```
####code van Harmelen et al., The interplay between adolescent friendships and resilience following early adversity ----

###load packages----
library("qgraph")
library('foreign')
library("semPlot")
library("lavaan")
library("ggplot2")
library('car')
library('psych')
library('pastecs')
library('dplyr')
library ('stargazer')
library ('beyonce')

###workspace and datafile----
#  datafile
load('Alldata')
Roots<-Alldata
########################################## calculate resilience scores at ages 14 and 17----

###PSF age 14----

PSFT1<-cbind.data.frame(Roots$id, Roots$t1_mfqtotal_3cat, Roots$t1_rcmastotal_3cat, Roots$t1_loitotal_3cat,Roots$t1_behtotal,Roots$t1_rumtot)
colnames(PSFT1)<-(c('id', 't1_mfqtotal_3cat', 't1_rcmastotal_3cat', 't1_loitotal_3cat', 't1_behtotal', 't1_rumtot'))

describe(PSFT1)
PSFT1<-na.omit(PSFT1)#1141 obs

set.seed(1)
res<-prcomp(PSFT1[,2:6], scale = TRUE, retx=TRUE)
summary(res)
res$sdev
screeplot(res, type='lines', col='blue')
#loadings
res$rotation

#PC1 = 0.502*Z_1 + 0.51*Z_2 + 0.44*Z_3 + 0.30*Z_4+0.44*Z4
#where Z_1, \ldots, Z_4 are the standardization of original variables.


##########centre and scale data (centre data)
c.fun<-function(df, center, scale) {
```

```
  return((df-center)/scale )
}
centeredData<-apply(PSFT1[,2:6], MARGIN=1, FUN=c.fun, res$center, res$scale  )

# rotation matrix (loadings) vermenigvuldigen met centre data
pcs<-t(res$rotation) %*% centeredData

# compare with results of prcom (option retx=TRUE gives ^cs in x)
head(t(pcs))
head(res$x)

# check if results are the same
sum(abs(t(pcs)-res$x))
plot(res$x,t(pcs))

plot(pcs[1,], res$x[,1])

PSFT1$PSFT1<-pcs[1,]


which.max(PSFT1$PSFT1)#337
describe(PSFT1[337,])# almost everything high
which.min(PSFT1$PSFT1)#54
describe(PSFT1[54,])# low
#high PSF is worse, so invert scores here
PSFT1$PSFT1<-(PSFT1$PSFT1*-1)


###PSF age 17----
PSFT3<-cbind.data.frame(Roots$id, Roots$t3_mfqtotal_3cat, Roots$t3_rcmastotal_3cat,
Roots$t3_loitotal_3cat,Roots$t3_behtotal,Roots$t3_rumintotal)
describe(PSFT3)
colnames(PSFT3)

PSFT3<-na.omit(PSFT3)

# PCA PSF
########## principle component analysis time 2
res2<-prcomp(PSFT3[,2:6], scale = TRUE, retx=TRUE)

##### centre and scale data (centre data)
c.fun<-function(df, center, scale) {
  return((df-center)/scale )
}

##use scale from time 3 and center from time 1 (centre is mean of all object)
centeredData2<-apply(PSFT3[,2:6], MARGIN=1, FUN=c.fun, res$center, res2$scale)
```

```
# rotation matrix (loadings van time 1) vermenigvuldigen met centre data van time 2
pcs2<-t(res$rotation) %*% centeredData2

pcs2[1,]

#invert to indicate higher is better PSF
PSFT3$PSFT3<-(pcs2[1,])*-1

###creating one dataframe with all PSF variables----
colnames(PSFT1)
colnames(PSFT3)
colnames(PSFT1)[1]<-'Roots$id'
PSFmerge<-merge(PSFT3, PSFT1, by='Roots$id', all=T)

cor.test(PSFmerge$PSFT3, PSFmerge$PSFT1)#r=.46,t = 15.256, df = 849, p-value < 2.2e-16

