Light Exposure Behavior Assessment (LEBA): Develop of a novel instrument to capture light exposure-related behaviours

Mushfiqul Anwar Siraji[1] & Rafael Robert Lazar[2]

[1] Wilhelm-Wundt-University

[2] Konstanz Business School

Author Note

Add complete departmental affiliations for each author here. Each new line herein must be indented, like this line.

Enter author note here.

The authors made the following contributions. Mushfiqul Anwar Siraji: Data Analysis, Writing - Original Draft Preparation, Data Visualization; Rafael Robert Lazar: Writing - Original Draft Preparation.

Correspondence concerning this article should be addressed to Mushfiqul Anwar Siraji, Monash University, Malaysia. E-mail: mushfiqul.anwarsiraji@monash.edu

Abstract

One or two sentences providing a **basic introduction** to the field, comprehensible to a scientist in any discipline.

Two to three sentences of **more detailed background**, comprehensible to scientists in related disciplines.

One sentence clearly stating the **general problem** being addressed by this particular study.

One sentence summarizing the main result (with the words "**here we show**" or their equivalent).

Two or three sentences explaining what the **main result** reveals in direct comparison to what was thought to be the case previously, or how the main result adds to previous knowledge.

One or two sentences to put the results into a more **general context**.

Two or three sentences to provide a **broader perspective**, readily comprehensible to a scientist in any discipline.

Keywords: keywords

Word count: X

Light Exposure Behavior Assessment (LEBA): Develop of a novel instrument to capture light exposure-related behaviours

Methods

Participants

Material

Procedure

Data analysis

We used R [Version 4.0.3; R Core Team (2020)] and the R-package *papaja* [Version 0.1.0.9997; Aust and Barth (2020)] for all our analyses.

