

# Pain Research - Dr. Jamison Data

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2025-03-25

Objective 1.1 Day-to-day (Concurrent) associations (No longer our objective)

Objective 1.2: Time-lag effects (No longer our objective)

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

icc(model_painimprove)

## # Intraclass Correlation Coefficient
##
##      Adjusted ICC: 0.415
##      Unadjusted ICC: 0.359

# 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

icc(model_moodimprove)

```

```
## # Intraclass Correlation Coefficient
##
##     Adjusted ICC: 0.383
##     Unadjusted ICC: 0.356

# 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

icc(model_sleepimprove)

## # Intraclass Correlation Coefficient
##
##     Adjusted ICC: 0.390
##     Unadjusted ICC: 0.357

# 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
```

```
icc(model_actimprove)
```

```
## # Intraclass Correlation Coefficient
##
## Adjusted ICC: 0.406
## Unadjusted ICC: 0.359
```

```
# 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), da
```

```
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
icc(model_compimprove)

## # Intraclass Correlation Coefficient
##
## Adjusted ICC: 0.445
## Unadjusted ICC: 0.362
# 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

icc(model_genderimprove)

## # Intraclass Correlation Coefficient
##
##      Adjusted ICC: 0.351
##      Unadjusted ICC: 0.350

# 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

icc(model_ethnimprove)

## # Intraclass Correlation Coefficient
```

```
##
## Adjusted ICC: 0.354
## Unadjusted ICC: 0.354
```

```
# 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
```

```
icc(model_ageimprove)
```

```
## # Intraclass Correlation Coefficient
```

```
##
```

```
## Adjusted ICC: 0.342
```

```
## Unadjusted ICC: 0.336
```

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
```

```
icc(model_paindurimprove)
```

```
## # Intraclass Correlation Coefficient
##
## Adjusted ICC: 0.362
## Unadjusted ICC: 0.360
```

```
# 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
icc(model_BMIimprove)

## # Intraclass Correlation Coefficient
##
##      Adjusted ICC: 0.350
##      Unadjusted ICC: 0.348
# 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
icc(model_Tramadolimprove)

## # Intraclass Correlation Coefficient
##
##      Adjusted ICC: 0.348
##      Unadjusted ICC: 0.345
# 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
icc(model_Suboxoneimprove)

## # Intraclass Correlation Coefficient
##
##      Adjusted ICC: 0.354
##      Unadjusted ICC: 0.354
# 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

icc(model_Marijuanaimprove)

## # Intraclass Correlation Coefficient
##
## Adjusted ICC: 0.354
## Unadjusted ICC: 0.354

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

## 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_NSAIDSimprove)

##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
icc(model_NSAIDSimprove)

## # Intraclass Correlation Coefficient
##
##      Adjusted ICC: 0.353
##      Unadjusted ICC: 0.353

# 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

icc(model_Anticonimprove)

## # Intraclass Correlation Coefficient
##
##      Adjusted ICC: 0.349
##      Unadjusted ICC: 0.346
```

```

# 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_Msc1R1 -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

icc(model_MuscleRelimprove)

## # Intraclass Correlation Coefficient
##
## Adjusted ICC: 0.352
## Unadjusted ICC: 0.351

# 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
icc(model_Antidepimprove)

## # Intraclass Correlation Coefficient
##
## Adjusted ICC: 0.353
## Unadjusted ICC: 0.353
# 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_Bnzdzp -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
icc(model_Benzoimprove)

## # Intraclass Correlation Coefficient
##
##   Adjusted ICC: 0.354
##   Unadjusted ICC: 0.354
# 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
icc(model_Stimuimprove)

## # Intraclass Correlation Coefficient
##
##      Adjusted ICC: 0.351
##      Unadjusted ICC: 0.350
# 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
```

```
icc(model_OtherMedimprove)
```

```
## # Intraclass Correlation Coefficient
```

```
##
```

```
## Adjusted ICC: 0.351
```

```
## Unadjusted ICC: 0.349
```

```
# 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
icc(model_OTCimprove)

## # Intraclass Correlation Coefficient
##
##      Adjusted ICC: 0.352
##      Unadjusted ICC: 0.351

# 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

icc(model_Opioid_improve)

## # Intraclass Correlation Coefficient
##
##      Adjusted ICC: 0.340
##      Unadjusted ICC: 0.333
```

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_PCSimprove <- lmer(GlobalImprovement ~ B_Psych_PCS + (1|ID), data = df_new)  
summary(model_PCSimprove) # 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_PCSimprove)
```

```
## 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
```

```
icc(model_PCSimprove)
```

```
## # Intraclass Correlation Coefficient
```

```
##
```

```
## Adjusted ICC: 0.330
```

```
## Unadjusted ICC: 0.319
```

```
# 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
```

```
icc(model_HADSimprove)
```

```
## # Intraclass Correlation Coefficient
##
## Adjusted ICC: 0.336
## Unadjusted ICC: 0.327
```

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

