(ffa_pcm2)
```



4 Two factor model

4.1 Devise factors

Items were assigned according to Sauer et al., 2013.

```
presence_factor <- c(1, 2, 3, 5, 7)
acceptance_factor <- c(4, 6, 8, 9, 10, 11, 12, 14)
```

```
ffa13_pres <-
  ffa_items2 %>%
  dplyr::select(any_of(presence_factor))

ffa13_acc <-
  ffa_items2 %>%
  dplyr::select(any_of(acceptance_factor))
```

4.2 Check distributions

```
ffa13_pres %>%
  describe_distribution()
```

```
Variable | Mean |   SD | IQR |         Range |  Skewness | Kurtosis |
n | n_Missing
----------------------------------------------------------------------
----------------
FFA_1    | 1.91 | 0.85 |   1 | [0.00, 3.00] |     -0.52 |    -0.24 |
1010 |         0
FFA_2    | 1.51 | 0.89 |   1 | [0.00, 3.00] | -7.47e-03 |    -0.73 |
1010 |         0
FFA_3    | 1.42 | 0.86 |   1 | [0.00, 3.00] |      0.02 |    -0.66 |
1010 |         0
FFA_5    | 1.84 | 0.83 |   1 | [0.00, 3.00] |     -0.44 |    -0.28 |
1010 |         0
FFA_7    | 1.78 | 0.84 |   1 | [0.00, 3.00] |     -0.39 |    -0.36 |
1010 |         0
```

```
ffa13_acc %>%
  describe_distribution()
```

```
Variable | Mean |   SD | IQR |         Range | Skewness | Kurtosis |
n | n_Missing
----------------------------------------------------------------------
---------------
```

```
FFA_4    | 1.89 | 0.85 |   2 | [0.00, 3.00] |    -0.40 |    -0.48 |
1010 |        0
FFA_6    | 1.80 | 0.82 |   1 | [0.00, 3.00] |    -0.29 |    -0.43 |
1010 |        0
FFA_8    | 1.84 | 0.77 |   1 | [0.00, 3.00] |    -0.29 |    -0.27 |
1010 |        0
FFA_9    | 1.71 | 0.84 |   1 | [0.00, 3.00] |    -0.26 |    -0.47 |
1010 |        0
FFA_10   | 1.72 | 0.85 |   1 | [0.00, 3.00] |    -0.29 |    -0.49 |
1010 |        0
FFA_11   | 1.74 | 0.84 |   1 | [0.00, 3.00] |    -0.28 |    -0.47 |
1010 |        0
FFA_12   | 1.54 | 0.86 |   1 | [0.00, 3.00] |    -0.07 |    -0.65 |
1010 |        0
FFA_14   | 1.60 | 0.84 |   1 | [0.00, 3.00] |    -0.14 |    -0.54 |
1010 |        0
```

4.3 Any categories not chosen?

Let's check if any category was not chosen at all, which may cause the model to fail according to this source.

```
ffa13_acc %>%
  pivot_longer(everything(), names_to = "item", values_to = "category
  count(item, category, sort = TRUE)
```

```
# A tibble: 32 × 3
   item   category     n
   <chr>     <dbl> <int>
 1 FFA_8         2   514
 2 FFA_6         2   477
 3 FFA_11        2   469
 4 FFA_9         2   469
 5 FFA_10        2   467
 6 FFA_4         2   453
 7 FFA_14        2   436
 8 FFA_12        2   401
 9 FFA_12        1   357
10 FFA_14        1   341
# … with 22 more rows
```

However, there appear to be no category with zero count.

5 RSM

5.1 Presence

5.1.1 Parameter estimation

```
ffa_rsm1_pres <- RSM(ffa13_pres, se = TRUE)
ffa_rsm1_pres
```

```
Results of RSM estimation:

Call:  RSM(X = ffa13_pres, se = TRUE)

Conditional log-likelihood: -3195.759
Number of iterations: 18
Number of parameters: 6

Item (Category) Difficulty Parameters (eta):
              FFA_2      FFA_3       FFA_5       FFA_7      Cat 2
Cat 3
Estimate 0.39599666 0.58536426 -0.32090754 -0.18635947 1.41513967
5.0277889
Std.Err  0.04180639 0.04274221  0.04263715  0.04196558 0.08641274
0.1740857
```

```
ffa_rsm1_pres_ppar <- person.parameter(ffa_rsm1_pres)
```

5.1.2 Itemfit

```
eRm::itemfit(ffa_rsm1_pres_ppar)
```

```
Itemfit Statistics:
        Chisq  df p-value Outfit MSQ Infit MSQ Outfit t Infit t
Discrim
FFA_1 883.502 971   0.979      0.909     0.927   -2.093  -1.697
```

```
0.477
FFA_2 819.184 971   1.000      0.843     0.823   -3.866  -4.429
0.538
FFA_3 847.283 971   0.998      0.872     0.859   -3.123  -3.500
0.472
FFA_5 771.695 971   1.000      0.794     0.793   -5.018  -5.082
0.550
FFA_7 735.241 971   1.000      0.756     0.751   -6.071  -6.260
0.589
```

Looks good.

5.1.3 Andersen test

A significant results indicates that the item parameters differ between groups, which indicates a violation of the Rasch model's assumption.

```r
LRtest(ffa_rsm1_pres)  # sign.
```

```
Andersen LR-test:
LR-value: 25.923
Chi-square df: 6
p-value:  0
```

```r
LRtest(ffa_rsm1_pres, d2$Evang)  # sign
```

```
Andersen LR-test:
LR-value: 15.57
Chi-square df: 6
p-value:  0.016
```

```r
LRtest(ffa_rsm1_pres, d2$Theorie)  # sign
```

```
Andersen LR-test:
LR-value: 42.911
Chi-square df: 6
p-value:  0
```

```r
#PHQ_medsplit <- ifelse(d$PHQ_Sum >= median(d$PHQ_Sum), "+", "-")
```

```
LRtest(ffa_rsm1_pres, d2$PHQ_medsplit)  # sign
```

```
Andersen LR-test:
LR-value: 113.556
Chi-square df: 6
p-value:  0
```

5.1.4 Wald Test

The Wald Tests computes the difference in item difficulty normalized to their SE between two groups.

A significant results indicates that the item parameters differ between groups, which indicates a violation of the Rasch model's assumption.

```
Waldtest(ffa_rsm1_pres)  # sign mostly
```

```
Wald test on item level (z-values):

              z-statistic p-value
beta FFA_1.c1      -0.507   0.612
beta FFA_1.c2      -4.207   0.000
beta FFA_1.c3      -4.032   0.000
beta FFA_2.c1      -1.989   0.047
beta FFA_2.c2      -4.861   0.000
beta FFA_2.c3      -4.421   0.000
beta FFA_3.c1       0.879   0.379
beta FFA_3.c2      -3.266   0.001
beta FFA_3.c3      -3.070   0.002
beta FFA_5.c1       0.538   0.591
beta FFA_5.c2      -3.687   0.000
beta FFA_5.c3      -3.551   0.000
beta FFA_7.c1       1.061   0.289
beta FFA_7.c2      -3.432   0.001
beta FFA_7.c3      -3.306   0.001
```

```
Waldtest(ffa_rsm1_pres, d2$PHQ_medsplit)  # signif mostly
```

```
Wald test on item level (z-values):
```

```
                 z-statistic p-value
beta FFA_1.c1          5.445   0.000
beta FFA_1.c2          6.955   0.000
beta FFA_1.c3          6.557   0.000
beta FFA_2.c1         -4.458   0.000
beta FFA_2.c2         -0.527   0.598
beta FFA_2.c3         -0.139   0.889
beta FFA_3.c1         -5.848   0.000
beta FFA_3.c2         -1.506   0.132
beta FFA_3.c3         -0.951   0.342
beta FFA_5.c1          1.324   0.185
beta FFA_5.c2          3.671   0.000
beta FFA_5.c3          3.509   0.000
beta FFA_7.c1          3.341   0.001
beta FFA_7.c2          5.111   0.000
beta FFA_7.c3          4.704   0.000
```

5.1.5 MLOEF Test

The M Loef tests checks whether the person parameter differ between items. According to the assumptions of the Rasch models, we expect invariance, i.e., there should be not subset of items for which the person parameters differ from the rest of the items.

```
MLoef(ffa_rsm1_pres)  # signif
```

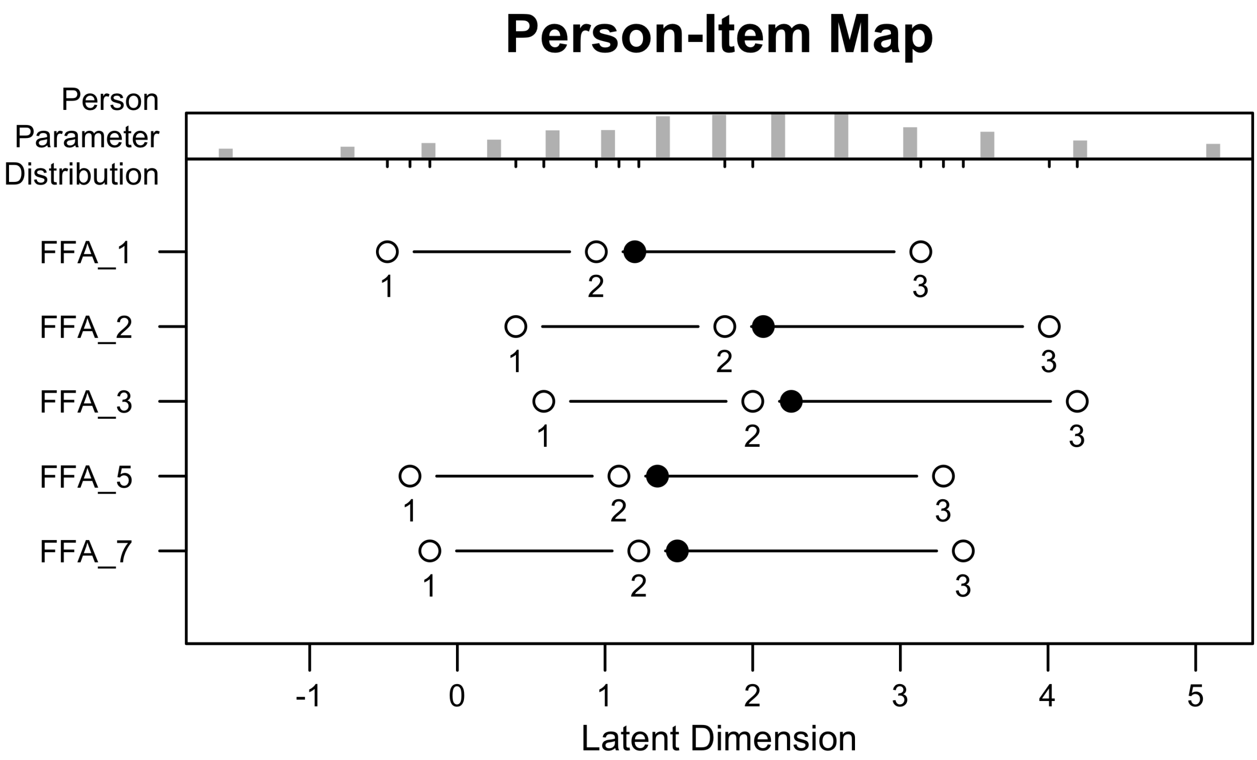
```
Martin-Loef-Test (split criterion: median)
LR-value: 124.152
Chi-square df: 53
p-value: 0
```

5.1.6 Item information

```
plotINFO(ffa_rsm1_pres, legpos = FALSE)
```

```
Error in plot.new(): figure margins too large
```

```
plotPImap(ffa_rsm1_pres)
```



5.2 Acceptance

5.2.1 Parameter estimation

This does NOT Run:

```
ffa_rsm1_acc <- RSM(ffa13_acc, se = TRUE)
ffa_rsm1_acc
ffa_rsm1_acc_ppar <- person.parameter(ffa_rsm1_acc)
```

Oh no: NaNs have been produced. There must be some edge cases in the data.

5.2.2 Itemfit

```
eRm::itemfit(ffa_rsm1_acc_ppar)
```

5.2.3 Itemfit

```
eRm::itemfit(ffa_rsm1_pres_ppar)
```

```
Itemfit Statistics:
        Chisq  df p-value Outfit MSQ Infit MSQ Outfit t Infit t
Discrim
FFA_1 883.502 971   0.979      0.909     0.927   -2.093  -1.697
0.477
FFA_2 819.184 971   1.000      0.843     0.823   -3.866  -4.429
0.538
FFA_3 847.283 971   0.998      0.872     0.859   -3.123  -3.500
0.472
FFA_5 771.695 971   1.000      0.794     0.793   -5.018  -5.082
0.550
FFA_7 735.241 971   1.000      0.756     0.751   -6.071  -6.260
0.589
```

5.2.4 Andersen test

A significant results indicates that the item parameters differ between groups, which indicates a violation of the Rasch model's assumption.

```r
LRtest(ffa_rsm1_acc)  # does not run
```

```
Error in LRtest(ffa_rsm1_acc): object 'ffa_rsm1_acc' not found
```

```r
LRtest(ffa_rsm1_acc, d2$Evang)  # sign
```

```
Error in LRtest(ffa_rsm1_acc, d2$Evang): object 'ffa_rsm1_acc' not
found
```

```r
LRtest(ffa_rsm1_acc, d2$Theorie)  # sign
```

```
Error in LRtest(ffa_rsm1_acc, d2$Theorie): object 'ffa_rsm1_acc' not
found
```

```r
#PHQ_medsplit <- ifelse(d$PHQ_Sum >= median(d$PHQ_Sum), "+", "-")
LRtest(ffa_rsm1_acc, d2$PHQ_medsplit)  # sign
```

```
Error in LRtest(ffa_rsm1_acc, d2$PHQ_medsplit): object 'ffa_rsm1_acc'
not found
```

5.2.5 Wald Test

The Wald Tests computes the difference in item difficulty normalized to their SE between two groups.

A significant results indicates that the item parameters differ between groups, which indicates a violation of the Rasch model's assumption.

This function yields error (singular matrix).

