Pain Research - Dr. Marc O. Martel

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```
# Two different files
#setwd("~/Desktop/Project; Daily diaries; 30-days/Pain-Research-1-Dr-Marc-O-Martel/Datasets; Project; M
#setwd("~/Desktop/Project; Daily diaries; 30-days/Pain-Research-1-Dr-Marc-O-Martel/Datasets; Project; J
```

```
## Load packages
library(tidyverse)
```

```
## -- Attaching core tidyverse packages ------------------------ tidyverse 2.0.0 --
## v dplyr     1.1.4     v readr     2.1.5
## v forcats   1.0.0     v stringr   1.5.1
## v ggplot2   3.4.4     v tibble    3.2.1
## v lubridate 1.9.3     v tidyr     1.3.0
## v purrr     1.0.2
## -- Conflicts ------------------------------------------ tidyverse_conflicts() --
## x dplyr::filter() masks stats::filter()
## x dplyr::lag()    masks stats::lag()
## i Use the conflicted package (<http://conflicted.r-lib.org/>) to force all conflicts to become error
```

```
library(ggplot2)
library(tidyr)
library(haven)## This library provides functions to read sav file into R
library(lme4)
```

```
## Loading required package: Matrix
##
## Attaching package: 'Matrix'
##
## The following objects are masked from 'package:tidyr':
##
##     expand, pack, unpack
```

```
library(lmerTest)
```

```
##
## Attaching package: 'lmerTest'
##
## The following object is masked from 'package:lme4':
##
##     lmer
##
## The following object is masked from 'package:stats':
##
##     step
```

```r
## Baseline data
#df1 <- read_sav("~/Desktop/Project; Daily diaries; 30-days/Pain-Research-1-Dr-Marc-O-Martel/Datasets; 
df1 <- read_sav("E:/UWO/DR Marc O Martel data/Pain-Research-1-Dr-Marc-O-Martel/Datasets; Project; Jamis
## Daily data
#df2 <- read_sav("~/Desktop/Project; Daily diaries; 30-days/Pain-Research-1-Dr-Marc-O-Martel/Datasets; 
df2 <- read_sav("E:/UWO/DR Marc O Martel data/Pain-Research-1-Dr-Marc-O-Martel/Datasets; Project; Jamis



## Examine the duplicated observation
df1$ID[which(duplicated(df1$ID))]
```

```
## [1] 476
```

```r
df2$StudyID[which(duplicated(df2$StudyID))]
```

```
## [1] 476
```

```r
df1 <- df1 |>
  filter(!duplicated(ID))
df2 <- df2 |>
  filter(!duplicated(StudyID)) |>
  rename(ID = StudyID)

## Time variable to numerical day (consecutive)
date_cols <- grep("^Date", names(df2), value = TRUE)

df2 <- df2 %>%
  mutate(across(all_of(date_cols), as.Date, format = "%Y-%m-%d"))
```

```
## Warning: There was 1 warning in `mutate()`.
## i In argument: `across(all_of(date_cols), as.Date, format = "%Y-%m-%d")`.
## Caused by warning:
## ! The `...` argument of `across()` is deprecated as of dplyr 1.1.0.
## Supply arguments directly to `.fns` through an anonymous function instead.
##
##   # Previously
##   across(a:b, mean, na.rm = TRUE)
##
##   # Now
##   across(a:b, \(x) mean(x, na.rm = TRUE))
```

```r
## Correct abberrant years
df2 <- df2 %>%
  rowwise() %>%
  mutate(across(all_of(date_cols), ~ {
    if (. != Date1 && !is.na(.)) {
      day_diff <- as.numeric(. - Date1)
      if (day_diff < 0) {
        update(., year = year(Date1))
      } else {
        .
      }
    } else {
      .
    }
```

```
  })) %>%
  ungroup()

