

# Pain Research - Dr. Jamison Data

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## Objective 1.1 Day-to-day (Concurrent) associations

```
#Analyses; Day-to-day; Univariate multilevel linear regressions
#- Outcome: Lev1 daily pain intensity
#- Examine Lev1 association; between daily mood and pain (Same-day Lev1 units)
#- Examine Lev1 association; between daily sleep and pain (Same-day Lev1 units)
#- All these multilevel must be done with Lev1 centered data
model_Pain1 <- lmer(Today_PainAve ~ Today_Mood_c + (1|ID), data = df_new)
summary(model_Pain1)

## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula: Today_PainAve ~ Today_Mood_c + (1 | ID)
## Data: df_new
##
## REML criterion at convergence: 15011.6
##
## Scaled residuals:
## Min 1Q Median 3Q Max
## -5.7045 -0.5554 -0.0477 0.5334 5.7811
##
## Random effects:
## Groups Name Variance Std.Dev.
## ID (Intercept) 3.680 1.918
## Residual 1.302 1.141
## Number of obs: 4550, groups: ID, 222
##
## Fixed effects:
## Estimate Std. Error df t value Pr(>|t|)
## (Intercept) 5.327e+00 1.300e-01 2.213e+02 40.97 <2e-16 ***
## Today_Mood_c 2.530e-01 1.481e-02 4.327e+03 17.09 <2e-16 ***
## ---
## Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
## (Intr)
## Today_Mod_c 0.000

confint(model_Pain1)

## Computing profile confidence intervals ...

## 2.5 % 97.5 %
## .sig01 1.7454201 2.1101539
```

```
## .sigma      1.1172842 1.1653647
## (Intercept) 5.0717382 5.5824304
## Today_Mood_c 0.2239451 0.2819929

model_Pain2 <- lmer(Today_PainAve ~ Today_Sleep_c + (1|ID), data = df_new)
summary(model_Pain2)

## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula: Today_PainAve ~ Today_Sleep_c + (1 | ID)
## Data: df_new
##
## REML criterion at convergence: 10933.3
##
## Scaled residuals:
##      Min       1Q   Median       3Q      Max
## -6.5284 -0.5819 -0.0394  0.5142  5.9042
##
## Random effects:
## Groups Name Variance Std.Dev.
## ID      (Intercept) 3.657 1.912
## Residual 1.258 1.122
## Number of obs: 3303, groups: ID, 221
##
## Fixed effects:
##              Estimate Std. Error      df t value Pr(>|t|)
## (Intercept) 5.323e+00 1.311e-01 2.222e+02 40.59 <2e-16 ***
## Today_Sleep_c 1.845e-01 1.646e-02 3.101e+03 11.21 <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##              (Intr)
## Today_Slp_c 0.006

confint(model_Pain2)

## Computing profile confidence intervals ...

##              2.5 %    97.5 %
## .sig01      1.7374495 2.1066502
## .sigma      1.0939984 1.1499834
## (Intercept) 5.0649905 5.5800950
## Today_Sleep_c 0.1521968 0.2167286

# Analyses; Multivariable models
#- Outcome: Lev1 daily pain intensity
#- Ivs entered simulatenously: daily (Lev1) mood, sleep
#- All these multlev must be done with Lev1 centered data
#- Same-day Lev1 units
model_Pain3 <- lmer(Today_PainAve ~ Today_Sleep_c + Today_Mood_c + (1|ID), data = df_new)
summary(model_Pain3)

## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula: Today_PainAve ~ Today_Sleep_c + Today_Mood_c + (1 | ID)
## Data: df_new
```

```

##
## REML criterion at convergence: 10777.6
##
## Scaled residuals:
##      Min       1Q   Median       3Q      Max
## -5.8858 -0.5809 -0.0514  0.5217  6.2497
##
## Random effects:
##   Groups   Name      Variance Std.Dev.
##    ID      (Intercept) 3.659    1.913
## Residual              1.195    1.093
## Number of obs: 3302, groups: ID, 221
##
## Fixed effects:
##              Estimate Std. Error      df t value Pr(>|t|)
## (Intercept)  5.321e+00  1.310e-01 2.221e+02  40.603   <2e-16 ***
## Today_Sleep_c 1.548e-01  1.621e-02 3.098e+03   9.547   <2e-16 ***
## Today_Mood_c  2.227e-01  1.751e-02 3.091e+03  12.716   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##              (Intr) Tdy_S_
## Today_Slp_c  0.006
## Today_Mod_c -0.001 -0.141

```

```

confint(model_Pain3)

## Computing profile confidence intervals ...

##              2.5 %    97.5 %
## .sig01        1.7382149 2.1069537
## .sigma        1.0662030 1.1207757
## (Intercept)   5.0638525 5.5786317
## Today_Sleep_c 0.1230106 0.1865591
## Today_Mood_c  0.1883642 0.2570086

```

```

# Analyses; Day-to-day; Univariate multilevel linear regressions
#-Outcome: Lev1 Sleep
#-Examine Lev1 association; between daily mood and sleep (Same-day Lev1 units)
#-Examine Lev1 association; between daily pain and sleep (Same-day Lev1 units)
#-All these multilev must be done with Lev1 centered data
model_Pain4 <- lmer(Today_Sleep ~ Today_Mood_c + (1|ID), data = df_new)
summary(model_Pain4)

```

```

## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula: Today_Sleep ~ Today_Mood_c + (1 | ID)
##      Data: df_new
##
## REML criterion at convergence: 11558
##
## Scaled residuals:
##      Min       1Q   Median       3Q      Max
## -5.0222 -0.4542 -0.0430  0.3844  4.7405
##

```

```

## Random effects:
##   Groups   Name      Variance Std.Dev.
##   ID      (Intercept) 7.051    2.655
##   Residual          1.472    1.213
## Number of obs: 3303, groups: ID, 221
##
## Fixed effects:
##               Estimate Std. Error      df t value Pr(>|t|)
## (Intercept)  4.198e+00  1.808e-01 2.201e+02  23.223 < 2e-16 ***
## Today_Mood_c 1.530e-01  1.924e-02 3.088e+03   7.952 2.54e-15 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##              (Intr)
## Today_Mod_c 0.000

```

```

confint(model_Pain4)

## Computing profile confidence intervals ...

##               2.5 %    97.5 %
## .sig01         2.4146433 2.9228138
## .sigma         1.1833356 1.2439177
## (Intercept)    3.8429193 4.5529965
## Today_Mood_c   0.1152788 0.1907008

```

```

model_Pain5 <- lmer(Today_Sleep ~ Today_PainAve_c + (1|ID), data = df_new)
summary(model_Pain5)

```

```

## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula: Today_Sleep ~ Today_PainAve_c + (1 | ID)
##   Data: df_new
##
## REML criterion at convergence: 11499.1
##
## Scaled residuals:
##      Min       1Q   Median       3Q      Max
## -5.0919 -0.4400 -0.0457  0.3781  4.8290
##
## Random effects:
##   Groups   Name      Variance Std.Dev.
##   ID      (Intercept) 7.037    2.653
##   Residual          1.444    1.202
## Number of obs: 3303, groups: ID, 221
##
## Fixed effects:
##               Estimate Std. Error      df t value Pr(>|t|)
## (Intercept)    4.200e+00  1.805e-01 2.202e+02  23.26  <2e-16 ***
## Today_PainAve_c 2.117e-01  1.891e-02 3.086e+03  11.19  <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##              (Intr)

```

```
## Tody_PnAv_c 0.001
confint(model_Pain5)

## Computing profile confidence intervals ...

##                2.5 %    97.5 %
## .sig01          2.4123271 2.9196923
## .sigma          1.1721656 1.2321750
## (Intercept)     3.8457760 4.5549940
## Today_PainAve_c 0.1745975 0.2487484

# Analyses; Multivariable models
#- Outcome: Lev1 sleep
#- Ivs entered simulatenously: daily (Lev1) mood, pain
#- All these multlev must be done with Lev1 centered data
#- Same-day Lev1 units
model_Pain6 <- lmer(Today_Sleep ~ Today_PainAve_c + Today_Mood_c + (1|ID), data = df_new)
summary(model_Pain6)

## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula: Today_Sleep ~ Today_PainAve_c + Today_Mood_c + (1 | ID)
## Data: df_new
##
## REML criterion at convergence: 11472.2
##
## Scaled residuals:
##      Min       1Q   Median       3Q      Max
## -5.0471 -0.4440 -0.0444  0.3613  4.9110
##
## Random effects:
## Groups   Name            Variance Std.Dev.
## ID       (Intercept) 7.031      2.652
## Residual                1.431      1.196
## Number of obs: 3302, groups: ID, 221
##
## Fixed effects:
##              Estimate Std. Error      df t value Pr(>|t|)
## (Intercept)   4.200e+00  1.805e-01 2.202e+02 23.274 < 2e-16 ***
## Today_PainAve_c 1.852e-01  1.942e-02 3.084e+03  9.532 < 2e-16 ***
## Today_Mood_c   1.073e-01  1.957e-02 3.086e+03  5.482 4.54e-08 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##              (Intr) Td_PA_
## Tody_PnAv_c   0.001
## Today_Mod_c -0.001 -0.245
confint(model_Pain6)

##Computing profile confidence intervals ...

##                2.5 %    97.5 %
## .sig01          2.4114685 2.9185218
## .sigma          1.1665697 1.2263023
```

```
## (Intercept)      3.8456850 4.5545636
## Today_PainAve_c  0.1470809 0.2232211
## Today_Mood_c     0.0689274 0.1456310
```

## Objective 1.2: Time-lag effects

```
# Yesterday sleep -> Toady Pain
# No lag needed here - LastDay_Sleep_c is equivalent to Sleep_c
model_SleepPain <- lmer(Today_PainAve ~ LastDay_Sleep_c + (1|ID), data = df_new)
icc(model_SleepPain)
```

```
## # Intraclass Correlation Coefficient
##
##      Adjusted ICC: 0.774
##      Unadjusted ICC: 0.729
```

```
summary(model_SleepPain)
```

```
## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula: Today_PainAve ~ LastDay_Sleep_c + (1 | ID)
##      Data: df_new
##
## REML criterion at convergence: 14183.2
##
## Scaled residuals:
##      Min       1Q   Median       3Q      Max
## -6.7956 -0.5835 -0.0156  0.5409  5.6682
##
## Random effects:
##      Groups   Name                Variance Std.Dev.
##      ID       (Intercept)  3.694      1.922
##      Residual                1.076      1.037
## Number of obs: 4549, groups: ID, 222
##
## Fixed effects:
##              Estimate Std. Error      df t value Pr(>|t|)
## (Intercept)    5.327e+00  1.300e-01 2.213e+02  40.96   <2e-16 ***
## LastDay_Sleep_c 4.255e-01  1.196e-02 4.326e+03  35.59   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##              (Intr)
## LstDy_Slp_c 0.000
```

```
confint(model_SleepPain)
```

```
## Computing profile confidence intervals ...
##
##              2.5 %    97.5 %
## .sig01        1.7495327 2.1138023
## .sigma        1.0156199 1.0593308
## (Intercept)    5.0718626 5.5827192
## LastDay_Sleep_c 0.4020557 0.4489307
```

```

# Yesterday pain -> Today sleep
# Today_Sleep is computed using Next Day's Sleep reportings,
# LastDay_PainAve_c is computed using Last Day's PainAve_c reportings
model_PainSleep <- lmer(Today_Sleep ~ LastDay_PainAve_c + (1|ID), data = df_new)
summary(model_PainSleep)

```

```

## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula: Today_Sleep ~ LastDay_PainAve_c + (1 | ID)
## Data: df_new
##
## REML criterion at convergence: 11418.6
##
## Scaled residuals:
##      Min       1Q   Median       3Q      Max
## -4.9873 -0.4373 -0.0525  0.3856  5.3624
##
## Random effects:
## Groups Name Variance Std.Dev.
## ID (Intercept) 7.177 2.679
## Residual 1.488 1.220
## Number of obs: 3249, groups: ID, 220
##
## Fixed effects:
## Estimate Std. Error df t value Pr(>|t|)
## (Intercept) 4.2056 0.1827 218.5013 23.021 < 2e-16 ***
## LastDay_PainAve_c 0.1072 0.0191 3033.6008 5.616 2.14e-08 ***
## ---
## Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
## (Intr)
## LstDy_PnAv_ 0.002

```

```

confint(model_PainSleep)

```

```

## Computing profile confidence intervals ...

```

```

##           2.5 %    97.5 %
## .sig01      2.43545667 2.9494551
## .sigma      1.18959773 1.2510508
## (Intercept)  3.84678260 4.5644047
## LastDay_PainAve_c 0.06981079 0.1446839

```

```

## Both are within cluster/within individual centered

```

## Objective 2: Analyses: Perceived Improvement

```

# Analyses; Univariate multilevel linear regressions
# Outcome: Lev1 perceived improvement
# Examine Lev1 association; between daily pain and perceived improvement (Same-day Lev1 units)
model_painimprove <- lmer(GlobalImprovement ~ AvePain_c + (1|ID), data = df_new)
summary(model_painimprove)

```

```

## Linear mixed model fit by REML. t-tests use Satterthwaite's method [

```

```
## lmerModLmerTest]
## Formula: GlobalImprovement ~ AvePain_c + (1 | ID)
## Data: df_new
##
## REML criterion at convergence: 15753.6
##
## Scaled residuals:
## Min 1Q Median 3Q Max
## -4.8904 -0.5018 -0.0428 0.4359 5.8656
##
## Random effects:
## Groups Name Variance Std.Dev.
## ID (Intercept) 1.157 1.076
## Residual 1.634 1.278
## Number of obs: 4551, groups: ID, 222
##
## Fixed effects:
## Estimate Std. Error df t value Pr(>|t|)
## (Intercept) 6.02260 0.07497 219.50479 80.33 <2e-16 ***
## AvePain_c -0.56930 0.01648 4326.95685 -34.55 <2e-16 ***
## ---
## Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
## (Intr)
## AvePain_c 0.000
```

```
confint(model_painimprove)

## Computing profile confidence intervals ...

## 2.5 % 97.5 %
## .sig01 0.9727485 1.1897264
## .sigma 1.2515144 1.3053738
## (Intercept) 5.8753590 6.1698673
## AvePain_c -0.6016027 -0.5370068
```

```
# Examine Lev1 association; between daily mood and perceived improvement (Same-day Lev1 units)
model_moodimprove <- lmer(GlobalImprovement ~ Mood_c + (1|ID), data = df_new)
summary(model_moodimprove)
```

```
## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula: GlobalImprovement ~ Mood_c + (1 | ID)
## Data: df_new
##
## REML criterion at convergence: 16284.1
##
## Scaled residuals:
## Min 1Q Median 3Q Max
## -4.7165 -0.4527 -0.0031 0.4594 4.7921
##
## Random effects:
## Groups Name Variance Std.Dev.
## ID (Intercept) 1.148 1.071
## Residual 1.846 1.359
```



```

## Number of obs: 4551, groups: ID, 222
##
## Fixed effects:
##           Estimate Std. Error      df t value Pr(>|t|)
## (Intercept)   6.02342    0.07503  219.43605   80.28  <2e-16 ***
## Mood_c       -0.41725    0.01763 4327.04478  -23.67  <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##      (Intr)
## Mood_c 0.000