```
#Waldtest(ffa_rsm1_acc)  # sign mostly
#Waldtest(ffa_rsm1_acc, d2$PHQ_medsplit)  # signif mostly
```

5.2.6 MLOEF Test

The M Loef tests checks whether the person parameter differ between items. According to the assumptions of the Rasch models, we expect invariance, i.e., there should be not subset of items for which the person parameters differ from the rest of the items.

```
MLoef(ffa_rsm1_acc)  # signif
```

```
Error in MLoef(ffa_rsm1_acc): object 'ffa_rsm1_acc' not found
```

5.2.7 Item information

```
plotINFO(ffa_rsm1_acc, legpos = FALSE)
```

```
Error in get_item_cats(X = ermobject$X, nitems = dim(ermobject$X)[2],
: object 'ffa_rsm1_acc' not found
```

```
plotPImap(ffa_rsm1_acc)
```

```
Error in plotPImap(ffa_rsm1_acc): object 'ffa_rsm1_acc' not found
```

5.3 Conclusion

The RSM is not appropriate for the data for some reason that is not entirely clear.

6 PCM

6.1 Presence

6.1.1 Parameter estimation

```
ffa_pcm1_pres <- PCM(ffa13_pres, se = TRUE)
ffa_pcm1_pres
```

```
Results of PCM estimation:

Call:  PCM(X = ffa13_pres, se = TRUE)

Conditional log-likelihood: -3183.913
Number of iterations: 31
Number of parameters: 14

Item (Category) Difficulty Parameters (eta):
           FFA_1.c2  FFA_1.c3   FFA_2.c1   FFA_2.c2  FFA_2.c3
FFA_3.c1
Estimate -1.4679274 0.5501084 -0.8282963 0.04465034 2.7220750
-0.7154672
Std.Err   0.1357334 0.1471584  0.1050176 0.11326886 0.1570351
0.1001023
          FFA_3.c2  FFA_3.c3   FFA_5.c1   FFA_5.c2  FFA_5.c3
FFA_7.c1
Estimate 0.2742468 3.4297143 -1.2716971 -1.3931592 0.8767761
-1.1587477
Std.Err  0.1108744 0.1704769  0.1424045  0.1338912 0.1498455
0.1334806
           FFA_7.c2  FFA_7.c3
Estimate -1.1452605 1.2737425
Std.Err   0.1275336 0.1494924
```

```
ffa_pcm1_pres_ppar <- person.parameter(ffa_pcm1_pres)
```

6.1.2 Itemfit

```
eRm::itemfit(ffa_pcm1_pres_ppar)
```

```
Itemfit Statistics:
        Chisq  df p-value Outfit MSQ Infit MSQ Outfit t Infit t
Discrim
FFA_1 856.206 971   0.997      0.881     0.890   -2.719  -2.540
0.477
FFA_2 801.639 971   1.000      0.825     0.806   -4.375  -4.907
0.538
FFA_3 874.078 971   0.988      0.899     0.894   -2.444  -2.585
0.472
FFA_5 773.795 971   1.000      0.796     0.795   -4.903  -4.965
0.550
FFA_7 738.222 971   1.000      0.759     0.755   -5.917  -6.092
0.589
```

Quite good.

6.1.3 Andersen test

A significant results indicates that the item parameters differ between groups, which indicates a violation of the Rasch model's assumption.

```
LRtest(ffa_pcm1_pres)  # sign.
```

```
Andersen LR-test:
LR-value: 34.352
Chi-square df: 14
p-value:  0.002
```

```
LRtest(ffa_pcm1_pres, d2$Evang)  # NOT sign
```

```
Andersen LR-test:
LR-value: 20.603
Chi-square df: 14
p-value:  0.112
```

```
LRtest(ffa_pcm1_pres, d2$Theorie)  # sign
```

```
Andersen LR-test:
LR-value: 54.516
```

```
Chi-square df: 14
p-value:  0
```

```
#PHQ_medsplit <- ifelse(d$PHQ_Sum >= median(d$PHQ_Sum), "+", "-")
LRtest(ffa_pcm1_pres, d2$PHQ_medsplit)  # sign
```

```
Andersen LR-test:
LR-value: 123.54
Chi-square df: 14
p-value:  0
```

6.1.4 Wald Test

The Wald Tests computes the difference in item difficulty normalized to their SE between two groups.

A significant results indicates that the item parameters differ between groups, which indicates a violation of the Rasch model’s assumption.

```
Waldtest(ffa_pcm1_pres)  #  mostly NOT signif
```

```
Wald test on item level (z-values):

              z-statistic p-value
beta FFA_1.c1       3.305   0.001
beta FFA_1.c2       1.858   0.063
beta FFA_1.c3       0.835   0.404
beta FFA_2.c1       1.971   0.049
beta FFA_2.c2      -0.530   0.596
beta FFA_2.c3      -1.313   0.189
beta FFA_3.c1       0.471   0.638
beta FFA_3.c2      -1.470   0.141
beta FFA_3.c3      -1.077   0.282
beta FFA_5.c1       0.490   0.624
beta FFA_5.c2      -0.395   0.693
beta FFA_5.c3      -0.988   0.323
beta FFA_7.c1       0.105   0.917
beta FFA_7.c2      -0.864   0.388
beta FFA_7.c3      -1.239   0.215
```

```
Waldtest(ffa_pcm1_pres, d2$PHQ_medsplit)  # mixed picture as to signi
```

```
Wald test on item level (z-values):

              z-statistic p-value
beta FFA_1.c1       1.193   0.233
beta FFA_1.c2       4.028   0.000
beta FFA_1.c3       6.154   0.000
beta FFA_2.c1      -2.984   0.003
beta FFA_2.c2      -2.408   0.016
beta FFA_2.c3      -2.998   0.003
beta FFA_3.c1      -4.059   0.000
beta FFA_3.c2      -4.572   0.000
beta FFA_3.c3      -3.494   0.000
beta FFA_5.c1      -0.800   0.424
beta FFA_5.c2       1.207   0.227
beta FFA_5.c3       2.082   0.037
beta FFA_7.c1      -1.333   0.182
beta FFA_7.c2       1.568   0.117
beta FFA_7.c3       3.391   0.001
```

6.1.5 MLOEF Test

The M Loef tests checks whether the person parameter differ between items. According to the assumptions of the Rasch models, we expect invariance, i.e., there should be not subset of items for which the person parameters differ from the rest of the items.

```
MLoef(ffa_pcm1_pres)  # signif
```

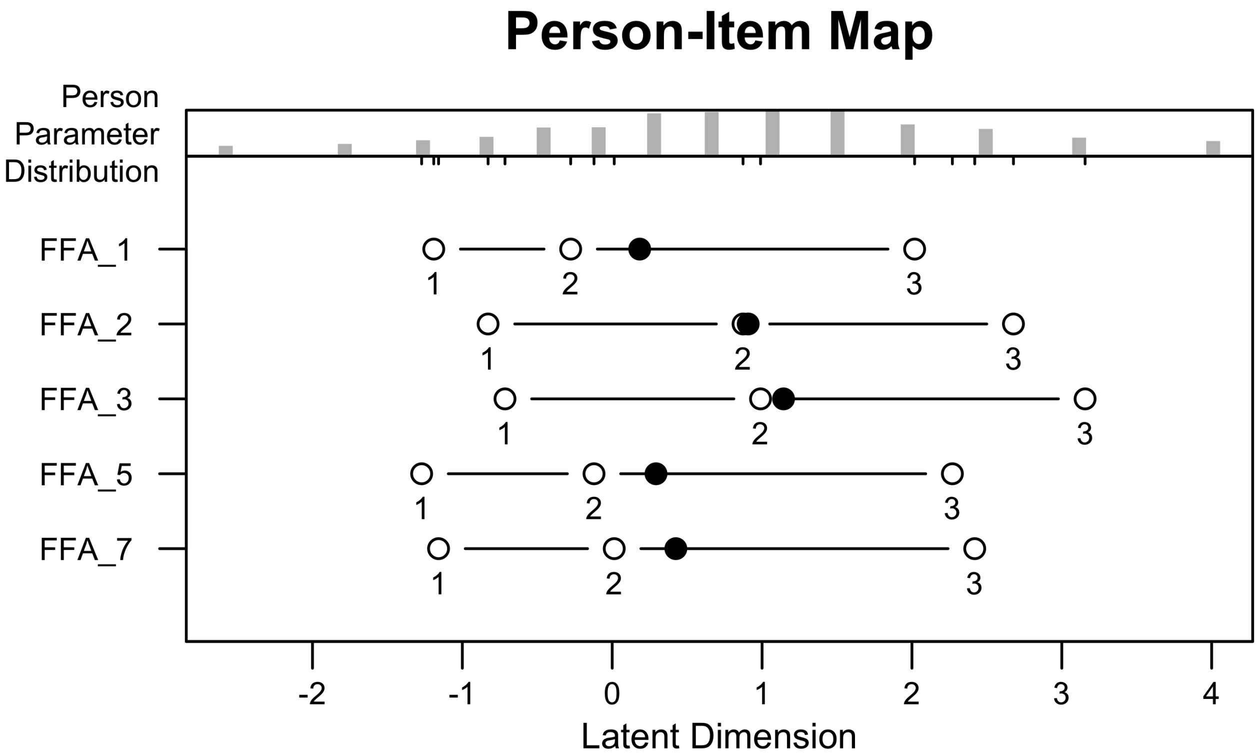
```
Martin-Loef-Test (split criterion: median)
LR-value: 100.46
Chi-square df: 53
p-value: 0
```

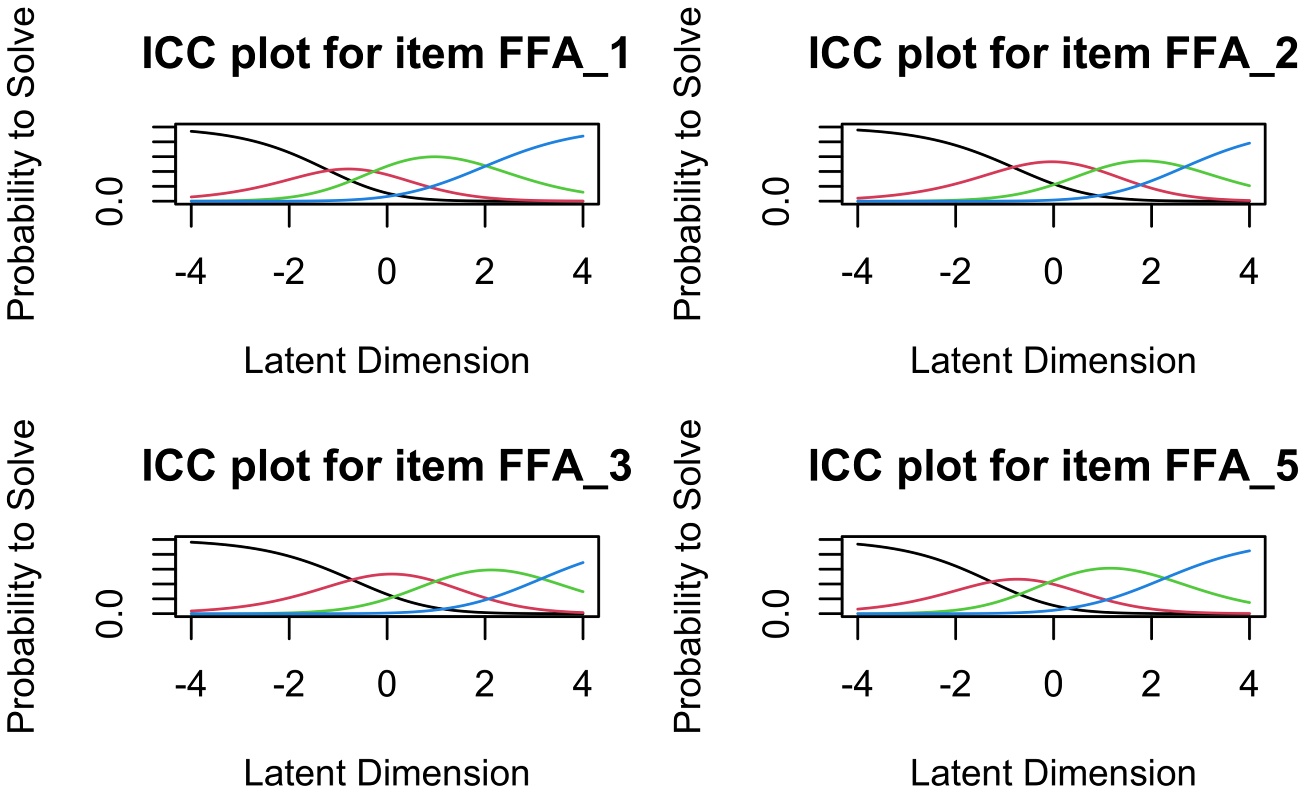
6.1.6 Item information

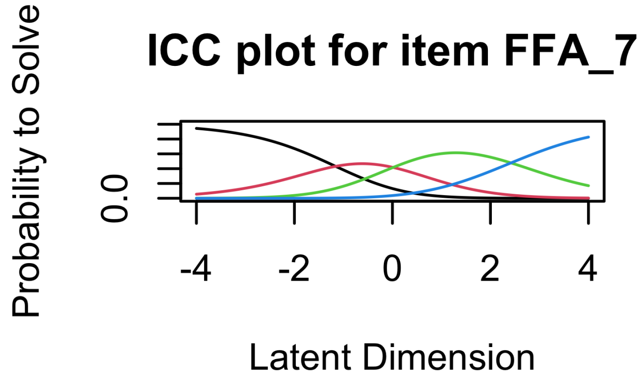
```
plotINFO(ffa_pcm1_pres, legpos = FALSE)
```