####### Below investigates the rest of aberrant objects #######
##### Above does not solve those entering a new year ##########
df2_investigate <- df2 |>
  pivot_longer(
  cols = starts_with("Date"),
  names_to = "Date_Number",
  values_to = "Date_Value"
) |>
  select(ID, Date_Value)

print(n = 36, df2_investigate[df2_investigate$ID == 673,])
```

```
## # A tibble: 36 x 2
##       ID Date_Value
##    <dbl> <date>
##  1   673 2023-01-04
##  2   673 2023-01-05
##  3   673 2023-01-06
##  4   673 2023-01-07
##  5   673 2023-01-08
##  6   673 2023-01-09
##  7   673 2023-01-10
##  8   673 2023-01-11
##  9   673 2023-01-12
## 10   673 2023-01-13
## 11   673 2023-01-14
## 12   673 2023-01-15
## 13   673 2023-01-16
## 14   673 2023-01-17
## 15   673 2023-01-18
## 16   673 2023-01-20
## 17   673 2023-01-21
## 18   673 2023-01-22
## 19   673 2023-01-23
## 20   673 2023-01-24
## 21   673 2023-01-25
## 22   673 2023-01-26
## 23   673 2023-01-27
## 24   673 2023-01-28
## 25   673 2023-01-29
## 26   673 2023-01-30
## 27   673 2023-01-31
## 28   673 2023-01-02
## 29   673 2023-02-08
## 30   673 2023-02-09
## 31   673 2023-02-10
## 32   673 2023-02-11
## 33   673 2023-02-12
## 34   673 2023-02-13
## 35   673 2023-02-14
## 36   673 NA
```

```
#####################################################################

## Below solved all objects date problem
df2$Date8[df2$ID == 610] <- "2023-01-01"
df2$Date8[df2$ID == 703] <- "2022-01-09"
df2$Date8[df2$ID == 741] <- "2021-01-10"
df2$Date8[df2$ID == 680] <- "2023-01-09"
df2$Date28[df2$ID == 673] <- "2023-02-02"

## Convert the date to number
df2 <- df2 |>
  mutate(across(all_of(date_cols[-1]), ~ as.numeric(. - df2$Date1 + 1)))

df2$Date1 <- 1
all_cols <- names(df2)

#for (i in 2:length(date_cols)) {
#  if (any(df2[[date_cols[i]]] == 1, na.rm = TRUE)) {
#    same_day_cols <- grep(paste0("_", i), all_cols, value = TRUE)
#    df2[df2[[date_cols[i]]] == 1 & !is.na(df2_test[[date_cols[i]]]), same_day_cols] <- NA
#  }
#}

## Wide to long
df2_long <- df2 |>
  pivot_longer(cols = -ID,
               names_to = c(".value", "day"),
               names_pattern = "([A-Za-z]+)(\\d+)") |>
  select(-day) |>
  rename(Day = Date) |>
  filter(Day <= 30 & !is.na(Day)) |>
  group_by(ID) |>
  distinct(Day, .keep_all = TRUE) |>
  complete(Day = seq(1,30))

## replace all -1 to NA
df2_long <- df2_long |>
  mutate_all(~if_else(. < 0, NA_real_, .))
```

```
## `mutate_all()` ignored the following grouping variables:
## * Column `ID`
## i Use `mutate_at(df, vars(-group_cols()), myoperation)` to silence the message.
```

```
df2_long <- df2_long |>
  rename(GlobalImprovement = Changed)

## Calculate the lagged variable
df2_long <- df2_long |>
  group_by(ID) |>
  arrange(ID, Day) |>
  mutate(AvePain_Change = AvePain - lag(AvePain),
         ActivityInt_Change = ActivityInt - lag(ActivityInt),
         Mood_Change = Mood - lag(Mood))
```

```r
df2_greaterthan7 <- df2_long |>
  group_by(ID) %>%
  summarise(NonMissingGI = sum(!is.na(GlobalImprovement))) %>%
  filter(NonMissingGI >= 7) %>%
  inner_join(df2_long, by = "ID")

## Add level 2 age, gender, and PCS to the longitudinal data
df1_temporary <- df1 |>
  select(c(B_Demog_Age, B_Demog_Gender, B_Psych_PCS, ID))

df_new <- merge(df2_greaterthan7, df1_temporary, by = "ID")