```

```

confint(model_moodimprove)

## Computing profile confidence intervals ...

##           2.5 %    97.5 %
## .sig01      0.9676451  1.1858657
## .sigma      1.3305648  1.3878259
## (Intercept)  5.8760587  6.1708057
## Mood_c      -0.4518087 -0.3826932

```

*# Examine Lev1 association; between daily sleep and perceived improvement (Same-day Lev1 unit)*

```

model_sleepimprove <- lmer(GlobalImprovement ~ Sleep_c + (1|ID), data = df_new)
summary(model_sleepimprove)

```

```

## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula: GlobalImprovement ~ Sleep_c + (1 | ID)
##      Data: df_new
##
## REML criterion at convergence: 16176.7
##
## Scaled residuals:
##      Min       1Q   Median       3Q      Max
## -5.1334 -0.4733 -0.0108  0.4473  5.4262
##
## Random effects:
##  Groups   Name      Variance Std.Dev.
##  ID       (Intercept) 1.151    1.073
##  Residual              1.803    1.343
## Number of obs: 4550, groups: ID, 222
##
## Fixed effects:
##           Estimate Std. Error      df t value Pr(>|t|)
## (Intercept)   6.02181    0.07507  219.56667   80.21  <2e-16 ***
## Sleep_c       -0.40231    0.01548 4326.12350  -25.99  <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##      (Intr)
## Sleep_c 0.000

```

```

confint(model_sleepimprove)

## Computing profile confidence intervals ...

##           2.5 %      97.5 %
## .sig01      0.9693305  1.1873852
## .sigma      1.3146478  1.3712297
## (Intercept)  5.8743714  6.1692689
## Sleep_c     -0.4326473 -0.3719721

# Examine Lev1 association; between daily ActivityInt and perceived improvement (Same-day Lev1 unit)
model_actimprove <- lmer(GlobalImprovement ~ ActivityInt_c + (1|ID), data = df_new)
summary(model_actimprove)

## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula: GlobalImprovement ~ ActivityInt_c + (1 | ID)
## Data: df_new
##
## REML criterion at convergence: 15895.9
##
## Scaled residuals:
##      Min       1Q   Median       3Q      Max
## -4.7369 -0.4823 -0.0091  0.4385  6.0088
##
## Random effects:
## Groups Name Variance Std.Dev.
## ID      (Intercept) 1.156  1.075
## Residual      1.688  1.299
## Number of obs: 4551, groups: ID, 222
##
## Fixed effects:
##              Estimate Std. Error      df t value Pr(>|t|)
## (Intercept)    6.02303    0.07502 219.50622   80.29 <2e-16 ***
## ActivityInt_c  -0.49764    0.01560 4327.00419  -31.90 <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##              (Intr)
## ActvtyInt_c 0.000

confint(model_actimprove)

##Computing profile confidence intervals ...

##           2.5 %      97.5 %
## .sig01      0.9718338  1.1891921
## .sigma      1.2722037  1.3269534
## (Intercept)  5.8756991  6.1703749
## ActivityInt_c -0.5282147 -0.4670559

# All these multilev must be done with Lev1 centered data

# Analysis; Multivariable/multilevel linear regression
# Outcome: Perceived improvement
# Ivs entered simulatenously: daily (Lev1) pain, mood, sleep, ActivityInt

```

```
model_compimprove <- lmer(GlobalImprovement ~ Sleep_c + AvePain_c + Mood_c + ActivityInt_c + (1|ID), data = df_new)
summary(model_compimprove)
```

```
## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula: GlobalImprovement ~ Sleep_c + AvePain_c + Mood_c + ActivityInt_c +
## (1 | ID)
## Data: df_new
##
## REML criterion at convergence: 15264.6
##
## Scaled residuals:
##      Min       1Q   Median       3Q      Max
## -4.9588 -0.4953 -0.0213  0.4476  5.4574
##
## Random effects:
## Groups Name Variance Std.Dev.
## ID      (Intercept) 1.167 1.081
## Residual 1.458 1.208
## Number of obs: 4547, groups: ID, 222
##
## Fixed effects:
##              Estimate Std. Error      df t value Pr(>|t|)
## (Intercept)    6.02109    0.07500 219.63353  80.286 < 2e-16 ***
## Sleep_c        -0.13345    0.01637 4319.99960  -8.153 4.61e-16 ***
## AvePain_c      -0.31707    0.02058 4319.99960 -15.406 < 2e-16 ***
## Mood_c         -0.23456    0.01669 4319.99960 -14.055 < 2e-16 ***
## ActivityInt_c  -0.18611    0.01913 4319.99960  -9.728 < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##              (Intr) Slep_c AvPn_c Mood_c
## Sleep_c      0.000
## AvePain_c     0.000 -0.279
## Mood_c        0.000 -0.123 -0.041
## ActvtyInt_c  0.000 -0.195 -0.492 -0.178
```

```
confint(model_compimprove)
```

```
## Computing profile confidence intervals ...
```

```
##              2.5 %      97.5 %
## .sig01        0.9778873  1.1940124
## .sigma        1.1819700  1.2328602
## (Intercept)   5.8738056  6.1683978
## Sleep_c      -0.1655270 -0.1013790
## AvePain_c     -0.3573965 -0.2767410
## Mood_c        -0.2672611 -0.2018564
## ActivityInt_c -0.2235920 -0.1486184
```

```
# All these multlev must be done with Lev1 centered data
# Perhaps get some colinearity indicator to know to what extent colinearity is an issue
collinear_test <- check_collinearity(model_compimprove)
print(collinear_test)
```

```
## # Check for Multicollinearity
##
## Low Correlation
##
##          Term   VIF   VIF 95% CI Increased SE Tolerance Tolerance 95% CI
##      Sleep_c 1.38 [1.33, 1.44]         1.18      0.72      [0.70, 0.75]
##      AvePain_c 1.75 [1.68, 1.82]         1.32      0.57      [0.55, 0.60]
##      Mood_c 1.13 [1.10, 1.18]         1.06      0.88      [0.85, 0.91]
##      ActivityInt_c 1.74 [1.67, 1.81]         1.32      0.58      [0.55, 0.60]
##
## Some comments on how to read this result: The VIF is around 1 => Low Multicollinearity
## The VIF is between 2 to 5, Moderate Multicollinearity
## The VIF >5 (or 10 sometimes), High Multicollinearity
## Low Tolerance (~ 0), High Multicollinearity
```

We have low multicollinearity in this case!

## Objective 2.2 Analyses: Moderators of perceived improvement

```
# Test if any of the baseline (Lev2) socio-demog variables are linked to perceived improvements; Univar
# B_Demog_Gender
model_genderimprove <- lmer(GlobalImprovement ~ B_Demog_Gender + (1|ID), data = df_new)
summary(model_genderimprove)

## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula: GlobalImprovement ~ B_Demog_Gender + (1 | ID)
##      Data: df_new
##
## REML criterion at convergence: 16807
##
## Scaled residuals:
##      Min       1Q   Median       3Q      Max
## -4.4120 -0.4415 -0.0034  0.4388  4.9641
##
## Random effects:
##      Groups   Name                Variance Std.Dev.
##      ID       (Intercept) 1.129      1.063
##      Residual                2.084      1.444
## Number of obs: 4552, groups: ID, 222
##
## Fixed effects:
##              Estimate Std. Error    df t value Pr(>|t|)
## (Intercept)    5.5544     0.3340 221.1166  16.630   <2e-16 ***
## B_Demog_Gender  0.2626     0.1823 220.5723   1.441    0.151
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##              (Intr)
## B_Demg_Gndr -0.975
confint(model_genderimprove)

## Computing profile confidence intervals ...
```

```
##              2.5 %    97.5 %
## .sig01        0.95610501 1.1745618
## .sigma        1.41389130 1.4747295
## (Intercept)   4.89983087 6.2088010
## B_Demog_Gender -0.09460566 0.6199379

# B_Demog_Ethnicity
model_ethnimprove <- lmer(GlobalImprovement ~ B_Demog_Ethnicity + (1|ID), data = df_new)
summary(model_ethnimprove)

## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula: GlobalImprovement ~ B_Demog_Ethnicity + (1 | ID)
## Data: df_new
##
## REML criterion at convergence: 16810.8
##
## Scaled residuals:
##      Min       1Q   Median       3Q      Max
## -4.4097 -0.4419 -0.0007  0.4351  4.9691
##
## Random effects:
## Groups Name Variance Std.Dev.
## ID      (Intercept) 1.140    1.068
## Residual                2.085    1.444
## Number of obs: 4552, groups: ID, 222
##
## Fixed effects:
##              Estimate Std. Error      df t value Pr(>|t|)
## (Intercept)    6.00103    0.12719 217.53061  47.180   <2e-16 ***
## B_Demog_Ethnicity 0.01584    0.07313 216.10493   0.217    0.829
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##              (Intr)
## B_Dmg_Ethnc -0.807

confint(model_ethnimprove)

## Computing profile confidence intervals ...

##              2.5 %    97.5 %
## .sig01        0.9608634 1.1802628
## .sigma        1.4139012 1.4747407
## (Intercept)   5.7518051 6.2502987
## B_Demog_Ethnicity -0.1274734 0.1591333

# B_Demog_Age
model_ageimprove <- lmer(GlobalImprovement ~ B_Demog_Age + (1|ID), data = df_new)
summary(model_ageimprove) # Significant!

## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula: GlobalImprovement ~ B_Demog_Age + (1 | ID)
## Data: df_new
##
```

```
## REML criterion at convergence: 16806.1
##
## Scaled residuals:
##      Min       1Q   Median       3Q      Max
## -4.4221 -0.4320  0.0060  0.4383  4.9723
##
## Random effects:
##   Groups   Name      Variance Std.Dev.
##   ID       (Intercept) 1.085    1.042
##   Residual                2.084    1.444
## Number of obs: 4552, groups: ID, 222
##
## Fixed effects:
##              Estimate Std. Error      df t value Pr(>|t|)
## (Intercept) 5.174e+00  2.756e-01 2.192e+02 18.771 < 2e-16 ***
## B_Demog_Age 1.643e-02  5.139e-03 2.185e+02  3.197  0.00159 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##              (Intr)
## B_Demog_Age -0.964
```

```
confint(model_ageimprove)
```

```
## Computing profile confidence intervals ...
```

```
##              2.5 %      97.5 %
## .sig01      0.936999138 1.15191933
## .sigma      1.413883734 1.47472084
## (Intercept) 4.633722247 5.71393232
## B_Demog_Age 0.006362664 0.02650471
```

Age tends to be associated with the improvement, older patients have better improvements.

```
# Test if any of the baseline (Lev2) clinical variables are linked to perceived improvements; Univariate
# B_Clin_PainDur"
model_paindurimprove <- lmer(GlobalImprovement ~ B_Clin_PainDur + (1|ID), data = df_new)
summary(model_paindurimprove)
```

```
## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula: GlobalImprovement ~ B_Clin_PainDur + (1 | ID)
##   Data: df_new
##
## REML criterion at convergence: 15755.7
##
## Scaled residuals:
##      Min       1Q   Median       3Q      Max
## -4.4949 -0.4460  0.0026  0.4333  5.0739
##
## Random effects:
##   Groups   Name      Variance Std.Dev.
##   ID       (Intercept) 1.140    1.068
##   Residual                2.009    1.417
## Number of obs: 4307, groups: ID, 208
```

```

##
## Fixed effects:
##           Estimate Std. Error      df t value Pr(>|t|)
## (Intercept)  5.853e+00  1.150e-01 2.023e+02  50.897  <2e-16 ***
## B_Clin_PainDur 1.054e-02  6.443e-03 2.008e+02   1.636   0.103
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##           (Intr)
## B_Clin_PnDr -0.739
confint(model_paindurimprove)

## Computing profile confidence intervals ...

##           2.5 %      97.5 %
## .sig01      0.957201880 1.18347983
## .sigma      1.387215156 1.44861026
## (Intercept)  5.627911643 6.07861770
## B_Clin_PainDur -0.002087504 0.02316534
# B_Clin_BMI"
model_BMIimprove <- lmer(GlobalImprovement ~ B_Clin_BMI + (1|ID), data = df_new)
summary(model_BMIimprove)

## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula: GlobalImprovement ~ B_Clin_BMI + (1 | ID)
## Data: df_new
##
## REML criterion at convergence: 16744.6
##
## Scaled residuals:
##      Min       1Q   Median       3Q      Max
## -4.3929 -0.4468 -0.0041  0.4384  4.9859
##
## Random effects:
## Groups Name Variance Std.Dev.
## ID      (Intercept) 1.127  1.062
## Residual          2.091  1.446
## Number of obs: 4530, groups: ID, 221
##
## Fixed effects:
##           Estimate Std. Error      df t value Pr(>|t|)
## (Intercept)  6.549705  0.307229 217.553450  21.319  <2e-16 ***
## B_Clin_BMI   -0.017618  0.009996 218.596599  -1.762   0.0794 .
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##           (Intr)
## B_Clin_BMI -0.970
confint(model_BMIimprove)

## Computing profile confidence intervals ...