```

```

icc(model_ageimprove_Sleep)

```

```

## # Intraclass Correlation Coefficient
##
##      Adjusted ICC: 0.379
##      Unadjusted ICC: 0.342

```

```

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
```

```
icc(model_Tramadolimprove_Sleep)
```

```
## # Intraclass Correlation Coefficient
```

```
##
```

```
##   Adjusted ICC: 0.386
```

```
##   Unadjusted ICC: 0.350
```

```
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
icc(model_Anticonimprove_Sleep)

## # Intraclass Correlation Coefficient
##
##   Adjusted ICC: 0.386
##   Unadjusted ICC: 0.351
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
icc(model_Opioid_improve_Sleep)

## # Intraclass Correlation Coefficient
##
## Adjusted ICC: 0.376
## Unadjusted ICC: 0.337
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

```

```

icc(model_PCSimprove_Sleep)

```

```

## # Intraclass Correlation Coefficient
##
## Adjusted ICC: 0.367
## Unadjusted ICC: 0.324

```

```

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
icc(model_HADSimprove_Sleep)

## # Intraclass Correlation Coefficient
##
##      Adjusted ICC: 0.373
##      Unadjusted ICC: 0.332
#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
icc(model_ageimprove_Mood)

## # Intraclass Correlation Coefficient
##
##      Adjusted ICC: 0.373
##      Unadjusted ICC: 0.340
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
```

```
icc(model_Tramadolimprove_Mood)
```

```
## # Intraclass Correlation Coefficient
```

```
##
```

```
## Adjusted ICC: 0.379
```

```
## Unadjusted ICC: 0.349
```

```
model_Anticonimprove_Mood <- lmer(GlobalImprovement ~ B_Med_Anticonvulsant*Mood_c + (1|ID), data = df_new)
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
icc(model_Anticonimprove_Mood)

## # Intraclass Correlation Coefficient
##
##      Adjusted ICC: 0.380
##      Unadjusted ICC: 0.350
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
icc(model_Opioid_improve_Mood)

## # Intraclass Correlation Coefficient
##
##      Adjusted ICC: 0.371
##      Unadjusted ICC: 0.337
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
icc(model_PCSimprove_Mood)

## # Intraclass Correlation Coefficient
##
##      Adjusted ICC: 0.361
##      Unadjusted ICC: 0.322
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

icc(model_HADSimprove_Mood)

## # Intraclass Correlation Coefficient
##
## Adjusted ICC: 0.367
## Unadjusted ICC: 0.331

#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       -0.816998347 -0.571025382
## B_Demog_Age:AvePain_c  0.0001147977  0.004627032
icc(model_ageimprove_AvePain)

## # Intraclass Correlation Coefficient
##
##      Adjusted ICC: 0.404
##      Unadjusted ICC: 0.343
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
```

```
icc(model_Tramadolimprove_AvePain)
```

```
## # Intraclass Correlation Coefficient
```

```
##
```

```
##   Adjusted ICC: 0.411
```

```
##   Unadjusted ICC: 0.352
```

```
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
icc(model_Anticonimprove_AvePain)

## # Intraclass Correlation Coefficient
##
##      Adjusted ICC: 0.412
##      Unadjusted ICC: 0.354
model_Opioid_improve_AvePain <- lmer(GlobalImprovement ~ B_Med_OpioidsYN*AvePain_c + (1|ID), data = df_new)
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

icc(model_Opioid_improve_AvePain)

## # Intraclass Correlation Coefficient
##
## Adjusted ICC: 0.402
## Unadjusted ICC: 0.340

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

icc(model_PCSimprove_AvePain)

## # Intraclass Correlation Coefficient
##
##      Adjusted ICC: 0.393
##      Unadjusted ICC: 0.326

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

icc(model_HADSimprove_AvePain)

## # Intraclass Correlation Coefficient
##
##      Adjusted ICC: 0.399
##      Unadjusted ICC: 0.334

#4; ActivInterf on daily improvement
model_ageimprove_ActivityInt <- lmer(GlobalImprovement ~ B_Demog_Age*ActivityInt_c + (1|ID), data = df_
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
icc(model_ageimprove_ActivityInt)

## # Intraclass Correlation Coefficient
##
## Adjusted ICC: 0.396
## Unadjusted ICC: 0.343
model_Tramadolimprove_ActivityInt <- lmer(GlobalImprovement ~ B_Med_Tramadol*ActivityInt_c + (1|ID), data = data,
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

icc(model_Tramadolimprove_ActivityInt)

## # Intraclass Correlation Coefficient
##
##      Adjusted ICC: 0.402
##      Unadjusted ICC: 0.351

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
```

```
icc(model_Anticonimprove_ActivityInt)
```

```
## # Intraclass Correlation Coefficient
```

```
##
```

```
##   Adjusted ICC: 0.403
```

```
##   Unadjusted ICC: 0.353
```

```
model_Opioid_improve_ActivityInt <- lmer(GlobalImprovement ~ B_Med_OpioidsYN*ActivityInt_c + (1|ID), data = data,
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
icc(model_Opioid_improve_ActivityInt)

## # Intraclass Correlation Coefficient
##
##      Adjusted ICC: 0.393
##      Unadjusted ICC: 0.339
model_PCSimprove_ActivityInt <- lmer(GlobalImprovement ~ B_Psych_PCS*ActivityInt_c + (1|ID), data = df_new)
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
```

```
icc(model_PCSimprove_ActivityInt)
```

```
## # Intraclass Correlation Coefficient
```

```
##
```

```
## Adjusted ICC: 0.383
```

```
## Unadjusted ICC: 0.325
```

```
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
icc(model_HADSimprove_ActivityInt)

## # Intraclass Correlation Coefficient
##
## Adjusted ICC: 0.390
## Unadjusted ICC: 0.333
model11 <- lmer(GlobalImprovement ~ Sleep_c * B_Demog_Age + (1|ID), data = df_new)
summary(model11)

## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula: GlobalImprovement ~ Sleep_c * B_Demog_Age + (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 ***
## Sleep_c      -4.198e-01  5.419e-02 4.325e+03  -7.746 1.18e-14 ***
## B_Demog_Age   1.627e-02  5.145e-03 2.188e+02   3.162 0.00179 **
## Sleep_c:B_Demog_Age 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) Slep_c B_Dm_A
## Sleep_c      0.000
## B_Demog_Age -0.964 0.000
## Slep_c:B_Dm_A 0.000 -0.958 0.000

