Measurement Invariance of the Dirty Dozen: Student and Working Adult Samples

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Abstract

Now we are evaluating the psychometric properties of the dirty dozen simplified Chinese version by using samples in real settings: job applicants and incumbents (in addition to students). We replicate a previous study using the student sample, then continue to evaluate with organizational data. We find that the scales are non-invariant.

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Measurement Invariance of the Dirty Dozen: Student and Working Adult Samples

Initially we were interested in looking at reliance on student samples. Now we are evaluating the psychometric properties of the dirty dozen (DD) simplified Chinese version by using samples in real settings: job applicants and incumbents (in addition to students). We replicate a previous study using the student sample (Yang gonna send some articles), then continue to evaluate with organizational data. We find that the scales are non-invariant.

SDSME another version (27 items).

All studies investigating psychometric properties of these scales use University students.

Some groups may be expected to exhibit different item-construct associations due to shifting motivational forces.

ITC guidlines for translating and adapting tests recommends looking at possible differences across motives - for example,

Methods

We report how we determined our sample size, all data exclusions (if any), all manipulations, and all measures in the study. We also look at intercorrelations among items within the samplings.

Participants

In total 1106 individuals responded to the Dirty Dozen (as well as additional scales not the focus of the current presentation). This total was comprised of 208 working adults low-stakes, 527 working adults high-stakes, and 371 students low-stakes individuals. After screening for undifferentiated responses via the `R` package `careless` (Yentes & Wilhelm, 2021), we retained 1054 respondents who had no more than 6 sequentially identical responses across the 12 total items.

Material

Procedure

Decrease in $\Delta\chi^2$ across models indicates a lack of invariance (typically not considered a "good thing"). Multiple indices are consulted across models, including $\Delta\chi^2$, RMSEA, CFI, TLI, BIC, and AIC.

Data analysis

We used R [Version 4.0.5; R Core Team (2021)] and the R-packages *careless* [Version 1.2.1; Yentes and Wilhelm (2021)], *foreign* [Version 0.8.81; R Core Team (2020)], *lavaan* [Version 0.6.8; Rosseel (2012)], *papaja* [Version 0.1.0.9997; Aust and Barth (2020)], and *semTools* [Version 0.5.5; Jorgensen, Pornprasertmanit, Schoemann, and Rosseel (2021)] for all our analyses.