summary(PSFmerge$PSFT3)

summary(PSFmerge$PSFT1)

t.test(PSFmerge$PSFT1, PSFmerge$PSFT3)#significant change


colnames(PSFmerge)
colnames(Roots[1:10])
colnames(PSFmerge)[1]<-'id'
colnames(PSFmerge[1])

RootsPSF<-merge(PSFmerge,Roots, by='id', all=T)
RootsPSF$id

###calculate resilience using the PSF variables age 14----
#Calculate early adversity variable

summary(RootsPSF$earlyadv) #optimal784,abberant76, discordant 213, hazardous, 66
summary(RootsPSF$adoladv) #same
summary(RootsPSF$lateradv)

RootsPSF$CA1<-as.numeric(RootsPSF$earlyadv)
summary(as.factor(RootsPSF$CA1))
RootsPSF$CA2<-as.numeric(RootsPSF$lateradv)
summary(as.factor(RootsPSF$CA2))
RootsPSF$CA3<-as.numeric(RootsPSF$adoladv)
summary(as.factor(RootsPSF$CA3))

RootsPSF$CAX<-(RootsPSF$CA1+RootsPSF$CA2+RootsPSF$CA3)
```

```
summary(RootsPSF$CAX)

#Cameei data
RootsPSF1<-data.frame(RootsPSF$id,RootsPSF$CAX, RootsPSF$PSFT1)
RootsPSF1<-na.omit(RootsPSF1)#1090 individuals
colnames(RootsPSF1)[1:10]
colnames(RootsPSF1)[1]<-'id'
colnames(RootsPSF1)[2]<-'CAX'
colnames(RootsPSF1)[3]<-'PSFT1'


RT1<-lm(RootsPSF1$PSFT1~RootsPSF1$CAX)


ggplot(RootsPSF1,aes(CAX,PSFT1))+geom_point(col='blue') +stat_smooth(method='lm')
ggplot(RootsPSF1,aes(CAX,PSFT1))+geom_point(col='dodgerblue',alpha=.6) +
stat_smooth(method='lm')+ylab('Psychological Functioning at age 14')+ xlab('Childhood and
Adolescent Adversity ages 0-14')

summary.lm(RT1)

###quadratic trend vs lineair?----
 RT1q<-update(RT1, .~.+ I(RootsPSF1$CAX^2))
 summary.lm(RT1q)
anova(RT1, RT1q)
AIC(RT1, RT1q)#
 BIC (RT1, RT1q)
RT1c<-update(RT1q, .~. +I(RootsPSF1$CAX^3))
summary.lm(RT1c)
AIC(RT1q, RT1c)#
BIC(RT1q, RT1c)
BIC(RT1, RT1c)
anova(RT1, RT1c)


#cubic
resT1 <- signif(residuals(RT1), 5)
colresT1=as.numeric(resT1>0)+2
preT1 <- predict(RT1) # plots distances between points and the regression line
datplotT1=data.frame(RootsPSF1$PSFT1,RootsPSF1$CAX,colresT1)

###add resilience scores to data frame----
RootsPSF1$resT1<-resT1
###plotting age 14 resilience graph -----
plott1g=ggplot(datplotT1, aes(RootsPSF1$CAX,RootsPSF1$PSFT1, col=resT1)) +
  scale_colour_gradient(high = "green",low='red')+
  geom_smooth(se=T, method = "lm", formula = y ~ x, col='black') +
```

```
  ylab('Psychosocial Functioning at age 14')+xlab('Childhood and Adolescent Adversity ages 0-14')+theme_bw()+geom_jitter(size=2)
plott1g + theme(axis.text = element_text(size = 20),axis.title=element_text(size=20))


###calculate resilience using the PSF variables age 17----

RootsPSF3<-data.frame(RootsPSF$id,RootsPSF$CAX, RootsPSF$PSFT3)
RootsPSF3<-na.omit(RootsPSF3)#856
colnames(RootsPSF3)[1:3]
colnames(RootsPSF3)[1]<-'id'
colnames(RootsPSF3)[2]<-'CAX'
colnames(RootsPSF3)[3]<-'PSFT3'
colnames(RootsPSF3)

###############lineair model:
RT3<-lm(RootsPSF3$PSFT3~RootsPSF3$CAX)
summary.lm(RT3)

#quadratische trend vs lineair?