```

```

icc(model11)

## # Intraclass Correlation Coefficient
##
## Adjusted ICC: 0.379
## Unadjusted ICC: 0.342

model12 <- lmer(GlobalImprovement ~ AvePain_c * B_Demog_Age + (1|ID), data = df_new) #
summary(model12)

## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula: GlobalImprovement ~ AvePain_c * B_Demog_Age + (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 ***
## AvePain_c -6.940e-01 6.275e-02 4.326e+03 -11.060 < 2e-16 ***
## B_Demog_Age 1.642e-02 5.135e-03 2.186e+02 3.197 0.00159 **
## AvePain_c:B_Demog_Age 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) AvPn_c B_Dm_A
## AvePain_c 0.000
## B_Demog_Age -0.964 0.000
## AvPn_:B_D_A 0.000 -0.965 0.000

icc(model12)

## # Intraclass Correlation Coefficient
##
## Adjusted ICC: 0.404
## Unadjusted ICC: 0.343

model13 <- lmer(GlobalImprovement ~ ActivityInt_c * B_Demog_Age + (1|ID), data = df_new)
summary(model13)

## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula: GlobalImprovement ~ ActivityInt_c * B_Demog_Age + (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 ***
## ActivityInt_c     -3.944e-01  5.905e-02  4.326e+03  -6.678 2.73e-11 ***
## B_Demog_Age       1.644e-02  5.138e-03  2.187e+02   3.200 0.00158 **
## ActivityInt_c:B_Demog_Age -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) ActvI_ B_Dm_A
## ActvtyInt_c  0.000
## B_Demog_Age -0.964  0.000
## ActI_:B_D_A  0.000 -0.964  0.000
```

```
icc(model13)
```

```
## # Intraclass Correlation Coefficient
##
##      Adjusted ICC: 0.396
##      Unadjusted ICC: 0.343
```

```
model14 <- lmer(GlobalImprovement ~ Mood_c * B_Demog_Age + (1|ID), data = df_new)
summary(model14)
```

```
## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula: GlobalImprovement ~ Mood_c * B_Demog_Age + (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 ***
## Mood_c         -4.067e-01  6.431e-02  4.326e+03  -6.324  2.8e-10 ***
## B_Demog_Age     1.647e-02  5.138e-03  2.186e+02   3.206  0.00155 **
## Mood_c:B_Demog_Age -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) Mood_c B_Dm_A
## Mood_c      0.000
## B_Demog_Age -0.964  0.000
## Md_c:B_Dm_A  0.000 -0.962  0.000

```

```

icc(model14)

## # Intraclass Correlation Coefficient
##
##   Adjusted ICC: 0.373
##   Unadjusted ICC: 0.340

```

```

model21 <- lmer(GlobalImprovement ~ Sleep_c * B_Med_OpioidsYN + (1|ID), data = df_new)
summary(model21)