```

```
##              2.5 %      97.5 %
## .sig01      0.95483504 1.173896041
## .sigma      1.41600771 1.477091251
## (Intercept) 5.94756133 7.151656409
## B_Clin_BMI -0.03720348 0.001974141

# All the medications below;
# separately/independently; association with perceived improvement; Univariate
# B_Med_Tramadol
model_Tramadolimprove <- lmer(GlobalImprovement ~ B_Med_Tramadol + (1|ID), data = df_new)
summary(model_Tramadolimprove) # Significant!

## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula: GlobalImprovement ~ B_Med_Tramadol + (1 | ID)
## Data: df_new
##
## REML criterion at convergence: 16803.3
##
## Scaled residuals:
##      Min       1Q   Median       3Q      Max
## -4.3805 -0.4434 -0.0029  0.4466  4.9618
##
## Random effects:
## Groups Name Variance Std.Dev.
## ID      (Intercept) 1.113 1.055
## Residual 2.085 1.444
## Number of obs: 4552, groups: ID, 222
##
## Fixed effects:
## Estimate Std. Error df t value Pr(>|t|)
## (Intercept) 6.06720 0.07706 218.39971 78.738 <2e-16 ***
## B_Med_Tramadol -0.64456 0.29501 214.59198 -2.185 0.03 *
## ---
## Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
## (Intr)
## B_Med_Trmdl -0.261

confint(model_Tramadolimprove)

## Computing profile confidence intervals ...

##              2.5 %      97.5 %
## .sig01      0.9490154 1.16639513
## .sigma      1.4139247 1.47476718
## (Intercept) 5.9162106 6.21819605
## B_Med_Tramadol -1.2226186 -0.06639294

# B_Med_Suboxone
model_Suboxoneimprove <- lmer(GlobalImprovement ~ B_Med_Suboxone + (1|ID), data = df_new)
summary(model_Suboxoneimprove)

## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula: GlobalImprovement ~ B_Med_Suboxone + (1 | ID)
```



```

## Data: df_new
##
## REML criterion at convergence: 16806.8
##
## Scaled residuals:
##      Min       1Q   Median       3Q      Max
## -4.4100 -0.4422 -0.0010  0.4347  4.9697
##
## Random effects:
##   Groups   Name      Variance Std.Dev.
##   ID       (Intercept) 1.141    1.068
##   Residual                2.085    1.444
## Number of obs: 4552, groups: ID, 222
##
## Fixed effects:
##              Estimate Std. Error      df t value Pr(>|t|)
## (Intercept)      6.02424    0.07589 218.40722  79.378  <2e-16 ***
## B_Med_Suboxone  -0.05481    0.56592 219.61262  -0.097    0.923
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##              (Intr)
## B_Med_Subxn -0.134

```

```

confint(model_Suboxoneimprove)

## Computing profile confidence intervals ...

##              2.5 %   97.5 %
## .sig01          0.9609876 1.180399
## .sigma          1.4138995 1.474739
## (Intercept)     5.8755257 6.172964
## B_Med_Suboxone -1.1638748 1.054071

```

```

# B_Med_Marijuana
model_Marijuanaimprove <- lmer(GlobalImprovement ~ B_Med_Marijuana + (1|ID), data = df_new)
summary(model_Marijuanaimprove)

```

```

## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula: GlobalImprovement ~ B_Med_Marijuana + (1 | ID)
## Data: df_new
##
## REML criterion at convergence: 16806
##
## Scaled residuals:
##      Min       1Q   Median       3Q      Max
## -4.4099 -0.4421 -0.0009  0.4349  4.9698
##
## Random effects:
##   Groups   Name      Variance Std.Dev.
##   ID       (Intercept) 1.140    1.068
##   Residual                2.085    1.444
## Number of obs: 4552, groups: ID, 222
##

```

```

## Fixed effects:
##           Estimate Std. Error      df t value Pr(>|t|)
## (Intercept)    6.02149    0.07553 218.34053  79.724   <2e-16 ***
## B_Med_Marijuana  0.19885    0.80349 227.64451   0.247    0.805
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##           (Intr)
## B_Med_Marjn -0.094
confint(model_Marijuanaimprove)

## Computing profile confidence intervals ...

##           2.5 %   97.5 %
## .sig01      0.9608479 1.180237
## .sigma      1.4139001 1.474740
## (Intercept)  5.8734877 6.169513
## B_Med_Marijuana -1.3756156 1.773272

# B_Med_NSAIDS
model_NSIDSImprove <- lmer(GlobalImprovement ~ B_Med_NSAIDS + (1|ID), data = df_new)
summary(model_NSIDSImprove)

## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula: GlobalImprovement ~ B_Med_NSAIDS + (1 | ID)
## Data: df_new
##
## REML criterion at convergence: 16807.8
##
## Scaled residuals:
##      Min       1Q   Median       3Q      Max
## -4.4105 -0.4427 -0.0016  0.4340  4.9685
##
## Random effects:
## Groups   Name      Variance Std.Dev.
## ID       (Intercept) 1.138    1.067
## Residual              2.085    1.444
## Number of obs: 4552, groups: ID, 222
##
## Fixed effects:
##           Estimate Std. Error      df t value Pr(>|t|)
## (Intercept)    6.03765    0.07839 218.53613  77.018   <2e-16 ***
## B_Med_NSAIDS  -0.17721    0.27499 217.56200  -0.644    0.52
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##           (Intr)
## B_Md_NSAIDS -0.285
confint(model_NSIDSImprove)

## Computing profile confidence intervals ...

```

```
##              2.5 %   97.5 %
## .sig01        0.9600212 1.179243
## .sigma        1.4138980 1.474737
## (Intercept)   5.8840426 6.191277
## B_Med_NSAIDS -0.7161135 0.361628

# B_Med_Anticonvulsant
model_Anticonimprove <- lmer(GlobalImprovement ~ B_Med_Anticonvulsant + (1|ID), data = df_new)
summary(model_Anticonimprove) # Significant!

## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula: GlobalImprovement ~ B_Med_Anticonvulsant + (1 | ID)
## Data: df_new
##
## REML criterion at convergence: 16805.1
##
## Scaled residuals:
##      Min       1Q   Median       3Q      Max
## -4.3967 -0.4454 -0.0048  0.4421  4.9595
##
## Random effects:
## Groups Name Variance Std.Dev.
## ID      (Intercept) 1.117 1.057
## Residual 2.085 1.444
## Number of obs: 4552, groups: ID, 222
##
## Fixed effects:
##              Estimate Std. Error      df t value Pr(>|t|)
## (Intercept)      6.11123    0.08635 217.49113  70.775 <2e-16 ***
## B_Med_Anticonvulsant -0.34396    0.17071 219.00087  -2.015  0.0451 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##              (Intr)
## B_Md_Antcnv -0.506

confint(model_Anticonimprove)

## Computing profile confidence intervals ...

##              2.5 %   97.5 %
## .sig01        0.9505424 1.168264279
## .sigma        1.4139343 1.474778015
## (Intercept)   5.9420200 6.280433914
## B_Med_Anticonvulsant -0.6784171 -0.009370955

# B_Med_MuscleRelaxer
model_MuscleRelimprove <- lmer(GlobalImprovement ~ B_Med_MuscleRelaxer + (1|ID), data = df_new)
summary(model_MuscleRelimprove)

## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula: GlobalImprovement ~ B_Med_MuscleRelaxer + (1 | ID)
## Data: df_new
##
```

```

## REML criterion at convergence: 16807.5
##
## Scaled residuals:
##      Min       1Q   Median       3Q      Max
## -4.4115 -0.4391 -0.0029  0.4405  4.9801
##
## Random effects:
##   Groups   Name      Variance Std.Dev.
##   ID       (Intercept) 1.132    1.064
##   Residual                2.085    1.444
## Number of obs: 4552, groups: ID, 222
##
## Fixed effects:
##              Estimate Std. Error      df t value Pr(>|t|)
## (Intercept)      6.06699    0.08328 218.74597  72.848  <2e-16 ***
## B_Med_MuscleRelaxer -0.22996    0.19094 216.50016  -1.204    0.23
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##              (Intr)
## B_Md_MsclRl -0.436

```

```

confint(model_MuscleRelimprove)

## Computing profile confidence intervals ...

##              2.5 %    97.5 %
## .sig01          0.9571279 1.1759473
## .sigma          1.4139180 1.4747596
## (Intercept)      5.9037877 6.2301813
## B_Med_MuscleRelaxer -0.6040729 0.1442792

```

```

# B_Med_Antidepressants
model_Antidepimprove <- lmer(GlobalImprovement ~ B_Med_Antidepressants + (1|ID), data = df_new)
summary(model_Antidepimprove)

## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula: GlobalImprovement ~ B_Med_Antidepressants + (1 | ID)
##   Data: df_new
##
## REML criterion at convergence: 16808.5
##
## Scaled residuals:
##      Min       1Q   Median       3Q      Max
## -4.4058 -0.4428 -0.0016  0.4339  4.9685
##
## Random effects:
##   Groups   Name      Variance Std.Dev.
##   ID       (Intercept) 1.139    1.067
##   Residual                2.085    1.444
## Number of obs: 4552, groups: ID, 222
##
## Fixed effects:
##              Estimate Std. Error      df t value Pr(>|t|)

```

```

## (Intercept)          6.03880    0.08141 217.81422  74.182   <2e-16 ***
## B_Med_Antidepressants -0.10539    0.21191 220.93126  -0.497    0.619
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##          (Intr)
## B_Md_Antdpr -0.384
confint(model_Antidepimprove)

## Computing profile confidence intervals ...

##                2.5 %    97.5 %
## .sig01          0.9602830 1.1796099
## .sigma          1.4139059 1.4747460
## (Intercept)      5.8792776 6.1983259
## B_Med_Antidepressants -0.5205751 0.3099154
# B_Med-Benzodiazepine
model_Benzoimprove <- lmer(GlobalImprovement ~ B_Med-Benzodiazepine + (1|ID), data = df_new)
summary(model_Benzoimprove)

## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula: GlobalImprovement ~ B_Med-Benzodiazepine + (1 | ID)
##   Data: df_new
##
## REML criterion at convergence: 16808.2
##
## Scaled residuals:
##      Min       1Q   Median       3Q      Max
## -4.4100 -0.4422 -0.0010  0.4348  4.9693
##
## Random effects:
##   Groups   Name      Variance Std.Dev.
##   ID       (Intercept) 1.141    1.068
##   Residual              2.085    1.444
## Number of obs: 4552, groups: ID, 222
##
## Fixed effects:
##              Estimate Std. Error      df t value Pr(>|t|)
## (Intercept)    6.02259    0.07847 218.53625   76.75   <2e-16 ***
## B_Med-Benzodiazepine  0.00818    0.27512 217.28816    0.03    0.976
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##          (Intr)
## B_Md_Bnzdpr -0.285
confint(model_Benzoimprove)

##Computing profile confidence intervals ...

##                2.5 %    97.5 %
## .sig01          0.9610017 1.1804179

```

```

## .sigma          1.4138998 1.4747392
## (Intercept)     5.8688229 6.1763525
## B_Med-Benzodiazepine -0.5308821 0.5473554

# B_Med_Stimulants
model_Stimuimprove <- lmer(GlobalImprovement ~ B_Med_Stimulants + (1|ID), data = df_new)
summary(model_Stimuimprove)

## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula: GlobalImprovement ~ B_Med_Stimulants + (1 | ID)
## Data: df_new
##
## REML criterion at convergence: 16804.8
##
## Scaled residuals:
##      Min       1Q   Median       3Q      Max
## -4.4087 -0.4413 -0.0004  0.4352  4.9687
##
## Random effects:
## Groups Name Variance Std.Dev.
## ID (Intercept) 1.130 1.063
## Residual 2.085 1.444
## Number of obs: 4552, groups: ID, 222
##
## Fixed effects:
## Estimate Std. Error df t value Pr(>|t|)
## (Intercept) 6.00902 0.07556 218.44470 79.524 <2e-16 ***
## B_Med_Stimulants 0.78498 0.56133 216.51366 1.398 0.163
## ---
## Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
## (Intr)
## B_Md_Stmlnt -0.135

confint(model_Stimuimprove)

## Computing profile confidence intervals ...

## 2.5 % 97.5 %
## .sig01 0.9562009 1.174741
## .sigma 1.4139019 1.474741
## (Intercept) 5.8609556 6.157096
## B_Med_Stimulants -0.3149942 1.884988

# B_Med_OtherMed
model_OtherMedimprove <- lmer(GlobalImprovement ~ B_Med_OtherMed + (1|ID), data = df_new)
summary(model_OtherMedimprove)

## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula: GlobalImprovement ~ B_Med_OtherMed + (1 | ID)
## Data: df_new
##
## REML criterion at convergence: 16738.4
##

```

```

## Scaled residuals:
##      Min       1Q   Median       3Q      Max
## -4.4002 -0.4395 -0.0022  0.4316  4.9531
##
## Random effects:
##   Groups   Name                Variance Std.Dev.
##   ID       (Intercept)  1.131      1.063
##   Residual                2.094      1.447
## Number of obs: 4528, groups:  ID, 221
##
## Fixed effects:
##              Estimate Std. Error      df t value Pr(>|t|)
## (Intercept)    6.05563    0.07744 218.03753   78.20  <2e-16 ***
## B_Med_OtherMed -0.53378    0.31773 213.76851   -1.68   0.0944 .
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##              (Intr)
## B_Md_OthrMd -0.244

```

```

confint(model_OtherMedimprove)

```

```

## Computing profile confidence intervals ...

##              2.5 %      97.5 %
## .sig01         0.956518 1.17558861
## .sigma         1.417199 1.47834351
## (Intercept)    5.903905 6.20738424
## B_Med_OtherMed -1.156587 0.08870723

```

```

# B_Med_OTC
model_OTCimprove <- lmer(GlobalImprovement ~ B_Med_OTC + (1|ID), data = df_new)
summary(model_OTCimprove)

```

```

## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula: GlobalImprovement ~ B_Med_OTC + (1 | ID)
##   Data: df_new
##
## REML criterion at convergence: 16808.1
##
## Scaled residuals:
##      Min       1Q   Median       3Q      Max
## -4.4053 -0.4394  0.0028  0.4369  4.9746
##
## Random effects:
##   Groups   Name                Variance Std.Dev.
##   ID       (Intercept)  1.134      1.065
##   Residual                2.084      1.444
## Number of obs: 4552, groups:  ID, 222
##
## Fixed effects:
##              Estimate Std. Error      df t value Pr(>|t|)
## (Intercept)    5.9290    0.1113 219.0857   53.284  <2e-16 ***
## B_Med_OTC      0.1726    0.1506 218.5990    1.146   0.253

```

```

## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##      (Intr)
## B_Med_OTC -0.739
confint(model_OTCimprove)

## Computing profile confidence intervals ...

##           2.5 %    97.5 %
## .sig01      0.9579311 1.1767401
## .sigma      1.4138921 1.4747306
## (Intercept)  5.7109624 6.1470576
## B_Med_OTC    -0.1224755 0.4678271
# B_Med_OpioidsYN
model_Opioid_improve <- lmer(GlobalImprovement ~ B_Med_OpioidsYN + (1|ID), data = df_new)
summary(model_Opioid_improve) # Significant!

## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula: GlobalImprovement ~ B_Med_OpioidsYN + (1 | ID)
##      Data: df_new
##
## REML criterion at convergence: 16796.7
##
## Scaled residuals:
##      Min       1Q   Median       3Q      Max
## -4.3877 -0.4486 -0.0084  0.4470  4.9455
##
## Random effects:
##  Groups   Name                Variance Std.Dev.
##  ID       (Intercept)  1.074      1.036
##  Residual                    2.084      1.444
## Number of obs: 4552, groups:  ID, 222
##
## Fixed effects:
##              Estimate Std. Error      df t value Pr(>|t|)
## (Intercept)    6.20058    0.08827 217.86764  70.247 < 2e-16 ***
## B_Med_OpioidsYN -0.56716    0.15783 221.19294  -3.593 0.000402 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##      (Intr)
## B_Md_OpdsYN -0.559
confint(model_Opioid_improve)

##Computing profile confidence intervals ...

##           2.5 %    97.5 %
## .sig01      0.9320611 1.1456483
## .sigma      1.4138145 1.4746427
## (Intercept)  6.0276537 6.3736066