Results

Confirmatory Factor Analysis

```
## Call: mardia(x = LB.cfa, na.rm = T, plot = F)
##
## Mardia tests of multivariate skew and kurtosis
## Use describe(x) the to get univariate tests
## n.obs = 199   num.vars =  48
## b1p =  761.72   skew =  25263.82  with probability  <=  8.8e-152
##  small sample skew =  25660.39  with probability <=  1.2e-171
## b2p =  2540.5   kurtosis =  14.3  with probability <=  0

## lavaan 0.6-9 ended normally after 64 iterations
##
```

```
##   Estimator                                      ML
##   Optimization method                        NLMINB
##   Number of model parameters                     79
##
##   Number of observations                        199
##   Number of missing patterns                      1
##
## Model Test User Model:
##                                              Standard      Robust
##   Test Statistic                              406.275     387.999
##   Degrees of freedom                              220         220
##   P-value (Chi-square)                          0.000       0.000
##   Scaling correction factor                                 1.047
##         Yuan-Bentler correction (Mplus variant)
##
## Model Test Baseline Model:
##
##   Test statistic                             1700.445    1368.235
##   Degrees of freedom                              253         253
##   P-value                                       0.000       0.000
##   Scaling correction factor                                 1.243
##
## User Model versus Baseline Model:
##
##   Comparative Fit Index (CFI)                   0.871       0.849
##   Tucker-Lewis Index (TLI)                      0.852       0.827
##
```

```
##   Robust Comparative Fit Index (CFI)                         0.873
##   Robust Tucker-Lewis Index (TLI)                            0.854
##
## Loglikelihood and Information Criteria:
##
##   Loglikelihood user model (H0)              -6371.304   -6371.304
##   Scaling correction factor                                  1.877
##       for the MLR correction
##   Loglikelihood unrestricted model (H1)      -6168.166   -6168.166
##   Scaling correction factor                                  1.266
##       for the MLR correction
##
##   Akaike (AIC)                               12900.607   12900.607
##   Bayesian (BIC)                             13160.778   13160.778
##   Sample-size adjusted Bayesian (BIC)        12910.502   12910.502
##
## Root Mean Square Error of Approximation:
##
##   RMSEA                                          0.065       0.062
##   90 Percent confidence interval - lower         0.055       0.052
##   90 Percent confidence interval - upper         0.075       0.072
##   P-value RMSEA <= 0.05                          0.007       0.026
##
##   Robust RMSEA                                               0.063
##   90 Percent confidence interval - lower                     0.053
##   90 Percent confidence interval - upper                     0.074
##
```

```
## Standardized Root Mean Square Residual:
##
##   SRMR                                           0.075       0.075
##
## Parameter Estimates:
##
##   Standard errors                             Sandwich
##   Information bread                           Observed
##   Observed information based on                Hessian
##
## Latent Variables:
##                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
##   F1 =~
##     item31           1.000                               0.397    0.873
##     item33           0.823    0.123    6.685    0.000    0.327    0.724
##     item1            0.990    0.158    6.246    0.000    0.393    0.644
##     item37           0.901    0.284    3.176    0.001    0.358    0.507
##     item24           0.437    0.265    1.647    0.100    0.173    0.175
##   F2 =~
##     item10           1.000                               0.859    0.783
##     item47           0.856    0.111    7.729    0.000    0.736    0.808
##     item36           0.945    0.137    6.876    0.000    0.812    0.701
##     item44          -0.714    0.139   -5.131    0.000   -0.613   -0.490
##     item35           0.739    0.139    5.300    0.000    0.635    0.508
##     item13           0.472    0.113    4.163    0.000    0.406    0.373
##   F3 =~
##     item43           1.000                               1.291    0.951
```

```
##     item26            0.918    0.056   16.313    0.000    1.186    0.843
##     item32            0.895    0.064   13.928    0.000    1.155    0.872
##   F4 =~
##     item14            1.000                               0.493    0.263
##     item7             0.640    0.267    2.392    0.017    0.316    0.171
##     item11            1.850    0.684    2.706    0.007    0.912    0.708
##     item42            0.788    0.314    2.513    0.012    0.389    0.225
##     item12            1.953    0.779    2.509    0.012    0.963    0.845
##     item16            1.017    0.410    2.479    0.013    0.501    0.343
##   F5 =~
##     item19            1.000                               0.875    0.683
##     item34            1.312    0.174    7.555    0.000    1.148    0.831
##     item2             0.974    0.143    6.827    0.000    0.852    0.606
##
## Covariances:
##                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
##   F1 ~~
##     F2                0.038    0.033    1.169    0.243    0.112    0.112
##     F3               -0.019    0.051   -0.372    0.710   -0.037   -0.037
##     F4                0.013    0.024    0.532    0.595    0.064    0.064
##     F5                0.027    0.034    0.795    0.427    0.078    0.078
##   F2 ~~
##     F3               -0.076    0.076   -0.998    0.318   -0.069   -0.069
##     F4                0.077    0.054    1.443    0.149    0.182    0.182
##     F5               -0.259    0.088   -2.929    0.003   -0.344   -0.344
##   F3 ~~
##     F4                0.032    0.065    0.501    0.616    0.051    0.051
```

```
##     F5                -0.035    0.103   -0.339    0.735   -0.031   -0.031
##   F4 ~~
##     F5                -0.015    0.044   -0.350    0.726   -0.036   -0.036
##
## Intercepts:
##                    Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
##    .item31            0.879    0.032   27.295    0.000    0.879    1.935
##    .item33            0.869    0.032   27.150    0.000    0.869    1.925
##    .item1             0.990    0.043   22.904    0.000    0.990    1.624
##    .item37            0.995    0.050   19.900    0.000    0.995    1.411
##    .item24            1.131    0.070   16.129    0.000    1.131    1.143
##    .item10            2.543    0.078   32.704    0.000    2.543    2.318
##    .item47            2.035    0.065   31.553    0.000    2.035    2.237
##    .item36            2.095    0.082   25.511    0.000    2.095    1.808
##    .item44            2.995    0.089   33.796    0.000    2.995    2.396
##    .item35            2.070    0.089   23.362    0.000    2.070    1.656
##    .item13            2.834    0.077   36.750    0.000    2.834    2.605
##    .item43            1.578    0.096   16.401    0.000    1.578    1.163
##    .item26            1.482    0.100   14.868    0.000    1.482    1.054
##    .item32            1.533    0.094   16.314    0.000    1.533    1.156
##    .item14            3.020    0.133   22.749    0.000    3.020    1.613
##    .item7             3.688    0.131   28.175    0.000    3.688    1.997
##    .item11            2.382    0.091   26.054    0.000    2.382    1.847
##    .item42            2.935    0.122   23.959    0.000    2.935    1.698
##    .item12            2.005    0.081   24.793    0.000    2.005    1.758
##    .item16            3.211    0.104   30.991    0.000    3.211    2.197
##    .item19            3.930    0.091   43.244    0.000    3.930    3.065
```

```
##    .item34            3.583    0.098   36.558    0.000    3.583    2.592
##    .item2             2.482    0.100   24.897    0.000    2.482    1.765
##     F1                0.000                               0.000    0.000
##     F2                0.000                               0.000    0.000
##     F3                0.000                               0.000    0.000
##     F4                0.000                               0.000    0.000
##     F5                0.000                               0.000    0.000
##
## Variances:
##                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
##    .item31           0.049    0.032    1.533    0.125    0.049    0.237
##    .item33           0.097    0.058    1.678    0.093    0.097    0.476
##    .item1            0.217    0.058    3.718    0.000    0.217    0.585
##    .item37           0.370    0.125    2.952    0.003    0.370    0.743
##    .item24           0.948    0.200    4.729    0.000    0.948    0.969
##    .item10           0.465    0.130    3.582    0.000    0.465    0.386
##    .item47           0.287    0.054    5.359    0.000    0.287    0.347
##    .item36           0.683    0.094    7.283    0.000    0.683    0.509
##    .item44           1.187    0.139    8.551    0.000    1.187    0.760
##    .item35           1.160    0.156    7.447    0.000    1.160    0.742
##    .item13           1.019    0.112    9.133    0.000    1.019    0.861
##    .item43           0.175    0.101    1.726    0.084    0.175    0.095
##    .item26           0.573    0.164    3.500    0.000    0.573    0.289
##    .item32           0.422    0.114    3.694    0.000    0.422    0.240
##    .item14           3.264    0.236   13.831    0.000    3.264    0.931
##    .item7            3.311    0.274   12.104    0.000    3.311    0.971
##    .item11           0.831    0.172    4.816    0.000    0.831    0.499
```

```
##    .item42           2.835    0.171   16.555    0.000    2.835    0.949
##    .item12           0.373    0.155    2.413    0.016    0.373    0.287
##    .item16           1.885    0.199    9.453    0.000    1.885    0.882
##    .item19           0.877    0.130    6.769    0.000    0.877    0.534
##    .item34           0.592    0.179    3.319    0.001    0.592    0.310
##    .item2            1.252    0.144    8.687    0.000    1.252    0.633
##     F1               0.158    0.033    4.750    0.000    1.000    1.000
##     F2               0.738    0.147    5.035    0.000    1.000    1.000
##     F3               1.667    0.246    6.764    0.000    1.000    1.000
##     F4               0.243    0.170    1.431    0.152    1.000    1.000
##     F5               0.766    0.164    4.669    0.000    1.000    1.000
##
## R-Square:
##                    Estimate
##     item31            0.763
##     item33            0.524
##     item1             0.415
##     item37            0.257
##     item24            0.031
##     item10            0.614
##     item47            0.653
##     item36            0.491
##     item44            0.240
##     item35            0.258
##     item13            0.139
##     item43            0.905
##     item26            0.711
```

```
##     item32            0.760
##     item14            0.069
##     item7             0.029
##     item11            0.501
##     item42            0.051
##     item12            0.713
##     item16            0.118
##     item19            0.466
##     item34            0.690
##     item2             0.367
```

```
##          gfi         agfi          nfi          rfi   cfi.robust   tli.robust
##        0.974        0.965        0.761        0.725        0.873        0.854
## rmsea.robust         srmr          aic
##        0.063        0.075    12900.607
```

```
##                F1        F2        F3        F4        F5
## alpha  0.6310368 0.4818562 0.9175522 0.5837683 0.7413266
## omega  0.6175478 0.6258140 0.9185279 0.5055608 0.7523535
## omega2 0.6175478 0.6258140 0.9185279 0.5055608 0.7523535
## omega3 0.5953438 0.6255108 0.9183889 0.4373745 0.7559532
## avevar 0.2554061 0.3750499 0.7902138 0.1670288 0.5080283
```

