library(lavaan)

library(semTools)

library(lavaanPlot)

#Grit-O Two-Factor Model

Model1 <- 'F1 =~ GS7 + GS3 + GS5 + GS11 + GS2 + GS8

F2 =~ GS10 + GS1 + GS9 + GS4 + GS6 + GS12'

result <- sem(Model1, data=GritData)

summary(result)

fit <- lavaan(Model1, data=GritData,

auto.var=TRUE, auto.fix.first=TRUE,

auto.cov.lv.x=TRUE, estimator = "DWLS")

summary(fit, fit.measures=TRUE)

resid(fit, type="standardized")

resid(fit, type="cor")

lavaanPlot(model = fit, node\_options = list(shape = "box", fontname = "Helvetica"), edge\_options = list(color = "grey"), coefs = F)

#Grit-O Single-Factor Model

Model2 <- 'F1 =~ GS7 + GS3 + GS5 + GS11 + GS2 + GS8 + GS10 + GS1 + GS9 + GS4 + GS6 + GS12'

result <- sem(Model2, data=GritData)

summary(result)

fit <- lavaan(Model2, data=GritData,

auto.var=TRUE, auto.fix.first=TRUE,

auto.cov.lv.x=TRUE, estimator = "DWLS")

summary(fit, fit.measures=TRUE)

resid(fit, type="standardized")

resid(fit, type="cor")

lavaanPlot(model = fit, node\_options = list(shape = "box", fontname = "Helvetica"), edge\_options = list(color = "grey"), coefs = F)

#Grit-S Two-Factor Model

Model3 <- 'F1 =~ GS5 + GS2 + GS7 + GS8

F2 =~ GS9 + GS4 + GS6 + GS12'

result <- sem(Model3, data= GritData)

summary(result)

fit <- lavaan(Model3, data=GritData,

auto.var=TRUE, auto.fix.first=TRUE,

auto.cov.lv.x=TRUE, estimator = "DWLS")

summary(fit, fit.measures=TRUE)

resid(fit, type="standardized")

resid(fit, type="cor")

lavaanPlot(model = fit, node\_options = list(shape = "box", fontname = "Helvetica"), edge\_options = list(color = "grey"), coefs = F)

#Grit-S Single-Factor Model

Model4 <- 'F1 =~ GS5 + GS2 + GS7 + GS8 + GS9 + GS4 + GS6 + GS12'

result <- sem(Model4, data=GritData)

summary(result)

fit <- lavaan(Model4, data=GritData,

auto.var=TRUE, auto.fix.first=TRUE,

auto.cov.lv.x=TRUE, estimator = "DWLS")

summary(fit, fit.measures=TRUE)

resid(fit, type="standardized")

resid(fit, type="cor")

lavaanPlot(model = fit, node\_options = list(shape = "box", fontname = "Helvetica"), edge\_options = list(color = "grey"), coefs = F)

#Grit-5 Single-Factor Model

Model5 <- 'F1 =~ GS6 + GS12 + GS4 + GS9 + GS8'

result <- sem(Model5, data=GritData)

summary(result)

fit <- lavaan(Model5, data=GritData,

auto.var=TRUE, auto.fix.first=TRUE,

auto.cov.lv.x=TRUE, estimator = "DWLS")

summary(fit, fit.measures=TRUE)

resid(fit, type="standardized")

resid(fit, type="cor")

lavaanPlot(model = fit, node\_options = list(shape = "box", fontname = "Helvetica"), edge\_options = list(color = "grey"), coefs = F)

#Grit-O Single Measurement Invariance Age

measurementInvariance(model = Model1, strict = TRUE, fit.measures = c("cfi", "rmsea", "srmr"), data = GRIT, group = "AgeBreak", check.gradient = FALSE)

#Grit-S Single Measurement Invariance Age

measurementInvariance(model = Model3, estimator = "DWLS", data = GritData, group = "AgeBreak", check.gradient = FALSE, fit.measures = c("cfi", "rmsea", "srmr"))

#Grit-O Single Measurement Invariance Education

measurementInvariance(model = Model1, strict = TRUE, fit.measures = c("cfi", "rmsea", "srmr"), data = GRIT, group = "education")

#Grit-S Single Measurement Invariance Education

measurementInvariance(model = Model3, estimator = "DWLS", data = GritData, group = "education", check.gradient = FALSE, fit.measures = c("cfi", "rmsea", "srmr"))

#Grit-O Two Measurement Invariance Educational Attainment

measurementInvariance(model = Model2, estimator = "DWLS", data = GritData, group = "education", check.gradient = FALSE, fit.measures = c("cfi", "rmsea", "srmr"))

#Grit-S Two Measurement Invariance Educational Attainment

measurementInvariance(model = Model4, data = GritData, group = "education", fit.measures = c("cfi", "rmsea", "srmr"))

#Grit-O Two Measurement Invariance Age

measurementInvariance(model = Model2, estimator = "DWLS", data = GritData, group = "AgeBreak", check.gradient = FALSE, fit.measures = c("cfi", "rmsea", "srmr"))