```



```
## B_Med_OpioidsYN -0.8765529 -0.2579604
```

B\_Med\_Tramadol, B\_Med\_Anticonvulsant, and B\_Med\_OpioidsYN are associated with the Global Improvement!

```
# Test if any of the baseline (Lev2) psych variables are linked to perceived improvements; Univariate  
# B_Psych_PCS"
```

```
model_PCImprove <- lmer(GlobalImprovement ~ B_Psych_PCS + (1|ID), data = df_new)  
summary(model_PCImprove) # Significant!
```

```
## Linear mixed model fit by REML. t-tests use Satterthwaite's method [  
## lmerModLmerTest]
```

```
## Formula: GlobalImprovement ~ B_Psych_PCS + (1 | ID)
```

```
## Data: df_new
```

```
##
```

```
## REML criterion at convergence: 16794.9
```

```
##
```

```
## Scaled residuals:
```

```
##      Min       1Q   Median       3Q      Max  
## -4.4284 -0.4347 -0.0002  0.4339  4.9977
```

```
##
```

```
## Random effects:
```

```
## Groups   Name                Variance Std.Dev.  
## ID      (Intercept)  1.027      1.013  
## Residual                    2.084      1.444
```

```
## Number of obs: 4552, groups: ID, 222
```

```
##
```

```
## Fixed effects:
```

```
##              Estimate Std. Error      df t value Pr(>|t|)  
## (Intercept)  6.522346   0.128253 219.069009  50.855 < 2e-16 ***  
## B_Psych_PCS  -0.025840   0.005504 220.087865  -4.695 4.69e-06 ***  
## ---
```

```
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
##
```

```
## Correlation of Fixed Effects:
```

```
##              (Intr)
```

```
## B_Psych_PCS -0.829
```

```
confint(model_PCImprove)
```

```
## Computing profile confidence intervals ...
```

```
##              2.5 %      97.5 %  
## .sig01      0.91090586  1.12099293  
## .sigma      1.41387693  1.47471229  
## (Intercept)  6.27105135  6.77370231  
## B_Psych_PCS  -0.03662589 -0.01505529
```

```
# B_Psych_HADS"
```

```
model_HADSimprove <- lmer(GlobalImprovement ~ B_Psych_HADS + (1|ID), data = df_new)  
summary(model_HADSimprove) # Significant!
```

```
## Linear mixed model fit by REML. t-tests use Satterthwaite's method [  
## lmerModLmerTest]
```

```
## Formula: GlobalImprovement ~ B_Psych_HADS + (1 | ID)
```

```
## Data: df_new
```

```
##
```

```
## REML criterion at convergence: 16799
##
## Scaled residuals:
##      Min       1Q   Median       3Q      Max
## -4.4170 -0.4304 -0.0055  0.4386  4.9812
##
## Random effects:
##   Groups   Name      Variance Std.Dev.
##   ID       (Intercept) 1.055    1.027
##   Residual                2.084    1.444
## Number of obs: 4552, groups: ID, 222
##
## Fixed effects:
##              Estimate Std. Error      df t value Pr(>|t|)
## (Intercept)   6.587636   0.156523 219.009063   42.09 < 2e-16 ***
## B_Psych_HADS  -0.035892   0.008818 219.764835   -4.07 6.55e-05 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##              (Intr)
## B_Psyc_HADS -0.886
```

```
confint(model_HADSimprove)
```

```
## Computing profile confidence intervals ...
```

```
##              2.5 %      97.5 %
## .sig01         0.92341224  1.13559144
## .sigma         1.41384078  1.47467228
## (Intercept)    6.28098471  6.89443548
## B_Psych_HADS  -0.05317654 -0.01861603
```

Both are significant!

```
# Then if any of the Lev2 variables above are significantly associated with the outcome (i.e., perceive
#1; Sleep on daily improvement
model_ageimprove_Sleep <- lmer(GlobalImprovement ~ B_Demog_Age*Sleep_c + (1|ID), data = df_new)
summary(model_ageimprove_Sleep)
```

```
## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula: GlobalImprovement ~ B_Demog_Age * Sleep_c + (1 | ID)
##      Data: df_new
##
## REML criterion at convergence: 16187.4
##
## Scaled residuals:
##      Min       1Q   Median       3Q      Max
## -5.1331 -0.4759 -0.0228  0.4517  5.4294
##
## Random effects:
##   Groups   Name      Variance Std.Dev.
##   ID       (Intercept) 1.103    1.050
##   Residual                1.803    1.343
## Number of obs: 4550, groups: ID, 222
```

```
##
## Fixed effects:
##               Estimate Std. Error      df t value Pr(>|t|)
## (Intercept)      5.181e+00  2.759e-01  2.193e+02  18.781 < 2e-16 ***
## B_Demog_Age       1.627e-02  5.145e-03  2.188e+02   3.162  0.00179 **
## Sleep_c          -4.198e-01  5.419e-02  4.325e+03  -7.746  1.18e-14 ***
## B_Demog_Age:Sleep_c  3.440e-04  1.023e-03  4.325e+03   0.336  0.73680
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##           (Intr) B_Dm_A Slep_c
## B_Demog_Age -0.964
## Sleep_c      0.000  0.000
## B_Dmg_Ag:S_  0.000  0.000 -0.958
confint(model_ageimprove_Sleep)

## Computing profile confidence intervals ...

##               2.5 %      97.5 %
## .sig01          0.945923497  1.159557837
## .sigma          1.314621677  1.371201502
## (Intercept)      4.640598503  5.721786315
## B_Demog_Age       0.006184892  0.026349702
## Sleep_c          -0.525980573 -0.313545633
## B_Demog_Age:Sleep_c -0.001661801  0.002349729
model_Tramadolimprove_Sleep <- lmer(GlobalImprovement ~ B_Med_Tramadol*Sleep_c + (1|ID), data = df_new)
summary(model_Tramadolimprove_Sleep)

## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula: GlobalImprovement ~ B_Med_Tramadol * Sleep_c + (1 | ID)
## Data: df_new
##
## REML criterion at convergence: 16165
##
## Scaled residuals:
##      Min       1Q   Median       3Q      Max
## -5.1114 -0.4701 -0.0121  0.4550  5.4251
##
## Random effects:
## Groups Name Variance Std.Dev.
## ID      (Intercept) 1.130  1.063
## Residual          1.798  1.341
## Number of obs: 4550, groups: ID, 222
##
## Fixed effects:
##               Estimate Std. Error      df t value Pr(>|t|)
## (Intercept)      6.06567    0.07709  218.55392  78.684 < 2e-16 ***
## B_Med_Tramadol    -0.64456    0.29529  215.11746  -2.183  0.030134 *
## Sleep_c          -0.38950    0.01592  4324.87947 -24.460 < 2e-16 ***
## B_Med_Tramadol:Sleep_c -0.22287    0.06640  4324.96426  -3.357  0.000796 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```

##
## Correlation of Fixed Effects:
##      (Intr) B_Md_T Slep_c
## B_Med_Trmdl -0.261
## Sleep_c      0.000  0.000
## B_Md_Trm:S_  0.000  0.001 -0.240
confint(model_Tramadolimprove_Sleep)

## Computing profile confidence intervals ...

##              2.5 %      97.5 %
## .sig01          0.9575689  1.17352757
## .sigma          1.3129660  1.36947721
## (Intercept)      5.9146124  6.21673070
## B_Med_Tramadol   -1.2231719 -0.06585173
## Sleep_c          -0.4207078 -0.35828858
## B_Med_Tramadol:Sleep_c -0.3530075 -0.09273616
model_Anticonimprove_Sleep <- lmer(GlobalImprovement ~ B_Med_Anticonvulsant*Sleep_c + (1|ID), data = df,
summary(model_Anticonimprove_Sleep)

## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula: GlobalImprovement ~ B_Med_Anticonvulsant * Sleep_c + (1 | ID)
## Data: df_new
##
## REML criterion at convergence: 16174.3
##
## Scaled residuals:
##      Min       1Q   Median       3Q      Max
## -5.0844 -0.4687 -0.0097  0.4387  5.4176
##
## Random effects:
## Groups Name Variance Std.Dev.
## ID      (Intercept) 1.134  1.065
## Residual          1.801  1.342
## Number of obs: 4550, groups: ID, 222
##
## Fixed effects:
##              Estimate Std. Error      df t value Pr(>|t|)
## (Intercept)      6.10918    0.08641  217.77561  70.696 <2e-16
## B_Med_Anticonvulsant -0.34134    0.17078  219.01754  -1.999  0.0469
## Sleep_c          -0.37844    0.01873  4324.76067 -20.205 <2e-16
## B_Med_Anticonvulsant:Sleep_c -0.07510    0.03322  4324.76972  -2.261  0.0238
##
## (Intercept)      ***
## B_Med_Anticonvulsant      *
## Sleep_c            ***
## B_Med_Anticonvulsant:Sleep_c *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##      (Intr) B_Md_A Slep_c
## B_Md_Antcnv -0.506

```

```

## Sleep_c      0.000  0.000
## B_Md_Ant:S_  0.000  0.000 -0.564
confint(model_Anticonimprove_Sleep)

## Computing profile confidence intervals ...

##              2.5 %      97.5 %
## .sig01          0.9592065  1.175551959
## .sigma          1.3139023  1.370454558
## (Intercept)     5.9398279  6.278504013
## B_Med_Anticonvulsant -0.6759366 -0.006603092
## Sleep_c        -0.4151524 -0.341730584
## B_Med_Anticonvulsant:Sleep_c -0.1402192 -0.009988142
model_Opioid_improve_Sleep <- lmer(GlobalImprovement ~ B_Med_OpioidsYN*Sleep_c + (1|ID), data = df_new)
summary(model_Opioid_improve_Sleep)

## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula: GlobalImprovement ~ B_Med_OpioidsYN * Sleep_c + (1 | ID)
## Data: df_new
##
## REML criterion at convergence: 16170.1
##
## Scaled residuals:
##      Min       1Q   Median       3Q      Max
## -5.1194 -0.4697 -0.0148  0.4437  5.4027
##
## Random effects:
## Groups Name Variance Std.Dev.
## ID      (Intercept) 1.088  1.043
## Residual      1.803  1.343
## Number of obs: 4550, groups: ID, 222
##
## Fixed effects:
##              Estimate Std. Error      df t value Pr(>|t|)
## (Intercept)      6.20152   0.08825  218.05756  70.274 < 2e-16 ***
## B_Med_OpioidsYN    -0.57441   0.15775  221.15594  -3.641 0.000338 ***
## Sleep_c          -0.39334   0.01939 4326.06831 -20.284 < 2e-16 ***
## B_Med_OpioidsYN:Sleep_c -0.02471   0.03219 4326.07543  -0.768 0.442643
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##              (Intr) B_Md_OYN Slep_c
## B_Md_OpdsYN -0.559
## Sleep_c      0.000  0.000
## B_Md_OYN:S_  0.000  0.000 -0.602
confint(model_Opioid_improve_Sleep)

##Computing profile confidence intervals ...

##              2.5 %      97.5 %
## .sig01          0.93971806  1.15176837
## .sigma          1.31448586  1.37105433

```

```

## (Intercept)          6.02863129  6.37450149
## B_Med_OpioidsYN      -0.88364830 -0.26537132
## Sleep_c              -0.43135118 -0.35533800
## B_Med_OpioidsYN:Sleep_c -0.08779466  0.03836847

model_PCSimprove_Sleep <- lmer(GlobalImprovement ~ B_Psych_PCS*Sleep_c + (1|ID), data = df_new)
summary(model_PCSimprove_Sleep)

## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula: GlobalImprovement ~ B_Psych_PCS * Sleep_c + (1 | ID)
## Data: df_new
##
## REML criterion at convergence: 16166.7
##
## Scaled residuals:
##      Min       1Q   Median       3Q      Max
## -5.1743 -0.4862 -0.0200  0.4523  5.4706
##
## Random effects:
## Groups Name Variance Std.Dev.
## ID (Intercept) 1.044 1.022
## Residual 1.799 1.341
## Number of obs: 4550, groups: ID, 222
##
## Fixed effects:
##              Estimate Std. Error      df t value Pr(>|t|)
## (Intercept)  6.518e+00  1.284e-01  2.192e+02  50.766 < 2e-16 ***
## B_Psych_PCS  -2.569e-02  5.509e-03  2.200e+02  -4.664 5.37e-06 ***
## Sleep_c      -3.215e-01  3.059e-02  4.325e+03 -10.510 < 2e-16 ***
## B_Psych_PCS:Sleep_c -3.762e-03  1.230e-03  4.325e+03  -3.059 0.00223 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##              (Intr) B_Ps_PCS Slep_c
## B_Psych_PCS -0.829
## Sleep_c      0.000 0.000
## B_Ps_PCS:S_  0.000 0.000 -0.863

confint(model_PCSimprove_Sleep)

## Computing profile confidence intervals ...
##              2.5 %      97.5 %
## .sig01      0.920206340  1.12898300
## .sigma      1.313215100  1.36973352
## (Intercept)  6.266736819  6.76995983
## B_Psych_PCS  -0.036489874 -0.01490053
## Sleep_c      -0.381504709 -0.26157917
## B_Psych_PCS:Sleep_c -0.006171837 -0.00135171

model_HADSimprove_Sleep <- lmer(GlobalImprovement ~ B_Psych_HADS*Sleep_c + (1|ID), data = df_new)
summary(model_HADSimprove_Sleep)

## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]

```

```

## Formula: GlobalImprovement ~ B_Psych_HADS * Sleep_c + (1 | ID)
## Data: df_new
##
## REML criterion at convergence: 16178
##
## Scaled residuals:
##      Min       1Q   Median       3Q      Max
## -5.1222 -0.4692 -0.0206  0.4503  5.4398
##
## Random effects:
## Groups Name Variance Std.Dev.
## ID (Intercept) 1.071 1.035
## Residual 1.803 1.343
## Number of obs: 4550, groups: ID, 222
##
## Fixed effects:
## Estimate Std. Error df t value Pr(>|t|)
## (Intercept) 6.586e+00 1.566e-01 2.191e+02 42.064 < 2e-16 ***
## B_Psych_HADS -3.589e-02 8.820e-03 2.197e+02 -4.069 6.58e-05 ***
## Sleep_c -3.693e-01 4.135e-02 4.326e+03 -8.932 < 2e-16 ***
## B_Psych_HADS:Sleep_c -1.894e-03 2.202e-03 4.326e+03 -0.860 0.39
## ---
## Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
## (Intr) B_Ps_HADS Slep_c
## B_Psyc_HADS -0.886
## Sleep_c 0.000 0.000
## B_P_HADS:S_ 0.000 0.000 -0.927

```

```

confint(model_HADSimprove_Sleep)

## Computing profile confidence intervals ...

##      2.5 %      97.5 %
## .sig01 0.931923408 1.142704043
## .sigma 1.314488005 1.371058713
## (Intercept) 6.279530764 6.893198883
## B_Psych_HADS -0.053178744 -0.018611697
## Sleep_c -0.450364740 -0.288281854
## B_Psych_HADS:Sleep_c -0.006210707 0.002421813

```

```

#2; Mood on daily improvement
model_ageimprove_Mood <- lmer(GlobalImprovement ~ B_Demog_Age*Mood_c + (1|ID), data = df_new)
summary(model_ageimprove_Mood)

```

```

## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula: GlobalImprovement ~ B_Demog_Age * Mood_c + (1 | ID)
## Data: df_new
##
## REML criterion at convergence: 16294.3
##
## Scaled residuals:
##      Min       1Q   Median       3Q      Max
## -4.7217 -0.4500 -0.0126  0.4615  4.7915