```

```

## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula: GlobalImprovement ~ Sleep_c * B_Med_OpioidsYN + (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  218.05755  70.274 < 2e-16 ***
## Sleep_c        -0.39334   0.01939 4326.06831 -20.284 < 2e-16 ***
## B_Med_OpioidsYN -0.57441   0.15775  221.15592  -3.641 0.000338 ***
## Sleep_c:B_Med_OpioidsYN -0.02471   0.03219 4326.07544  -0.768 0.442643
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##           (Intr) Slep_c B_M_OY
## Sleep_c      0.000
## B_Md_OpdsYN -0.559  0.000

```

```
## Sl_:B_M_OYN 0.000 -0.602 0.000
```

```
icc(model21)
```

```
## # Intraclass Correlation Coefficient
```

```
##
```

```
## Adjusted ICC: 0.376
```

```
## Unadjusted ICC: 0.337
```

```
model22 <- lmer(GlobalImprovement ~ AvePain_c * B_Med_OpioidsYN + (1|ID), data = df_new)
summary(model22)
```

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

```
## lmerModLmerTest]
```

```
## Formula: GlobalImprovement ~ AvePain_c * B_Med_OpioidsYN + (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 ***
```

```
## AvePain_c -0.54684 0.01974 4326.79467 -27.699 < 2e-16 ***
```

```
## B_Med_OpioidsYN -0.56945 0.15755 220.76390 -3.614 0.000373 ***
```

```
## AvePain_c:B_Med_OpioidsYN -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) AvPn_c B_M_OY
```

```
## AvePain_c 0.000
```

```
## B_Md_OpdsYN -0.560 0.000
```

```
## AP_:B_M_OYN 0.000 -0.551 0.000
```

```
icc(model22)
```

```
## # Intraclass Correlation Coefficient
```

```
##
```

```
## Adjusted ICC: 0.402
```

```
## Unadjusted ICC: 0.340
```

```
model23 <- lmer(GlobalImprovement ~ ActivityInt_c * B_Med_OpioidsYN + (1|ID), data = df_new)
summary(model23)
```

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

```
## lmerModLmerTest]
```

```
## Formula: GlobalImprovement ~ ActivityInt_c * B_Med_OpioidsYN + (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
## ActivityInt_c     -0.50180    0.02029  4326.85734 -24.736 < 2e-16
## B_Med_OpioidsYN   -0.56953    0.15765   220.82250  -3.613 0.000375
## ActivityInt_c:B_Med_OpioidsYN  0.01021    0.03174  4326.84691   0.322 0.747742
##
## (Intercept)          ***
## ActivityInt_c          ***
## B_Med_OpioidsYN       ***
## ActivityInt_c:B_Med_OpioidsYN
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##              (Intr) ActvI_ B_M_OY
## ActvtyInt_c  0.000
## B_Md_OpdsYN -0.560  0.000
## AI_:B_M_OYN  0.000 -0.639  0.000

```

```

icc(model23)

## # Intraclass Correlation Coefficient
##
## Adjusted ICC: 0.393
## Unadjusted ICC: 0.339

```

```

model24 <- lmer(GlobalImprovement ~ Mood_c * B_Med_OpioidsYN + (1|ID), data = df_new)
summary(model24)

```

```

## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula: GlobalImprovement ~ Mood_c * B_Med_OpioidsYN + (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 ***
## Mood_c           -0.38217    0.02227 4326.91482 -17.162 <2e-16 ***
## B_Med_OpioidsYN  -0.56725    0.15777  220.92818  -3.595  0.0004 ***
## Mood_c:B_Med_OpioidsYN -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) Mood_c B_M_OY
## Mood_c        0.000
## B_Md_OpdsYN  -0.559  0.000
## Md_:B_M_OYN  0.000 -0.612  0.000

```

```
icc(model24)
```

```

## # Intraclass Correlation Coefficient
##
##   Adjusted ICC: 0.371
##   Unadjusted ICC: 0.337

```

```
model_PEI <- lmer(AvePain_Change ~ B_Med_OpioidsYN + (1|ID), data = df_new)
```

```

## boundary (singular) fit: see help('isSingular')

```

```
summary(model_PEI)
```

```

## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula: AvePain_Change ~ B_Med_OpioidsYN + (1 | ID)
##   Data: df_new
##
## REML criterion at convergence: 11111.1
##
## Scaled residuals:
##      Min       1Q   Median       3Q      Max
## -6.9019 -0.7480  0.0103  0.7795  4.6367
##
## Random effects:
##   Groups   Name      Variance Std.Dev.
##   ID       (Intercept) 0.00     0.0
##   Residual              1.69     1.3
## Number of obs: 3302, groups: ID, 221
##
## Fixed effects:
##               Estimate Std. Error      df t value Pr(>|t|)
## (Intercept)    -0.01333    0.02695 3300.00000  -0.494    0.621
## B_Med_OpioidsYN -0.01434    0.04958 3300.00000  -0.289    0.772
##