#Grit-S Two Measurement Invariance Age

measurementInvariance(model = Model4, data = GritData, group = "AgeBreak", fit.measures = c("cfi", "rmsea", "srmr"))

#Grit-5 Measurement Invariance Age

measurementInvariance(model = Model5, data = GritData, group = "AgeBreak", fit.measures = c("cfi", "rmsea", "srmr"))

#Grit-5 Measurement Invariance Educational Attainment

measurementInvariance(model = Model5, data = GritData, group = "education", fit.measures = c("cfi", "rmsea", "srmr"))

#Grit-O Bifactor Model

Model6 <- 'F1 =~ GS7 + GS3 + GS5 + GS11 + GS2 + GS8

F2 =~ GS10 + GS1 + GS9 + GS4 + GS6 + GS12

F3 =~ GS7 + GS3 + GS5 + GS11 + GS2 + GS8 + GS10 + GS1 + GS9 + GS4 + GS6 + GS12

F1 ~~ 0\*F2

F1 ~~ 0\*F3

F2 ~~ 0\*F3'

result <- sem(Model6, data=GritData)

summary(result)

fit <- lavaan(Model6, data=GritData,

auto.var=TRUE, auto.fix.first=TRUE,

auto.cov.lv.x=TRUE, estimator = "DWLS")

summary(fit, fit.measures=TRUE, standardized=TRUE, rsquare = TRUE)

resid(fit, type="standardized")

resid(fit, type="cor")

lavaanPlot(model = fit, node\_options = list(shape = "box", fontname = "Helvetica"), edge\_options = list(color = "grey"), coefs = F)

#Grit-O Bifactor Measurement Invariance Age

measurementInvariance(model = Model6, data = GritData, group = "AgeBreak", fit.measures = c("cfi", "rmsea", "srmr"), check.gradient = FALSE)

#Grit-O BifactorMeasurement Invariance Educational Attainment

measurementInvariance(model = Model6, data = GritData, group = "education", fit.measures = c("cfi", "rmsea", "srmr"), check.gradient = FALSE)

#Grit-S Bifactor Model

Model7 <- 'F1 =~ GS5 + GS2 + GS7 + GS8

F2 =~ GS9 + GS4 + GS6 + GS12

F3 =~ GS5 + GS2 + GS7 + GS8 + GS9 + GS4 + GS6 + GS12

F1 ~~ 0\*F2

F1 ~~ 0\*F3

F2 ~~ 0\*F3'

result <- sem(Model7, data = GritData)

summary(result)

fit <- lavaan(Model3, data=GritData,

auto.var=TRUE, auto.fix.first=TRUE,

auto.cov.lv.x=TRUE, estimator = "DWLS")

summary(fit, fit.measures=TRUE, standardized=TRUE, rsquare = TRUE)

inspect(fit, 'r2')

resid(fit, type="standardized")

resid(fit, type="cor")

lavaanPlot(model = fit, node\_options = list(shape = "box", fontname = "Helvetica"), edge\_options = list(color = "grey"), coefs = F)

#Grit-S Bifactor Measurement Invariance Age

measurementInvariance(model = Model6, data = GritData, group = "AgeBreak", fit.measures = c("cfi", "rmsea", "srmr"), check.gradient = FALSE)

#Grit-S BifactorMeasurement Invariance Educational Attainment

measurementInvariance(model = Model6, data = GritData, group = "education", fit.measures = c("cfi", "rmsea", "srmr"), check.gradient = FALSE)

#Grit vs. Con

Model3 <- 'F1 =~ GS5 + GS2 + GS7 + GS8 + GS9 + GS4 + GS6 + GS12 + C1 + C2 + C3 + C4 + C5 + C6 + C7 + C8 + C9 + C10'

result <- sem(Model3, data = GritData)

summary(result)

fit <- lavaan(Model3, data=GritData,

auto.var=TRUE, auto.fix.first=TRUE,

auto.cov.lv.x=TRUE, estimator = "DWLS")

summary(fit, fit.measures=TRUE)

resid(fit, type="standardized")

resid(fit, type="cor")

lavaanPlot(model = fit, node\_options = list(shape = "box", fontname = "Helvetica"), edge\_options = list(color = "grey"), coefs = F)

Model3 <- 'F1 =~ GS5 + GS2 + GS7 + GS8 + GS9 + GS4 + GS6 + GS12 + C1 + C2 + C3 + C4 + C5 + C6 + C7 + C8 + C9 + C10'

result <- sem(Model3, data = GritData)

summary(result)

fit <- lavaan(Model3, data=GritData,

auto.var=TRUE, auto.fix.first=TRUE,

auto.cov.lv.x=TRUE, estimator = "DWLS")

summary(fit, fit.measures=TRUE)

resid(fit, type="standardized")

resid(fit, type="cor")

lavaanPlot(model = fit, node\_options = list(shape = "box", fontname = "Helvetica"), edge\_options = list(color = "grey"), coefs = F)