## Global improvement 10 to 1, 9 to 2, ...
df_new <- df_new |>
  mutate(GlobalImprovement = 11-GlobalImprovement)
```

```r
## lmer Analysis (GlobImp vs. AvePain_Change)
model_1 <- lmer(GlobalImprovement ~ AvePain_Change + Day + (1|ID), data = df2_greaterthan7) # Random in
summary(model_1)
```

```
## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula: GlobalImprovement ~ AvePain_Change + Day + (1 | ID)
##    Data: df2_greaterthan7
##
## REML criterion at convergence: 15963
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -5.2035 -0.4653  0.0104  0.4963  4.3924
##
## Random effects:
##  Groups   Name        Variance Std.Dev.
##  ID       (Intercept) 1.300    1.140
##  Residual             1.838    1.356
## Number of obs: 4418, groups:  ID, 334
##
## Fixed effects:
##                  Estimate Std. Error        df t value Pr(>|t|)
## (Intercept)    5.056e+00  7.627e-02 5.051e+02  66.290   <2e-16 ***
## AvePain_Change 3.912e-01  1.601e-02 4.123e+03  24.437   <2e-16 ***
## Day            5.886e-03  2.577e-03 4.236e+03   2.284   0.0224 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##             (Intr) AvPn_C
## AvePan_Chng  0.008
## Day         -0.464 -0.010
```

```r
model_2 <- lmer(GlobalImprovement ~ AvePain_Change + Day + (Day|ID), data = df2_greaterthan7) # Random
```

```
## Warning in checkConv(attr(opt, "derivs"), opt$par, ctrl = control$checkConv, :
## Model failed to converge with max|grad| = 0.00293479 (tol = 0.002, component 1)
```

```r
summary(model_2)
```

```
## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula: GlobalImprovement ~ AvePain_Change + Day + (Day | ID)
##    Data: df2_greaterthan7
##
## REML criterion at convergence: 15862.9
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -5.1370 -0.4367 -0.0004  0.4580  4.3993
##
## Random effects:
##  Groups   Name        Variance Std.Dev. Corr
##  ID       (Intercept) 1.598138 1.26418
##           Day         0.002075 0.04555  -0.44
##  Residual             1.706147 1.30620
## Number of obs: 4418, groups:  ID, 334
##
## Fixed effects:
##                  Estimate Std. Error        df t value Pr(>|t|)
## (Intercept)    5.061e+00  8.294e-02 2.907e+02  61.017   <2e-16 ***
## AvePain_Change 3.921e-01  1.558e-02 3.976e+03  25.171   <2e-16 ***
## Day            5.328e-03  3.826e-03 2.341e+02   1.393    0.165
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##             (Intr) AvPn_C
## AvePan_Chng  0.007
## Day         -0.579 -0.008
## optimizer (nloptwrap) convergence code: 0 (OK)
## Model failed to converge with max|grad| = 0.00293479 (tol = 0.002, component 1)
```

```r
model_3 <- lmer(GlobalImprovement ~ AvePain_Change + Mood_Change + Day + (1|ID), data = df2_greaterthan
summary(model_3)
```

```
## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula: GlobalImprovement ~ AvePain_Change + Mood_Change + Day + (1 |      ID)
##    Data: df2_greaterthan7
##
## REML criterion at convergence: 15831.4
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -5.1162 -0.4627  0.0070  0.4953  4.4936
##
## Random effects:
##  Groups   Name        Variance Std.Dev.
##  ID       (Intercept) 1.280    1.131
##  Residual             1.783    1.335
## Number of obs: 4416, groups:  ID, 334
```

```
##
## Fixed effects:
##                  Estimate Std. Error        df t value Pr(>|t|)
## (Intercept)    5.055e+00  7.551e-02 5.045e+02  66.946   <2e-16 ***
## AvePain_Change 3.502e-01  1.618e-02 4.118e+03  21.649   <2e-16 ***
## Mood_Change    1.741e-01  1.530e-02 4.124e+03  11.378   <2e-16 ***
## Day            6.057e-03  2.540e-03 4.232e+03   2.385   0.0171 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##             (Intr) AvPn_C Md_Chn
## AvePan_Chng  0.007
## Mood_Change  0.001 -0.222
## Day         -0.461 -0.011  0.001
```