RT3q<-update(RT3, .~.+ I(RootsPSF3$CAX^2))
summary.lm(RT3q)
anova(RT3, RT3q)
AIC(RT3, RT3q)#
BIC (RT3, RT3q)

RT3c<-update(RT3q, .~. +I(RootsPSF3$CAX^3))
summary.lm(RT3c)
AIC(RT3q, RT3c)#
BIC(RT3q, RT3c)
BIC(RT3, RT3c)
anova(RT3, RT3c)


#LINEAIR has best fit
resT3 <- signif(residuals(RT3), 5)
colresT3=as.numeric(resT3>0)+2
preT3 <- predict(RT3) # plot distances between points and the regression line
datplott3=data.frame(RootsPSF3$PSFT3,RootsPSF3$CAX,colresT3)
#add resilience scores to data frame
RootsPSF3$resT3<-resT3

###plotting age 17 resilience graph----

plott1g=ggplot(datplott3, aes(RootsPSF3$CAX,RootsPSF3$PSFT3, col=resT3)) +
  scale_colour_gradient(high = "green",low='red')+
  geom_jitter(size=2) +
```

```
  geom_smooth(se=T, method = "lm", formula = y ~ x, col='black') +
  ylab('Psychosocial Functioning at age 17')+xlab('Childhood and Adolescent Adversity ages
0-14')+theme_bw()
plott1g + theme(axis.text = element_text(size = 20),axis.title=element_text(size=20))

###Root_Resilience datafile write----
Roots_Resilience<-merge(RootsPSF, RootsPSF1, by='id', all=T)
Roots_Resilience<-merge(Roots_Resilience, RootsPSF3, by='id', all=T)
#write.csv(Roots_Resilience, 'Roots_Resilience.csv') (if you save this file you can run LCSM
models without having to run the above code)
###correlations and plots----

  cor.test(Roots_Resilience$resT1, Roots_Resilience$resT3)
#r=.47

###correlation friendships and resilience baseline

Roots_Resilience$friendst1<-scale(Roots_Resilience$t1_friendtot)
Roots_Resilience$friendst3<-scale(Roots_Resilience$t3_friendtotal)

Roots_Resilience$sex1<-as.numeric(Roots_Resilience$sex)
Roots_Resilience$sex1[Roots_Resilience$sex1==2]<-0
summary(as.factor(Roots_Resilience$sex1))#1 is male
summary(as.factor(Roots_Resilience$sex))

###raw correlations and plots between friendships and resilience

cor.test(Roots_Resilience$resT1, Roots_Resilience$t1_friendtot)
plot(Roots_Resilience$resT1, Roots_Resilience$t1_friendtot)

#####graph friendships and resilience time 1
friendplotT1<-ggplot(Roots_Resilience,aes(t1_friendtot,resT1,
col=resT1))+geom_point(size=3)+geom_smooth(method='lm', colour='black')+
  theme(text = element_text(size=22))+ scale_colour_gradient(high = "green",low='red')+
  ylab('Resilient functioning at age 14')+xlab('Friendships')+theme_bw()+theme(text =
element_text(size=20))

friendplotT1

########resilience time 3

cor.test(Roots_Resilience$resT3, Roots_Resilience$t1_friendtot)
plot(Roots_Resilience$resT3, Roots_Resilience$t1_friendtot)

friendplotT3<-ggplot(Roots_Resilience,aes(t1_friendtot,resT3,
col=resT3))+geom_point(size=3)+geom_smooth(method='lm', colour='black')+
  theme(text = element_text(size=22))+ scale_colour_gradient(high = "green",low='red')+
```

```
  ylab('Resilient functioning at age
17')+xlab('Friendships')+theme_bw()+theme_bw()+theme(text = element_text(size=20))

friendplotT3


###raw correlations other vars



Roots_Resilience$ses<-scale(as.numeric(Roots_Resilience$acorn_ses))
Roots_Resilience$aget1<-scale(Roots_Resilience$age_intt1)
Roots_Resilience$aget3<-scale(Roots_Resilience$age_intt3)

cor.test(Roots_Resilience$resT1,Roots_Resilience$CAX)

cor.test(Roots_Resilience$resT1,Roots_Resilience$resT3)
cor.test(Roots_Resilience$resT1,Roots_Resilience$aget1)#not related
cor.test(Roots_Resilience$resT3,Roots_Resilience$aget1)#not related
cor.test(Roots_Resilience$resT1,Roots_Resilience$ses)#not related