```
Error in plot.new(): figure margins too large
```

```
plotPImap(ffa_pcm1_pres)
plotICC(ffa_pcm1_pres,mplot=TRUE,legpos=FALSE,ask=FALSE)
```







6.2 Acceptance

6.2.1 Parameter estimation

```
ffa_pcm1_acc <- PCM(ffa13_acc, se = TRUE)
ffa_pcm1_acc
```

```
Results of PCM estimation:

Call:  PCM(X = ffa13_acc, se = TRUE)

Conditional log-likelihood: -5665.854
Number of iterations: 27
Number of parameters: 23

Item (Category) Difficulty Parameters (eta):
          FFA_4.c2  FFA_4.c3   FFA_6.c1  FFA_6.c2  FFA_6.c3
FFA_8.c1
Estimate -1.198001 1.0485305 -1.5537148 -1.208498 1.4719554
-1.9861856
Std.Err   0.151804 0.1662774  0.1553209  0.153429 0.1730271
```

```
0.1832482
           FFA_8.c2  FFA_8.c3   FFA_9.c1   FFA_9.c2  FFA_9.c3
FFA_10.c1
Estimate -1.7975028 0.9951131 -1.1475755 -0.6528500 2.2922089
-1.0194943
Std.Err   0.1774485 0.1913627  0.1339019  0.1355878 0.1659322
0.1308545
          FFA_10.c2 FFA_10.c3  FFA_11.c1  FFA_11.c2 FFA_11.c3
FFA_12.c1
Estimate -0.5725264 2.2895048 -1.2088360 -0.7746536 2.0360393
-0.8061815
Std.Err   0.1326501 0.1625221  0.1379859  0.1387522 0.1654349
0.1132583
         FFA_12.c2 FFA_12.c3  FFA_14.c1  FFA_14.c2 FFA_14.c3
Estimate  0.178661  3.376419 -1.0632220 -0.2573247 2.9479657
Std.Err   0.122176  0.167022  0.1238444  0.1292577 0.1692504
```

```
ffa_pcm1_acc_ppar <- person.parameter(ffa_pcm1_acc)
```

6.2.2 Itemfit

```
eRm::itemfit(ffa_pcm1_acc_ppar)
```

```
Itemfit Statistics:
          Chisq  df p-value Outfit MSQ Infit MSQ Outfit t Infit t
Discrim
FFA_4   935.975 977   0.823      0.957     0.916   -0.941  -1.974
0.569
FFA_6   820.706 977   1.000      0.839     0.837   -3.827  -3.943
0.614
FFA_8  1051.808 977   0.048      1.075     1.081    1.669   1.795
0.426
FFA_9   767.624 977   1.000      0.785     0.779   -5.238  -5.474
0.655
FFA_10  855.842 977   0.998      0.875     0.863   -2.915  -3.284
0.601
FFA_11  780.714 977   1.000      0.798     0.791   -4.876  -5.142
0.647
FFA_12  814.717 977   1.000      0.833     0.826   -4.075  -4.305
0.627
```

```
FFA_14 1029.331 977   0.119      1.052     1.029    1.199   0.682
0.483
```

Quite good.

6.2.3 Andersen test

A significant results indicates that the item parameters differ between groups, which indicates a violation of the Rasch model's assumption.

```
LRtest(ffa_pcm1_acc)  # signif
```

```
Andersen LR-test:
LR-value: 112.123
Chi-square df: 20
p-value:  0
```

```
LRtest(ffa_pcm1_acc, d2$Evang)  # NOT sign
```

```
Andersen LR-test:
LR-value: 31.755
Chi-square df: 23
p-value:  0.105
```

```
LRtest(ffa_pcm1_acc, d2$Theorie)  # sign
```

```
Andersen LR-test:
LR-value: 52.22
Chi-square df: 23
p-value:  0
```

```
#PHQ_medsplit <- ifelse(d$PHQ_Sum >= median(d$PHQ_Sum), "+", "-")
LRtest(ffa_pcm1_acc, d2$PHQ_medsplit)  # sign
```

```
Andersen LR-test:
LR-value: 71.234
Chi-square df: 23
p-value:  0
```

6.2.4 Wald Test

The Wald Tests computes the difference in item difficulty normalized to their SE between two groups.

A significant results indicates that the item parameters differ between groups, which indicates a violation of the Rasch model's assumption.

```
Waldtest(ffa_pcm1_acc)  #  mostly not signif
```

```
Wald test on item level (z-values):

               z-statistic p-value
beta FFA_4.c1       -0.321   0.748
beta FFA_4.c2       -1.191   0.234
beta FFA_4.c3       -1.436   0.151
beta FFA_8.c1        4.036   0.000
beta FFA_8.c2        2.920   0.004
beta FFA_8.c3        3.021   0.003
beta FFA_9.c1        1.289   0.197
beta FFA_9.c2       -0.901   0.367
beta FFA_9.c3       -2.024   0.043
beta FFA_10.c1       3.723   0.000
beta FFA_10.c2       0.964   0.335
beta FFA_10.c3       0.330   0.742
beta FFA_11.c1       0.880   0.379
beta FFA_11.c2      -1.155   0.248
beta FFA_11.c3      -1.388   0.165
beta FFA_12.c1      -1.429   0.153
beta FFA_12.c2      -3.112   0.002
beta FFA_12.c3      -2.438   0.015
beta FFA_14.c1       2.509   0.012
beta FFA_14.c2       0.706   0.480
beta FFA_14.c3       1.481   0.139
```

```
Waldtest(ffa_pcm1_acc, d2$PHQ_medsplit)  #  NOT signif
```

```
Wald test on item level (z-values):

               z-statistic p-value
```

```
beta FFA_4.c1         0.269   0.788
beta FFA_4.c2         1.564   0.118
beta FFA_4.c3         2.220   0.026
beta FFA_6.c1         0.120   0.904
beta FFA_6.c2         0.687   0.492
beta FFA_6.c3        -0.026   0.979
beta FFA_8.c1        -0.225   0.822
beta FFA_8.c2        -1.323   0.186
beta FFA_8.c3        -1.100   0.271
beta FFA_9.c1         0.027   0.978
beta FFA_9.c2         1.841   0.066
beta FFA_9.c3         2.322   0.020
beta FFA_10.c1       -3.520   0.000
beta FFA_10.c2       -3.552   0.000
beta FFA_10.c3       -3.887   0.000
beta FFA_11.c1       -0.305   0.761
beta FFA_11.c2        1.453   0.146
beta FFA_11.c3        1.122   0.262
beta FFA_12.c1        0.279   0.780
beta FFA_12.c2        1.315   0.189
beta FFA_12.c3        0.042   0.967
beta FFA_14.c1        0.408   0.683
beta FFA_14.c2        0.551   0.582
beta FFA_14.c3       -1.188   0.235
```

6.2.5 MLOEF Test

The M Loef tests checks whether the person parameter differ between items. According to the assumptions of the Rasch models, we expect invariance, i.e., there should be not subset of items for which the person parameters differ from the rest of the items.

```
MLoef(ffa_pcm1_acc)  # NOT signif
```

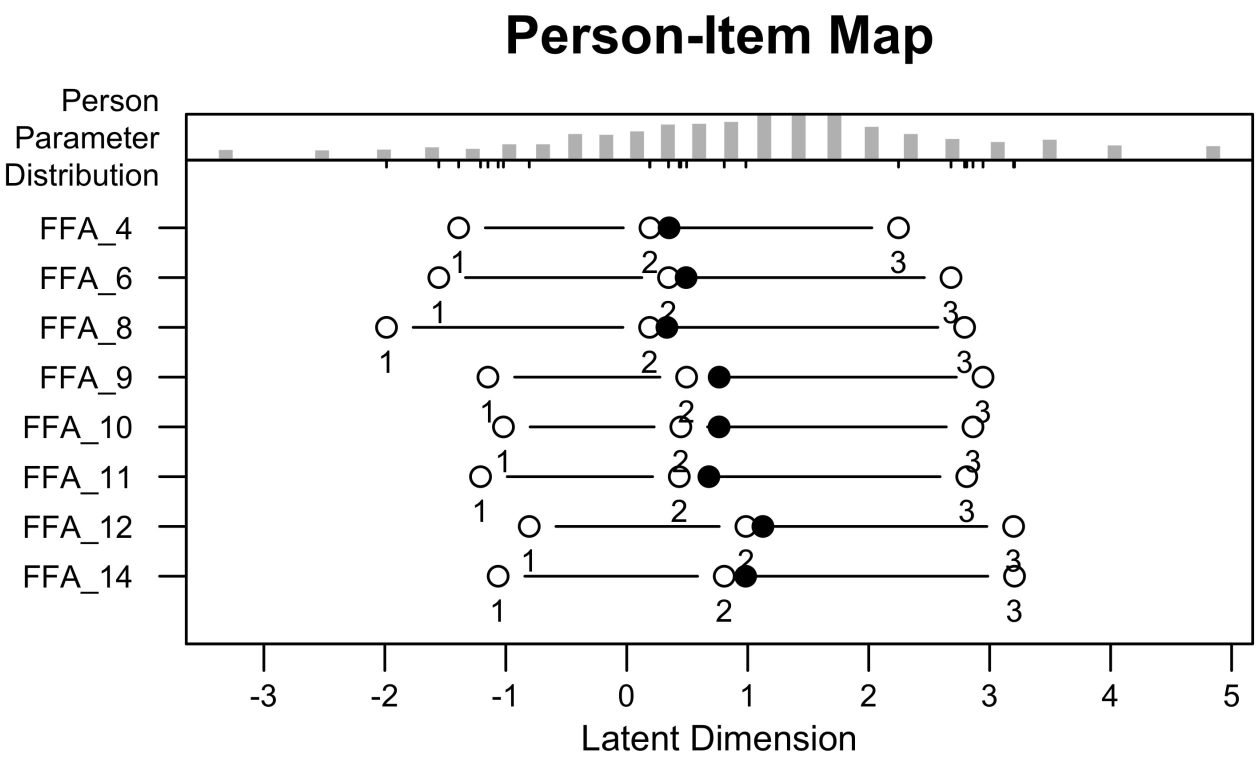
```
Martin-Loef-Test (split criterion: median)
LR-value: 152.265
Chi-square df: 143
p-value: 0.282
```

6.2.6 Item information

```
plotINFO(ffa_pcm1_acc, legpos = FALSE)
```

```
Error in plot.new(): figure margins too large
```

```
plotPImap(ffa_pcm1_acc)
```



7 Model comparison

7.1 Presence

```
anova(ffa_rsm1_pres, ffa_pcm1_pres)
```

```
Analysis of Deviances Table

Model 1: PCM(X = ffa13_pres, se = TRUE)
Model 2: RSM(X = ffa13_pres, se = TRUE)

        cond. LL Deviance npar     LR df p-value
```

```
Model 1  -3183.9   6367.8   14
Model 2  -3195.8   6391.5    6 11.846  8  0.1582
```

```
eRm::IC(ffa_rsm1_pres_ppar)
```

```
Information Criteria:
                        value npar       AIC       BIC      cAIC
joint log-lik       -4494.832   20  9029.663  9127.250  9147.250
marginal log-lik    -5705.088    6 11422.175 11451.681 11457.681
conditional log-lik -3195.759    6  6403.518  6433.024  6439.024
```

```
eRm::IC(ffa_pcm1_pres_ppar)
```

```
Information Criteria:
                        value npar       AIC       BIC      cAIC
joint log-lik       -4483.367   28  9022.735  9159.357  9187.357
marginal log-lik    -5693.242   14 11414.483 11483.331 11497.331
conditional log-lik -3183.913   14  6395.826  6464.674  6478.674
```

Small values are better.

That means the PCM models is to be preferred.

8 DIF Analysis using ordinal logistic regression

8.1 Presence

8.1.1 Gender

```
ffa13_pres_dif_geschlecht <- lordif(ffa13_pres, group = d2$Geschlecht
```

```
Iteration: 1, Log-Lik: -5824.319, Max-Change: 0.42764
Iteration: 2, Log-Lik: -5726.643, Max-Change: 0.31012
Iteration: 3, Log-Lik: -5698.280, Max-Change: 0.16853
Iteration: 4, Log-Lik: -5689.386, Max-Change: 0.08465
```