```

```

## Correlation of Fixed Effects:
##      (Intr)
## B_Md_OpdsYN -0.544
## optimizer (nloptwrap) convergence code: 0 (OK)
## boundary (singular) fit: see help('isSingular')

icc(model_PEI)

## Warning: Can't compute random effect variances. Some variance components equal
## zero. Your model may suffer from singularity (see `?lme4::isSingular`
## and `?performance::check_singularity`).
## Solution: Respecify random structure! You may also decrease the
## `tolerance` level to enforce the calculation of random effect variances.

## [1] NA

df_new <- df_new |>
  mutate(APEI = ifelse(AvePain_Change >= 2, 1, 0))
model_APEI <- glmer(APEI ~ B_Med_OpioidsYN + (1|ID), data = df_new, family = binomial())
summary(model_APEI)

## Generalized linear mixed model fit by maximum likelihood (Laplace
## Approximation) [glmerMod]
## Family: binomial ( logit )
## Formula: APEI ~ B_Med_OpioidsYN + (1 | ID)
## Data: df_new
##
##      AIC      BIC   logLik deviance df.resid
## 2058.4   2076.7 -1026.2  2052.4     3299
##
## Scaled residuals:
##      Min       1Q   Median       3Q      Max
## -0.5457 -0.3335 -0.2780 -0.2384  4.0560
##
## Random effects:
## Groups Name      Variance Std.Dev.
## ID      (Intercept) 0.4676  0.6838
## Number of obs: 3302, groups: ID, 221
##
## Fixed effects:
##              Estimate Std. Error z value Pr(>|z|)
## (Intercept)   -2.4910    0.1069 -23.312  <2e-16 ***
## B_Med_OpioidsYN  0.2591    0.1710  1.515    0.13
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##      (Intr)
## B_Md_OpdsYN -0.542

icc(model_APEI)

## # Intraclass Correlation Coefficient
##
##      Adjusted ICC: 0.124
##      Unadjusted ICC: 0.124

```

## 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(

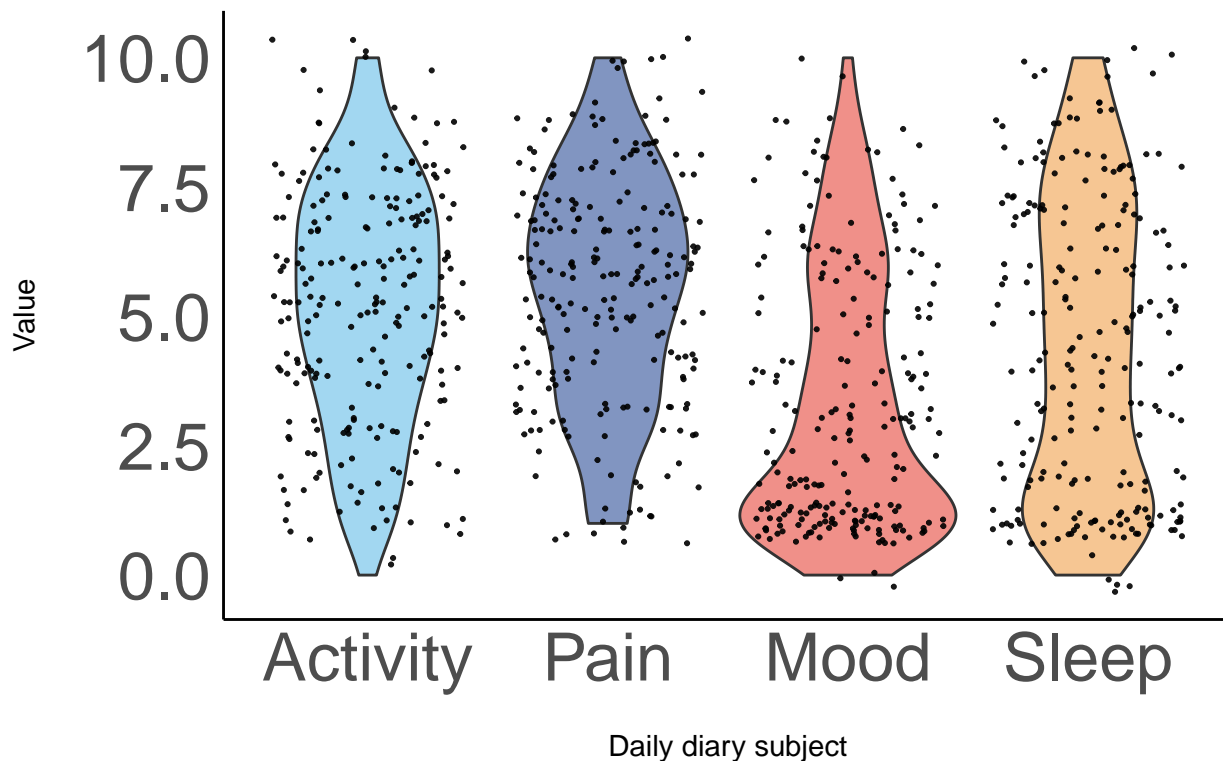
```

```

    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")

```

Violin plot of daily diary scores