cor.test(Roots_Resilience$resT3,Roots_Resilience$ses)#not related
cor.test(Roots_Resilience$resT1,Roots_Resilience$sex1)#related
cor.test(Roots_Resilience$resT3,Roots_Resilience$sex1)
cor.test(Roots_Resilience$ses,Roots_Resilience$sex1)#unrelated
cor.test(Roots_Resilience$aget1,Roots_Resilience$sex1)#unrelated
cor.test(Roots_Resilience$ses,Roots_Resilience$aget1)#unrelated
#only sex is related with resilience

describe(Roots_Resilience$sex1)
describe(Roots_Resilience$ses)
describe(Roots_Resilience$aget1)
describe(Roots_Resilience$aget3)
summary(as.factor(Roots_Resilience$sex1))




########################################## Latent change score models----

###preparing data -----

Roots_Resilience$gender<-as.numeric(Roots_Resilience$sex)
summary(Roots_Resilience$sex)

####scaling the difference between t1 and t3 for everyone.
Roots_Resilience$t1srqdate [1:10]
Roots_Resilience$t3srqdate[1:10]
```

```
Roots_Resilience$date1<-as.Date(Roots_Resilience$t1srqdate)
Roots_Resilience$date2<-as.Date(Roots_Resilience$t3srqdate)

Roots_Resilience$diff_days<- difftime(Roots_Resilience$date2 ,Roots_Resilience$date1,
units = c("days"))
Roots_Resilience$diff_years<-Roots_Resilience$diff_days/365
summary(as.numeric(Roots_Resilience$diff_days))#median=1102
summary(as.numeric(Roots_Resilience$diff_years))

#Computing rescaled resilience at T3
diffres<-Roots_Resilience$resT3-Roots_Resilience$resT1
resperyear<-diffres/as.numeric(Roots_Resilience$diff_years)
restT3_equaldays<-Roots_Resilience$resT1+(resperyear*3)

#Computing rescaled friendships at t3
diff_friends<-Roots_Resilience$t3_friendtotal-Roots_Resilience$t1_friendtot
friendsperyear<-diff_friends/as.numeric(Roots_Resilience$diff_years)
friendst3_equaldays<-Roots_Resilience$t1_friendtot+(friendsperyear*3)

###making dataframe for LCSM ----

roots<-data.frame (Roots_Resilience$gender, Roots_Resilience$ses,
Roots_Resilience$age_intt1,Roots_Resilience$resT1,restT3_equaldays,Roots_Resilience$t1_
friendtot,friendst3_equaldays)
colnames(roots)

names(roots) <- gsub("scale.", "", names(roots), fixed = TRUE)
names(roots) <- gsub("Roots_Resilience.", "", names(roots), fixed = TRUE)
names(roots) <- gsub(".", "", names(roots), fixed = TRUE)
names(roots)

colnames(roots)[6]
colnames(roots)[6]<-'friendst1'
colnames(roots)[7]<-'friendst3'
colnames(roots)[5]<-'resT3'

colnames(roots)

summary(as.factor(roots$gender))
roots$sex<-as.factor(roots$gender)
roots$sex
levels(roots$sex)<-c('Female','Male')
summary(roots$sex)

###resilience change score model----
LCS_res<-'
```

```
resT3 ~ 1*resT1     # This parameter regresses resT3 perfectly on resT1
dresT1 =~ 1*resT3     # This defines the latent change score factor as measured perfectly by
scores on resT3
dresT1 ~ 1           # This estimates the intercept of the change score
resT1 ~  1          # This estimates the intercept of resT1
resT3 ~ 0*1         # This constrains the intercept of resT3 to 0
dresT1 ~~  dresT1       # This estimates the variance of the change scores
resT1 ~~   resT1    # This estimates the variance of the resT1
resT3 ~~ 0*resT3    # This fixes the variance of the resT3 to 0
dresT1~~resT1   # This estimates the NEU to COG coupling parameter and the NEU to NEU
self-feedback
'

fitLCS_res <- lavaan(LCS_res, data=roots, estimator='mlr',fixed.x=FALSE,missing='fiml')
summary(fitLCS_res, fit.measures=TRUE, standardized=TRUE, rsquare=TRUE, ci=TRUE)