```
model_4 <- lmer(GlobalImprovement ~ AvePain_Change + Mood_Change + Day + (Day|ID), data = df2_greaterth
```

```
## Warning in checkConv(attr(opt, "derivs"), opt$par, ctrl = control$checkConv, :
## Model failed to converge with max|grad| = 0.0080542 (tol = 0.002, component 1)
```

```
summary(model_4)
```

```
## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula: GlobalImprovement ~ AvePain_Change + Mood_Change + Day + (Day |
##     ID)
##    Data: df2_greaterthan7
##
## REML criterion at convergence: 15723.1
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -5.0140 -0.4439 -0.0015  0.4708  4.5065
##
## Random effects:
##  Groups   Name        Variance Std.Dev. Corr
##  ID       (Intercept) 1.602434 1.26587
##           Day         0.002127 0.04611  -0.45
##  Residual             1.648244 1.28384
## Number of obs: 4416, groups:  ID, 334
##
## Fixed effects:
##                  Estimate Std. Error        df t value Pr(>|t|)
## (Intercept)    5.060e+00  8.269e-02 2.914e+02  61.192   <2e-16 ***
## AvePain_Change 3.512e-01  1.571e-02 3.969e+03  22.350   <2e-16 ***
## Mood_Change    1.736e-01  1.484e-02 3.962e+03  11.695   <2e-16 ***
## Day            5.407e-03  3.821e-03 2.355e+02   1.415    0.158
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##             (Intr) AvPn_C Md_Chn
## AvePan_Chng  0.007
## Mood_Change  0.000 -0.222
```

```
## Day         -0.585 -0.008 -0.001
## optimizer (nloptwrap) convergence code: 0 (OK)
## Model failed to converge with max|grad| = 0.0080542 (tol = 0.002, component 1)
```

```
## Model comparison for above analysis
anova(model_1, model_2)
```

```
## refitting model(s) with ML (instead of REML)
```

```
## Data: df2_greaterthan7
## Models:
## model_1: GlobalImprovement ~ AvePain_Change + Day + (1 | ID)
## model_2: GlobalImprovement ~ AvePain_Change + Day + (Day | ID)
##         npar   AIC   BIC  logLik deviance  Chisq Df Pr(>Chisq)
## model_1    5 15953 15985 -7971.5    15943
## model_2    7 15858 15902 -7921.8    15844 99.331  2  < 2.2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
anova(model_3, model_4)
```

```
## refitting model(s) with ML (instead of REML)
```

```
## Data: df2_greaterthan7
## Models:
## model_3: GlobalImprovement ~ AvePain_Change + Mood_Change + Day + (1 | ID)
## model_4: GlobalImprovement ~ AvePain_Change + Mood_Change + Day + (Day | ID)
##         npar   AIC   BIC  logLik deviance  Chisq Df Pr(>Chisq)
## model_3    6 15817 15855 -7902.4    15805
## model_4    8 15713 15764 -7848.6    15697 107.57  2  < 2.2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
## lmer Analysis (GlobImp vs. Mood_Change)
model_5 <- lmer(GlobalImprovement ~ Mood_Change + Day + (1|ID), data = df2_greaterthan7) # random inter
summary(model_5)
```

```
## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula: GlobalImprovement ~ Mood_Change + Day + (1 | ID)
##    Data: df2_greaterthan7
##
## REML criterion at convergence: 16284.1
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -4.1992 -0.4668 -0.0036  0.4831  4.5103
##
## Random effects:
##  Groups   Name        Variance Std.Dev.
##  ID       (Intercept) 1.292    1.137
##  Residual             1.987    1.410
## Number of obs: 4418, groups:  ID, 334
##
## Fixed effects:
##              Estimate Std. Error        df t value Pr(>|t|)
## (Intercept) 5.046e+00  7.709e-02 5.213e+02  65.462   <2e-16 ***
```