Model3 <- 'F1 =~ GS5 + GS2 + GS7 + GS8 + GS9 + GS4 + GS6 + GS12

F3 =~ C1 + C2 + C3 + C4 + C5 + C6 + C7 + C8 + C9 + C10'

result <- sem(Model3, data = GritData)

summary(result)

fit <- lavaan(Model3, data=GritData,

auto.var=TRUE, auto.fix.first=TRUE,

auto.cov.lv.x=TRUE, estimator = "DWLS")

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

resid(fit, type="standardized")

resid(fit, type="cor")

lavaanPlot(model = fit, node\_options = list(shape = "box", fontname = "Helvetica"), edge\_options = list(color = "grey"), coefs = F)

Model3 <- 'F1 =~ GS5 + GS2 + GS7 + GS8

F2 =~ GS9 + GS4 + GS6 + GS12

F3 =~ C1 + C2 + C3 + C4 + C5 + C6 + C7 + C8 + C9 + C10'

result <- sem(Model3, data = GritData)

summary(result)

fit <- lavaan(Model3, data=GritData,

auto.var=TRUE, auto.fix.first=TRUE,

auto.cov.lv.x=TRUE, estimator = "DWLS")

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

resid(fit, type="standardized")

resid(fit, type="cor")

lavaanPlot(model = fit, node\_options = list(shape = "box", fontname = "Helvetica"), edge\_options = list(color = "grey"), coefs = F)

#Grit-5

Model3 <- 'F1 =~ GS6 + GS12 + GS4 + GS9 + GS8 + C1 + C2 + C3 + C4 + C5 + C6 + C7 + C8 + C9 + C10'

result <- sem(Model3, data = GritData)

summary(result)

fit <- lavaan(Model3, data=GritData,

auto.var=TRUE, auto.fix.first=TRUE,

auto.cov.lv.x=TRUE, estimator = "DWLS")

summary(fit, fit.measures=TRUE)

resid(fit, type="standardized")

resid(fit, type="cor")

lavaanPlot(model = fit, node\_options = list(shape = "box", fontname = "Helvetica"), edge\_options = list(color = "grey"), coefs = F)

Model3 <- 'F1 =~ GS6 + GS12 + GS4 + GS9 + GS8

F3 =~ C1 + C2 + C3 + C4 + C5 + C6 + C7 + C8 + C9 + C10'

result <- sem(Model3, data = GritData)

summary(result)

fit <- lavaan(Model3, data=GritData,

auto.var=TRUE, auto.fix.first=TRUE,

auto.cov.lv.x=TRUE, estimator = "DWLS")

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

resid(fit, type="standardized")

resid(fit, type="cor")

lavaanPlot(model = fit, node\_options = list(shape = "box", fontname = "Helvetica"), edge\_options = list(color = "grey"), coefs = F)

#Grit-O Bifactor with Con

Model1 <- 'F1 =~ GS7 + GS3 + GS5 + GS11 + GS2 + GS8

F2 =~ GS10 + GS1 + GS9 + GS4 + GS6 + GS12

F3 =~ GS7 + GS3 + GS5 + GS11 + GS2 + GS8 + GS10 + GS1 + GS9 + GS4 + GS6 + GS12 + C1 + C2 + C3 + C4 + C5 + C6 + C7 + C8 + C9 + C10

F1 ~~ 0\*F2

F1 ~~ 0\*F3

F2 ~~ 0\*F3'

result <- sem(Model1, data=GritData)

summary(result)

fit <- lavaan(Model1, data=GritData,

auto.var=TRUE, auto.fix.first=TRUE,

auto.cov.lv.x=TRUE, estimator = "DWLS")

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

resid(fit, type="standardized")

resid(fit, type="cor")

lavaanPlot(model = fit, node\_options = list(shape = "box", fontname = "Helvetica"), edge\_options = list(color = "grey"), coefs = F)

Model1 <- 'F1 =~ GS7 + GS3 + GS5 + GS11 + GS2 + GS8

F2 =~ GS10 + GS1 + GS9 + GS4 + GS6 + GS12

F3 =~ GS7 + GS3 + GS5 + GS11 + GS2 + GS8 + GS10 + GS1 + GS9 + GS4 + GS6 + GS12

F4 =~ C1 + C2 + C3 + C4 + C5 + C6 + C7 + C8 + C9 + C10

F1 ~~ 0\*F2

F1 ~~ 0\*F3

F2 ~~ 0\*F3

F1 ~~ 0\*F4

F2 ~~ 0\*F4'

result <- sem(Model1, data=GritData)

summary(result)

fit <- lavaan(Model1, data=GritData,

auto.var=TRUE, auto.fix.first=TRUE,

auto.cov.lv.x=TRUE, estimator = "DWLS")

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

resid(fit, type="standardized")

resid(fit, type="cor")

lavaanPlot(model = fit, node\_options = list(shape = "box", fontname = "Helvetica"), edge\_options = list(color = "grey"), coefs = F)