```

```

##
## Random effects:
##   Groups   Name      Variance Std.Dev.
##   ID       (Intercept) 1.098    1.048
##   Residual              1.847    1.359
## Number of obs: 4551, groups: ID, 222
##
## Fixed effects:
##              Estimate Std. Error      df t value Pr(>|t|)
## (Intercept)    5.172e+00  2.756e-01  2.192e+02  18.769 < 2e-16 ***
## B_Demog_Age    1.647e-02  5.138e-03  2.186e+02   3.206  0.00155 **
## Mood_c        -4.067e-01  6.431e-02  4.326e+03  -6.324  2.8e-10 ***
## B_Demog_Age:Mood_c -2.072e-04  1.214e-03  4.326e+03  -0.171  0.86452
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##              (Intr) B_Dm_A Mood_c
## B_Demog_Age -0.964
## Mood_c       0.000  0.000
## B_Dmg_Ag:M_  0.000  0.000 -0.962

```

```

confint(model_ageimprove_Mood)

```

```

## Computing profile confidence intervals ...
##              2.5 %      97.5 %
## .sig01        0.943663607  1.157335497
## .sigma        1.330546403  1.387805307
## (Intercept)   4.631968816  5.711903096
## B_Demog_Age   0.006406012  0.026544796
## Mood_c       -0.532756642 -0.280669265
## B_Demog_Age:Mood_c -0.002587233  0.002172804

```

```

model_Tramadolimprove_Mood <- lmer(GlobalImprovement ~ B_Med_Tramadol*Mood_c + (1|ID), data = df_new)
summary(model_Tramadolimprove_Mood)

```

```

## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula: GlobalImprovement ~ B_Med_Tramadol * Mood_c + (1 | ID)
##   Data: df_new
##
## REML criterion at convergence: 16283.1
##
## Scaled residuals:
##      Min       1Q   Median       3Q      Max
## -4.7141 -0.4528 -0.0046  0.4563  4.7811
##
## Random effects:
##   Groups   Name      Variance Std.Dev.
##   ID       (Intercept) 1.126    1.061
##   Residual              1.847    1.359
## Number of obs: 4551, groups: ID, 222
##
## Fixed effects:
##              Estimate Std. Error      df t value Pr(>|t|)

```



```

## (Intercept)          6.06729    0.07705  218.42440  78.740    <2e-16 ***
## B_Med_Tramadol      -0.64396    0.29516  214.97661  -2.182    0.0302 *
## Mood_c              -0.41483    0.01823  4325.81378 -22.760    <2e-16 ***
## B_Med_Tramadol:Mood_c -0.03778    0.07195  4325.75449  -0.525    0.5995
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##          (Intr) B_Md_T Mood_c
## B_Med_Trmdl -0.261
## Mood_c      0.000  0.000
## B_Md_Trm:M_  0.000  0.000 -0.253
confint(model_Tramadolimprove_Mood)

## Computing profile confidence intervals ...
##
##          2.5 %      97.5 %
## .sig01      0.9558230  1.17198854
## .sigma      1.3305434  1.38780527
## (Intercept)  5.9163007  6.21828646
## B_Med_Tramadol -1.2223158 -0.06551047
## Mood_c      -0.4505504 -0.37910556
## B_Med_Tramadol:Mood_c -0.1787977  0.10323339
model_Anticonimprove_Mood <- lmer(GlobalImprovement ~ B_Med_Anticonvulsant*Mood_c + (1|ID), data = df_n
summary(model_Anticonimprove_Mood)

## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula: GlobalImprovement ~ B_Med_Anticonvulsant * Mood_c + (1 | ID)
## Data: df_new
##
## REML criterion at convergence: 16286.1
##
## Scaled residuals:
##      Min       1Q   Median       3Q      Max
## -4.7286 -0.4484 -0.0072  0.4614  4.8622
##
## Random effects:
## Groups   Name      Variance Std.Dev.
## ID       (Intercept) 1.130    1.063
## Residual              1.847    1.359
## Number of obs: 4551, groups: ID, 222
##
## Fixed effects:
##
##              Estimate Std. Error      df t value Pr(>|t|)
## (Intercept)      6.11122    0.08636  217.61364  70.765    <2e-16
## B_Med_Anticonvulsant -0.34309    0.17070  218.95411  -2.010    0.0457
## Mood_c          -0.40901    0.02168  4325.72020 -18.869    <2e-16
## B_Med_Anticonvulsant:Mood_c -0.02436    0.03726  4325.66105  -0.654    0.5133
##
## (Intercept)      ***
## B_Med_Anticonvulsant      *
## Mood_c            ***
## B_Med_Anticonvulsant:Mood_c

```

```

## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##          (Intr) B_Md_A Mood_c
## B_Md_Antcnv -0.506
## Mood_c      0.000  0.000
## B_Md_Ant:M_ 0.000  0.000 -0.582
confint(model_Anticonimprove_Mood)

## Computing profile confidence intervals ...

##              2.5 %      97.5 %
## .sig01          0.95738127  1.173890210
## .sigma          1.33052777  1.387789700
## (Intercept)      5.94198085  6.280442475
## B_Med_Anticonvulsant -0.67752289 -0.008519729
## Mood_c           -0.45149560 -0.366525783
## B_Med_Anticonvulsant:Mood_c -0.09739163  0.048675311
model_Opioid_improve_Mood <- lmer(GlobalImprovement ~ B_Med_OpioidsYN*Mood_c + (1|ID), data = df_new)
summary(model_Opioid_improve_Mood)

## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula: GlobalImprovement ~ B_Med_OpioidsYN * Mood_c + (1 | ID)
## Data: df_new
##
## REML criterion at convergence: 16271.5
##
## Scaled residuals:
##      Min       1Q   Median       3Q      Max
## -4.6760 -0.4558 -0.0115  0.4506  4.6678
##
## Random effects:
## Groups Name Variance Std.Dev.
## ID      (Intercept) 1.087  1.042
## Residual 1.844  1.358
## Number of obs: 4551, groups: ID, 222
##
## Fixed effects:
##              Estimate Std. Error      df t value Pr(>|t|)
## (Intercept)      6.20099    0.08827  217.94399  70.248 <2e-16 ***
## B_Med_OpioidsYN  -0.56725    0.15777  220.92818  -3.595  0.0004 ***
## Mood_c           -0.38217    0.02227 4326.91482 -17.162 <2e-16 ***
## B_Med_OpioidsYN:Mood_c -0.09372    0.03641 4326.98995  -2.574  0.0101 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##          (Intr) B_Md_OYN Mood_c
## B_Md_OpdsYN -0.559
## Mood_c      0.000  0.000
## B_Md_OYN:M_ 0.000  0.000 -0.612

```

```

confint(model_Opioid_improve_Mood)

## Computing profile confidence intervals ...

##              2.5 %      97.5 %
## .sig01          0.9388311  1.15119859
## .sigma          1.3294728  1.38668063
## (Intercept)      6.0280566  6.37402680
## B_Med_OpioidsYN  -0.8765148 -0.25816639
## Mood_c           -0.4258189 -0.33852742
## B_Med_OpioidsYN:Mood_c -0.1650728 -0.02235868

model_PCSimprove_Mood <- lmer(GlobalImprovement ~ B_Psych_PCS*Mood_c + (1|ID), data = df_new)
summary(model_PCSimprove_Mood)

## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula: GlobalImprovement ~ B_Psych_PCS * Mood_c + (1 | ID)
## Data: df_new
##
## REML criterion at convergence: 16272
##
## Scaled residuals:
##      Min       1Q   Median       3Q      Max
## -4.8271 -0.4637 -0.0099  0.4580  5.1125
##
## Random effects:
## Groups Name Variance Std.Dev.
## ID      (Intercept) 1.040  1.020
## Residual          1.842  1.357
## Number of obs: 4551, groups: ID, 222
##
## Fixed effects:
##              Estimate Std. Error      df t value Pr(>|t|)
## (Intercept)    6.523e+00  1.282e-01  2.190e+02  50.877 < 2e-16 ***
## B_Psych_PCS    -2.588e-02  5.502e-03  2.199e+02  -4.703 4.52e-06 ***
## Mood_c        -3.100e-01  3.703e-02  4.327e+03  -8.371 < 2e-16 ***
## B_Psych_PCS:Mood_c -4.493e-03  1.364e-03  4.326e+03  -3.294 0.000996 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##              (Intr) B_Ps_PCS Mood_c
## B_Psych_PCS  -0.829
## Mood_c       -0.001  0.000
## B_Ps_PCS:M_  0.000  0.000 -0.880

confint(model_PCSimprove_Mood)

##Computing profile confidence intervals ...

##              2.5 %      97.5 %
## .sig01          0.917794239  1.126580054
## .sigma          1.328880633  1.386066905
## (Intercept)      6.271999122  6.774499344
## B_Psych_PCS     -0.036657477 -0.015096233

```

```

## Mood_c          -0.382548809 -0.237397038
## B_Psych_PCS:Mood_c -0.007166646 -0.001819727

model_HADSimprove_Mood <- lmer(GlobalImprovement ~ B_Psych_HADS*Mood_c + (1|ID), data = df_new)
summary(model_HADSimprove_Mood)

## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula: GlobalImprovement ~ B_Psych_HADS * Mood_c + (1 | ID)
## Data: df_new
##
## REML criterion at convergence: 16280
##
## Scaled residuals:
##      Min       1Q   Median       3Q      Max
## -4.7999 -0.4513 -0.0129  0.4510  5.0392
##
## Random effects:
## Groups Name Variance Std.Dev.
## ID      (Intercept) 1.067 1.033
## Residual 1.844 1.358
## Number of obs: 4551, groups: ID, 222
##
## Fixed effects:
##              Estimate Std. Error      df t value Pr(>|t|)
## (Intercept)  6.589e+00  1.565e-01  2.190e+02  42.103 < 2e-16 ***
## B_Psych_HADS -3.595e-02  8.815e-03  2.196e+02  -4.078 6.36e-05 ***
## Mood_c       -3.024e-01  5.137e-02  4.327e+03  -5.886 4.25e-09 ***
## B_Psych_HADS:Mood_c -6.136e-03  2.577e-03  4.327e+03  -2.381 0.0173 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##              (Intr) B_Ps_HADS Mood_c
## B_Psyc_HADS -0.886
## Mood_c      0.000 0.000
## B_P_HADS:M_ 0.000 0.000 -0.939

confint(model_HADSimprove_Mood)

## Computing profile confidence intervals ...

##              2.5 %      97.5 %
## .sig01      0.93017448  1.141091407
## .sigma      1.32964284  1.386859731
## (Intercept)  6.28212872  6.895449716
## B_Psych_HADS -0.05322552 -0.018675790
## Mood_c       -0.40303347 -0.201686240
## B_Psych_HADS:Mood_c -0.01118578 -0.001085654

#3; Pain on daily improvement
model_ageimprove_AvePain <- lmer(GlobalImprovement ~ B_Demog_Age*AvePain_c + (1|ID), data = df_new)
summary(model_ageimprove_AvePain)

## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula: GlobalImprovement ~ B_Demog_Age * AvePain_c + (1 | ID)

```

```
## Data: df_new
##
## REML criterion at convergence: 15759.7
##
## Scaled residuals:
##      Min       1Q   Median       3Q      Max
## -4.8905 -0.5040 -0.0440  0.4439  5.8815
##
## Random effects:
##   Groups   Name      Variance Std.Dev.
##    ID      (Intercept) 1.108    1.053
##   Residual          1.632    1.278
## Number of obs: 4551, groups: ID, 222
##
## Fixed effects:
##              Estimate Std. Error      df t value Pr(>|t|)
## (Intercept)    5.174e+00  2.753e-01 2.192e+02  18.792 < 2e-16 ***
## B_Demog_Age    1.642e-02  5.135e-03 2.186e+02   3.197  0.00159 **
## AvePain_c     -6.940e-01  6.275e-02 4.326e+03 -11.060 < 2e-16 ***
## B_Demog_Age:AvePain_c 2.371e-03  1.151e-03 4.326e+03   2.060  0.03949 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##              (Intr) B_Dm_A AvPn_c
## B_Demog_Age -0.964
## AvePain_c    0.000  0.000
## B_Dmg_A:AP_  0.000  0.000 -0.965
```

```
confint(model_ageimprove_AvePain)
```

```
## Computing profile confidence intervals ...
```

```
##              2.5 %      97.5 %
## .sig01        0.9490867333  1.161520739
## .sigma        1.2508893304  1.304720779
## (Intercept)    4.6346204678  5.713719104
## B_Demog_Age    0.0063558406  0.026480689
## AvePain_c     -0.8169998347 -0.571025382
## B_Demog_Age:AvePain_c 0.0001147977  0.004627032
```

```
model_Tramadolimprove_AvePain <- lmer(GlobalImprovement ~ B_Med_Tramadol*AvePain_c + (1|ID), data = df_
summary(model_Tramadolimprove_AvePain)
```

```
## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula: GlobalImprovement ~ B_Med_Tramadol * AvePain_c + (1 | ID)
## Data: df_new
##
## REML criterion at convergence: 15737
##
## Scaled residuals:
##      Min       1Q   Median       3Q      Max
## -4.8971 -0.5018 -0.0275  0.4329  5.8643
##
## Random effects:
```

```
## Groups Name Variance Std.Dev.
## ID (Intercept) 1.136 1.066
## Residual 1.628 1.276
## Number of obs: 4551, groups: ID, 222
##
## Fixed effects:
## Estimate Std. Error df t value Pr(>|t|)
## (Intercept) 6.06642 0.07699 218.49385 78.795 < 2e-16 ***
## B_Med_Tramadol -0.64401 0.29505 215.39166 -2.183 0.0301 *
## AvePain_c -0.55225 0.01699 4325.73918 -32.498 < 2e-16 ***
## B_Med_Tramadol:AvePain_c -0.27045 0.06767 4325.74630 -3.997 6.53e-05 ***
## ---
## Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
## (Intr) B_Md_T AvPn_c
## B_Med_Trmdl -0.261
## AvePain_c 0.000 0.000
## B_Md_Tr:AP_ 0.000 0.000 -0.251
```

```
confint(model_Tramadolimprove_AvePain)
```

```
## Computing profile confidence intervals ...
```

```
## 2.5 % 97.5 %
## .sig01 0.9611832 1.17605308
## .sigma 1.2492308 1.30299346
## (Intercept) 5.9155537 6.21728639
## B_Med_Tramadol -1.2221549 -0.06577881
## AvePain_c -0.5855591 -0.51894642
## B_Med_Tramadol:AvePain_c -0.4030813 -0.13782360
```

```
model_Anticonimprove_AvePain <- lmer(GlobalImprovement ~ B_Med_Anticonvulsant*AvePain_c + (1|ID), data =
summary(model_Anticonimprove_AvePain)
```

```
## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula: GlobalImprovement ~ B_Med_Anticonvulsant * AvePain_c + (1 | ID)
## Data: df_new
##
## REML criterion at convergence: 15739.1
##
## Scaled residuals:
## Min 1Q Median 3Q Max
## -4.8960 -0.5023 -0.0353 0.4344 5.8550
##
## Random effects:
## Groups Name Variance Std.Dev.
## ID (Intercept) 1.140 1.068
## Residual 1.628 1.276
## Number of obs: 4551, groups: ID, 222
##
## Fixed effects:
## Estimate Std. Error df t value
## (Intercept) 6.11003 0.08631 217.77168 70.794
## B_Med_Anticonvulsant -0.34145 0.17056 218.96174 -2.002
```

```

## AvePain_c                -0.52895      0.01915 4325.63728 -27.620
## B_Med_Anticonvulsant:AvePain_c -0.15376      0.03738 4325.62738  -4.113
##                               Pr(>|t|)
## (Intercept)                < 2e-16 ***
## B_Med_Anticonvulsant        0.0465 *
## AvePain_c                  < 2e-16 ***
## B_Med_Anticonvulsant:AvePain_c 3.98e-05 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##      (Intr) B_Md_A AvPn_c
## B_Md_Antcnv -0.506
## AvePain_c   0.000  0.000
## B_Md_An:AP_ 0.000  0.000 -0.512
confint(model_Anticonimprove_AvePain)

## Computing profile confidence intervals ...

##                2.5 %      97.5 %
## .sig01          0.9628815  1.178114922
## .sigma          1.2490982  1.302855773
## (Intercept)     5.9408933  6.279148261
## B_Med_Anticonvulsant -0.6756240 -0.007150329
## AvePain_c       -0.5664871 -0.491416811
## B_Med_Anticonvulsant:AvePain_c -0.2270288 -0.080490479
model_Opioid_improve_AvePain <- lmer(GlobalImprovement ~ B_Med_OpioidsYN*AvePain_c + (1|ID), data = df_
summary(model_Opioid_improve_AvePain)

## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula: GlobalImprovement ~ B_Med_OpioidsYN * AvePain_c + (1 | ID)
## Data: df_new
##
## REML criterion at convergence: 15743.2
##
## Scaled residuals:
##      Min       1Q   Median       3Q      Max
## -4.8716 -0.5050 -0.0415  0.4269  5.8392
##
## Random effects:
## Groups Name Variance Std.Dev.
## ID      (Intercept) 1.095  1.046
## Residual 1.632  1.278
## Number of obs: 4551, groups: ID, 222
##
## Fixed effects:
##              Estimate Std. Error      df t value Pr(>|t|)
## (Intercept)    6.20095    0.08818 218.07776  70.321 < 2e-16 ***
## B_Med_OpioidsYN -0.56945    0.15755 220.76390  -3.614 0.000373 ***
## AvePain_c      -0.54684    0.01974 4326.79467 -27.699 < 2e-16 ***
## B_Med_OpioidsYN:AvePain_c -0.07391    0.03580 4326.79278  -2.064 0.039067 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