```
Iteration: 5, Log-Lik: -5686.866, Max-Change: 0.05223
Iteration: 6, Log-Lik: -5685.830, Max-Change: 0.04014
Iteration: 7, Log-Lik: -5685.104, Max-Change: 0.01591
Iteration: 8, Log-Lik: -5685.026, Max-Change: 0.01001
Iteration: 9, Log-Lik: -5684.997, Max-Change: 0.00626
Iteration: 10, Log-Lik: -5684.980, Max-Change: 0.00258
Iteration: 11, Log-Lik: -5684.976, Max-Change: 0.00296
Iteration: 12, Log-Lik: -5684.974, Max-Change: 0.00188
Iteration: 13, Log-Lik: -5684.974, Max-Change: 0.00152
Iteration: 14, Log-Lik: -5684.973, Max-Change: 0.00067
Iteration: 15, Log-Lik: -5684.973, Max-Change: 0.00046
Iteration: 16, Log-Lik: -5684.973, Max-Change: 0.00034
Iteration: 17, Log-Lik: -5684.973, Max-Change: 0.00028
Iteration: 18, Log-Lik: -5684.973, Max-Change: 0.00023
Iteration: 19, Log-Lik: -5684.973, Max-Change: 0.00022
Iteration: 20, Log-Lik: -5684.973, Max-Change: 0.00023
Iteration: 21, Log-Lik: -5684.973, Max-Change: 0.00024
Iteration: 22, Log-Lik: -5684.973, Max-Change: 0.00012
Iteration: 23, Log-Lik: -5684.973, Max-Change: 0.00010
Iteration: 24, Log-Lik: -5684.973, Max-Change: 0.00012
Iteration: 25, Log-Lik: -5684.973, Max-Change: 0.00006
 (mirt) | Iteration: 1, 2 items flagged for DIF (1,4)

Iteration: 1, Log-Lik: -6482.438, Max-Change: 1.84095
Iteration: 2, Log-Lik: -5768.069, Max-Change: 0.32301
Iteration: 3, Log-Lik: -5711.589, Max-Change: 0.28219
Iteration: 4, Log-Lik: -5693.283, Max-Change: 0.16033
Iteration: 5, Log-Lik: -5683.322, Max-Change: 0.11414
Iteration: 6, Log-Lik: -5678.856, Max-Change: 0.07636
Iteration: 7, Log-Lik: -5676.935, Max-Change: 0.03782
Iteration: 8, Log-Lik: -5676.204, Max-Change: 0.02734
Iteration: 9, Log-Lik: -5675.814, Max-Change: 0.01969
Iteration: 10, Log-Lik: -5675.464, Max-Change: 0.01083
Iteration: 11, Log-Lik: -5675.409, Max-Change: 0.00743
Iteration: 12, Log-Lik: -5675.377, Max-Change: 0.00532
Iteration: 13, Log-Lik: -5675.336, Max-Change: 0.00214
Iteration: 14, Log-Lik: -5675.334, Max-Change: 0.00129
Iteration: 15, Log-Lik: -5675.333, Max-Change: 0.00105
Iteration: 16, Log-Lik: -5675.332, Max-Change: 0.00110
Iteration: 17, Log-Lik: -5675.332, Max-Change: 0.00101
Iteration: 18, Log-Lik: -5675.332, Max-Change: 0.00099
Iteration: 19, Log-Lik: -5675.331, Max-Change: 0.00017
Iteration: 20, Log-Lik: -5675.331, Max-Change: 0.00016
Iteration: 21, Log-Lik: -5675.331, Max-Change: 0.00015
```

```
Iteration: 22, Log-Lik: -5675.331, Max-Change: 0.00025
Iteration: 23, Log-Lik: -5675.331, Max-Change: 0.00021
Iteration: 24, Log-Lik: -5675.331, Max-Change: 0.00024
Iteration: 25, Log-Lik: -5675.331, Max-Change: 0.00010
Iteration: 26, Log-Lik: -5675.331, Max-Change: 0.00010
 (mirt) | Iteration: 2, 2 items flagged for DIF (1,4)
```

```r
print(ffa13_pres_dif_geschlecht)
```

```
Call:
lordif(resp.data = ffa13_pres, group = d2$Geschlecht, pseudo.R2 =
"McFadden",
    minCell = 5)

  Number of DIF groups: 2

  Number of items flagged for DIF: 2 of 5

  Items flagged: 1, 4

  Number of iterations for purification: 2 of 10

  Detection criterion: Chisqr

  Threshold: alpha = 0.01

  item ncat  chi12  chi13  chi23
1    1    4 0.7875 0.0071 0.0017
2    2    4 0.0656 0.1659 0.6522
3    3    4 0.1233 0.2164 0.4075
4    4    4 0.0039 0.0001 0.0016
5    5    4 0.0355 0.0566 0.2494
```

```r
summary(ffa13_pres_dif_geschlecht)
```

```
Call:
lordif(resp.data = ffa13_pres, group = d2$Geschlecht, pseudo.R2 =
"McFadden",
    minCell = 5)

$criterion
[1] "Chisqr"
```

```
$alpha
[1] 0.01

$pseudo.R2
[1] "McFadden"

$R2.change
[1] 0.02

$beta.change
[1] 0.1

$maxIter
[1] 10

$minCell
[1] 5

$stats
  item ncat  chi12  chi13  chi23 beta12 pseudo12.McFadden
pseudo13.McFadden
1    1    4 0.7875 0.0071 0.0017 0.0004            0.0000
0.0041
2    2    4 0.0656 0.1659 0.6522 0.0006            0.0013
0.0014
3    3    4 0.1233 0.2164 0.4075 0.0005            0.0009
0.0012
4    4    4 0.0039 0.0001 0.0016 0.0096            0.0034
0.0076
5    5    4 0.0355 0.0566 0.2494 0.0048            0.0018
0.0023
  pseudo23.McFadden pseudo12.Nagelkerke pseudo13.Nagelkerke
pseudo23.Nagelkerke
1            0.0040              0.0000              0.0059
0.0058
2            0.0001              0.0018              0.0019
0.0001
3            0.0003              0.0015              0.0019
0.0004
4            0.0041              0.0040              0.0088
0.0048
5            0.0005              0.0019              0.0025
0.0006
  pseudo12.CoxSnell pseudo13.CoxSnell pseudo23.CoxSnell df12 df13
```

```
df23
1           0.0000          0.0054          0.0053    1    2
1
2           0.0016          0.0017          0.0001    1    2
1
3           0.0013          0.0017          0.0004    1    2
1
4           0.0036          0.0080          0.0043    1    2
1
5           0.0017          0.0023          0.0005    1    2
1

$flag
[1]  TRUE FALSE FALSE  TRUE FALSE

$flag.raw
[1]  TRUE FALSE FALSE  TRUE FALSE
```

```
plot(ffa13_pres_dif_geschlecht, labels = c("Frauen", "Männer"))
```

Small DIF only, according to the R squared value.

8.1.2 Age

```
ffa13_pres_dif_age <- lordif(ffa13_pres, group = d2$Alter_medsplit, p
```

```
Iteration: 1, Log-Lik: -5824.319, Max-Change: 0.42764
Iteration: 2, Log-Lik: -5726.643, Max-Change: 0.31012
Iteration: 3, Log-Lik: -5698.280, Max-Change: 0.16853
Iteration: 4, Log-Lik: -5689.386, Max-Change: 0.08465
Iteration: 5, Log-Lik: -5686.866, Max-Change: 0.05223
Iteration: 6, Log-Lik: -5685.830, Max-Change: 0.04014
Iteration: 7, Log-Lik: -5685.104, Max-Change: 0.01591
Iteration: 8, Log-Lik: -5685.026, Max-Change: 0.01001
Iteration: 9, Log-Lik: -5684.997, Max-Change: 0.00626
Iteration: 10, Log-Lik: -5684.980, Max-Change: 0.00258
Iteration: 11, Log-Lik: -5684.976, Max-Change: 0.00296
Iteration: 12, Log-Lik: -5684.974, Max-Change: 0.00188
Iteration: 13, Log-Lik: -5684.974, Max-Change: 0.00152
Iteration: 14, Log-Lik: -5684.973, Max-Change: 0.00067
Iteration: 15, Log-Lik: -5684.973, Max-Change: 0.00046
```

```
Iteration: 16, Log-Lik: -5684.973, Max-Change: 0.00034
Iteration: 17, Log-Lik: -5684.973, Max-Change: 0.00028
Iteration: 18, Log-Lik: -5684.973, Max-Change: 0.00023
Iteration: 19, Log-Lik: -5684.973, Max-Change: 0.00022
Iteration: 20, Log-Lik: -5684.973, Max-Change: 0.00023
Iteration: 21, Log-Lik: -5684.973, Max-Change: 0.00024
Iteration: 22, Log-Lik: -5684.973, Max-Change: 0.00012
Iteration: 23, Log-Lik: -5684.973, Max-Change: 0.00010
Iteration: 24, Log-Lik: -5684.973, Max-Change: 0.00012
Iteration: 25, Log-Lik: -5684.973, Max-Change: 0.00006
 (mirt) | Iteration: 1, 3 items flagged for DIF (1,2,3)

Iteration: 1, Log-Lik: -6903.604, Max-Change: 2.34723
Iteration: 2, Log-Lik: -5805.344, Max-Change: 0.44722
Iteration: 3, Log-Lik: -5738.895, Max-Change: 0.30599
Iteration: 4, Log-Lik: -5691.169, Max-Change: 0.17286
Iteration: 5, Log-Lik: -5671.489, Max-Change: 0.13734
Iteration: 6, Log-Lik: -5663.006, Max-Change: 0.06553
Iteration: 7, Log-Lik: -5658.182, Max-Change: 0.10543
Iteration: 8, Log-Lik: -5655.064, Max-Change: 0.05100
Iteration: 9, Log-Lik: -5653.288, Max-Change: 0.03652
Iteration: 10, Log-Lik: -5651.528, Max-Change: 0.02980
Iteration: 11, Log-Lik: -5651.169, Max-Change: 0.01739
Iteration: 12, Log-Lik: -5650.976, Max-Change: 0.01236
Iteration: 13, Log-Lik: -5650.713, Max-Change: 0.00528
Iteration: 14, Log-Lik: -5650.699, Max-Change: 0.00327
Iteration: 15, Log-Lik: -5650.692, Max-Change: 0.00276
Iteration: 16, Log-Lik: -5650.682, Max-Change: 0.00180
Iteration: 17, Log-Lik: -5650.681, Max-Change: 0.00145
Iteration: 18, Log-Lik: -5650.681, Max-Change: 0.00111
Iteration: 19, Log-Lik: -5650.681, Max-Change: 0.00022
Iteration: 20, Log-Lik: -5650.681, Max-Change: 0.00018
Iteration: 21, Log-Lik: -5650.681, Max-Change: 0.00017
Iteration: 22, Log-Lik: -5650.681, Max-Change: 0.00018
Iteration: 23, Log-Lik: -5650.681, Max-Change: 0.00015
Iteration: 24, Log-Lik: -5650.681, Max-Change: 0.00014
Iteration: 25, Log-Lik: -5650.681, Max-Change: 0.00013
Iteration: 26, Log-Lik: -5650.681, Max-Change: 0.00012
Iteration: 27, Log-Lik: -5650.681, Max-Change: 0.00012
Iteration: 28, Log-Lik: -5650.681, Max-Change: 0.00011
Iteration: 29, Log-Lik: -5650.681, Max-Change: 0.00010
Iteration: 30, Log-Lik: -5650.681, Max-Change: 0.00010
 (mirt) | Iteration: 2, 3 items flagged for DIF (1,2,3)
```

```r
print(ffa13_pres_dif_age)
```

```
Call:
lordif(resp.data = ffa13_pres, group = d2$Alter_medsplit, pseudo.R2 =
"McFadden",
    minCell = 5)

  Number of DIF groups: 2

  Number of items flagged for DIF: 3 of 5

  Items flagged: 1, 2, 3

  Number of iterations for purification: 2 of 10

  Detection criterion: Chisqr

  Threshold: alpha = 0.01

  item ncat  chi12  chi13  chi23
1    1    4 0.0000 0.0000 0.0028
2    2    4 0.0015 0.0056 0.5810
3    3    4 0.0000 0.0000 0.0608
4    4    4 0.6726 0.8789 0.7779
5    5    4 0.2395 0.4419 0.6171
```

```r
summary(ffa13_pres_dif_age)
```

```
Call:
lordif(resp.data = ffa13_pres, group = d2$Alter_medsplit, pseudo.R2 =
"McFadden",
    minCell = 5)

$criterion
[1] "Chisqr"

$alpha
[1] 0.01

$pseudo.R2
[1] "McFadden"

$R2.change
```

```
[1] 0.02

$beta.change
[1] 0.1

$maxIter
[1] 10

$minCell
[1] 5

$stats
  item ncat  chi12  chi13  chi23 beta12 pseudo12.McFadden
pseudo13.McFadden
1    1    4 0.0000 0.0000 0.0028 0.0188            0.0157
0.0194
2    2    4 0.0015 0.0056 0.5810 0.0114            0.0039
0.0040
3    3    4 0.0000 0.0000 0.0608 0.0183            0.0075
0.0089
4    4    4 0.6726 0.8789 0.7779 0.0005            0.0001
0.0001
5    5    4 0.2395 0.4419 0.6171 0.0004            0.0006
0.0007
  pseudo23.McFadden pseudo12.Nagelkerke pseudo13.Nagelkerke
pseudo23.Nagelkerke
1            0.0037              0.0220              0.0270
0.0050
2            0.0001              0.0052              0.0054
0.0002
3            0.0014              0.0113              0.0134
0.0021
4            0.0000              0.0001              0.0001
0.0000
5            0.0001              0.0006              0.0007
0.0001
  pseudo12.CoxSnell pseudo13.CoxSnell pseudo23.CoxSnell df12 df13
df23
1            0.0200            0.0246            0.0046    1    2
1
2            0.0048            0.0050            0.0001    1    2
1
3            0.0104            0.0123            0.0019    1    2
1
```

```
4           0.0001           0.0001           0.0000    1    2
1
5           0.0005           0.0006           0.0001    1    2
1

$flag
[1]  TRUE  TRUE  TRUE FALSE FALSE

$flag.raw
[1]  TRUE  TRUE  TRUE FALSE FALSE
```

```
plot(ffa13_pres_dif_age, labels = c("Frauen", "Männer"))
```

Small DIF only, according to the R squared value.

8.2 Acceptance

8.2.1 Gender

Small DIF only, according to the R squared value.