Results

```
##
## Measurement invariance models:
##
## Model 1 : fit.configural
## Model 2 : fit.loadings
## Model 3 : fit.intercepts
## Model 4 : fit.means
##
## Chi-Squared Difference Test
##
##                 Df   AIC   BIC  Chisq Chisq diff Df diff
## fit.configural 153 37059 37640 1407.7
## fit.loadings   171 37135 37626 1518.9     111.25      18
```

```
## fit.intercepts 189 37230 37632 1650.5     131.54      18
## fit.means      195 37344 37716 1775.9     125.40       6
##                Pr(>Chisq)
## fit.configural
## fit.loadings    1.837e-15 ***
## fit.intercepts  < 2.2e-16 ***
## fit.means       < 2.2e-16 ***
## ---
## Signif. codes:
## 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
##
## Fit measures:
##
##                  cfi rmsea cfi.delta rmsea.delta
## fit.configural 0.641 0.153        NA          NA
## fit.loadings   0.615 0.150     0.027       0.003
## fit.intercepts 0.582 0.148     0.032       0.001
## fit.means      0.548 0.152     0.034       0.004

## lavaan 0.6-8 ended normally after 108 iterations
##
##   Estimator                                         ML
##   Optimization method                           NLMINB
##   Number of model parameters                       117
##
##   Number of observations per group:
##     working adults low-stakes                      191
```

```
##     working adults high-stakes                   510
##     students low-stakes                          351
##
## Model Test User Model:
##
##   Test statistic                              1407.674
##   Degrees of freedom                           153
##   P-value (Chi-square)                          0.000
##   Test statistic for each group:
##     working adults low-stakes                  182.467
##     working adults high-stakes                 523.812
##     students low-stakes                        701.395
##
## Model Test Baseline Model:
##
##   Test statistic                              3696.466
##   Degrees of freedom                           198
##   P-value                                       0.000
##
## User Model versus Baseline Model:
##
##   Comparative Fit Index (CFI)                   0.641
##   Tucker-Lewis Index (TLI)                      0.536
##
## Loglikelihood and Information Criteria:
##
##   Loglikelihood user model (H0)            -18412.727
```

```
##   Loglikelihood unrestricted model (H1)     -17708.890
##
##   Akaike (AIC)                               37059.454
##   Bayesian (BIC)                             37639.593
##   Sample-size adjusted Bayesian (BIC)        37267.983
##
## Root Mean Square Error of Approximation:
##
##   RMSEA                                          0.153
##   90 Percent confidence interval - lower         0.146
##   90 Percent confidence interval - upper         0.160
##   P-value RMSEA <= 0.05                          0.000
##
## Standardized Root Mean Square Residual:
##
##   SRMR                                           0.110
##
## Parameter Estimates:
##
##   Standard errors                             Standard
##   Information                                 Expected
##   Information saturated (h1) model          Structured
##
##
## Group 1 [working adults low-stakes]:
##
## Latent Variables:
```

```
##                    Estimate  Std.Err  z-value  P(>|z|)
##   mach =~
##     A30               1.000
##     A31               0.392    0.095    4.111    0.000
##     A32               0.224    0.096    2.332    0.020
##     A33               0.538    0.063    8.507    0.000
##   narc =~
##     A34               1.000
##     A35               0.262    0.263    0.996    0.319
##     A36               1.982    0.367    5.394    0.000
##     A37               1.752    0.332    5.277    0.000
##   psyc =~
##     A38               1.000
##     A39               1.328    0.240    5.541    0.000
##     A40               0.820    0.195    4.196    0.000
##     A41               0.814    0.205    3.969    0.000
##
## Covariances:
##                    Estimate  Std.Err  z-value  P(>|z|)
##   mach ~~
##     narc              0.311    0.066    4.691    0.000
##     psyc              0.700    0.144    4.859    0.000
##   narc ~~
##     psyc              0.251    0.065    3.863    0.000
##
## Intercepts:
##                    Estimate  Std.Err  z-value  P(>|z|)
```

```
##    .A30               1.948    0.089   21.789    0.000
##    .A31               1.901    0.083   22.999    0.000
##    .A32               4.607    0.083   55.484    0.000
##    .A33               1.340    0.056   24.095    0.000
##    .A34               1.393    0.061   22.680    0.000
##    .A35               4.267    0.091   46.791    0.000
##    .A36               1.890    0.083   22.892    0.000
##    .A37               1.508    0.078   19.429    0.000
##    .A38               2.984    0.122   24.507    0.000
##    .A39               1.759    0.087   20.119    0.000
##    .A40               2.031    0.100   20.231    0.000
##    .A41               3.288    0.109   30.174    0.000
##     mach              0.000
##     narc              0.000
##     psyc              0.000
##
## Variances:
##                    Estimate  Std.Err  z-value  P(>|z|)
##    .A30               0.678    0.099    6.865    0.000
##    .A31               1.174    0.122    9.608    0.000
##    .A32               1.274    0.131    9.725    0.000
##    .A33               0.345    0.041    8.401    0.000
##    .A34               0.562    0.063    8.951    0.000
##    .A35               1.578    0.162    9.753    0.000
##    .A36               0.682    0.099    6.890    0.000
##    .A37               0.666    0.088    7.523    0.000
##    .A38               2.350    0.247    9.509    0.000
```

```
##    .A39               0.610    0.098    6.251    0.000
##    .A40               1.601    0.168    9.514    0.000
##    .A41               1.948    0.204    9.572    0.000
##     mach              0.848    0.157    5.419    0.000
##     narc              0.158    0.052    3.008    0.003
##     psyc              0.482    0.172    2.812    0.005
##
##
## Group 2 [working adults high-stakes]:
##
## Latent Variables:
##                   Estimate  Std.Err  z-value  P(>|z|)
##   mach =~
##     A30               1.000
##     A31               0.495    0.059    8.361    0.000
##     A32               0.152    0.060    2.537    0.011
##     A33               0.398    0.031   12.716    0.000
##   narc =~
##     A34               1.000
##     A35               0.377    0.148    2.544    0.011
##     A36               1.683    0.188    8.946    0.000
##     A37               0.622    0.098    6.323    0.000
##   psyc =~
##     A38               1.000
##     A39               1.148    0.139    8.287    0.000
##     A40               0.408    0.087    4.692    0.000
##     A41               0.864    0.142    6.100    0.000
```