```
## Mood_Change 2.482e-01  1.575e-02 4.133e+03  15.759   <2e-16 ***
## Day         6.339e-03  2.677e-03 4.246e+03   2.368   0.0179 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##             (Intr) Md_Chn
## Mood_Change  0.002
## Day         -0.477 -0.001
```

```
model_6 <- lmer(GlobalImprovement ~ Mood_Change + Day + (Day|ID), data = df2_greaterthan7) # Add random
```

```
## Warning in checkConv(attr(opt, "derivs"), opt$par, ctrl = control$checkConv, :
## Model failed to converge with max|grad| = 0.00397988 (tol = 0.002, component 1)
```

```
summary(model_6)
```

```
## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula: GlobalImprovement ~ Mood_Change + Day + (Day | ID)
##    Data: df2_greaterthan7
##
## REML criterion at convergence: 16203.4
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -4.3118 -0.4244 -0.0109  0.4523  4.5002
##
## Random effects:
##  Groups   Name        Variance Std.Dev. Corr
##  ID       (Intercept) 1.552117 1.24584
##           Day         0.001928 0.04391  -0.42
##  Residual             1.863542 1.36512
## Number of obs: 4418, groups:  ID, 334
##
## Fixed effects:
##              Estimate Std. Error        df t value Pr(>|t|)
## (Intercept) 5.049e+00  8.297e-02 2.889e+02  60.850   <2e-16 ***
## Mood_Change 2.477e-01  1.537e-02 3.982e+03  16.119   <2e-16 ***
## Day         5.917e-03  3.831e-03 2.347e+02   1.545    0.124
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##             (Intr) Md_Chn
## Mood_Change  0.002
## Day         -0.577 -0.002
## optimizer (nloptwrap) convergence code: 0 (OK)
## Model failed to converge with max|grad| = 0.00397988 (tol = 0.002, component 1)
```

```
anova(model_5, model_6) # prefer random slope + intercept
```

```
## refitting model(s) with ML (instead of REML)
```

```
## Data: df2_greaterthan7
## Models:
## model_5: GlobalImprovement ~ Mood_Change + Day + (1 | ID)
```

```
## model_6: GlobalImprovement ~ Mood_Change + Day + (Day | ID)
##         npar   AIC   BIC logLik deviance  Chisq Df Pr(>Chisq)
## model_5    5 16274 16306  -8132    16264
## model_6    7 16198 16243  -8092    16184 79.939  2  < 2.2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
model_4plus <- lmer(GlobalImprovement ~ AvePain_Change + Mood_Change + Sleep + Day + (Day|ID),
                    data = df2_greaterthan7)
```

```
## Warning in checkConv(attr(opt, "derivs"), opt$par, ctrl = control$checkConv, :
## Model failed to converge with max|grad| = 0.010327 (tol = 0.002, component 1)
```

```
summary(model_4plus)
```

```
## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula: GlobalImprovement ~ AvePain_Change + Mood_Change + Sleep + Day +
##     (Day | ID)
##    Data: df2_greaterthan7
##
## REML criterion at convergence: 15133.5
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -5.6944 -0.4464  0.0247  0.4596  4.4767
##
## Random effects:
##  Groups   Name        Variance Std.Dev. Corr
##  ID       (Intercept) 1.42773  1.19488
##           Day         0.00196  0.04428  -0.55
##  Residual             1.44937  1.20390
## Number of obs: 4415, groups:  ID, 334
##
## Fixed effects:
##                  Estimate Std. Error        df t value Pr(>|t|)
## (Intercept)    3.559e+00  9.846e-02 5.555e+02  36.145   <2e-16 ***
## AvePain_Change 2.811e-01  1.499e-02 4.037e+03  18.749   <2e-16 ***
## Mood_Change    1.532e-01  1.395e-02 3.950e+03  10.984   <2e-16 ***
## Sleep          3.196e-01  1.275e-02 2.254e+03  25.074   <2e-16 ***
## Day            8.056e-03  3.619e-03 2.251e+02   2.226    0.027 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##             (Intr) AvPn_C Md_Chn Sleep
## AvePan_Chng  0.118
## Mood_Change  0.038 -0.207
## Sleep       -0.610 -0.185 -0.061
## Day         -0.528 -0.013 -0.003  0.033
## optimizer (nloptwrap) convergence code: 0 (OK)
## Model failed to converge with max|grad| = 0.010327 (tol = 0.002, component 1)
```