semPaths(fitLCS_res,what= "std", layout = "tree", whatLabels = 'std', residuals=F,
       intercepts=F, title= T , title.color='blue',
       edge.label.cex = 1, cut=.1)



fitLCS_res_params<-lavaan::parameterEstimates(fitLCS_res)
#save table in xls
write.csv(fitLCS_res_params,'fitLCS_res_params.csv')


##the The covariance between dresT1 and resT1 is negative, suggesting that kids that start
high go down and vice versa (av chage not sign)
#the d-rest1 intercept indicate the mean of change (paired t-test), if non significant than on
average no change
#the variance indicates whether there are individual differences in where you start (rest1)
and how much you change (drest1)
#intercept=mean change (similar to paired t-test)
#variance=individual differences


###resilience model split on sex -----

LCS_sexmultigroup<-'

resT3 ~ 1*resT1     # This parameter regresses resT3 perfectly on resT1
dresT1 =~ 1*resT3     # This defines the latent change score factor as measured perfectly by
scores on resT3
dresT1 ~ 1           # This estimates the intercept of the change score
resT1 ~  1          # This estimates the intercept of resT1
```

```
resT3 ~ 0*1         # This constrains the intercept of resT3 to 0
dresT1 ~~  dresT1       # This estimates the variance of the change scores
resT1 ~~   resT1    # This estimates the variance of the resT1
resT3 ~~ 0*resT3    # This fixes the variance of the resT3 to 0
dresT1~~resT1   # This estimates the NEU to COG coupling parameter and the NEU to NEU
self-feedback
'

fitLCS_sexmultigroup <- lavaan(LCS_sexmultigroup,
data=roots,estimator='mlr',fixed.x=FALSE,missing='fiml', group='sex')
summary(fitLCS_sexmultigroup, fit.measures=TRUE, standardized=TRUE, rsquare=TRUE,
ci=TRUE)

###resilience model split on sex with equality constrains intercept-----

LCS_sexmultigroup_cons<-'

resT3 ~ 1*resT1     # This parameter regresses resT3 perfectly on resT1
dresT1 =~ 1*resT3     # This defines the latent change score factor as measured perfectly by
scores on resT3
dresT1 ~ 1           # This estimates the intercept of the change score
resT1 ~  c(meanresilience,meanresilience)*1          # This estimates the intercept of resT1
resT3 ~ 0*1         # This constrains the intercept of resT3 to 0
dresT1 ~~  dresT1       # This estimates the variance of the change scores
resT1 ~~   resT1    # This estimates the variance of the resT1
resT3 ~~ 0*resT3    # This fixes the variance of the resT3 to 0
dresT1~~resT1   # This estimates the NEU to COG coupling parameter and the NEU to NEU
self-feedback
'

fitLCS_sexmultigroup_cons <- lavaan(LCS_sexmultigroup_cons,
estimator='mlr',data=roots,fixed.x=FALSE,missing='fiml', group='sex')
summary(fitLCS_sexmultigroup_cons, fit.measures=TRUE, standardized=TRUE,
rsquare=TRUE, ci=TRUE)

###comparison equal constr intercept model
anova(fitLCS_sexmultigroup_cons,fitLCS_sexmultigroup)

par(mfcol=c(1,2))
semPaths(fitLCS_sexmultigroup, what = "std", layout = "spring", whatLabels = 'std',
residuals=T ,
       intercepts=F, title= T , title.color='blue' )

standardizedsolution(fitLCS_sexmultigroup)
saveasexcell<-partable(fitLCS_sexmultigroup)
write.csv(saveasexcell,'LCSs.csv')
```

```
#groups are 1=female (N=674), and 2=male (N=564)

###change model for friendships -----
LCSf<-'

friendst3  ~ 1*friendst1     # This parameter regresses friendst3 perfectly on friendst1