Based on CFI, TLI, RMSEA and SRMR value the fitted five factor model is not acceptable. As a result a close inspection on items with low factor-loadings and low R-square value was conducted. two items were found to be problematic **item7, item 24** with vary low R-square value thus discarded from the model.

```
## lavaan 0.6-9 ended normally after 67 iterations
```

```
##
##   Estimator                                      ML
##   Optimization method                        NLMINB
##   Number of model parameters                     73
##
##   Number of observations                        199
##   Number of missing patterns                      1
##
## Model Test User Model:
##                                            Standard      Robust
##   Test Statistic                            273.193     263.376
##   Degrees of freedom                            179         179
##   P-value (Chi-square)                        0.000       0.000
##   Scaling correction factor                               1.037
##         Yuan-Bentler correction (Mplus variant)
##
## Model Test Baseline Model:
##
##   Test statistic                           1557.809    1230.314
##   Degrees of freedom                            210         210
##   P-value                                     0.000       0.000
##   Scaling correction factor                               1.266
##
## User Model versus Baseline Model:
##
##   Comparative Fit Index (CFI)                 0.930       0.917
##   Tucker-Lewis Index (TLI)                    0.918       0.903
```

```
##
##   Robust Comparative Fit Index (CFI)                         0.932
##   Robust Tucker-Lewis Index (TLI)                            0.921
##
## Loglikelihood and Information Criteria:
##
##   Loglikelihood user model (H0)              -5691.495   -5691.495
##   Scaling correction factor                                  1.890
##       for the MLR correction
##   Loglikelihood unrestricted model (H1)      -5554.899   -5554.899
##   Scaling correction factor                                  1.284
##       for the MLR correction
##
##   Akaike (AIC)                               11528.990   11528.990
##   Bayesian (BIC)                             11769.401   11769.401
##   Sample-size adjusted Bayesian (BIC)        11538.134   11538.134
##
## Root Mean Square Error of Approximation:
##
##   RMSEA                                          0.051       0.049
##   90 Percent confidence interval - lower         0.039       0.036
##   90 Percent confidence interval - upper         0.063       0.061
##   P-value RMSEA <= 0.05                          0.412       0.559
##
##   Robust RMSEA                                               0.050
##   90 Percent confidence interval - lower                     0.036
##   90 Percent confidence interval - upper                     0.062
```

```
##
## Standardized Root Mean Square Residual:
##
##   SRMR                                           0.068       0.068
##
## Parameter Estimates:
##
##   Standard errors                             Sandwich
##   Information bread                           Observed
##   Observed information based on                Hessian
##
## Latent Variables:
##                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
##   F1 =~
##     item31           1.000                               0.397    0.873
##     item33           0.828    0.119    6.962    0.000    0.328    0.727
##     item1            0.992    0.153    6.503    0.000    0.394    0.645
##     item37           0.890    0.278    3.203    0.001    0.353    0.501
##   F2 =~
##     item10           1.000                               0.859    0.783
##     item47           0.856    0.111    7.739    0.000    0.735    0.808
##     item36           0.946    0.138    6.876    0.000    0.812    0.701
##     item35           0.739    0.139    5.300    0.000    0.635    0.508
##     item13           0.472    0.113    4.162    0.000    0.405    0.373
##     item44          -0.714    0.139   -5.133    0.000   -0.613   -0.490
##   F3 =~
##     item43           1.000                               1.291    0.951
```

```
##     item26            0.919    0.056   16.331    0.000    1.186    0.843
##     item32            0.895    0.064   13.941    0.000    1.155    0.872
##   F4 =~
##     item14            1.000                               0.444    0.237
##     item42            0.867    0.332    2.614    0.009    0.385    0.223
##     item12            2.245    0.830    2.704    0.007    0.996    0.873
##     item11            2.009    0.720    2.791    0.005    0.891    0.691
##     item16            1.108    0.445    2.488    0.013    0.492    0.336
##   F5 =~
##     item19            1.000                               0.875    0.683
##     item34            1.312    0.173    7.568    0.000    1.148    0.831
##     item2             0.974    0.143    6.828    0.000    0.852    0.606
##
## Covariances:
##                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
##   F1 ~~
##     F2                0.037    0.032    1.143    0.253    0.108    0.108
##     F3               -0.020    0.051   -0.400    0.689   -0.040   -0.040
##     F4                0.011    0.020    0.535    0.593    0.062    0.062
##     F5                0.029    0.034    0.843    0.399    0.083    0.083
##   F2 ~~
##     F3               -0.076    0.076   -0.998    0.318   -0.069   -0.069
##     F4                0.069    0.048    1.434    0.152    0.181    0.181
##     F5               -0.259    0.088   -2.931    0.003   -0.344   -0.344
##   F3 ~~
##     F4                0.025    0.056    0.449    0.654    0.044    0.044
##     F5               -0.035    0.103   -0.339    0.735   -0.031   -0.031
```

```