```
ffa13_acc_dif_geschlecht <- lordif(ffa13_acc, group = d2$Geschlecht,
```

```
Iteration: 1, Log-Lik: -8872.140, Max-Change: 0.70854
Iteration: 2, Log-Lik: -8637.150, Max-Change: 0.29476
Iteration: 3, Log-Lik: -8584.463, Max-Change: 0.16797
Iteration: 4, Log-Lik: -8564.003, Max-Change: 0.09840
Iteration: 5, Log-Lik: -8555.357, Max-Change: 0.06883
Iteration: 6, Log-Lik: -8550.847, Max-Change: 0.04964
Iteration: 7, Log-Lik: -8546.419, Max-Change: 0.02507
Iteration: 8, Log-Lik: -8546.008, Max-Change: 0.01598
Iteration: 9, Log-Lik: -8545.777, Max-Change: 0.01082
Iteration: 10, Log-Lik: -8545.592, Max-Change: 0.00642
Iteration: 11, Log-Lik: -8545.553, Max-Change: 0.00470
Iteration: 12, Log-Lik: -8545.531, Max-Change: 0.00346
Iteration: 13, Log-Lik: -8545.508, Max-Change: 0.00191
Iteration: 14, Log-Lik: -8545.505, Max-Change: 0.00271
Iteration: 15, Log-Lik: -8545.504, Max-Change: 0.00145
Iteration: 16, Log-Lik: -8545.503, Max-Change: 0.00073
Iteration: 17, Log-Lik: -8545.502, Max-Change: 0.00045
```

```
Iteration: 18, Log-Lik: -8545.502, Max-Change: 0.00035
Iteration: 19, Log-Lik: -8545.502, Max-Change: 0.00040
Iteration: 20, Log-Lik: -8545.502, Max-Change: 0.00038
Iteration: 21, Log-Lik: -8545.502, Max-Change: 0.00049
Iteration: 22, Log-Lik: -8545.502, Max-Change: 0.00034
Iteration: 23, Log-Lik: -8545.501, Max-Change: 0.00045
Iteration: 24, Log-Lik: -8545.501, Max-Change: 0.00052
Iteration: 25, Log-Lik: -8545.501, Max-Change: 0.00029
Iteration: 26, Log-Lik: -8545.501, Max-Change: 0.00033
Iteration: 27, Log-Lik: -8545.501, Max-Change: 0.00041
Iteration: 28, Log-Lik: -8545.501, Max-Change: 0.00022
Iteration: 29, Log-Lik: -8545.501, Max-Change: 0.00027
Iteration: 30, Log-Lik: -8545.501, Max-Change: 0.00033
Iteration: 31, Log-Lik: -8545.501, Max-Change: 0.00018
Iteration: 32, Log-Lik: -8545.501, Max-Change: 0.00021
Iteration: 33, Log-Lik: -8545.501, Max-Change: 0.00025
Iteration: 34, Log-Lik: -8545.501, Max-Change: 0.00014
Iteration: 35, Log-Lik: -8545.501, Max-Change: 0.00016
Iteration: 36, Log-Lik: -8545.501, Max-Change: 0.00020
Iteration: 37, Log-Lik: -8545.501, Max-Change: 0.00011
Iteration: 38, Log-Lik: -8545.501, Max-Change: 0.00013
Iteration: 39, Log-Lik: -8545.501, Max-Change: 0.00016
Iteration: 40, Log-Lik: -8545.501, Max-Change: 0.00009
 (mirt) | Iteration: 1, 1 items flagged for DIF (3)

Iteration: 1, Log-Lik: -9286.267, Max-Change: 2.52636
Iteration: 2, Log-Lik: -8625.737, Max-Change: 0.44941
Iteration: 3, Log-Lik: -8573.205, Max-Change: 0.20548
Iteration: 4, Log-Lik: -8556.243, Max-Change: 0.09924
Iteration: 5, Log-Lik: -8548.733, Max-Change: 0.07911
Iteration: 6, Log-Lik: -8544.225, Max-Change: 0.04588
Iteration: 7, Log-Lik: -8542.665, Max-Change: 0.03566
Iteration: 8, Log-Lik: -8541.171, Max-Change: 0.02853
Iteration: 9, Log-Lik: -8540.204, Max-Change: 0.02383
Iteration: 10, Log-Lik: -8539.038, Max-Change: 0.02855
Iteration: 11, Log-Lik: -8538.820, Max-Change: 0.03268
Iteration: 12, Log-Lik: -8538.672, Max-Change: 0.00695
Iteration: 13, Log-Lik: -8538.591, Max-Change: 0.00567
Iteration: 14, Log-Lik: -8538.530, Max-Change: 0.00472
Iteration: 15, Log-Lik: -8538.487, Max-Change: 0.00450
Iteration: 16, Log-Lik: -8538.404, Max-Change: 0.00582
Iteration: 17, Log-Lik: -8538.395, Max-Change: 0.00223
Iteration: 18, Log-Lik: -8538.391, Max-Change: 0.00159
Iteration: 19, Log-Lik: -8538.383, Max-Change: 0.00089
```

```
Iteration: 20, Log-Lik: -8538.382, Max-Change: 0.00072
Iteration: 21, Log-Lik: -8538.382, Max-Change: 0.00064
Iteration: 22, Log-Lik: -8538.380, Max-Change: 0.00029
Iteration: 23, Log-Lik: -8538.380, Max-Change: 0.00018
Iteration: 24, Log-Lik: -8538.380, Max-Change: 0.00015
Iteration: 25, Log-Lik: -8538.380, Max-Change: 0.00009
 (mirt) | Iteration: 2, 1 items flagged for DIF (3)
```

```
print(ffa13_acc_dif_geschlecht)
```

```
Call:
lordif(resp.data = ffa13_acc, group = d2$Geschlecht, pseudo.R2 =
"McFadden",
    minCell = 5)

  Number of DIF groups: 2

  Number of items flagged for DIF: 1 of 8

  Items flagged: 3

  Number of iterations for purification: 2 of 10

  Detection criterion: Chisqr

  Threshold: alpha = 0.01

  item ncat  chi12  chi13  chi23
1    1    4 0.0307 0.0622 0.3468
2    2    4 0.4105 0.2641 0.1588
3    3    4 0.0162 0.0003 0.0014
4    4    4 0.0676 0.1625 0.5880
5    5    4 0.0723 0.1014 0.2456
6    6    4 0.9911 0.9530 0.7566
7    7    4 0.0585 0.1525 0.6691
8    8    4 0.0710 0.0983 0.2402
```

```
summary(ffa13_acc_dif_geschlecht)
```

```
Call:
lordif(resp.data = ffa13_acc, group = d2$Geschlecht, pseudo.R2 =
"McFadden",
    minCell = 5)
```

```
$criterion
[1] "Chisqr"

$alpha
[1] 0.01

$pseudo.R2
[1] "McFadden"

$R2.change
[1] 0.02

$beta.change
[1] 0.1

$maxIter
[1] 10

$minCell
[1] 5

$stats
  item ncat  chi12  chi13  chi23 beta12 pseudo12.McFadden
pseudo13.McFadden
1    1    4 0.0307 0.0622 0.3468 0.0006            0.0019
0.0022
2    2    4 0.4105 0.2641 0.1588 0.0003            0.0003
0.0011
3    3    4 0.0162 0.0003 0.0014 0.0064            0.0025
0.0069
4    4    4 0.0676 0.1625 0.5880 0.0039            0.0014
0.0015
5    5    4 0.0723 0.1014 0.2456 0.0050            0.0013
0.0018
6    6    4 0.9911 0.9530 0.7566 0.0000            0.0000
0.0000
7    7    4 0.0585 0.1525 0.6691 0.0008            0.0014
0.0015
8    8    4 0.0710 0.0983 0.2402 0.0044            0.0013
0.0019
  pseudo23.McFadden pseudo12.Nagelkerke pseudo13.Nagelkerke
pseudo23.Nagelkerke
1            0.0004              0.0027              0.0033
```

```
0.0005
2            0.0008              0.0004              0.0014
0.0011
3            0.0044              0.0042              0.0115
0.0073
4            0.0001              0.0015              0.0016
0.0001
5            0.0005              0.0017              0.0024
0.0007
6            0.0000              0.0000              0.0000
0.0000
7            0.0001              0.0017              0.0018
0.0001
8            0.0006              0.0022              0.0031
0.0009
  pseudo12.CoxSnell pseudo13.CoxSnell pseudo23.CoxSnell df12 df13
df23
1            0.0025            0.0030            0.0005    1    2
1
2            0.0003            0.0013            0.0010    1    2
1
3            0.0038            0.0103            0.0066    1    2
1
4            0.0014            0.0015            0.0001    1    2
1
5            0.0015            0.0022            0.0006    1    2
1
6            0.0000            0.0000            0.0000    1    2
1
7            0.0016            0.0016            0.0001    1    2
1
8            0.0020            0.0028            0.0008    1    2
1

$flag
[1] FALSE FALSE  TRUE FALSE FALSE FALSE FALSE FALSE

$flag.raw
[1] FALSE FALSE  TRUE FALSE FALSE FALSE FALSE FALSE
```

```r
plot(ffa13_acc_dif_geschlecht, labels = c("Frauen", "Männer"))
```

Small DIF only, according to the R squared value.

8.2.2 Age

```r
ffa13_acc_dif_age <- lordif(ffa13_pres, group = d2$Alter_medsplit, ps
```

```
Iteration: 1, Log-Lik: -5824.319, Max-Change: 0.42764
Iteration: 2, Log-Lik: -5726.643, Max-Change: 0.31012
Iteration: 3, Log-Lik: -5698.280, Max-Change: 0.16853
Iteration: 4, Log-Lik: -5689.386, Max-Change: 0.08465
Iteration: 5, Log-Lik: -5686.866, Max-Change: 0.05223
Iteration: 6, Log-Lik: -5685.830, Max-Change: 0.04014
Iteration: 7, Log-Lik: -5685.104, Max-Change: 0.01591
Iteration: 8, Log-Lik: -5685.026, Max-Change: 0.01001
Iteration: 9, Log-Lik: -5684.997, Max-Change: 0.00626
Iteration: 10, Log-Lik: -5684.980, Max-Change: 0.00258
Iteration: 11, Log-Lik: -5684.976, Max-Change: 0.00296
Iteration: 12, Log-Lik: -5684.974, Max-Change: 0.00188
Iteration: 13, Log-Lik: -5684.974, Max-Change: 0.00152
Iteration: 14, Log-Lik: -5684.973, Max-Change: 0.00067
Iteration: 15, Log-Lik: -5684.973, Max-Change: 0.00046
Iteration: 16, Log-Lik: -5684.973, Max-Change: 0.00034
Iteration: 17, Log-Lik: -5684.973, Max-Change: 0.00028
Iteration: 18, Log-Lik: -5684.973, Max-Change: 0.00023
Iteration: 19, Log-Lik: -5684.973, Max-Change: 0.00022
Iteration: 20, Log-Lik: -5684.973, Max-Change: 0.00023
Iteration: 21, Log-Lik: -5684.973, Max-Change: 0.00024
Iteration: 22, Log-Lik: -5684.973, Max-Change: 0.00012
Iteration: 23, Log-Lik: -5684.973, Max-Change: 0.00010
Iteration: 24, Log-Lik: -5684.973, Max-Change: 0.00012
Iteration: 25, Log-Lik: -5684.973, Max-Change: 0.00006
 (mirt) | Iteration: 1, 3 items flagged for DIF (1,2,3)

Iteration: 1, Log-Lik: -6903.604, Max-Change: 2.34723
Iteration: 2, Log-Lik: -5805.344, Max-Change: 0.44722
Iteration: 3, Log-Lik: -5738.895, Max-Change: 0.30599
Iteration: 4, Log-Lik: -5691.169, Max-Change: 0.17286
Iteration: 5, Log-Lik: -5671.489, Max-Change: 0.13734
Iteration: 6, Log-Lik: -5663.006, Max-Change: 0.06553
Iteration: 7, Log-Lik: -5658.182, Max-Change: 0.10543
Iteration: 8, Log-Lik: -5655.064, Max-Change: 0.05100
Iteration: 9, Log-Lik: -5653.288, Max-Change: 0.03652
```

```
Iteration: 10, Log-Lik: -5651.528, Max-Change: 0.02980
Iteration: 11, Log-Lik: -5651.169, Max-Change: 0.01739
Iteration: 12, Log-Lik: -5650.976, Max-Change: 0.01236
Iteration: 13, Log-Lik: -5650.713, Max-Change: 0.00528
Iteration: 14, Log-Lik: -5650.699, Max-Change: 0.00327
Iteration: 15, Log-Lik: -5650.692, Max-Change: 0.00276
Iteration: 16, Log-Lik: -5650.682, Max-Change: 0.00180
Iteration: 17, Log-Lik: -5650.681, Max-Change: 0.00145
Iteration: 18, Log-Lik: -5650.681, Max-Change: 0.00111
Iteration: 19, Log-Lik: -5650.681, Max-Change: 0.00022
Iteration: 20, Log-Lik: -5650.681, Max-Change: 0.00018
Iteration: 21, Log-Lik: -5650.681, Max-Change: 0.00017
Iteration: 22, Log-Lik: -5650.681, Max-Change: 0.00018
Iteration: 23, Log-Lik: -5650.681, Max-Change: 0.00015
Iteration: 24, Log-Lik: -5650.681, Max-Change: 0.00014
Iteration: 25, Log-Lik: -5650.681, Max-Change: 0.00013
Iteration: 26, Log-Lik: -5650.681, Max-Change: 0.00012
Iteration: 27, Log-Lik: -5650.681, Max-Change: 0.00012
Iteration: 28, Log-Lik: -5650.681, Max-Change: 0.00011
Iteration: 29, Log-Lik: -5650.681, Max-Change: 0.00010
Iteration: 30, Log-Lik: -5650.681, Max-Change: 0.00010
 (mirt) | Iteration: 2, 3 items flagged for DIF (1,2,3)
```