```
##
## Covariances:
##                   Estimate  Std.Err  z-value  P(>|z|)
##   mach ~~
##     narc             0.336    0.038    8.881    0.000
##     psyc             0.579    0.079    7.293    0.000
##   narc ~~
##     psyc             0.251    0.039    6.388    0.000
##
## Intercepts:
##                   Estimate  Std.Err  z-value  P(>|z|)
##    .A30              1.761    0.050   34.986    0.000
##    .A31              1.727    0.047   36.930    0.000
##    .A32              4.788    0.047  101.300    0.000
##    .A33              1.204    0.025   48.421    0.000
##    .A34              1.224    0.033   36.737    0.000
##    .A35              4.422    0.050   87.885    0.000
##    .A36              1.825    0.050   36.532    0.000
##    .A37              1.198    0.030   39.522    0.000
##    .A38              3.076    0.075   40.922    0.000
##    .A39              1.539    0.044   35.365    0.000
##    .A40              1.557    0.048   32.693    0.000
##    .A41              2.800    0.069   40.364    0.000
##     mach             0.000
##     narc             0.000
##     psyc             0.000
##
```

```
## Variances:
##                    Estimate  Std.Err  z-value  P(>|z|)
##    .A30               0.564    0.053   10.564    0.000
##    .A31               0.938    0.061   15.403    0.000
##    .A32               1.123    0.070   15.926    0.000
##    .A33               0.200    0.014   14.029    0.000
##    .A34               0.434    0.030   14.306    0.000
##    .A35               1.272    0.080   15.941    0.000
##    .A36               0.902    0.068   13.291    0.000
##    .A37               0.418    0.027   15.564    0.000
##    .A38               2.415    0.158   15.304    0.000
##    .A39               0.350    0.048    7.324    0.000
##    .A40               1.079    0.069   15.726    0.000
##    .A41               2.105    0.137   15.401    0.000
##     mach              0.728    0.083    8.767    0.000
##     narc              0.131    0.026    4.974    0.000
##     psyc              0.468    0.108    4.315    0.000
##
##
## Group 3 [students low-stakes]:
##
## Latent Variables:
##                    Estimate  Std.Err  z-value  P(>|z|)
##   mach =~
##     A30               1.000
##     A31               0.322    0.076    4.220    0.000
##     A32               0.424    0.063    6.764    0.000
```

```
##     A33               0.854    0.078   10.963    0.000
##   narc =~
##     A34               1.000
##     A35               1.286    0.240    5.359    0.000
##     A36               1.756    0.300    5.853    0.000
##     A37               1.486    0.276    5.387    0.000
##   psyc =~
##     A38               1.000
##     A39               1.430    0.150    9.551    0.000
##     A40               0.785    0.119    6.627    0.000
##     A41               1.130    0.140    8.083    0.000
##
## Covariances:
##                   Estimate  Std.Err  z-value  P(>|z|)
##   mach ~~
##     narc              0.433    0.076    5.678    0.000
##     psyc              0.794    0.105    7.585    0.000
##   narc ~~
##     psyc              0.326    0.060    5.403    0.000
##
## Intercepts:
##                   Estimate  Std.Err  z-value  P(>|z|)
##    .A30               2.627    0.082   31.924    0.000
##    .A31               2.316    0.072   32.342    0.000
##    .A32               4.826    0.057   84.238    0.000
##    .A33               1.801    0.066   27.348    0.000
##    .A34               1.638    0.063   26.055    0.000
```

```
##    .A35               4.490    0.063   70.785    0.000
##    .A36               2.083    0.067   30.984    0.000
##    .A37               1.892    0.072   26.127    0.000
##    .A38               3.903    0.073   53.138    0.000
##    .A39               2.205    0.074   29.698    0.000
##    .A40               1.829    0.072   25.382    0.000
##    .A41               3.903    0.078   49.869    0.000
##     mach              0.000
##     narc              0.000
##     psyc              0.000
##
## Variances:
##                   Estimate  Std.Err  z-value  P(>|z|)
##    .A30               1.474    0.124   11.919    0.000
##    .A31               1.707    0.129   13.240    0.000
##    .A32               0.990    0.075   13.148    0.000
##    .A33               0.863    0.076   11.335    0.000
##    .A34               1.276    0.095   13.396    0.000
##    .A35               1.227    0.093   13.238    0.000
##    .A36               1.241    0.099   12.522    0.000
##    .A37               1.593    0.120   13.220    0.000
##    .A38               1.407    0.109   12.936    0.000
##    .A39               0.938    0.085   11.028    0.000
##    .A40               1.522    0.116   13.139    0.000
##    .A41               1.528    0.119   12.827    0.000
##     mach              0.903    0.151    5.989    0.000
##     narc              0.112    0.039    2.896    0.004
```

```
##     psyc              0.487    0.099    4.944    0.000
```

We looked at structural invariance as well as latent means (Meredith, 1993; Steinmetz, Schmidt, Tina-Booh, Wieczorek, & Schwartz, 2009).

Discussion

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	Constrained parameters	Free parameters	comparison model
configural	FMean (=0)	fl+inter+res+var	
Weak/loading invariance	fl+Fmean (=0)	inter+res+var	configural
Strong/scalar invariance	fl+inter	res+var+Fmean*	Weak/loading invariance
strict invariance	fl+inter+res	Fmean*+var	Strong/scalar invariance

Note. fl= factor loadings, inter = item intercepts, res = item residual variances, Fmean = mean of latent variable, var = variance of latent variable
*Fmean is fixed to 0 in group 1 and estimated in the other group(s)

Figure 1. Steps for measurement invariance (taken from Xu, 2012).