##   F4 ~~
##     F5                -0.015    0.039   -0.376    0.707   -0.038   -0.038
##
## Intercepts:
##                    Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
##    .item31            0.879    0.032   27.295    0.000    0.879    1.935
##    .item33            0.869    0.032   27.150    0.000    0.869    1.925
##    .item1             0.990    0.043   22.904    0.000    0.990    1.624
##    .item37            0.995    0.050   19.900    0.000    0.995    1.411
##    .item10            2.543    0.078   32.704    0.000    2.543    2.318
##    .item47            2.035    0.065   31.553    0.000    2.035    2.237
##    .item36            2.095    0.082   25.511    0.000    2.095    1.808
##    .item35            2.070    0.089   23.362    0.000    2.070    1.656
##    .item13            2.834    0.077   36.750    0.000    2.834    2.605
##    .item44            2.995    0.089   33.796    0.000    2.995    2.396
##    .item43            1.578    0.096   16.401    0.000    1.578    1.163
##    .item26            1.482    0.100   14.868    0.000    1.482    1.054
##    .item32            1.533    0.094   16.314    0.000    1.533    1.156
##    .item14            3.020    0.133   22.749    0.000    3.020    1.613
##    .item42            2.935    0.122   23.959    0.000    2.935    1.698
##    .item12            2.005    0.081   24.793    0.000    2.005    1.758
##    .item11            2.382    0.091   26.054    0.000    2.382    1.847
##    .item16            3.211    0.104   30.991    0.000    3.211    2.197
##    .item19            3.930    0.091   43.244    0.000    3.930    3.065
##    .item34            3.583    0.098   36.558    0.000    3.583    2.592
##    .item2             2.482    0.100   24.897    0.000    2.482    1.765
##     F1                0.000                               0.000    0.000
```

```
##     F2                0.000                           0.000    0.000
##     F3                0.000                           0.000    0.000
##     F4                0.000                           0.000    0.000
##     F5                0.000                           0.000    0.000
##
## Variances:
##                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
##    .item31           0.049    0.031    1.578    0.115    0.049    0.238
##    .item33           0.096    0.058    1.669    0.095    0.096    0.472
##    .item1            0.217    0.058    3.717    0.000    0.217    0.583
##    .item37           0.373    0.124    3.005    0.003    0.373    0.749
##    .item10           0.465    0.130    3.584    0.000    0.465    0.387
##    .item47           0.287    0.054    5.343    0.000    0.287    0.347
##    .item36           0.683    0.094    7.276    0.000    0.683    0.509
##    .item35           1.160    0.156    7.452    0.000    1.160    0.742
##    .item13           1.019    0.112    9.133    0.000    1.019    0.861
##    .item44           1.187    0.139    8.549    0.000    1.187    0.759
##    .item43           0.175    0.101    1.731    0.083    0.175    0.095
##    .item26           0.572    0.164    3.498    0.000    0.572    0.289
##    .item32           0.422    0.114    3.695    0.000    0.422    0.240
##    .item14           3.310    0.213   15.534    0.000    3.310    0.944
##    .item42           2.838    0.170   16.714    0.000    2.838    0.950
##    .item12           0.310    0.180    1.719    0.086    0.310    0.238
##    .item11           0.869    0.182    4.765    0.000    0.869    0.522
##    .item16           1.895    0.201    9.419    0.000    1.895    0.887
##    .item19           0.877    0.129    6.775    0.000    0.877    0.534
##    .item34           0.593    0.178    3.327    0.001    0.593    0.310
```

```
##    .item2             1.252    0.144    8.693    0.000    1.252    0.633
##     F1                0.157    0.032    4.874    0.000    1.000    1.000
##     F2                0.738    0.146    5.037    0.000    1.000    1.000
##     F3                1.667    0.246    6.765    0.000    1.000    1.000
##     F4                0.197    0.132    1.493    0.136    1.000    1.000
##     F5                0.766    0.164    4.669    0.000    1.000    1.000
##
## R-Square:
##                    Estimate
##     item31            0.762
##     item33            0.528
##     item1             0.417
##     item37            0.251
##     item10            0.613
##     item47            0.653
##     item36            0.491
##     item35            0.258
##     item13            0.139
##     item44            0.241
##     item43            0.905
##     item26            0.711
##     item32            0.760
##     item14            0.056
##     item42            0.050
##     item12            0.762
##     item11            0.478
##     item16            0.113
```

```
##     item19            0.466
##     item34            0.690
##     item2             0.367

##                F1        F2        F3        F4        F5
## alpha  0.7547222 0.4818562 0.9175522 0.5566040 0.7413266
## omega  0.7466444 0.6258291 0.9185357 0.5272886 0.7523499
## omega2 0.7466444 0.6258291 0.9185357 0.5272886 0.7523499
## omega3 0.7344825 0.6255092 0.9184124 0.4921277 0.7559546
## avevar 0.4256850 0.3750895 0.7902299 0.2046565 0.5080155

##        lhs op    rhs     mi    epc sepc.lv sepc.all sepc.nox
## 168 item31 ~~ item33 17.975  0.090   0.090    1.313    1.313
## 136     F4 =~  item1 14.553  0.339   0.150    0.247    0.247
## 245 item10 ~~ item13 13.377  0.222   0.222    0.322    0.322
## 134     F4 =~ item31 11.467 -0.210  -0.093   -0.205   -0.205
## 359 item42 ~~ item16 11.094  0.562   0.562    0.242    0.242
## 207  item1 ~~ item37 10.910  0.078   0.078    0.274    0.274
## 104     F2 =~ item37 10.403  0.184   0.158    0.224    0.224
## 363 item12 ~~ item11  9.624  1.312   1.312    2.529    2.529
## 339 item26 ~~ item19  8.623  0.177   0.177    0.250    0.250
## 137     F4 =~ item37  7.959  0.316   0.140    0.199    0.199
## 101     F2 =~ item31  7.808 -0.089  -0.076   -0.167   -0.167
## 237 item37 ~~ item11  7.249  0.122   0.122    0.215    0.215
## 218  item1 ~~ item42  7.190  0.159   0.159    0.203    0.203
## 188 item33 ~~  item1  6.541 -0.046  -0.046   -0.318   -0.318
## 308 item13 ~~ item16  6.525  0.258   0.258    0.186    0.186
## 332 item43 ~~  item2  6.427  0.140   0.140    0.300    0.300
```

```