```

```

##
## Correlation of Fixed Effects:
##      (Intr) B_Md_OYN AvPn_c
## B_Md_OpdsYN -0.560
## AvePain_c    0.000  0.000
## B_M_OYN:AP_  0.000  0.000  -0.551
confint(model_Opioid_improve_AvePain)

## Computing profile confidence intervals ...

##              2.5 %      97.5 %
## .sig01          0.9436430  1.154702267
## .sigma          1.2508379  1.304662818
## (Intercept)      6.0281920  6.373798297
## B_Med_OpioidsYN -0.8782698 -0.260808445
## AvePain_c        -0.5855354 -0.508147471
## B_Med_OpioidsYN:AvePain_c -0.1440806 -0.003729326
model_PCSimprove_AvePain <- lmer(GlobalImprovement ~ B_Psych_PCS*AvePain_c + (1|ID), data = df_new)
summary(model_PCSimprove_AvePain)

## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula: GlobalImprovement ~ B_Psych_PCS * AvePain_c + (1 | ID)
## Data: df_new
##
## REML criterion at convergence: 15713.7
##
## Scaled residuals:
##      Min       1Q   Median       3Q      Max
## -4.9054 -0.4972 -0.0454  0.4501  5.9961
##
## Random effects:
## Groups Name Variance Std.Dev.
## ID      (Intercept) 1.050  1.025
## Residual      1.619  1.273
## Number of obs: 4551, groups: ID, 222
##
## Fixed effects:
##              Estimate Std. Error      df t value Pr(>|t|)
## (Intercept)    6.522e+00  1.281e-01  2.190e+02  50.912 < 2e-16 ***
## B_Psych_PCS    -2.585e-02  5.496e-03  2.198e+02  -4.703 4.52e-06 ***
## AvePain_c      -4.187e-01  2.920e-02  4.326e+03 -14.340 < 2e-16 ***
## B_Psych_PCS:AvePain_c -7.938e-03  1.273e-03  4.326e+03  -6.237 4.89e-10 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##      (Intr) B_Ps_PCS AvPn_c
## B_Psych_PCS -0.829
## AvePain_c    0.000  0.000
## B_P_PCS:AP_  0.000  0.000  -0.827
confint(model_PCSimprove_AvePain)

##Computing profile confidence intervals ...

```



```

##              2.5 %      97.5 %
## .sig01        0.92351662  1.130987214
## .sigma        1.24591270  1.299529381
## (Intercept)    6.27108211  6.773152071
## B_Psych_PCS    -0.03662196 -0.015081687
## AvePain_c      -0.47590033 -0.361456763
## B_Psych_PCS:AvePain_c -0.01043256 -0.005443471

model_HADSimprove_AvePain <- lmer(GlobalImprovement ~ B_Psych_HADS*AvePain_c + (1|ID), data = df_new)
summary(model_HADSimprove_AvePain)

## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula: GlobalImprovement ~ B_Psych_HADS * AvePain_c + (1 | ID)
## Data: df_new
##
## REML criterion at convergence: 15723
##
## Scaled residuals:
##      Min       1Q   Median       3Q      Max
## -4.9037 -0.5082 -0.0344  0.4550  5.9472
##
## Random effects:
## Groups Name Variance Std.Dev.
## ID      (Intercept) 1.077 1.038
## Residual 1.622 1.273
## Number of obs: 4551, groups: ID, 222
##
## Fixed effects:
##              Estimate Std. Error      df t value Pr(>|t|)
## (Intercept)    6.588e+00 1.563e-01 2.190e+02 42.138 < 2e-16 ***
## B_Psych_HADS   -3.595e-02 8.807e-03 2.196e+02 -4.083 6.24e-05 ***
## AvePain_c      -3.852e-01 3.618e-02 4.327e+03 -10.646 < 2e-16 ***
## B_Psych_HADS:AvePain_c -1.190e-02 2.083e-03 4.327e+03 -5.712 1.19e-08 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##              (Intr) B_Ps_HADS AvPn_c
## B_Psyc_HADS -0.886
## AvePain_c    0.000 0.000
## B_P_HADS:AP  0.000 0.000 -0.891

confint(model_HADSimprove_AvePain)

## Computing profile confidence intervals ...

##              2.5 %      97.5 %
## .sig01        0.93567701  1.145272017
## .sigma        1.24677821  1.300430071
## (Intercept)    6.28180251  6.894556939
## B_Psych_HADS   -0.05321476 -0.018699926
## AvePain_c      -0.45605928 -0.314244053
## B_Psych_HADS:AvePain_c -0.01598284 -0.007816636

```

```
#4; ActivInterf on daily improvement
```

```
model_ageimprove_ActivityInt <- lmer(GlobalImprovement ~ B_Demog_Age*ActivityInt_c + (1|ID), data = df_new)
summary(model_ageimprove_ActivityInt)
```

```
## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula: GlobalImprovement ~ B_Demog_Age * ActivityInt_c + (1 | ID)
## Data: df_new
##
## REML criterion at convergence: 15903
##
## Scaled residuals:
##      Min       1Q   Median       3Q      Max
## -4.6711 -0.4780 -0.0198  0.4337  6.0118
##
## Random effects:
## Groups Name Variance Std.Dev.
## ID      (Intercept) 1.106 1.052
## Residual 1.687 1.299
## Number of obs: 4551, groups: ID, 222
##
## Fixed effects:
##              Estimate Std. Error      df t value Pr(>|t|)
## (Intercept)    5.173e+00  2.755e-01 2.192e+02 18.779 < 2e-16 ***
## B_Demog_Age    1.644e-02  5.138e-03 2.187e+02 3.200 0.00158 **
## ActivityInt_c  -3.944e-01  5.905e-02 4.326e+03 -6.678 2.73e-11 ***
## B_Demog_Age:ActivityInt_c -2.034e-03  1.122e-03 4.326e+03 -1.813 0.06984 .
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##              (Intr) B_Dm_A ActvI_
## B_Demog_Age -0.964
## ActvtyInt_c 0.000 0.000
## B_Dmg_A:AI_ 0.000 0.000 -0.964
```

```
confint(model_ageimprove_ActivityInt)
```

```
## Computing profile confidence intervals ...
```

```
##              2.5 %      97.5 %
## .sig01      0.948047995 1.1608486359
## .sigma      1.271709764 1.3264369217
## (Intercept) 4.633440753 5.7131086548
## B_Demog_Age 0.006375613 0.0265107139
## ActivityInt_c -0.510094665 -0.2786086166
## B_Demog_Age:ActivityInt_c -0.004233233 0.0001643541
```

```
model_Tramadolimprove_ActivityInt <- lmer(GlobalImprovement ~ B_Med_Tramadol*ActivityInt_c + (1|ID), data = df_new)
summary(model_Tramadolimprove_ActivityInt)
```

```
## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula: GlobalImprovement ~ B_Med_Tramadol * ActivityInt_c + (1 | ID)
## Data: df_new
##
```

```

## REML criterion at convergence: 15893.8
##
## Scaled residuals:
##      Min       1Q   Median       3Q      Max
## -4.7344 -0.4855 -0.0067  0.4378  5.9825
##
## Random effects:
##   Groups   Name      Variance Std.Dev.
##   ID       (Intercept) 1.134    1.065
##   Residual             1.688    1.299
## Number of obs: 4551, groups: ID, 222
##
## Fixed effects:
##              Estimate Std. Error      df t value Pr(>|t|)
## (Intercept)      6.06713    0.07703  218.47778  78.768 <2e-16
## B_Med_Tramadol    -0.64780    0.29517  215.34603  -2.195  0.0293
## ActivityInt_c      -0.49240    0.01614 4325.77405 -30.505 <2e-16
## B_Med_Tramadol:ActivityInt_c -0.07928    0.06280 4325.73965  -1.262  0.2069
##
## (Intercept)          ***
## B_Med_Tramadol        *
## ActivityInt_c          ***
## B_Med_Tramadol:ActivityInt_c
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##              (Intr) B_Md_T ActvI_
## B_Med_Trmdl -0.261
## ActvtyInt_c  0.000  0.000
## B_Md_Tr:AI_  0.000  0.000 -0.257
confint(model_Tramadolimprove_ActivityInt)

## Computing profile confidence intervals ...

##              2.5 %      97.5 %
## .sig01          0.9599652  1.17523084
## .sigma          1.2719887  1.32673069
## (Intercept)      5.9161922  6.21806262
## B_Med_Tramadol   -1.2261723 -0.06933107
## ActivityInt_c     -0.5240361 -0.46076205
## B_Med_Tramadol:ActivityInt_c -0.2023731  0.04381226
model_Anticonimprove_ActivityInt <- lmer(GlobalImprovement ~ B_Med_Anticonvulsant*ActivityInt_c + (1|ID),
summary(model_Anticonimprove_ActivityInt)

## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula: GlobalImprovement ~ B_Med_Anticonvulsant * ActivityInt_c + (1 |
##      ID)
##      Data: df_new
##
## REML criterion at convergence: 15894.6
##
## Scaled residuals:

```

```

##      Min      1Q  Median      3Q      Max
## -4.7260 -0.4865 -0.0084  0.4386  6.2404
##
## Random effects:
##   Groups   Name      Variance Std.Dev.
##   ID       (Intercept) 1.138    1.067
##   Residual              1.687    1.299
## Number of obs: 4551, groups: ID, 222
##
## Fixed effects:
##                                Estimate Std. Error      df t value
## (Intercept)                   6.11093    0.08634  217.73555  70.774
## B_Med_Anticonvulsant          -0.34339    0.17065  218.98406  -2.012
## ActivityInt_c                 -0.47738    0.01864 4325.68183 -25.606
## B_Med_Anticonvulsant:ActivityInt_c -0.06747    0.03402 4325.64755  -1.983
##                                Pr(>|t|)
## (Intercept)                   <2e-16 ***
## B_Med_Anticonvulsant          0.0454 *
## ActivityInt_c                 <2e-16 ***
## B_Med_Anticonvulsant:ActivityInt_c 0.0474 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##              (Intr) B_Md_A ActvI_
## B_Md_Antcnv -0.506
## ActvtyInt_c  0.000  0.000
## B_Md_An:AI_  0.000  0.000 -0.548
confint(model_Anticonimprove_ActivityInt)

## Computing profile confidence intervals ...

##              2.5 %      97.5 %
## .sig01          0.9616863  1.1773120867
## .sigma          1.2716506  1.3263786728
## (Intercept)      5.9417244  6.2801254975
## B_Med_Anticonvulsant -0.6777355 -0.0089272928
## ActivityInt_c      -0.5139189 -0.4408390246
## B_Med_Anticonvulsant:ActivityInt_c -0.1341513 -0.0007813839
model_Opioid_improve_ActivityInt <- lmer(GlobalImprovement ~ B_Med_OpioidsYN*ActivityInt_c + (1|ID), da
summary(model_Opioid_improve_ActivityInt)

## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula: GlobalImprovement ~ B_Med_OpioidsYN * ActivityInt_c + (1 | ID)
##   Data: df_new
##
## REML criterion at convergence: 15890
##
## Scaled residuals:
##      Min      1Q  Median      3Q      Max
## -4.7460 -0.4847 -0.0129  0.4444  6.0193
##
## Random effects:

```

```

## Groups   Name            Variance Std.Dev.
## ID       (Intercept) 1.093    1.046
## Residual              1.688    1.299
## Number of obs: 4551, groups: ID, 222
##
## Fixed effects:
##
##              Estimate Std. Error      df t value Pr(>|t|)
## (Intercept)      6.20136    0.08823 218.04218  70.288 < 2e-16
## B_Med_OpioidsYN  -0.56953    0.15765 220.82250  -3.613 0.000375
## ActivityInt_c    -0.50180    0.02029 4326.85734 -24.736 < 2e-16
## B_Med_OpioidsYN:ActivityInt_c  0.01021    0.03174 4326.84691   0.322 0.747742
##
## (Intercept)          ***
## B_Med_OpioidsYN      ***
## ActivityInt_c         ***
## B_Med_OpioidsYN:ActivityInt_c
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##              (Intr) B_Md_OYN ActvI_
## B_Md_OpdsYN  -0.560
## ActvtyInt_c  0.000  0.000
## B_M_OYN:AI_  0.000  0.000  -0.639

```

```

confint(model_Opioid_improve_ActivityInt)