```
print(ffa13_acc_dif_age)
```

```
Call:
lordif(resp.data = ffa13_pres, group = d2$Alter_medsplit, pseudo.R2 =
"McFadden",
    minCell = 5)

  Number of DIF groups: 2

  Number of items flagged for DIF: 3 of 5

  Items flagged: 1, 2, 3

  Number of iterations for purification: 2 of 10

  Detection criterion: Chisqr

  Threshold: alpha = 0.01

  item ncat  chi12  chi13  chi23
```

```
1    1    4 0.0000 0.0000 0.0028
2    2    4 0.0015 0.0056 0.5810
3    3    4 0.0000 0.0000 0.0608
4    4    4 0.6726 0.8789 0.7779
5    5    4 0.2395 0.4419 0.6171
```

```
summary(ffa13_acc_dif_age)
```

```
Call:
lordif(resp.data = ffa13_pres, group = d2$Alter_medsplit, pseudo.R2 =
"McFadden",
    minCell = 5)

$criterion
[1] "Chisqr"

$alpha
[1] 0.01

$pseudo.R2
[1] "McFadden"

$R2.change
[1] 0.02

$beta.change
[1] 0.1

$maxIter
[1] 10

$minCell
[1] 5

$stats
  item ncat  chi12  chi13  chi23 beta12 pseudo12.McFadden
pseudo13.McFadden
1    1    4 0.0000 0.0000 0.0028 0.0188            0.0157
0.0194
2    2    4 0.0015 0.0056 0.5810 0.0114            0.0039
0.0040
3    3    4 0.0000 0.0000 0.0608 0.0183            0.0075
0.0089
```

```
4    4    4 0.6726 0.8789 0.7779 0.0005            0.0001
0.0001
5    5    4 0.2395 0.4419 0.6171 0.0004            0.0006
0.0007
  pseudo23.McFadden pseudo12.Nagelkerke pseudo13.Nagelkerke
pseudo23.Nagelkerke
1             0.0037              0.0220              0.0270
0.0050
2             0.0001              0.0052              0.0054
0.0002
3             0.0014              0.0113              0.0134
0.0021
4             0.0000              0.0001              0.0001
0.0000
5             0.0001              0.0006              0.0007
0.0001
  pseudo12.CoxSnell pseudo13.CoxSnell pseudo23.CoxSnell df12 df13
df23
1             0.0200            0.0246            0.0046    1    2
1
2             0.0048            0.0050            0.0001    1    2
1
3             0.0104            0.0123            0.0019    1    2
1
4             0.0001            0.0001            0.0000    1    2
1
5             0.0005            0.0006            0.0001    1    2
1

$flag
[1]  TRUE  TRUE  TRUE FALSE FALSE

$flag.raw
[1]  TRUE  TRUE  TRUE FALSE FALSE
```

```
plot(ffa13_acc_dif_age, labels = c("Frauen", "Männer"))
```

Small DIF only, according to the R squared value.

9 Dimensionality

9.1 EFA

9.2 Determine number of factors

2 factors, oblimin rotation, ML factor scores:

```
ffa_fa <- psych::fa(ffa13_items, nfactors = 2, rotate = "oblimin", fm
print(ffa_fa)
```

```
Factor Analysis using method =  ml
Call: psych::fa(r = ffa13_items, nfactors = 2, rotate = "oblimin", 
    fm = "ml")
Standardized loadings (pattern matrix) based upon correlation matrix
        ML1   ML2   h2   u2 com
FFA_1  0.31  0.29 0.30 0.70 2.0
FFA_2  0.02  0.68 0.48 0.52 1.0
FFA_3  0.10  0.54 0.37 0.63 1.1
FFA_4  0.68 -0.07 0.41 0.59 1.0
FFA_5  0.53  0.20 0.45 0.55 1.3
FFA_6  0.72 -0.07 0.47 0.53 1.0
FFA_7  0.54  0.20 0.47 0.53 1.3
FFA_8  0.44  0.14 0.28 0.72 1.2
FFA_9  0.76 -0.13 0.48 0.52 1.1
FFA_10 0.56  0.16 0.45 0.55 1.2
FFA_11 0.69  0.00 0.47 0.53 1.0
FFA_12 0.60  0.10 0.43 0.57 1.1
FFA_14 0.46  0.13 0.31 0.69 1.2

                       ML1  ML2
SS loadings           4.07 1.29
Proportion Var        0.31 0.10
Cumulative Var        0.31 0.41
Proportion Explained  0.76 0.24
Cumulative Proportion 0.76 1.00

 With factor correlations of 
     ML1  ML2
ML1 1.00 0.61
ML2 0.61 1.00

Mean item complexity =  1.2
Test of the hypothesis that 2 factors are sufficient.
```

```
The degrees of freedom for the null model are  78  and the objective
function was  4.32 with Chi Square of  4341.12
The degrees of freedom for the model are 53  and the objective
function was  0.19

The root mean square of the residuals (RMSR) is  0.03
The df corrected root mean square of the residuals is  0.03

The harmonic number of observations is  1010 with the empirical chi
square  130.4  with prob <  1.8e-08
The total number of observations was  1010  with Likelihood Chi
Square =  186.49  with prob <  9.3e-17

Tucker Lewis Index of factoring reliability =  0.954
RMSEA index =  0.05  and the 90 % confidence intervals are  0.042
0.058
BIC =  -180.15
Fit based upon off diagonal values = 0.99
Measures of factor score adequacy
                                                   ML1  ML2
Correlation of (regression) scores with factors   0.94 0.84
Multiple R square of scores with factors          0.88 0.70
Minimum correlation of possible factor scores     0.76 0.41
```

```
print(ffa_fa$loadings, cutoff = 0.2)
```

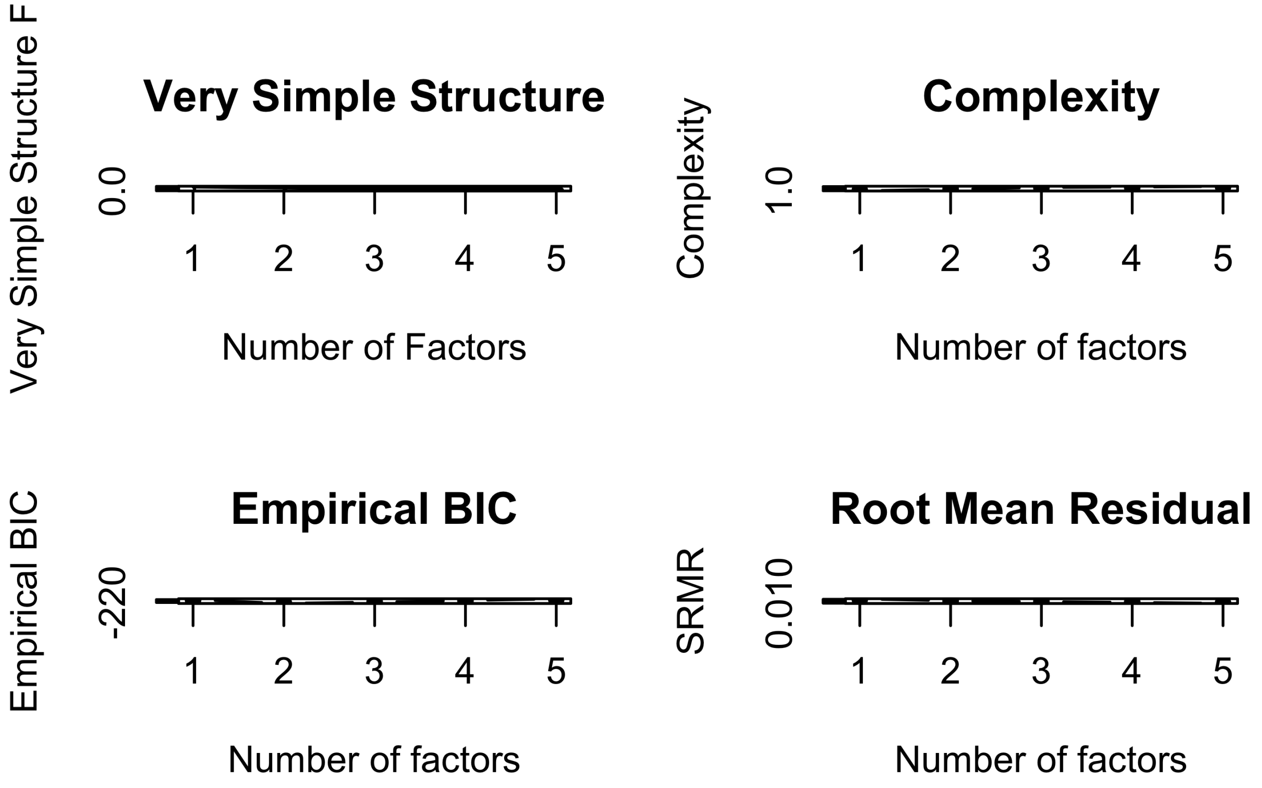
```
Loadings:
       ML1    ML2
FFA_1   0.314  0.292
FFA_2          0.678
FFA_3          0.543
FFA_4   0.683
FFA_5   0.532
FFA_6   0.722
FFA_7   0.540  0.202
FFA_8   0.437
FFA_9   0.762
FFA_10  0.559
FFA_11  0.685
FFA_12  0.596
FFA_14  0.465
```

```
                  ML1   ML2
SS loadings    3.795 1.018
Proportion Var 0.292 0.078
Cumulative Var 0.292 0.370
```

Try different number of factors:

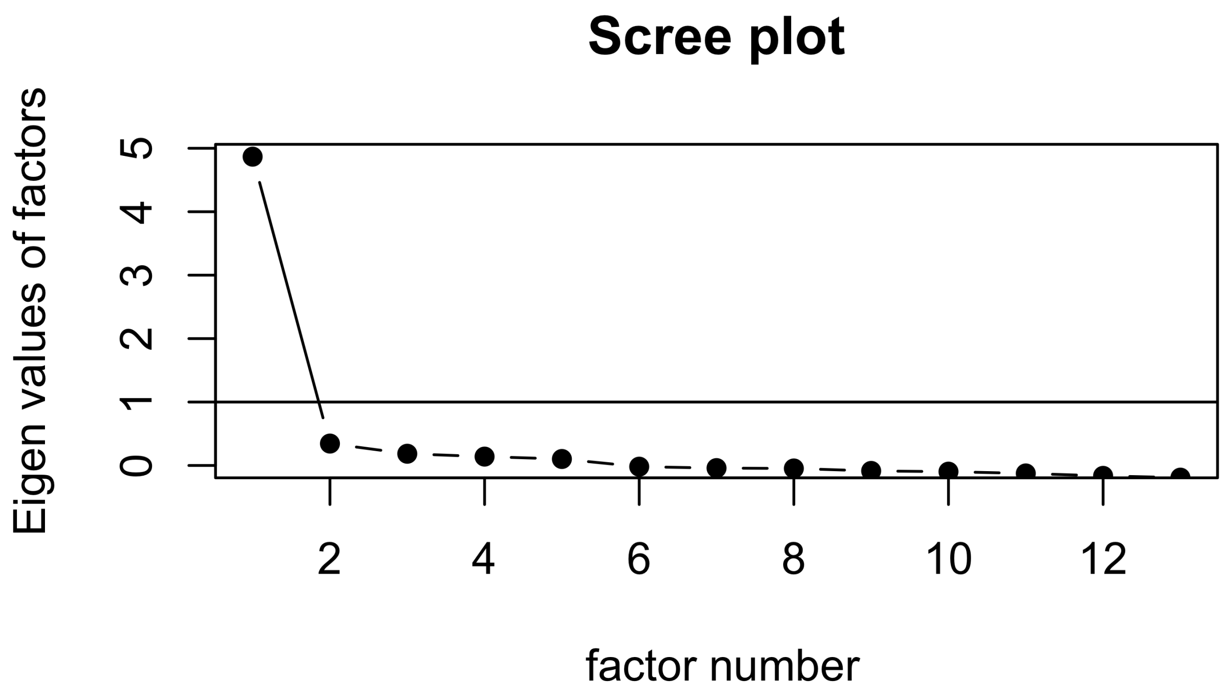
```
ffa_div_fa <- nfactors(ffa13_items, n = 5, fm = "ml")
ffa_div_fa
```

```
Number of factors
Call: vss(x = x, n = n, rotate = rotate, diagonal = diagonal, fm =
fm,
    n.obs = n.obs, plot = FALSE, title = title, use = use, cor = cor)
VSS complexity 1 achieves a maximimum of 0.84  with  1  factors
VSS complexity 2 achieves a maximimum of 0.87  with  2  factors
The Velicer MAP achieves a minimum of 0.01  with  1  factors
Empirical BIC achieves a minimum of  -236.24  with  2  factors
Sample Size adjusted BIC achieves a minimum of  -62.5  with  5
factors

Statistics by number of factors
  vss1 vss2   map dof chisq    prob sqresid  fit  RMSEA  BIC SABIC
complex
1 0.84 0.00 0.012  65   326 1.8e-36     5.5 0.84 0.0631 -123    83
1.0
2 0.63 0.87 0.020  53   186 9.3e-17     4.7 0.87 0.0499 -180   -12
1.5
3 0.37 0.73 0.030  42   119 3.2e-09     4.3 0.88 0.0425 -172   -39
2.2
4 0.36 0.65 0.041  32    66 4.0e-04     4.0 0.89 0.0323 -156   -54
2.3
5 0.30 0.56 0.061  23    24 4.3e-01     3.6 0.90 0.0048 -136   -62
2.6
  eChisq   SRMR eCRMS eBIC
1    288 0.0428 0.047 -161
2    130 0.0288 0.035 -236
3     81 0.0227 0.031 -210
4     44 0.0166 0.026 -178
5     14 0.0093 0.017 -146
```



This analyses both supports the 1- and the 2-F solution.