dfriendst1 =~ 1*friendst3     # This defines the latent change score factor as measured
perfectly by scores on friendst3
dfriendst1 ~ 1            # This estimates the intercept of the change score
friendst1 ~  1          # This estimates the intercept of friendst1
friendst3 ~ 0*1         # This constrains the intercept of friendst3 to 0
dfriendst1 ~~  dfriendst1       # This estimates the variance of the change scores
friendst1 ~~   friendst1    # This estimates the variance of the friendst1
friendst3 ~~ 0*friendst3    # This fixes the variance of the friendst3 to 0
dfriendst1~~friendst1   # This estimates the NEU to COG coupling parameter and the NEU to
NEU self-feedback
'

fitLCSf <- lavaan(LCSf, data=roots, estimator='mlr',fixed.x=FALSE,missing='fiml')
summary(fitLCSf, fit.measures=TRUE, standardized=TRUE, rsquare=TRUE, ci=TRUE)

semPaths(fitLCSf,what= "std", layout = "spring", whatLabels = 'std', residuals=F,
       intercepts=F, title= T , title.color='blue',
       edge.label.cex = 1, cut=.1)


fitLCS_friendship_params<-lavaan::parameterEstimates(fitLCSf)
write.csv(fitLCS_friendship_params,'fitLCS_friendship_params.csv')



###bivariate latent change model resilience and friendships----

BLCS<-'

resT3 ~ 1*resT1     # This parameter regresses resT3 perfectly on resT1
dresT1 =~ 1*resT3     # This defines the latent change score factor as measured perfectly by
scores on resT3
dresT1 ~ 1           # This estimates the intercept of the change score
resT1 ~  1          # This estimates the intercept of resT1
resT3 ~ 0*1         # This constrains the intercept of resT3 to 0

friendst3 ~ 1*friendst1     # This parameter regresses friendst3 perfectly on friendst1
dfriendst1 =~ 1*friendst3     # This defines the latent change score factor as measured
perfectly by scores on friendst3
friendst3 ~ 0*1         # This line constrains the intercept of friendst3 to 0
friendst3 ~~ 0*friendst3    # This fixes the variance of the friendst1 to 0
```

```
dresT1 ~~  dresT1      # This estimates the variance of the change scores
resT1 ~~   resT1    # This estimates the variance of the resT1
resT3 ~~ 0*resT3    # This fixes the variance of the resT3 to 0

dfriendst1 ~ 1           # This estimates the intercept of the change score
friendst1 ~ 1          # This estimates the intercept of friendst1
dfriendst1 ~~ dfriendst1       # This estimates the variance of the change scores
friendst1 ~~ friendst1      # This estimates the variance of friendst1

dfriendst1~resT1+friendst1   # This estimates the COG to NEU coupling parameter and the
COG to COG self-feedback
dresT1~friendst1+resT1   # This estimates the NEU to COG coupling parameter and the NEU
to NEU self-feedback

resT1 ~~  friendst1     # This estimates the resT1 friendst1 covariance
dresT1~~dfriendst1         # This estimates the dCOG and dNEU covariance
'


fitBLCS <- lavaan(BLCS, data=roots, estimator='mlr',fixed.x=FALSE,missing='fiml')
summary(fitBLCS, fit.measures=TRUE, standardized=TRUE, rsquare=TRUE, ci=TRUE)

par(mfcol=c(1,1))
semPaths(fitBLCS, "std", layout = "tree", whatLabels = 'std', residuals=F,
       intercepts=F, title= T , title.color='blue' ,edge.label.cex = 1, cut=.1,nodeLabels = c('res
17', 'Fr 17', 'res 14', 'fr 14','dRes', 'dFriends'))

output<-predict(fitBLCS)
summary(output)
colnames(output)

fitBLCSparams<-partable(fitBLCS)
write.csv(fitBLCSparams,'fitBLCSparams.csv')

roots$friendschange<-predict(fitLCSf)