```

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,

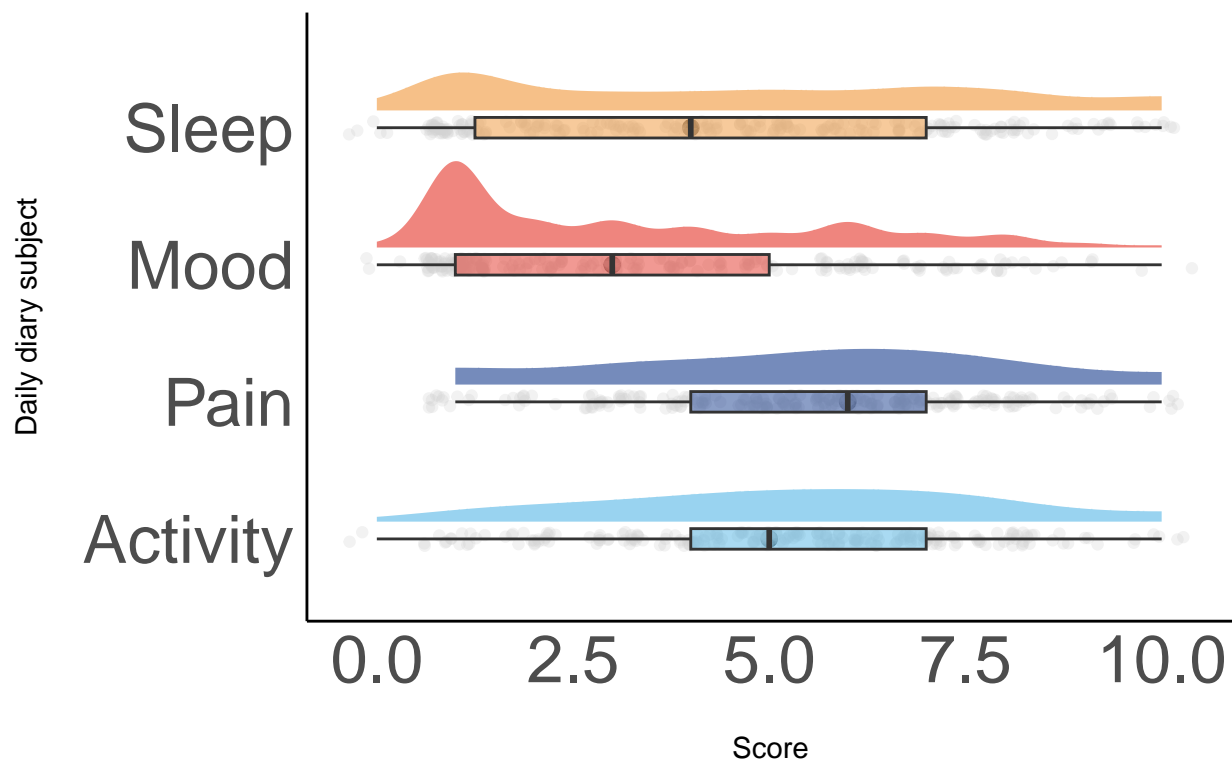
```

```

    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

## Style 2 for Pain model ****
model12 <- lmer(GlobalImprovement ~ AvePain_c * B_Demog_Age + (1|ID), data = df_new) #
summary(model12)

## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula: GlobalImprovement ~ AvePain_c * B_Demog_Age + (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 ***
## AvePain_c        -6.940e-01  6.275e-02  4.326e+03 -11.060 < 2e-16 ***
## B_Demog_Age       1.642e-02  5.135e-03  2.186e+02   3.197  0.00159 **
## AvePain_c:B_Demog_Age 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) AvPn_c B_Dm_A
## AvePain_c      0.000
## B_Demog_Age -0.964  0.000
## AvPn_:B_D_A   0.000 -0.965  0.000

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

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

predictions_act <- predict(model12, newdata = new_data_act, re.form = NULL)
new_data_act$GlobalImprovement <- predictions_act

a <- ggplot(df_new, aes(x = AvePain_c, y = GlobalImprovement, color = B_Demog_Age)) +
  geom_line(data = new_data_act, aes(group = B_Demog_Age), size = 2.5) +
  scale_color_gradientn(colors = c("#2878B5", "#9AC9DB", "#F8AC8C", "#C82423", "#FF8884"), # Change colors by age
                        name = "Age",
                        limits = range(df_new$B_Demog_Age)) +
  labs(title = "Cross-Level Moderation: Average Pain and Improvement by Age",
       x = "Average Pain",
       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; Average Pain and global improve by age")