## 350 item14 ~~ item42  5.773  0.530   0.530    0.173    0.173
## 362 item42 ~~  item2  5.298  0.330   0.330    0.175    0.175
## 100     F1 =~  item2  5.261 -0.547  -0.217   -0.154   -0.154
## 233 item37 ~~ item32  5.251  0.074   0.074    0.186    0.186
## 173 item31 ~~ item36  5.150 -0.045  -0.045   -0.248   -0.248
## 330 item43 ~~ item19  5.106 -0.109  -0.109   -0.277   -0.277
## 192 item33 ~~ item36  4.870  0.048   0.048    0.187    0.187
## 167     F5 =~ item16  4.750  0.278   0.243    0.166    0.166
## 170 item31 ~~ item37  4.638 -0.042  -0.042   -0.313   -0.313
## 141     F4 =~ item35  4.630  0.435   0.193    0.154    0.154
## 258 item47 ~~ item36  4.608  0.121   0.121    0.273    0.273
## 358 item42 ~~ item11  4.551 -0.293  -0.293   -0.187   -0.187
## 115     F2 =~  item2  4.513 -0.260  -0.224   -0.159   -0.159
## 226 item37 ~~ item47  4.505  0.060   0.060    0.184    0.184
## 114     F2 =~ item34  4.482  0.276   0.237    0.172    0.172
## 219  item1 ~~ item12  4.328  0.064   0.064    0.247    0.247
## 206 item33 ~~  item2  4.291 -0.060  -0.060   -0.173   -0.173
## 96      F1 =~ item11  4.020 -0.412  -0.164   -0.127   -0.127

## lavaan 0.6-9 ended normally after 67 iterations
##
##   Estimator                                         ML
##   Optimization method                           NLMINB
##   Number of model parameters                        75
##
##   Number of observations                           199
##   Number of missing patterns                         1
##
```

```
## Model Test User Model:
##                                                Standard      Robust
##   Test Statistic                                233.643     228.963
##   Degrees of freedom                                177         177
##   P-value (Chi-square)                            0.003       0.005
##   Scaling correction factor                                   1.020
##         Yuan-Bentler correction (Mplus variant)
##
## Model Test Baseline Model:
##
##   Test statistic                               1557.809    1230.314
##   Degrees of freedom                                210         210
##   P-value                                         0.000       0.000
##   Scaling correction factor                                   1.266
##
## User Model versus Baseline Model:
##
##   Comparative Fit Index (CFI)                     0.958       0.949
##   Tucker-Lewis Index (TLI)                        0.950       0.940
##
##   Robust Comparative Fit Index (CFI)                          0.959
##   Robust Tucker-Lewis Index (TLI)                             0.951
##
## Loglikelihood and Information Criteria:
##
##   Loglikelihood user model (H0)               -5671.720   -5671.720
##   Scaling correction factor                                   1.907
```

```
##       for the MLR correction
##   Loglikelihood unrestricted model (H1)      -5554.899   -5554.899
##   Scaling correction factor                                  1.284
##       for the MLR correction
##
##   Akaike (AIC)                              11493.441   11493.441
##   Bayesian (BIC)                            11740.438   11740.438
##   Sample-size adjusted Bayesian (BIC)       11502.834   11502.834
##
## Root Mean Square Error of Approximation:
##
##   RMSEA                                          0.040       0.038
##   90 Percent confidence interval - lower         0.024       0.022
##   90 Percent confidence interval - upper         0.053       0.052
##   P-value RMSEA <= 0.05                          0.884       0.920
##
##   Robust RMSEA                                               0.039
##   90 Percent confidence interval - lower                     0.022
##   90 Percent confidence interval - upper                     0.052
##
## Standardized Root Mean Square Residual:
##
##   SRMR                                           0.061       0.061
##
## Parameter Estimates:
##
##   Standard errors                             Sandwich
```

```
##   Information bread                           Observed
##   Observed information based on                Hessian
##
## Latent Variables:
##                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
##   F1 =~
##     item31           1.000                               0.293    0.645
##     item33           0.755    0.145    5.204    0.000    0.221    0.490
##     item1            1.782    0.655    2.721    0.007    0.522    0.856
##     item37           1.345    0.379    3.548    0.000    0.394    0.559
##   F2 =~
##     item10           1.000                               0.858    0.782
##     item47           0.859    0.109    7.846    0.000    0.736    0.809
##     item36           0.947    0.137    6.937    0.000    0.813    0.701
##     item35           0.740    0.139    5.318    0.000    0.634    0.507
##     item13           0.475    0.114    4.169    0.000    0.407    0.374
##     item44          -0.714    0.139   -5.146    0.000   -0.612   -0.490
##   F3 =~
##     item43           1.000                               1.291    0.951
##     item26           0.918    0.056   16.327    0.000    1.185    0.843
##     item32           0.895    0.064   13.889    0.000    1.155    0.872
##   F4 =~
##     item14           1.000                               0.658    0.351
##     item42           1.470    0.481    3.058    0.002    0.967    0.559
##     item12           0.797    0.266    2.995    0.003    0.524    0.459
##     item11           0.527    0.254    2.078    0.038    0.347    0.269
##     item16           0.993    0.429    2.313    0.021    0.653    0.447
```

```
##   F5 =~
##     item19            1.000                               0.870    0.679
##     item34            1.313    0.167    7.871    0.000    1.142    0.826
##     item2             0.995    0.150    6.653    0.000    0.866    0.615
##
## Covariances:
##                    Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
##  .item31 ~~
##    .item33            0.070    0.027    2.632    0.008    0.070    0.513
##  .item12 ~~
##    .item11            0.716    0.139    5.135    0.000    0.716    0.569
##   F1 ~~
##     F2                0.050    0.027    1.849    0.064    0.197    0.197
##     F3               -0.008    0.035   -0.239    0.811   -0.022   -0.022
##     F4                0.080    0.031    2.530    0.011    0.413    0.413
##     F5                0.010    0.026    0.395    0.693    0.040    0.040
##   F2 ~~
##     F3               -0.076    0.076   -1.000    0.317   -0.069   -0.069
##     F4                0.119    0.083    1.424    0.154    0.210    0.210
##     F5               -0.259    0.087   -2.972    0.003   -0.347   -0.347
##   F3 ~~
##     F4                0.073    0.102    0.716    0.474    0.086    0.086
##     F5               -0.034    0.102   -0.336    0.737   -0.031   -0.031
##   F4 ~~
##     F5                0.089    0.076    1.171    0.242    0.155    0.155
##
## Intercepts:
```