roots$reschange<-predict(fitLCS_res)


###bivariate change score model with gender as grouping----
BLCS_g<-'

resT3 ~ 1*resT1     # This parameter regresses resT3 perfectly on resT1
dresT1 =~ 1*resT3     # This defines the latent change score factor as measured perfectly by
scores on resT3
dresT1 ~ 1           # This estimates the intercept of the change score
resT1 ~  1          # This estimates the intercept of resT1
resT3 ~ 0*1         # This constrains the intercept of resT3 to 0
```

```
friendst3 ~ 1*friendst1     # This parameter regresses friendst3 perfectly on friendst1
dfriendst1 =~ 1*friendst3     # This defines the latent change score factor as measured perfectly by scores on friendst3
friendst3 ~ 0*1         # This line constrains the intercept of friendst3 to 0
friendst3 ~~ 0*friendst3    # This fixes the variance of the friendst1 to 0

dresT1 ~~  dresT1       # This estimates the variance of the change scores
resT1 ~~   resT1    # This estimates the variance of the resT1
resT3 ~~ 0*resT3    # This fixes the variance of the resT3 to 0

dfriendst1 ~ 1           # This estimates the intercept of the change score
friendst1 ~ 1          # This estimates the intercept of friendst1
dfriendst1 ~~ dfriendst1       # This estimates the variance of the change scores
friendst1 ~~ friendst1      # This estimates the variance of friendst1

dfriendst1~resT1+friendst1  # This estimates the COG to NEU coupling parameter and the COG to COG self-feedback
dresT1~friendst1+resT1   # This estimates the NEU to COG coupling parameter and the NEU to NEU self-feedback

resT1 ~~  friendst1     # This estimates the resT1 friendst1 covariance
dresT1~~dfriendst1         # This estimates the dCOG and dNEU covariance
'



fitBLCS_g <- growth(BLCS_g, data=roots,missing='fiml',estimator='mlr', group='sex')
summary(fitBLCS_g, fit.measures=TRUE, standardized=TRUE, rsquare=TRUE, ci = TRUE)



standardizedsolution(fitBLCS_g)
saveasexcell<-standardizedsolution(fitBLCS_g)
write.csv(saveasexcell,'BLCSM_g.csv')

###bivariate model with gender as grouping and equality constrains on coupling -----
BLCS_ge<-'

resT3 ~ 1*resT1     # This parameter regresses resT3 perfectly on resT1
dresT1 =~ 1*resT3     # This defines the latent change score factor as measured perfectly by scores on resT3
dresT1 ~ 1           # This estimates the intercept of the change score
resT1 ~  1         # This estimates the intercept of resT1
resT3 ~ 0*1         # This constrains the intercept of resT3 to 0

friendst3 ~ 1*friendst1     # This parameter regresses friendst3 perfectly on friendst1
dfriendst1 =~ 1*friendst3     # This defines the latent change score factor as measured perfectly by scores on friendst3
```

```
friendst3 ~ 0*1         # This line constrains the intercept of friendst3 to 0
friendst3 ~~ 0*friendst3    # This fixes the variance of the friendst1 to 0

dresT1 ~~  dresT1       # This estimates the variance of the change scores
resT1 ~~   resT1    # This estimates the variance of the resT1
resT3 ~~ 0*resT3    # This fixes the variance of the resT3 to 0

dfriendst1 ~ 1           # This estimates the intercept of the change score
friendst1 ~ 1          # This estimates the intercept of friendst1
dfriendst1 ~~ dfriendst1       # This estimates the variance of the change scores
friendst1 ~~ friendst1      # This estimates the variance of friendst1

dfriendst1~c(coup_res_to_f,coup_res_to_f)*resT1+friendst1  # This estimates the COG to