## Saving 6.5 x 4.5 in image

## Warning: Removed 75 rows containing missing values or values outside the scale range
## (`geom_line()`).
```



```
model12 <- lmer(GlobalImprovement ~ ActivityInt_c + Mood_c + Sleep_c + AvePain_c + B_Med_OpioidsYN + (1
summary(model12)
```

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

```
## REML criterion at convergence: 15253.3
```

```
##
```

```
## Scaled residuals:
```

```
##      Min       1Q   Median       3Q      Max
## -4.9285 -0.4984 -0.0264  0.4471  5.4495
```

```
##
```

```
## Random effects:
```

```
## Groups   Name              Variance Std.Dev.
## ID       (Intercept)  1.103      1.050
## Residual                    1.458      1.207
```

```
## Number of obs: 4547, groups: ID, 222
```

```
##
```

```
## Fixed effects:
```

```
##              Estimate Std. Error      df t value Pr(>|t|)
## (Intercept)    6.20161    0.08814 218.20837  70.359 < 2e-16 ***
## ActivityInt_c  -0.18611    0.01913 4320.78542  -9.728 < 2e-16 ***
## Mood_c         -0.23456    0.01669 4320.78542 -14.055 < 2e-16 ***
## Sleep_c        -0.13345    0.01637 4320.78542  -8.153 4.59e-16 ***
## AvePain_c      -0.31707    0.02058 4320.78542 -15.407 < 2e-16 ***
## B_Med_OpioidsYN -0.57619    0.15746 220.79085  -3.659 0.000316 ***
```

```
## ---
```

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

```
##
```

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

```
##              (Intr) ActvI_ Mood_c Slep_c AvPn_c
## ActvtyInt_c  0.000
## Mood_c       0.000 -0.178
## Sleep_c      0.000 -0.195 -0.123
## AvePain_c    0.000 -0.492 -0.041 -0.279
## B_Md_OpdsYN -0.560  0.000  0.000  0.000  0.000
```

```
## Style 2 for Pain model ****
```

```
model12 <- lmer(GlobalImprovement ~ AvePain_c * B_Med_OpioidsYN + (1 | ID), data = df_new)
summary(model12)
```

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

```
## lmerModLmerTest]
```

```
## Formula: GlobalImprovement ~ AvePain_c * B_Med_OpioidsYN + (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 ***
## AvePain_c           -0.54684    0.01974  4326.79467 -27.699 < 2e-16 ***
## B_Med_OpioidsYN      -0.56945    0.15755   220.76390  -3.614 0.000373 ***
## AvePain_c:B_Med_OpioidsYN -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) AvPn_c B_M_OY
## AvePain_c    0.000
## B_Md_OpdsYN -0.560  0.000
## AP_:B_M_OYN  0.000 -0.551  0.000

new_data_act <- expand.grid(
  AvePain_c = seq(min(df_new$AvePain_c, na.rm = TRUE),
                  max(df_new$AvePain_c, na.rm = TRUE),
                  length.out = 100),
  B_Med_OpioidsYN = factor(unique(df_new$B_Med_OpioidsYN)),
  ID = unique(df_new$ID)[1]
)

predictions_act <- predict(model12, newdata = new_data_act, re.form = NA)
new_data_act$GlobalImprovement <- predictions_act

a <- ggplot(df_new, aes(x = AvePain_c, y = GlobalImprovement, color = factor(B_Med_OpioidsYN))) +
  geom_line(data = new_data_act, aes(group = factor(B_Med_OpioidsYN)), size = 2.5) +
  scale_color_manual(values = c("0" = "#299D8F", "1" = "#E9C46A"), # adjust levels if necessary
                    name = "Opioids Use") +
  labs(title = "Cross-Level Moderation: Average Pain and Improvement by Opioids Use",
       x = "Average Pain",
       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; Activity intensity and global improve

## Saving 6.5 x 4.5 in image

## Warning: Removed 30 rows containing missing values or values outside the scale range
## (`geom_line()`).

## Missingness investigation
library(naniar)
# 1. Identify IDs with any missing AvePain_c
ids_with_missing <- df_new %>%
  filter(is.na(AvePain_c)) %>%
  distinct(ID) %>%
  pull(ID)

# 2. Randomly sample 10 IDs (set seed for reproducibility)
set.seed(123)
selected_ids <- sample(ids_with_missing, 8)

# 3. Subset the data for these selected IDs
df_sample <- df_new %>%
  filter(ID %in% selected_ids)

# 4. Create a status column for observed vs missing values
df_sample <- df_sample %>%
  mutate(status = ifelse(is.na(AvePain_c), "Missing", "Observed"))