```
##                    Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
##     .item31           0.879    0.032   27.295    0.000    0.879    1.935
##     .item33           0.869    0.032   27.150    0.000    0.869    1.925
##     .item1            0.990    0.043   22.904    0.000    0.990    1.624
##     .item37           0.995    0.050   19.900    0.000    0.995    1.411
##     .item10           2.543    0.078   32.704    0.000    2.543    2.318
##     .item47           2.035    0.065   31.553    0.000    2.035    2.237
##     .item36           2.095    0.082   25.511    0.000    2.095    1.808
##     .item35           2.070    0.089   23.362    0.000    2.070    1.656
##     .item13           2.834    0.077   36.750    0.000    2.834    2.605
##     .item44           2.995    0.089   33.796    0.000    2.995    2.396
##     .item43           1.578    0.096   16.401    0.000    1.578    1.163
##     .item26           1.482    0.100   14.868    0.000    1.482    1.054
##     .item32           1.533    0.094   16.314    0.000    1.533    1.156
##     .item14           3.020    0.133   22.749    0.000    3.020    1.613
##     .item42           2.935    0.122   23.959    0.000    2.935    1.698
##     .item12           2.005    0.081   24.793    0.000    2.005    1.758
##     .item11           2.382    0.091   26.054    0.000    2.382    1.847
##     .item16           3.211    0.104   30.991    0.000    3.211    2.197
##     .item19           3.930    0.091   43.244    0.000    3.930    3.065
##     .item34           3.583    0.098   36.558    0.000    3.583    2.592
##     .item2            2.482    0.100   24.897    0.000    2.482    1.765
##      F1               0.000                               0.000    0.000
##      F2               0.000                               0.000    0.000
##      F3               0.000                               0.000    0.000
##      F4               0.000                               0.000    0.000
##      F5               0.000                               0.000    0.000
```

```
##
## Variances:
##                    Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
##    .item31            0.121    0.035    3.491    0.000    0.121    0.584
##    .item33            0.155    0.070    2.218    0.027    0.155    0.760
##    .item1             0.099    0.090    1.099    0.272    0.099    0.267
##    .item37            0.342    0.130    2.621    0.009    0.342    0.688
##    .item10            0.468    0.128    3.650    0.000    0.468    0.389
##    .item47            0.286    0.054    5.312    0.000    0.286    0.345
##    .item36            0.682    0.094    7.244    0.000    0.682    0.508
##    .item35            1.161    0.155    7.465    0.000    1.161    0.743
##    .item13            1.018    0.112    9.101    0.000    1.018    0.860
##    .item44            1.188    0.138    8.579    0.000    1.188    0.760
##    .item43            0.175    0.101    1.731    0.083    0.175    0.095
##    .item26            0.573    0.164    3.503    0.000    0.573    0.290
##    .item32            0.422    0.114    3.684    0.000    0.422    0.240
##    .item14            3.075    0.292   10.534    0.000    3.075    0.877
##    .item42            2.051    0.322    6.376    0.000    2.051    0.687
##    .item12            1.027    0.150    6.867    0.000    1.027    0.789
##    .item11            1.543    0.172    8.957    0.000    1.543    0.928
##    .item16            1.710    0.272    6.292    0.000    1.710    0.800
##    .item19            0.886    0.131    6.783    0.000    0.886    0.539
##    .item34            0.606    0.178    3.402    0.001    0.606    0.317
##    .item2             1.229    0.150    8.214    0.000    1.229    0.621
##     F1                0.086    0.036    2.376    0.017    1.000    1.000
##     F2                0.735    0.145    5.067    0.000    1.000    1.000
##     F3                1.667    0.246    6.771    0.000    1.000    1.000
```

```
##     F4                0.433    0.228    1.902    0.057    1.000    1.000
##     F5                0.757    0.162    4.668    0.000    1.000    1.000
##
## R-Square:
##                    Estimate
##     item31            0.416
##     item33            0.240
##     item1             0.733
##     item37            0.312
##     item10            0.611
##     item47            0.655
##     item36            0.492
##     item35            0.257
##     item13            0.140
##     item44            0.240
##     item43            0.905
##     item26            0.710
##     item32            0.760
##     item14            0.123
##     item42            0.313
##     item12            0.211
##     item11            0.072
##     item16            0.200
##     item19            0.461
##     item34            0.683
##     item2             0.379

##              F1        F2        F3        F4        F5     total
```

```
## alpha  0.7547222 0.4818562 0.9175522 0.5566040 0.7413266 0.5705737
## omega  0.7047603 0.6261744 0.9185244 0.4777356 0.7527269 0.7006145
## omega2 0.7047603 0.6261744 0.9185244 0.4777356 0.7527269 0.7006145
## omega3 0.6939390 0.6265598 0.9183878 0.4742914 0.7572671 0.6879404
## avevar 0.4397748 0.3749622 0.7902041 0.1887734 0.5081583 0.4058147

## lavaan 0.6-9 ended normally after 86 iterations
##
##   Estimator                                         ML
##   Optimization method                           NLMINB
##   Number of model parameters                        91
##
##   Number of observations                           199
##   Number of missing patterns                         1
##
## Model Test User Model:
##                                                   Standard      Robust
##   Test Statistic                                  312.650     319.502
##   Degrees of freedom                                  233         233
##   P-value (Chi-square)                              0.000       0.000
##   Scaling correction factor                                     0.979
##         Yuan-Bentler correction (Mplus variant)
##
## Model Test Baseline Model:
##
##   Test statistic                                 1718.830    1439.817
##   Degrees of freedom                                  276         276
##   P-value                                           0.000       0.000
```