NEU coupling parameter and the COG to COG self-feedback
dresT1~c(coup_f_to_res,coup_f_to_res)*friendst1+resT1   # This estimates the NEU to COG
coupling parameter and the NEU to NEU self-feedback

resT1 ~~  friendst1     # This estimates the resT1 friendst1 covariance
dresT1~~dfriendst1         # This estimates the dCOG and dNEU covariance
'


fitBLCS_ge <- growth(BLCS_ge, data=roots,estimator='mlr',missing='fiml', group='sex')
summary(fitBLCS_ge, fit.measures=TRUE, standardized=TRUE, rsquare=TRUE, ci=TRUE)



#equality constraints did not harm fit:
anova(fitBLCS_ge,fitBLCS_g)

##### bivariate model with equal constrainst boys and girls on cov and coupling
parameters:

BLCS_ge_all<-'

resT3 ~ 1*resT1     # This parameter regresses resT3 perfectly on resT1
dresT1 =~ 1*resT3     # This defines the latent change score factor as measured perfectly by
scores on resT3
dresT1 ~ 1           # This estimates the intercept of the change score
resT1 ~  1          # This estimates the intercept of resT1
resT3 ~ 0*1         # This constrains the intercept of resT3 to 0

friendst3 ~ 1*friendst1     # This parameter regresses friendst3 perfectly on friendst1
dfriendst1 =~ 1*friendst3     # This defines the latent change score factor as measured
perfectly by scores on friendst3
friendst3 ~ 0*1         # This line constrains the intercept of friendst3 to 0
friendst3 ~~ 0*friendst3    # This fixes the variance of the friendst1 to 0

dresT1 ~~  dresT1       # This estimates the variance of the change scores
```

```
resT1 ~~   resT1    # This estimates the variance of the resT1
resT3 ~~ 0*resT3    # This fixes the variance of the resT3 to 0

dfriendst1 ~ 1            # This estimates the intercept of the change score
friendst1 ~ 1           # This estimates the intercept of friendst1
dfriendst1 ~~ dfriendst1       # This estimates the variance of the change scores
friendst1 ~~ friendst1      # This estimates the variance of friendst1

dfriendst1~c(coup_res_to_f,coup_res_to_f)*resT1+c(selfFB_F,selfFB_F)*friendst1  # This
estimates the COG to NEU coupling parameter and the COG to COG self-feedback
dresT1~c(coup_f_to_res,coup_f_to_res)*friendst1+c(selfFB_res,selfFB_res)*resT1   # This
estimates the NEU to COG coupling parameter and the NEU to NEU self-feedback

resT1 ~~  c(covT1,covT1)*friendst1     # This estimates the resT1 friendst1 covariance
dresT1~~c(corchange,corchange)*dfriendst1          # This estimates the dCOG and dNEU
covariance
'
fitBLCS_ge_all <- growth(BLCS_ge_all, data=roots,estimator='mlr',missing='fiml',
group='sex')
summary(fitBLCS_ge_all, fit.measures=TRUE, standardized=TRUE, rsquare=TRUE, ci=TRUE)

#equality constraints does not harm fit:
#mlr may need to be removed from model estimation otherwise it may not work in some R
versions
anova(fitBLCS_g,fitBLCS_ge_all)


###plotting findings----
roots$friendschange<-predict(fitLCSf)
roots$reschange<-predict(fitLCS_res)
ggplot(roots,aes(resT1,friendschange))+
  geom_jitter(alpha=.7,color='dodgerblue',size=2)+
  stat_smooth(method='lm',color='black')+
  xlab("Resilient function at age 14")+
  ylab("Change in friendship quality")

ggplot(roots,aes(reschange,friendschange))+
  geom_jitter(width=2,height=2,alpha=.7, colour='dodgerblue', size=2)+
  stat_smooth(method='lm',color='black') +
  xlab("Change in resilient function")+
  ylab("Change in friendship quality")
```