```
scree(ffa13_items, pc = FALSE)
```



Screeplot (in combination with Kaiser criterion) suggests a unidimensional solution.

```
vss(ffa13_items, fm = "ml", n = 3, plot = FALSE)
```

```
Very Simple Structure
Call: vss(x = ffa13_items, n = 3, fm = "ml", plot = FALSE)
VSS complexity 1 achieves a maximimum of 0.84  with  1  factors
VSS complexity 2 achieves a maximimum of 0.87  with  2  factors

The Velicer MAP achieves a minimum of 0.01  with  1  factors
BIC achieves a minimum of  -180.15  with  2  factors
Sample Size adjusted BIC achieves a minimum of  -38.62  with  3
factors

Statistics by number of factors
  vss1 vss2   map dof chisq    prob sqresid  fit RMSEA  BIC SABIC
complex
1 0.84 0.00 0.012  65   326 1.8e-36     5.5 0.84 0.063 -123    83
1.0
2 0.63 0.87 0.020  53   186 9.3e-17     4.7 0.87 0.050 -180   -12
1.5
3 0.37 0.73 0.030  42   119 3.2e-09     4.3 0.88 0.042 -172   -39
2.2
  eChisq  SRMR eCRMS eBIC
1    288 0.043 0.047 -161
2    130 0.029 0.035 -236
3     81 0.023 0.031 -210
```

VSS seems to suggest a 1 factor solution too.

MAP favors the 1 factor solution too.

9.2.1 Goodness of fit

```
summary(ffa_fa)
```

```
Factor analysis with Call: psych::fa(r = ffa13_items, nfactors = 2,
rotate = "oblimin",
    fm = "ml")

Test of the hypothesis that 2 factors are sufficient.
The degrees of freedom for the model is 53  and the objective
```

```
function was  0.19
The number of observations was  1010  with Chi Square =  186.49  with
prob <  9.3e-17

The root mean square of the residuals (RMSA) is  0.03
The df corrected root mean square of the residuals is  0.03

Tucker Lewis Index of factoring reliability =  0.954
RMSEA index =  0.05  and the 10 % confidence intervals are  0.042
0.058
BIC =  -180.15
 With factor correlations of
     ML1  ML2
ML1 1.00 0.61
ML2 0.61 1.00
```

9.3 CFA

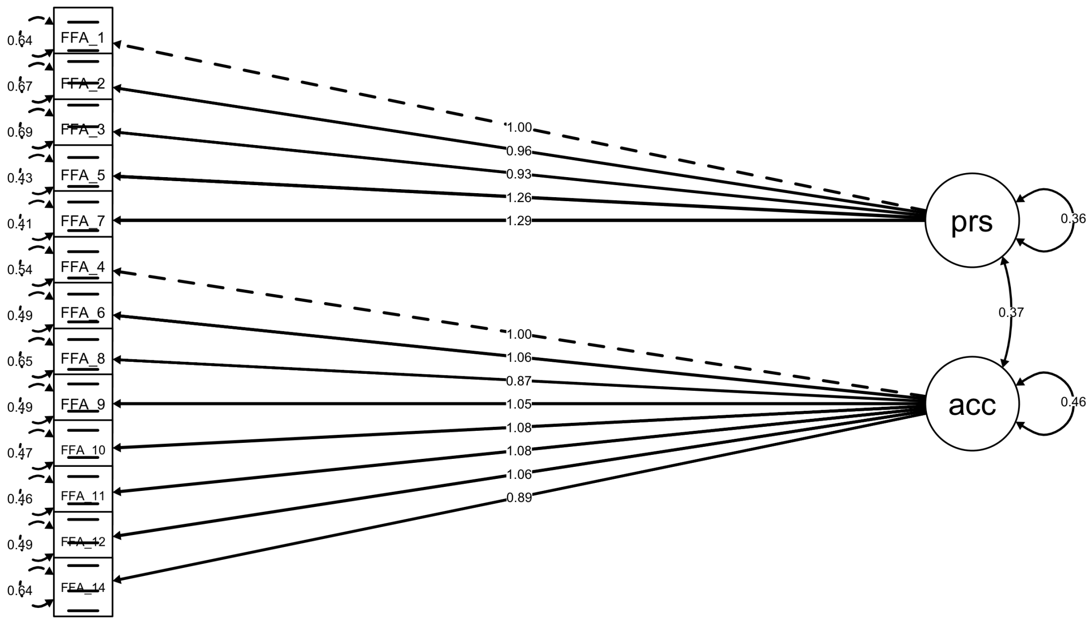
9.3.1 2F model

```
ffa_mod <- '
pres =~ FFA_1 + FFA_2 + FFA_3 + FFA_5 + FFA_7
acc =~ FFA_4 + FFA_6 + FFA_8 + FFA_9 + FFA_10 + FFA_11 + FFA_12 + FFA

ffa_cfa <- lavaan::cfa(ffa_mod, data = ffa_items2, ordered = TRUE)
#ffa_cfa <- lavaan::cfa(ffa_mod, data = ffa_items2)

ffa_cfa
```

```
lavaan 0.6-12 ended normally after 32 iterations

  Estimator                                         DWLS
  Optimization method                             NLMINB
  Number of model parameters                          53

  Number of observations                            1010

Model Test User Model:
                                              Standard      Robust
  Test Statistic                               235.356     432.002
```

```
  Degrees of freedom                                64          64
  P-value (Chi-square)                           0.000       0.000
  Scaling correction factor                                  0.555
  Shift parameter                                            8.057
    simple second-order correction
```

```r
semPaths(ffa_cfa, what = "est", intercepts = FALSE,
         rotation = 4, edge.color = 1, fade = FALSE,
         edge.label.cex = .5, edge.width = .3)
```




```r
summary(ffa_cfa, standardized = TRUE, fit.measures = TRUE)
```

```
lavaan 0.6-12 ended normally after 32 iterations

  Estimator                                       DWLS
  Optimization method                           NLMINB
  Number of model parameters                        53

  Number of observations                          1010

Model Test User Model:
                                              Standard      Robust
  Test Statistic                               235.356     432.002
```

```
  Degrees of freedom                                64          64
  P-value (Chi-square)                           0.000       0.000
  Scaling correction factor                                  0.555
  Shift parameter                                            8.057
    simple second-order correction

Model Test Baseline Model:

  Test statistic                             23657.526    8990.511
  Degrees of freedom                                78          78
  P-value                                        0.000       0.000
  Scaling correction factor                                  2.646

User Model versus Baseline Model:

  Comparative Fit Index (CFI)                    0.993       0.959
  Tucker-Lewis Index (TLI)                       0.991       0.950

  Robust Comparative Fit Index (CFI)                            NA
  Robust Tucker-Lewis Index (TLI)                               NA

Root Mean Square Error of Approximation:

  RMSEA                                          0.052       0.075
  90 Percent confidence interval - lower         0.045       0.069
  90 Percent confidence interval - upper         0.059       0.082
  P-value RMSEA <= 0.05                          0.350       0.000

  Robust RMSEA                                                  NA
  90 Percent confidence interval - lower                        NA
  90 Percent confidence interval - upper                        NA

Standardized Root Mean Square Residual:

  SRMR                                           0.041       0.041

Parameter Estimates:

  Standard errors                           Robust.sem
  Information                                 Expected
  Information saturated (h1) model         Unstructured

Latent Variables:
                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv
```

```
Std.all
  pres =~
    FFA_1             1.000                               0.597
0.597
    FFA_2             0.964    0.049   19.674    0.000    0.576
0.576
    FFA_3             0.934    0.046   20.172    0.000    0.558
0.558
    FFA_5             1.259    0.053   23.871    0.000    0.752
0.752
    FFA_7             1.289    0.051   25.172    0.000    0.770
0.770
  acc =~
    FFA_4             1.000                               0.677
0.677
    FFA_6             1.059    0.031   34.081    0.000    0.717
0.717
    FFA_8             0.871    0.038   23.190    0.000    0.590
0.590
    FFA_9             1.049    0.033   31.978    0.000    0.711
0.711
    FFA_10            1.077    0.034   31.636    0.000    0.730
0.730
    FFA_11            1.080    0.035   30.534    0.000    0.731
0.731
    FFA_12            1.058    0.035   30.596    0.000    0.717
0.717
    FFA_14            0.889    0.037   23.840    0.000    0.602
0.602

Covariances:
                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv
Std.all
  pres ~~
    acc               0.373    0.020   18.824    0.000    0.922
0.922

Intercepts:
                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv
Std.all
   .FFA_1             0.000                               0.000
0.000
   .FFA_2             0.000                               0.000
0.000
```

```
   .FFA_3            0.000                                 0.000
0.000
   .FFA_5            0.000                                 0.000
0.000
   .FFA_7            0.000                                 0.000
0.000
   .FFA_4            0.000                                 0.000
0.000
   .FFA_6            0.000                                 0.000
0.000
   .FFA_8            0.000                                 0.000
0.000
   .FFA_9            0.000                                 0.000
0.000
   .FFA_10           0.000                                 0.000
0.000
   .FFA_11           0.000                                 0.000
0.000
   .FFA_12           0.000                                 0.000
0.000
   .FFA_14           0.000                                 0.000
0.000
    pres             0.000                                 0.000
0.000
    acc              0.000                                 0.000
0.000

Thresholds:
                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv
Std.all
    FFA_1|t1         -1.474    0.060  -24.664    0.000   -1.474
-1.474
    FFA_1|t2         -0.621    0.042  -14.662    0.000   -0.621
-0.621
    FFA_1|t3          0.679    0.043   15.814    0.000    0.679
0.679
    FFA_2|t1         -1.118    0.050  -22.425    0.000   -1.118
-1.118
    FFA_2|t2         -0.012    0.039   -0.315    0.753   -0.012
-0.012
    FFA_2|t3          1.091    0.049   22.132    0.000    1.091
1.091
    FFA_3|t1         -1.047    0.048  -21.626    0.000   -1.047
-1.047
```

```
    FFA_3|t2          0.082    0.040    2.076    0.038    0.082
0.082
    FFA_3|t3          1.282    0.054   23.814    0.000    1.282
1.282
    FFA_5|t1         -1.466    0.059  -24.647    0.000   -1.466
-1.466
    FFA_5|t2         -0.536    0.042  -12.885    0.000   -0.536
-0.536
    FFA_5|t3          0.803    0.044   18.073    0.000    0.803
0.803
    FFA_7|t1         -1.397    0.057  -24.427    0.000   -1.397
-1.397
    FFA_7|t2         -0.454    0.041  -11.091    0.000   -0.454
-0.454
    FFA_7|t3          0.881    0.046   19.341    0.000    0.881
0.881
    FFA_4|t1         -1.527    0.062  -24.752    0.000   -1.527
-1.527
    FFA_4|t2         -0.530    0.042  -12.762    0.000   -0.530
-0.530
    FFA_4|t3          0.664    0.043   15.512    0.000    0.664
0.664
    FFA_6|t1         -1.551    0.063  -24.771    0.000   -1.551
-1.551
    FFA_6|t2         -0.435    0.041  -10.657    0.000   -0.435
-0.435
    FFA_6|t3          0.856    0.045   18.941    0.000    0.856
0.856
    FFA_8|t1         -1.711    0.070  -24.583    0.000   -1.711
-1.711
    FFA_8|t2         -0.516    0.041  -12.453    0.000   -0.516
-0.516
    FFA_8|t3          0.885    0.046   19.397    0.000    0.885
0.885
    FFA_9|t1         -1.384    0.057  -24.373    0.000   -1.384
-1.384
    FFA_9|t2         -0.328    0.040   -8.162    0.000   -0.328
-0.328
    FFA_9|t3          0.977    0.047   20.728    0.000    0.977
0.977
    FFA_10|t1        -1.346    0.056  -24.195    0.000   -1.346
-1.346
    FFA_10|t2        -0.347    0.040   -8.600    0.000   -0.347
-0.347
```

```
    FFA_10|t3          0.941    0.047   20.237    0.000    0.941
0.941
    FFA_11|t1         -1.417    0.058  -24.502    0.000   -1.417
-1.417
    FFA_11|t2         -0.368    0.040   -9.099    0.000   -0.368
-0.368
    FFA_11|t3          0.918    0.046   19.904    0.000    0.918
0.918
    FFA_12|t1         -1.181    0.051  -23.029    0.000   -1.181
-1.181
    FFA_12|t2         -0.070    0.039   -1.761    0.078   -0.070
-0.070
    FFA_12|t3          1.123    0.050   22.473    0.000    1.123
1.123
    FFA_14|t1         -1.304    0.054  -23.960    0.000   -1.304
-1.304
    FFA_14|t2         -0.167    0.040   -4.213    0.000   -0.167
-0.167
    FFA_14|t3          1.105    0.050   22.279    0.000    1.105
1.105