```
##   Scaling correction factor                                 1.194
##
## User Model versus Baseline Model:
##
##   Comparative Fit Index (CFI)                    0.945       0.926
##   Tucker-Lewis Index (TLI)                       0.935       0.912
##
##   Robust Comparative Fit Index (CFI)                         0.939
##   Robust Tucker-Lewis Index (TLI)                            0.928
##
## Loglikelihood and Information Criteria:
##
##   Loglikelihood user model (H0)              -6703.605   -6703.605
##   Scaling correction factor                                  1.802
##       for the MLR correction
##   Loglikelihood unrestricted model (H1)      -6547.280   -6547.280
##   Scaling correction factor                                  1.210
##       for the MLR correction
##
##   Akaike (AIC)                               13589.210   13589.210
##   Bayesian (BIC)                             13888.900   13888.900
##   Sample-size adjusted Bayesian (BIC)        13600.607   13600.607
##
## Root Mean Square Error of Approximation:
##
##   RMSEA                                          0.041       0.043
##   90 Percent confidence interval - lower         0.028       0.031
```

```
##   90 Percent confidence interval - upper         0.053       0.055
##   P-value RMSEA <= 0.05                          0.885       0.830
##
##   Robust RMSEA                                               0.043
##   90 Percent confidence interval - lower                     0.030
##   90 Percent confidence interval - upper                     0.054
##
## Standardized Root Mean Square Residual:
##
##   SRMR                                           0.065       0.065
##
## Parameter Estimates:
##
##   Standard errors                             Sandwich
##   Information bread                           Observed
##   Observed information based on                Hessian
##
## Latent Variables:
##                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
##   F1 =~
##     item31           1.000                               0.294    0.646
##     item33           0.752    0.145    5.183    0.000    0.221    0.489
##     item1            1.776    0.638    2.781    0.005    0.521    0.855
##     item37           1.344    0.379    3.549    0.000    0.395    0.560
##   F2 =~
##     item10           1.000                               0.830    0.757
##     item47           0.899    0.124    7.268    0.000    0.747    0.821
```

```
##     item36            0.997    0.151    6.609    0.000    0.828    0.714
##     item35            0.766    0.147    5.201    0.000    0.636    0.509
##     item13            0.398    0.119    3.347    0.001    0.330    0.303
##     item44           -0.751    0.146   -5.135    0.000   -0.624   -0.499
##   F3 =~
##     item43            1.000                               1.297    0.956
##     item26            0.904    0.055   16.458    0.000    1.173    0.838
##     item32            0.887    0.063   14.039    0.000    1.150    0.868
##   F4 =~
##     item14            1.000                               0.632    0.337
##     item42            1.476    0.486    3.039    0.002    0.932    0.540
##     item12            0.855    0.351    2.437    0.015    0.540    0.474
##     item11            0.595    0.375    1.586    0.113    0.376    0.292
##     item16            1.088    0.568    1.916    0.055    0.687    0.470
##   F5 =~
##     item19            1.000                               0.889    0.689
##     item34            1.271    0.147    8.639    0.000    1.130    0.817
##     item2             0.990    0.147    6.759    0.000    0.880    0.626
##   F6 =~
##     item38            1.000                               0.526    0.388
##     item28            2.058    3.153    0.653    0.514    1.083    0.737
##     item45            1.518    0.693    2.192    0.028    0.799    0.512
##
## Covariances:
##                    Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
##  .item31 ~~
##    .item33           0.070    0.026    2.680    0.007    0.070    0.513
```

```
##  .item10 ~~
##    .item13          0.218    0.098    2.213    0.027    0.218    0.293
##  .item12 ~~
##    .item11          0.694    0.153    4.549    0.000    0.694    0.560
##  .item26 ~~
##    .item19          0.179    0.072    2.487    0.013    0.179    0.250
##   F1 ~~
##     F2              0.047    0.026    1.860    0.063    0.195    0.195
##     F3             -0.008    0.035   -0.238    0.812   -0.022   -0.022
##     F4              0.075    0.036    2.120    0.034    0.407    0.407
##     F5              0.011    0.027    0.403    0.687    0.041    0.041
##     F6              0.021    0.053    0.406    0.685    0.138    0.138
##   F2 ~~
##     F3             -0.086    0.072   -1.181    0.237   -0.079   -0.079
##     F4              0.094    0.084    1.116    0.265    0.179    0.179
##     F5             -0.258    0.086   -3.002    0.003   -0.350   -0.350
##     F6             -0.035    0.146   -0.240    0.810   -0.080   -0.080
##   F3 ~~
##     F4              0.079    0.098    0.804    0.421    0.096    0.096
##     F5             -0.039    0.105   -0.374    0.708   -0.034   -0.034
##     F6             -0.025    0.132   -0.187    0.851   -0.036   -0.036
##   F4 ~~
##     F5              0.087    0.076    1.133    0.257    0.154    0.154
##     F6              0.081    0.054    1.488    0.137    0.243    0.243
##   F5 ~~
##     F6              0.114    0.150    0.759    0.448    0.244    0.244
##
```

```