```

```

## Computing profile confidence intervals ...
##
##              2.5 %      97.5 %
## .sig01          0.94265061  1.15410450
## .sigma          1.27212643  1.32686715
## (Intercept)      6.02850649  6.37429936
## B_Med_OpioidsYN  -0.87855207 -0.26068517
## ActivityInt_c    -0.54155866 -0.46203936
## B_Med_OpioidsYN:ActivityInt_c -0.05199487  0.07241343

```

```

model_PCSimprove_ActivityInt <- lmer(GlobalImprovement ~ B_Psych_PCS*ActivityInt_c + (1|ID), data = df_
summary(model_PCSimprove_ActivityInt)

```

```

## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula: GlobalImprovement ~ B_Psych_PCS * ActivityInt_c + (1 | ID)
## Data: df_new
##
## REML criterion at convergence: 15886.9
##
## Scaled residuals:
##      Min       1Q   Median       3Q      Max
## -4.7461 -0.4870 -0.0197  0.4494  6.4615
##
## Random effects:
## Groups   Name            Variance Std.Dev.
## ID       (Intercept) 1.048    1.024
## Residual              1.685    1.298
## Number of obs: 4551, groups: ID, 222

```

```

##
## Fixed effects:
##
##              Estimate Std. Error      df t value Pr(>|t|)
## (Intercept)      6.522e+00  1.282e-01  2.191e+02  50.880 < 2e-16 ***
## B_Psych_PCS      -2.584e-02  5.500e-03  2.199e+02  -4.699 4.61e-06 ***
## ActivityInt_c     -4.273e-01  2.939e-02  4.326e+03 -14.538 < 2e-16 ***
## B_Psych_PCS:ActivityInt_c -3.417e-03  1.210e-03  4.326e+03  -2.824 0.00476 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##      (Intr) B_Ps_PCS ActvI_
## B_Psych_PCS -0.829
## ActvtyInt_c  0.000  0.000
## B_P_PCS:AI_  0.000  0.000  -0.848
confint(model_PCSimprove_ActivityInt)

## Computing profile confidence intervals ...
##
##              2.5 %      97.5 %
## .sig01          0.92224019  1.130158977
## .sigma          1.27101720  1.325713788
## (Intercept)      6.27113160  6.773536674
## B_Psych_PCS      -0.03662293 -0.015067629
## ActivityInt_c     -0.48487778 -0.369671785
## B_Psych_PCS:ActivityInt_c -0.00578772 -0.001045784
model_HADSimprove_ActivityInt <- lmer(GlobalImprovement ~ B_Psych_HADS*ActivityInt_c + (1|ID), data = d)
summary(model_HADSimprove_ActivityInt)

## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula: GlobalImprovement ~ B_Psych_HADS * ActivityInt_c + (1 | ID)
## Data: df_new
##
## REML criterion at convergence: 15885.4
##
## Scaled residuals:
##      Min       1Q   Median       3Q      Max
## -4.7344 -0.4928 -0.0168  0.4479  6.0692
##
## Random effects:
## Groups Name Variance Std.Dev.
## ID      (Intercept) 1.075  1.037
## Residual          1.683  1.297
## Number of obs: 4551, groups: ID, 222
##
## Fixed effects:
##
##              Estimate Std. Error      df t value Pr(>|t|)
## (Intercept)      6.588e+00  1.564e-01  2.190e+02  42.114 < 2e-16
## B_Psych_HADS      -3.595e-02  8.812e-03  2.196e+02  -4.079 6.32e-05
## ActivityInt_c     -3.792e-01  3.685e-02  4.327e+03 -10.289 < 2e-16
## B_Psych_HADS:ActivityInt_c -7.187e-03  2.027e-03  4.327e+03  -3.546 0.000395
##
## (Intercept)          ***

```

```

## B_Psych_HADS          ***
## ActivityInt_c         ***
## B_Psych_HADS:ActivityInt_c ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##      (Intr) B_Ps_HADS ActvI_
## B_Psyc_HADS -0.886
## ActvtyInt_c  0.000  0.000
## B_P_HADS:AI  0.000  0.000  -0.906
confint(model_HADSimprove_ActivityInt)

## Computing profile confidence intervals ...

##              2.5 %      97.5 %
## .sig01          0.93453848  1.14456008
## .sigma          1.27031289  1.32497715
## (Intercept)      6.28191744  6.89505793
## B_Psych_HADS     -0.05322112 -0.01868377
## ActivityInt_c    -0.45142259 -0.30695691
## B_Psych_HADS:ActivityInt_c -0.01115902 -0.00321500

```

## Graphs



## Graphs; Objective 2

*# Obj2: Graph; Multilevel linear reg slopes; random intercept & random slope; Pain (IV) & Improvement*

```
## Warning: Using `size` aesthetic for lines was deprecated in ggplot2 3.4.0.  
## i Please use `linewidth` instead.  
## This warning is displayed once every 8 hours.  
## Call `lifecycle::last_lifecycle_warnings()` to see where this warning was  
## generated.  
  
## Saving 6.5 x 4.5 in image  
  
## Warning: Removed 1387 rows containing missing values or values outside the scale range  
## (`geom_line()`).
```

```
## Saving 6.5 x 4.5 in image
## Warning: Removed 748 rows containing missing values or values outside the scale range
## (`geom_line()`).
```

```
## Saving 6.5 x 4.5 in image
## Warning: Removed 439 rows containing missing values or values outside the scale range
## (`geom_line()`).
```

```

## Saving 6.5 x 4.5 in image
## Warning: Removed 465 rows containing missing values or values outside the scale range
## (`geom_line()`).
## Obj1: Not a graph; but test/analysis of random slopes effects (for 4 graphs above) to make sure that
AIC(model_painimprove, model_painimprove_rs)

##           df      AIC
## model_painimprove      4 15761.57
## model_painimprove_rs   6 15486.89
AIC(model_actimprove, model_actimprove_rs)

##           df      AIC
## model_actimprove      4 15903.89
## model_actimprove_rs   6 15776.22
AIC(model_sleepimprove, model_sleepimprove_rs)

##           df      AIC
## model_sleepimprove      4 16184.75
## model_sleepimprove_rs   6 16051.02
AIC(model_moodimprove, model_moodimprove_rs)

##           df      AIC
## model_moodimprove      4 16292.11
## model_moodimprove_rs   6 16164.32

```

Random slope model always has lower AICs among these four models.

```
# Graphs; Objective 2.2 (Moderators of day-to-day perceived improvements)  
# Lev1_PainIntensity (IV) and Lev1_improvement (outcome)  
# as a function of Lev2_PCS (moderator)
```

```

## Style 2 for Activity Intensity model ****
model_ActImprove_PCSmod <- lmer(GlobalImprovement ~ ActivityInt_c * B_Psych_PCS + (1 | ID), data = df_new)
summary(model_ActImprove_PCSmod)

## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula: GlobalImprovement ~ ActivityInt_c * B_Psych_PCS + (1 | ID)
## Data: df_new
##
## REML criterion at convergence: 15886.9
##
## Scaled residuals:
##      Min       1Q   Median       3Q      Max
## -4.7461 -0.4870 -0.0197  0.4494  6.4615
##
## Random effects:
## Groups Name Variance Std.Dev.
## ID      (Intercept) 1.048 1.024
## Residual 1.685 1.298
## Number of obs: 4551, groups: ID, 222
##
## Fixed effects:
##              Estimate Std. Error      df t value Pr(>|t|)
## (Intercept)      6.522e+00  1.282e-01  2.191e+02  50.880 < 2e-16 ***
## ActivityInt_c     -4.273e-01  2.939e-02  4.326e+03 -14.538 < 2e-16 ***
## B_Psych_PCS       -2.584e-02  5.500e-03  2.199e+02  -4.699 4.61e-06 ***
## ActivityInt_c:B_Psych_PCS -3.417e-03  1.210e-03  4.326e+03  -2.824 0.00476 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##              (Intr) ActvI_ B_P_PC
## ActvtyInt_c  0.000
## B_Psych_PCS -0.829 0.000
## AI_:B_P_PCS 0.000 -0.848 0.000

percentiles <- quantile(df_new$B_Psych_PCS, probs = c(0, 0.25, 0.5, 0.75, 1))

new_data_act <- expand.grid(ActivityInt_c = seq(min(df_new$ActivityInt_c, na.rm = TRUE), max(df_new$Acti
length.out = 100),
                        B_Psych_PCS = percentiles,
                        ID = unique(df_new$ID)[1])

predictions_act <- predict(model_ActImprove_PCSmod, newdata = new_data_act, re.form = NULL)
new_data_act$GlobalImprovement <- predictions_act

a <- ggplot(df_new, aes(x = ActivityInt_c, y = GlobalImprovement, color = B_Psych_PCS)) +
  geom_line(data = new_data_act, aes(group = B_Psych_PCS), size = 2.5) +
  scale_color_gradientn(colors = c("#299D8F", "#E9C46A", "#D87659", "#5382ba", "#b5aad5"),
                        name = "Moderator (PCS)",
                        limits = range(df_new$B_Psych_PCS)) +
  labs(title = "Cross-Level Moderation: Activity Intensity and Improvement by PCS",
       x = "Activity Intensity",
       y = "Global Improvement") +

```



```

scale_x_continuous(limits = c(-6,6),
                   breaks = seq(-6, 6, 2)) +
scale_y_continuous(limits = c(0, 10), breaks = seq(0, 10, by = 2)) +
theme_minimal() +
theme(
  text = element_text(size = 12),
  plot.title = element_text(size = 12, hjust = 0.45, margin = margin(b = 20)),
  axis.title.x = element_text(margin = margin(t = 20)),
  axis.title.y = element_text(margin = margin(r = 20)),
  axis.text.x = element_text(size = 25),
  axis.text.y = element_text(size = 25),
  panel.grid.major = element_line(color = "lightgrey", size = 0),
  panel.grid.minor = element_line(color = "lightgrey", size = 0),
  axis.line = element_line(color = "black", linewidth = 0.5)
)

```

```

## Warning: The `size` argument of `element_line()` is deprecated as of ggplot2 3.4.0.
## i Please use the `linewidth` argument instead.
## This warning is displayed once every 8 hours.
## Call `lifecycle::last_lifecycle_warnings()` to see where this warning was
## generated.

```

```

ggsave(a, dpi=1200, filename = "Figure Mar 2025; Moderation plot; Activity intensity and global improve

```

```

## Saving 6.5 x 4.5 in image

```

```

## Warning: Removed 110 rows containing missing values or values outside the scale range
## (`geom_line()`).

```

```

# Lev1_Sleep (IV) and Lev1_improvement (outcome)
# as a function of Lev2_PCS (moderator)
model_SleepImprove_PCSmod <- lmer(GlobalImprovement ~ LastDay_Sleep_c * B_Psych_PCS + (1 | ID), data = 
summary(model_SleepImprove_PCSmod)

## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula: GlobalImprovement ~ LastDay_Sleep_c * B_Psych_PCS + (1 | ID)
## Data: df_new
##
## REML criterion at convergence: 16166.7
##
## Scaled residuals:
## Min 1Q Median 3Q Max
## -5.1743 -0.4862 -0.0200 0.4523 5.4706
##
## Random effects:
## Groups Name Variance Std.Dev.
## ID (Intercept) 1.044 1.022
## Residual 1.799 1.341
## Number of obs: 4550, groups: ID, 222
##
## Fixed effects:
## Estimate Std. Error df t value Pr(>|t|)
## (Intercept) 6.518e+00 1.284e-01 2.192e+02 50.766 < 2e-16
## LastDay_Sleep_c -3.215e-01 3.059e-02 4.325e+03 -10.510 < 2e-16
## B_Psych_PCS -2.569e-02 5.509e-03 2.200e+02 -4.664 5.37e-06
## LastDay_Sleep_c:B_Psych_PCS -3.762e-03 1.230e-03 4.325e+03 -3.059 0.00223
##
## (Intercept) ***
## LastDay_Sleep_c ***
## B_Psych_PCS ***
## LastDay_Sleep_c:B_Psych_PCS **
## ---
## Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
## (Intr) LsD_S_ B_P_PC
## LstDy_Slp_c 0.000
## B_Psych_PCS -0.829 0.000
## LD_S_:B_P_P 0.000 -0.863 0.000

```

```

# Lev1_Mood (IV) and Lev1_improvement (outcome)
# as a function of Lev2_PCS (moderator)
## Style 2 for Mood model ****
model_MoodImprove_PCSmod <- lmer(GlobalImprovement ~ Mood_c * B_Psych_PCS + (1 | ID), data = df_new)
summary(model_MoodImprove_PCSmod)

## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula: GlobalImprovement ~ Mood_c * B_Psych_PCS + (1 | ID)
## Data: df_new
##
## REML criterion at convergence: 16272
##
## Scaled residuals:
## Min 1Q Median 3Q Max
## -4.8271 -0.4637 -0.0099 0.4580 5.1125
##
## Random effects:
## Groups Name Variance Std.Dev.
## ID (Intercept) 1.040 1.020
## Residual 1.842 1.357
## Number of obs: 4551, groups: ID, 222
##
## Fixed effects:
## Estimate Std. Error df t value Pr(>|t|)
## (Intercept) 6.523e+00 1.282e-01 2.190e+02 50.877 < 2e-16 ***
## Mood_c -3.100e-01 3.703e-02 4.327e+03 -8.371 < 2e-16 ***
## B_Psych_PCS -2.588e-02 5.502e-03 2.199e+02 -4.703 4.52e-06 ***
## Mood_c:B_Psych_PCS -4.493e-03 1.364e-03 4.326e+03 -3.294 0.000996 ***
## ---
## Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
## (Intr) Mood_c B_P_PC
## Mood_c -0.001
## B_Psych_PCS -0.829 0.000
## Md_:B_P_PCS 0.000 -0.880 0.000

percentiles <- quantile(df_new$B_Psych_PCS, probs = c(0, 0.25, 0.5, 0.75, 1))

new_data_mood <- expand.grid(Mood_c = seq(min(df_new$Mood_c, na.rm = TRUE),
max(df_new$Mood_c, na.rm = TRUE),
length.out = 100),
B_Psych_PCS = percentiles,
ID = unique(df_new$ID)[1])

predictions_mood <- predict(model_MoodImprove_PCSmod, newdata = new_data_mood, re.form = NULL)
new_data_mood$GlobalImprovement <- predictions_mood

a <- ggplot(df_new, aes(x = Mood_c, y = GlobalImprovement, color = B_Psych_PCS)) +
geom_line(data = new_data_mood, aes(group = B_Psych_PCS), size = 2.5) +
scale_color_gradientn(colors = c("#299D8F", "#E9C46A", "#D87659", "#5382ba", "#b5aad5"),
name = "Moderator (PCS)",
limits = range(df_new$B_Psych_PCS)) +

```

```

labs(title = "Cross-Level Moderation: Mood and Improvement by PCS",
     x = "Mood",
     y = "Global Improvement") +
scale_x_continuous(limits = c(-6, 6),
                   breaks = seq(-6, 6, 2)) +
scale_y_continuous(limits = c(0, 10), breaks = seq(0, 10, by = 2)) +
theme_minimal() +
theme(
  text = element_text(size = 12),
  plot.title = element_text(size = 12, hjust = 0.45, margin = margin(b = 20)),
  axis.title.x = element_text(margin = margin(t = 20)),
  axis.title.y = element_text(margin = margin(r = 20)),
  axis.text.x = element_text(size = 25),
  axis.text.y = element_text(size = 25),
  panel.grid.major = element_line(color = "lightgrey", size = 0),
  panel.grid.minor = element_line(color = "lightgrey", size = 0),
  axis.line = element_line(color = "black", linewidth = 0.5)
)
ggsave(a, dpi=1200, filename = "Figure Mar 2025; Moderation plot; Mood and global improve by PCS.tif", l

## Saving 6.5 x 4.5 in image

## Warning: Removed 70 rows containing missing values or values outside the scale range
## (`geom_line()`).