Variances:
                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv
Std.all
   .FFA_1              0.643                               0.643
0.643
   .FFA_2              0.668                               0.668
0.668
   .FFA_3              0.689                               0.689
0.689
   .FFA_5              0.435                               0.435
0.435
   .FFA_7              0.407                               0.407
0.407
   .FFA_4              0.541                               0.541
0.541
   .FFA_6              0.486                               0.486
0.486
   .FFA_8              0.652                               0.652
0.652
   .FFA_9              0.495                               0.495
0.495
   .FFA_10             0.467                               0.467
0.467
```

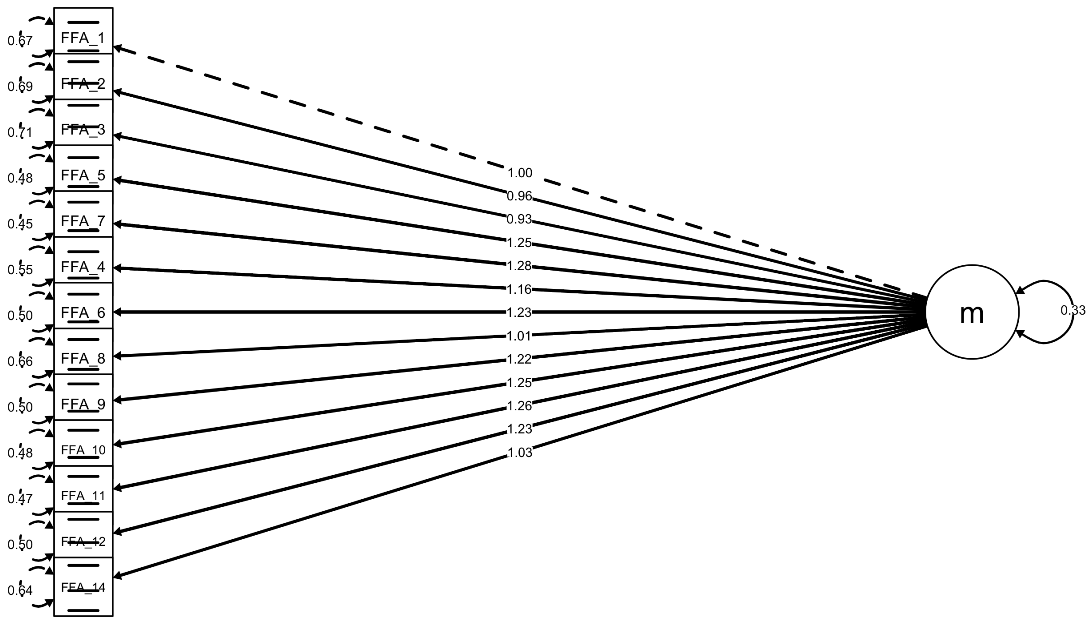
```
   .FFA_11          0.465                                  0.465
0.465
   .FFA_12          0.486                                  0.486
0.486
   .FFA_14          0.637                                  0.637
0.637
    pres            0.357    0.027   13.130    0.000    1.000
1.000
    acc             0.459    0.026   17.743    0.000    1.000
1.000

Scales y*:
                 Estimate  Std.Err  z-value  P(>|z|)   Std.lv
Std.all
    FFA_1           1.000                                  1.000
1.000
    FFA_2           1.000                                  1.000
1.000
    FFA_3           1.000                                  1.000
1.000
    FFA_5           1.000                                  1.000
1.000
    FFA_7           1.000                                  1.000
1.000
    FFA_4           1.000                                  1.000
1.000
    FFA_6           1.000                                  1.000
1.000
    FFA_8           1.000                                  1.000
1.000
    FFA_9           1.000                                  1.000
1.000
    FFA_10          1.000                                  1.000
1.000
    FFA_11          1.000                                  1.000
1.000
    FFA_12          1.000                                  1.000
1.000
    FFA_14          1.000                                  1.000
1.000
```

9.3.2 1F model

```r
ffa_mod_1F <- 'm =~ FFA_1 + FFA_2 + FFA_3 + FFA_5 + FFA_7 + FFA_4 + F

ffa_cfa_1F <- lavaan::cfa(ffa_mod_1F, data = ffa_items2, ordered = TR
#ffa_cfa <- lavaan::cfa(ffa_mod, data = ffa_items2)

ffa_cfa_1F
```

```
lavaan 0.6-12 ended normally after 23 iterations

  Estimator                                         DWLS
  Optimization method                             NLMINB
  Number of model parameters                          52

  Number of observations                            1010

Model Test User Model:
                                              Standard      Robust
  Test Statistic                               265.438     482.961
  Degrees of freedom                                65          65
  P-value (Chi-square)                           0.000       0.000
  Scaling correction factor                                  0.559
  Shift parameter                                            8.327
    simple second-order correction
```

```r
semPaths(ffa_cfa_1F, what = "est", intercepts = FALSE,
         rotation = 4, edge.color = 1, fade = FALSE,
         edge.label.cex = .5, edge.width = .3)
```



```
summary(ffa_cfa_1F, standardized = TRUE, fit.measures = TRUE)
```

```
lavaan 0.6-12 ended normally after 23 iterations

  Estimator                                         DWLS
  Optimization method                             NLMINB
  Number of model parameters                          52

  Number of observations                            1010

Model Test User Model:
                                              Standard      Robust
  Test Statistic                               265.438     482.961
  Degrees of freedom                                65          65
  P-value (Chi-square)                           0.000       0.000
  Scaling correction factor                                  0.559
  Shift parameter                                            8.327
    simple second-order correction

Model Test Baseline Model:

  Test statistic                             23657.526    8990.511
  Degrees of freedom                                78          78
  P-value                                        0.000       0.000
```

```
  Scaling correction factor                                  2.646

User Model versus Baseline Model:

  Comparative Fit Index (CFI)                    0.991       0.953
  Tucker-Lewis Index (TLI)                       0.990       0.944

  Robust Comparative Fit Index (CFI)                            NA
  Robust Tucker-Lewis Index (TLI)                               NA

Root Mean Square Error of Approximation:

  RMSEA                                          0.055       0.080
  90 Percent confidence interval - lower         0.048       0.073
  90 Percent confidence interval - upper         0.062       0.087
  P-value RMSEA <= 0.05                          0.100       0.000

  Robust RMSEA                                                  NA
  90 Percent confidence interval - lower                        NA
  90 Percent confidence interval - upper                        NA

Standardized Root Mean Square Residual:

  SRMR                                           0.044       0.044

Parameter Estimates:

  Standard errors                           Robust.sem
  Information                                 Expected
  Information saturated (h1) model        Unstructured

Latent Variables:
                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv
Std.all
  m =~
    FFA_1             1.000                                0.577
0.577
    FFA_2             0.961    0.049   19.627    0.000    0.555
0.555
    FFA_3             0.932    0.046   20.112    0.000    0.538
0.538
    FFA_5             1.253    0.052   24.005    0.000    0.724
0.724
    FFA_7             1.281    0.051   25.358    0.000    0.740
```

```
0.740
    FFA_4             1.162    0.053   22.115    0.000    0.671
0.671
    FFA_6             1.230    0.052   23.441    0.000    0.710
0.710
    FFA_8             1.013    0.050   20.431    0.000    0.585
0.585
    FFA_9             1.220    0.052   23.583    0.000    0.704
0.704
    FFA_10            1.251    0.050   24.817    0.000    0.722
0.722
    FFA_11            1.255    0.053   23.683    0.000    0.725
0.725
    FFA_12            1.231    0.050   24.444    0.000    0.711
0.711
    FFA_14            1.035    0.051   20.441    0.000    0.597
0.597

Intercepts:
                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv
Std.all
   .FFA_1             0.000                                0.000
0.000
   .FFA_2             0.000                                0.000
0.000
   .FFA_3             0.000                                0.000
0.000
   .FFA_5             0.000                                0.000
0.000
   .FFA_7             0.000                                0.000
0.000
   .FFA_4             0.000                                0.000
0.000
   .FFA_6             0.000                                0.000
0.000
   .FFA_8             0.000                                0.000
0.000
   .FFA_9             0.000                                0.000
0.000
   .FFA_10            0.000                                0.000
0.000
   .FFA_11            0.000                                0.000
0.000
   .FFA_12            0.000                                0.000
```

```
0.000
   .FFA_14           0.000                              0.000
0.000
    m                0.000                              0.000
0.000

Thresholds:
                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv
Std.all
    FFA_1|t1         -1.474    0.060  -24.664    0.000   -1.474
-1.474
    FFA_1|t2         -0.621    0.042  -14.662    0.000   -0.621
-0.621
    FFA_1|t3          0.679    0.043   15.814    0.000    0.679
0.679
    FFA_2|t1         -1.118    0.050  -22.425    0.000   -1.118
-1.118
    FFA_2|t2         -0.012    0.039   -0.315    0.753   -0.012
-0.012
    FFA_2|t3          1.091    0.049   22.132    0.000    1.091
1.091
    FFA_3|t1         -1.047    0.048  -21.626    0.000   -1.047
-1.047
    FFA_3|t2          0.082    0.040    2.076    0.038    0.082
0.082
    FFA_3|t3          1.282    0.054   23.814    0.000    1.282
1.282
    FFA_5|t1         -1.466    0.059  -24.647    0.000   -1.466
-1.466
    FFA_5|t2         -0.536    0.042  -12.885    0.000   -0.536
-0.536
    FFA_5|t3          0.803    0.044   18.073    0.000    0.803
0.803
    FFA_7|t1         -1.397    0.057  -24.427    0.000   -1.397
-1.397
    FFA_7|t2         -0.454    0.041  -11.091    0.000   -0.454
-0.454
    FFA_7|t3          0.881    0.046   19.341    0.000    0.881
0.881
    FFA_4|t1         -1.527    0.062  -24.752    0.000   -1.527
-1.527
    FFA_4|t2         -0.530    0.042  -12.762    0.000   -0.530
-0.530
    FFA_4|t3          0.664    0.043   15.512    0.000    0.664
```

```
0.664
    FFA_6|t1         -1.551    0.063  -24.771    0.000   -1.551
-1.551
    FFA_6|t2         -0.435    0.041  -10.657    0.000   -0.435
-0.435
    FFA_6|t3          0.856    0.045   18.941    0.000    0.856
0.856
    FFA_8|t1         -1.711    0.070  -24.583    0.000   -1.711
-1.711
    FFA_8|t2         -0.516    0.041  -12.453    0.000   -0.516
-0.516
    FFA_8|t3          0.885    0.046   19.397    0.000    0.885
0.885
    FFA_9|t1         -1.384    0.057  -24.373    0.000   -1.384
-1.384
    FFA_9|t2         -0.328    0.040   -8.162    0.000   -0.328
-0.328
    FFA_9|t3          0.977    0.047   20.728    0.000    0.977
0.977
    FFA_10|t1        -1.346    0.056  -24.195    0.000   -1.346
-1.346
    FFA_10|t2        -0.347    0.040   -8.600    0.000   -0.347
-0.347
    FFA_10|t3         0.941    0.047   20.237    0.000    0.941
0.941
    FFA_11|t1        -1.417    0.058  -24.502    0.000   -1.417
-1.417
    FFA_11|t2        -0.368    0.040   -9.099    0.000   -0.368
-0.368
    FFA_11|t3         0.918    0.046   19.904    0.000    0.918
0.918
    FFA_12|t1        -1.181    0.051  -23.029    0.000   -1.181
-1.181
    FFA_12|t2        -0.070    0.039   -1.761    0.078   -0.070
-0.070
    FFA_12|t3         1.123    0.050   22.473    0.000    1.123
1.123
    FFA_14|t1        -1.304    0.054  -23.960    0.000   -1.304
-1.304
    FFA_14|t2        -0.167    0.040   -4.213    0.000   -0.167
-0.167
    FFA_14|t3         1.105    0.050   22.279    0.000    1.105
1.105
```

```
Variances:
                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv
Std.all
   .FFA_1             0.667                                0.667
0.667
   .FFA_2             0.692                                0.692
0.692
   .FFA_3             0.710                                0.710
0.710
   .FFA_5             0.476                                0.476
0.476
   .FFA_7             0.453                                0.453
0.453
   .FFA_4             0.550                                0.550
0.550
   .FFA_6             0.496                                0.496
0.496
   .FFA_8             0.658                                0.658
0.658
   .FFA_9             0.504                                0.504
0.504
   .FFA_10            0.478                                0.478
0.478
   .FFA_11            0.474                                0.474
0.474
   .FFA_12            0.495                                0.495
0.495
   .FFA_14            0.643                                0.643
0.643
    m                 0.333    0.026   12.752    0.000    1.000
1.000

Scales y*:
                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv
Std.all
    FFA_1             1.000                                1.000
1.000
    FFA_2             1.000                                1.000
1.000
    FFA_3             1.000                                1.000
1.000
    FFA_5             1.000                                1.000
1.000
    FFA_7             1.000                                1.000
```

```
1.000
    FFA_4              1.000                                    1.000
1.000
    FFA_6              1.000                                    1.000
1.000
    FFA_8              1.000                                    1.000
1.000
    FFA_9              1.000                                    1.000
1.000
    FFA_10             1.000                                    1.000
1.000
    FFA_11             1.000                                    1.000
1.000
    FFA_12             1.000                                    1.000
1.000
    FFA_14             1.000                                    1.000
1.000
```

9.3.3 Conclusion

The CFA seems to speaks in favor of the 2F solution.