# 5. To display missing points on the plot, determine a baseline value.
# Here we use the overall minimum observed AvePain_c (from df_new) minus a small offset.
min_val <- min(df_new$AvePain_c, na.rm = TRUE)
df_sample <- df_sample %>%
  mutate(AvePain_plot = ifelse(is.na(AvePain_c), min_val - 0.5, AvePain_c))

# 6. Plot the data by ID with facets
a <- ggplot(df_sample, aes(x = Day, group = ID)) +
  # Draw lines connecting observed values (missing values cause gaps)
  geom_line(aes(y = AvePain_c), color = "grey", na.rm = TRUE) +
  # Plot points, using a different color for missing values (plotted at AvePain_plot)
  geom_point(aes(y = AvePain_plot, color = status), size = 2) +
  facet_wrap(~ ID, scales = "free_y") +
  labs(title = "Observed Patterns of Average Pain with Missingness",
       x = "Day",
       y = "Average Pain (Centered)",
       color = "Data Status") +
  scale_color_manual(values = c("Observed" = "blue", "Missing" = "red")) +
  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.line = element_line(color = "black", linewidth = 0.5)
  )
ggsave(a, dpi=1200, filename = "Figure Apr 2025; Missing Pattern Plot.tif", bg="white")

## Saving 6.5 x 4.5 in image
df_new2 <- df_new |>
  mutate(missingpain = ifelse(is.na(AvePain_c), 1, 0))
missing_model <- glmer(missingpain ~ B_Demog_Age + B_Demog_Gender + B_Clin_BMI + B_Demog_Ethnicity + B_

## Warning in checkConv(attr(opt, "derivs"), opt$par, ctrl = control$checkConv, :
## Model failed to converge with max|grad| = 0.0603533 (tol = 0.002, component 1)

## Warning in checkConv(attr(opt, "derivs"), opt$par, ctrl = control$checkConv, : Model is nearly unidentifi
## - Rescale variables?;Model is nearly unidentifiable: large eigenvalue ratio
## - Rescale variables?

summary(missing_model)

## Generalized linear mixed model fit by maximum likelihood (Laplace
## Approximation) [glmerMod]
## Family: binomial ( logit )
## Formula:
## missingpain ~ B_Demog_Age + B_Demog_Gender + B_Clin_BMI + B_Demog_Ethnicity +
## B_Clin_Height + B_Clin_Weight + B_Clin_PainDur + (1 | ID)
## Data: df_new2
##
##      AIC      BIC   logLik deviance df.resid
##  6875.7   6936.3  -3428.8   6857.7     6201
##
## Scaled residuals:
##      Min       1Q   Median       3Q      Max
## -1.6116 -0.6105 -0.3816  0.7623  3.7372
##
## Random effects:
## Groups Name             Variance Std.Dev.
## ID      (Intercept) 1.222      1.105
## Number of obs: 6210, groups: ID, 207
##
## Fixed effects:
##              Estimate Std. Error z value Pr(>|z|)
## (Intercept)  -0.9839452  0.7217436  -1.363    0.173
## B_Demog_Age   -0.0099724  0.0060977  -1.635    0.102
## B_Demog_Gender -0.1394130  0.3018483  -0.462    0.644
## B_Clin_BMI     0.0404101  0.0276554   1.461    0.144
## B_Demog_Ethnicity -0.0171475  0.0910623  -0.188    0.851
## B_Clin_Height  -0.0007784  0.0014672  -0.531    0.596
## B_Clin_Weight  -0.0021966  0.0046637  -0.471    0.638
## B_Clin_PainDur -0.0034224  0.0075091  -0.456    0.649
##
## Correlation of Fixed Effects:
##              (Intr) B_Dm_A B_Dm_G B_C_BM B_Dm_E B_Cl_H B_Cl_W
## B_Demog_Age  -0.367
## B_Demog_Gndr -0.761 -0.059
## B_Clin_BMI    0.371 -0.078 -0.648
## B_Dmg_Ethnc  -0.109  0.134 -0.049 -0.084

```

```
## B_Clin_Hght  0.022  0.012 -0.135  0.236 -0.173
## B_Clin_Wght -0.613  0.062  0.735 -0.912  0.015 -0.184
## B_Clin_PnDr  0.061 -0.217 -0.065  0.037  0.044 -0.251 -0.078
## optimizer (Nelder_Mead) convergence code: 0 (OK)
## Model failed to converge with max|grad| = 0.0603533 (tol = 0.002, component 1)
## Model is nearly unidentifiable: very large eigenvalue
## - Rescale variables?
## Model is nearly unidentifiable: large eigenvalue ratio
## - Rescale variables?
```