## Intercepts:
##                    Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
##    .item31            0.879    0.032   27.295    0.000    0.879    1.935
##    .item33            0.869    0.032   27.150    0.000    0.869    1.925
##    .item1             0.990    0.043   22.904    0.000    0.990    1.624
##    .item37            0.995    0.050   19.900    0.000    0.995    1.411
##    .item10            2.543    0.078   32.704    0.000    2.543    2.318
##    .item47            2.035    0.065   31.553    0.000    2.035    2.237
##    .item36            2.095    0.082   25.511    0.000    2.095    1.808
##    .item35            2.070    0.089   23.362    0.000    2.070    1.656
##    .item13            2.834    0.077   36.750    0.000    2.834    2.605
##    .item44            2.995    0.089   33.796    0.000    2.995    2.396
##    .item43            1.578    0.096   16.401    0.000    1.578    1.163
##    .item26            1.482    0.100   14.868    0.000    1.482    1.060
##    .item32            1.533    0.094   16.314    0.000    1.533    1.156
##    .item14            3.020    0.133   22.749    0.000    3.020    1.613
##    .item42            2.935    0.122   23.959    0.000    2.935    1.698
##    .item12            2.005    0.081   24.793    0.000    2.005    1.758
##    .item11            2.382    0.091   26.054    0.000    2.382    1.847
##    .item16            3.211    0.104   30.991    0.000    3.211    2.197
##    .item19            3.930    0.091   43.244    0.000    3.930    3.043
##    .item34            3.583    0.098   36.558    0.000    3.583    2.592
##    .item2             2.482    0.100   24.897    0.000    2.482    1.765
##    .item38            2.201    0.096   22.896    0.000    2.201    1.623
##    .item28            2.111    0.104   20.264    0.000    2.111    1.437
##    .item45            2.432    0.111   21.981    0.000    2.432    1.558
##     F1                0.000                               0.000    0.000
```

```
##     F2                0.000                           0.000    0.000
##     F3                0.000                           0.000    0.000
##     F4                0.000                           0.000    0.000
##     F5                0.000                           0.000    0.000
##     F6                0.000                           0.000    0.000
##
## Variances:
##                    Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
##    .item31            0.120    0.034    3.520    0.000    0.120    0.583
##    .item33            0.155    0.070    2.220    0.026    0.155    0.761
##    .item1             0.100    0.087    1.155    0.248    0.100    0.269
##    .item37            0.342    0.129    2.641    0.008    0.342    0.687
##    .item10            0.513    0.131    3.925    0.000    0.513    0.427
##    .item47            0.270    0.057    4.734    0.000    0.270    0.327
##    .item36            0.657    0.096    6.878    0.000    0.657    0.490
##    .item35            1.158    0.157    7.382    0.000    1.158    0.741
##    .item13            1.075    0.103   10.395    0.000    1.075    0.908
##    .item44            1.174    0.137    8.550    0.000    1.174    0.751
##    .item43            0.160    0.091    1.757    0.079    0.160    0.087
##    .item26            0.582    0.166    3.505    0.000    0.582    0.297
##    .item32            0.434    0.114    3.813    0.000    0.434    0.247
##    .item14            3.108    0.316    9.836    0.000    3.108    0.886
##    .item42            2.116    0.334    6.345    0.000    2.116    0.709
##    .item12            1.009    0.148    6.804    0.000    1.009    0.776
##    .item11            1.522    0.190    8.005    0.000    1.522    0.915
##    .item16            1.664    0.316    5.267    0.000    1.664    0.779
##    .item19            0.877    0.132    6.664    0.000    0.877    0.526
```

```
##    .item34           0.634    0.162    3.905    0.000    0.634    0.332
##    .item2            1.203    0.151    7.993    0.000    1.203    0.608
##    .item38           1.562    0.478    3.270    0.001    1.562    0.849
##    .item28           0.985    1.584    0.622    0.534    0.985    0.456
##    .item45           1.798    0.670    2.681    0.007    1.798    0.738
##     F1               0.086    0.036    2.407    0.016    1.000    1.000
##     F2               0.690    0.150    4.608    0.000    1.000    1.000
##     F3               1.682    0.244    6.901    0.000    1.000    1.000
##     F4               0.399    0.251    1.588    0.112    1.000    1.000
##     F5               0.791    0.161    4.899    0.000    1.000    1.000
##     F6               0.277    0.473    0.586    0.558    1.000    1.000
##
## R-Square:
##                    Estimate
##     item31            0.417
##     item33            0.239
##     item1             0.731
##     item37            0.313
##     item10            0.573
##     item47            0.673
##     item36            0.510
##     item35            0.259
##     item13            0.092
##     item44            0.249
##     item43            0.913
##     item26            0.703
##     item32            0.753
```

```
##     item14            0.114
##     item42            0.291
##     item12            0.224
##     item11            0.085
##     item16            0.221
##     item19            0.474
##     item34            0.668
##     item2             0.392
##     item38            0.151
##     item28            0.544
##     item45            0.262
```

```
##                F1        F2        F3        F4        F5        F6     total
## alpha  0.7547222 0.4818562 0.9175522 0.5566040 0.7413266 0.5529540 0.5867087
## omega  0.7047233 0.5882585 0.9176537 0.4814294 0.7559836 0.5718535 0.6975681
## omega2 0.7047233 0.5882585 0.9176537 0.4814294 0.7559836 0.5718535 0.6975681
## omega3 0.6939357 0.5880241 0.9123335 0.4801057 0.7686670 0.5694246 0.6768555
## avevar 0.4396193 0.3689684 0.7883714 0.1875180 0.5116007 0.3247497 0.3906214
```

Discussion

References

Aust, F., & Barth, M. (2020). *papaja: Create APA manuscripts with R Markdown.* Retrieved from https://github.com/crsh/papaja

R Core Team. (2020). *R: A language and environment for statistical computing.* Vienna, Austria: R Foundation for Statistical Computing. Retrieved from https://www.R-project.org/