```

```

# Lev1_Sleep (IV) and Lev1_improvement (outcome)
# as a function of Lev2_PCS (moderator)
## Style 2 for Sleep model ****
model_sleep_c <- lmer(GlobalImprovement ~ Sleep_c * B_Psych_PCS + (1 | ID), data = df_new)
summary(model_sleep_c)

## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula: GlobalImprovement ~ Sleep_c * B_Psych_PCS + (1 | ID)
## Data: df_new
##
## REML criterion at convergence: 16166.7
##
## Scaled residuals:
## Min 1Q Median 3Q Max
## -5.1743 -0.4862 -0.0200 0.4523 5.4706
##
## Random effects:
## Groups Name Variance Std.Dev.
## ID (Intercept) 1.044 1.022
## Residual 1.799 1.341
## Number of obs: 4550, groups: ID, 222
##
## Fixed effects:
## Estimate Std. Error df t value Pr(>|t|)
## (Intercept) 6.518e+00 1.284e-01 2.192e+02 50.766 < 2e-16 ***
## Sleep_c -3.215e-01 3.059e-02 4.325e+03 -10.510 < 2e-16 ***
## B_Psych_PCS -2.569e-02 5.509e-03 2.200e+02 -4.664 5.37e-06 ***
## Sleep_c:B_Psych_PCS -3.762e-03 1.230e-03 4.325e+03 -3.059 0.00223 **
## ---
## Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
## (Intr) Slep_c B_P_PC
## Sleep_c 0.000
## B_Psych_PCS -0.829 0.000
## Sl_:B_P_PCS 0.000 -0.863 0.000

percentiles <- quantile(df_new$B_Psych_PCS, probs = c(0, 0.25, 0.5, 0.75, 1))

new_data_sleep <- expand.grid(Sleep_c = seq(min(df_new$Sleep_c, na.rm = TRUE),
max(df_new$Sleep_c, na.rm = TRUE),
length.out = 100),
B_Psych_PCS = percentiles,
ID = unique(df_new$ID)[1])

predictions_sleep <- predict(model_sleep_c, newdata = new_data_sleep, re.form = NULL)
new_data_sleep$GlobalImprovement <- predictions_sleep

a <- ggplot(df_new, aes(x = Sleep_c, y = GlobalImprovement, color = B_Psych_PCS)) +
geom_line(data = new_data_sleep, aes(group = B_Psych_PCS), size = 2.5) +
scale_color_gradientn(colors = c("#299D8F", "#E9C46A", "#D87659", "#5382ba", "#b5aad5"),
name = "Moderator (PCS)",
limits = range(df_new$B_Psych_PCS)) +

```

```

labs(title = "Cross-Level Moderation: Sleep and Improvement by PCS",
     x = "Sleep",
     y = "Global Improvement") +
scale_x_continuous(limits = c(min(df_new$Sleep_c, na.rm = TRUE), max(df_new$Sleep_c, na.rm = TRUE)),
                  breaks = scales::pretty_breaks(n = 10)) +
scale_y_continuous(limits = c(0, 10), breaks = seq(0, 10, by = 2)) +
theme_minimal() +
theme(
  text = element_text(size = 12),
  plot.title = element_text(size = 12, hjust = 0.45, margin = margin(b = 20)),
  axis.title.x = element_text(margin = margin(t = 20)),
  axis.title.y = element_text(margin = margin(r = 20)),
  axis.text.x = element_text(size = 25),
  axis.text.y = element_text(size = 25),
  panel.grid.major = element_line(color = "lightgrey", size = 0),
  panel.grid.minor = element_line(color = "lightgrey", size = 0),
  axis.line = element_line(color = "black", linewidth = 0.5)
)

ggsave(a, dpi=1200, filename = "Figure Mar 2025; Moderation plot; Sleep and global improve by PCS.tif",

## Saving 6.5 x 4.5 in image
## November 2024
## Violin plot
df_new_violin <- df_new |>
  distinct(ID, .keep_all = TRUE) |>
  select(c(ID, Sleep, Mood,
           AvePain, ActivityInt)) |>
  pivot_longer(cols = c("Sleep", "Mood",
                        "AvePain", "ActivityInt"),
               names_to = "Variable",
               values_to = "Value")

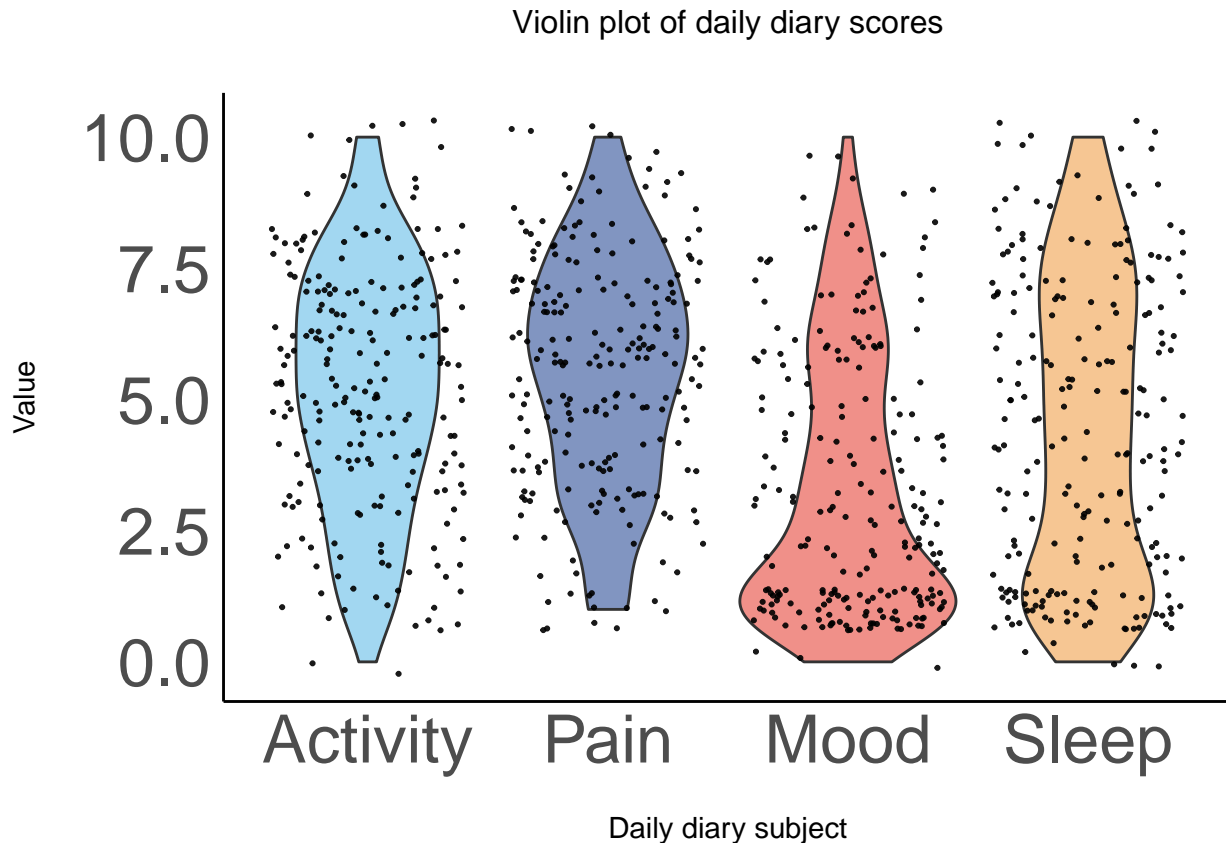
df_new_violin |>
  ggplot(aes(x = Variable, y = Value, fill = Variable, alpha = 0.7)) +
  geom_violin() +
  geom_jitter(color="black", size=0.4, alpha=0.9) +
  scale_x_discrete(labels = c("Activity", "Pain", "Mood", "Sleep")) +
  scale_fill_manual(values = c("#55B7E6", "#193E8F", "#E53528", "#F09739")) +
  theme_minimal() +
  theme(legend.position = "none") +
  theme(element_blank()) +
  theme(panel.grid.major = element_blank(), panel.grid.minor = element_blank(),
        panel.background = element_blank(), axis.line = element_line(colour = "black"),
        plot.title = element_text(
          size = 12,
          hjust = 0.5,
          margin = margin(b = 20)
        ),
        axis.title.x = element_text(
          margin = margin(t = 15)
        ),
        axis.title.y = element_text(

```

```

margin = margin(r = 15)
),
axis.text.x = element_text(
  size = 25
),
axis.text.y = element_text(
  size = 25
)) + # Remove background grids
ggtitle("Violin plot of daily diary scores") +
xlab("Daily diary subject")

```



```

df_new_violin |>
  ggplot(aes(x = Value, y = Variable, fill = Variable)) +
  ggdist::stat_halfeye(width = 0.7, .width = 0, justification = -0.2, alpha = 0.6, height = 0.7) +
  geom_jitter(color = "lightgrey", alpha = 0.3, height = 0.05) +
  geom_boxplot(width = 0.15, outlier.shape = NA, alpha = 0.5) +
  scale_y_discrete(labels = c("Activity", "Pain", "Mood", "Sleep")) +
  scale_fill_manual(values = c("#55B7E6", "#193E8F", "#E53528", "#F09739")) +
  theme_minimal() +
  theme(
    legend.position = "none",
    panel.grid.major = element_blank(),
    panel.grid.minor = element_blank(),
    panel.background = element_blank(),
    axis.line = element_line(colour = "black"),
    plot.title = element_text(
      size = 12,

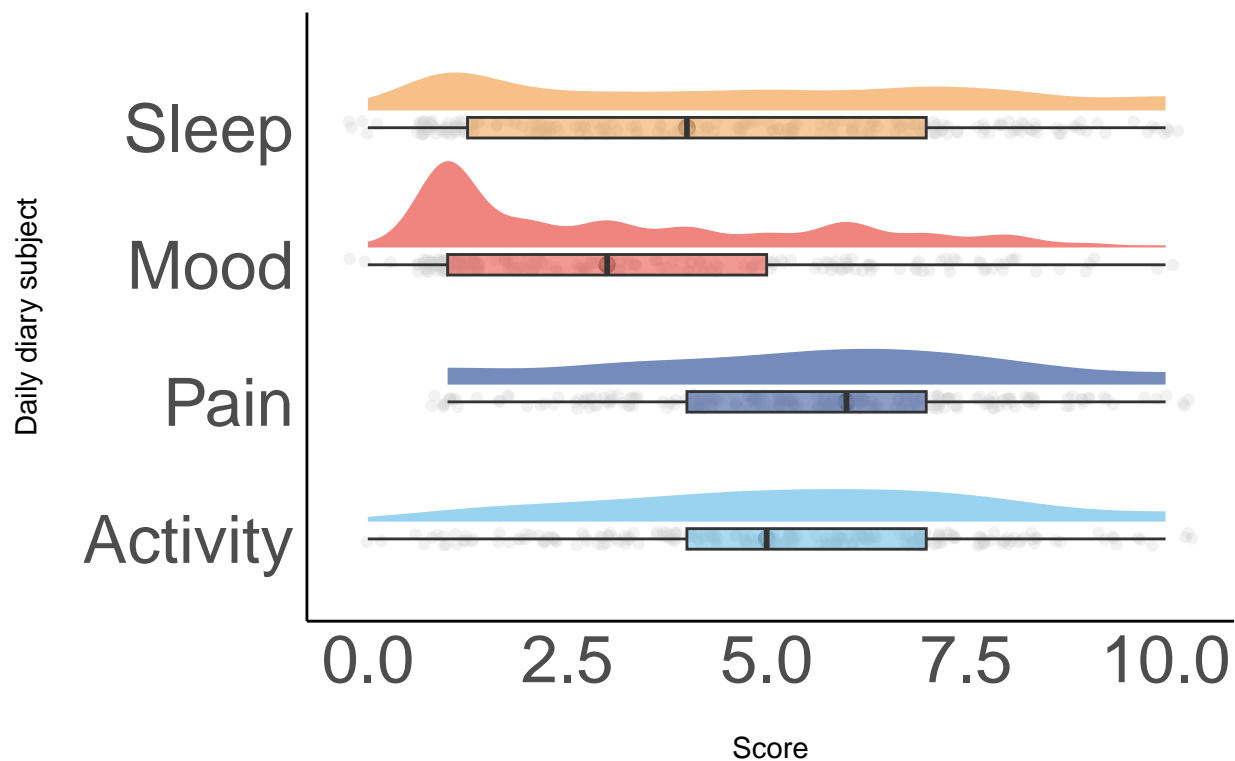
```

```

    hjust = 0.5,
    margin = margin(b = 20)
  ),
  axis.title.x = element_text(
    margin = margin(t = 15)
  ),
  axis.title.y = element_text(
    margin = margin(r = 15)
  ),
  axis.text.x = element_text(
    size = 25
  ),
  axis.text.y = element_text(
    size = 25
  )
) +
ggtitle("Raincloud plot of daily diary scores") +
ylab("Daily diary subject") +
xlab("Score")

```

Raincloud plot of daily diary scores



```

## Density plot for PCS
library(ggplot2)
library(dplyr)
df_level2 <- df_new |> distinct(ID, .keep_all = TRUE)
a <- ggplot(df_level2, aes(x = B_Psych_PCS)) +
  geom_density(fill = "#99d6ff", color = "black") +
  theme_minimal() +

```



```

theme(
  legend.position = "none",
  panel.grid.major = element_blank(),
  panel.grid.minor = element_blank(),
  panel.background = element_blank(),
  axis.line = element_line(colour = "black"),
  plot.title = element_text(
    size = 12,
    hjust = 0.5,
    margin = margin(b = 20)
  ),
  axis.title.x = element_text(
    margin = margin(t = 15)
  ),
  axis.title.y = element_text(
    margin = margin(r = 15)
  ),
  axis.text.x = element_text(
    size = 25
  ),
  axis.text.y = element_text(
    size = 25
  )
) +
ggtitle("Density Plot for Level 2: B_Psych_PCS") +
xlab("B_Psych_PCS") +
ylab("Density")

ggsave(a, dpi=1200, filename = "Figure Mar 2025; Density plot; PCS density.tif", bg="white")

## Saving 6.5 x 4.5 in image

```