```
confint(model_4plus)
```

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

```
##                       2.5 %      97.5 %
## .sig01           1.067452536  1.32927467
## .sig02          -0.661350130 -0.40598666
## .sig03           0.036925411  0.05186034
## .sigma           1.176821096  1.23126884
## (Intercept)      3.363607156  3.75301219
## AvePain_Change   0.251740310  0.31058156
## Mood_Change      0.125885124  0.18057442
## Sleep            0.294104583  0.34508793
## Day              0.000939749  0.01515566
```

```
model_4plus_level2 <- lmer(GlobalImprovement ~ AvePain_Change + Mood_Change + Sleep + B_Demog_Age + B_D
                     data = df_new)
```

```
## Warning in checkConv(attr(opt, "derivs"), opt$par, ctrl = control$checkConv, :
## Model failed to converge with max|grad| = 0.0129052 (tol = 0.002, component 1)
```

```
model_test1 <- lmer(GlobalImprovement ~ B_Demog_Age + Day + (Day|ID),
                     data = df_new)
```

```
## Warning in checkConv(attr(opt, "derivs"), opt$par, ctrl = control$checkConv, :
## Model failed to converge with max|grad| = 0.0775683 (tol = 0.002, component 1)
```

```
summary(model_test1)
```

```
## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula: GlobalImprovement ~ B_Demog_Age + Day + (Day | ID)
##    Data: df_new
##
## REML criterion at convergence: 23973.7
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -4.4086 -0.4380  0.0102  0.4437  4.6538
##
## Random effects:
##  Groups   Name        Variance Std.Dev. Corr
##  ID       (Intercept) 1.241442 1.11420
##           Day         0.001468 0.03831  -0.28
##  Residual             2.177044 1.47548
## Number of obs: 6349, groups:  ID, 336
##
## Fixed effects:
##               Estimate Std. Error         df t value Pr(>|t|)
## (Intercept)   5.466750   0.237260 342.682521  23.041   <2e-16 ***
## B_Demog_Age   0.009224   0.004299 330.855128   2.146   0.0326 *
## Day          -0.004876   0.003131 273.540710  -1.558   0.1205
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##             (Intr) B_Dm_A
## B_Demog_Age -0.954
## Day         -0.133 -0.012
## optimizer (nloptwrap) convergence code: 0 (OK)
```

```
## Model failed to converge with max|grad| = 0.0775683 (tol = 0.002, component 1)
```

```
model_test2 <- lmer(GlobalImprovement ~ B_Demog_Age + AvePain_Change + Mood_Change + Sleep + Day + (Day
                    data = df_new)
```

```
## Warning in checkConv(attr(opt, "derivs"), opt$par, ctrl = control$checkConv, :
## Model failed to converge with max|grad| = 0.0059806 (tol = 0.002, component 1)
```

```
summary(model_test2)
```

```
## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula: GlobalImprovement ~ B_Demog_Age + AvePain_Change + Mood_Change +
##     Sleep + Day + (Day | ID)
##    Data: df_new
##
## REML criterion at convergence: 15142.6
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -4.4760 -0.4598 -0.0250  0.4465  5.6947
##
## Random effects:
##  Groups   Name        Variance Std.Dev. Corr
##  ID       (Intercept) 1.432282 1.19678
##           Day         0.001961 0.04428  -0.55
##  Residual             1.449363 1.20389
## Number of obs: 4415, groups:  ID, 334
##
## Fixed effects:
##                  Estimate Std. Error         df t value Pr(>|t|)
## (Intercept)     7.412e+00  2.462e-01  3.773e+02  30.101   <2e-16 ***
## B_Demog_Age     5.454e-04  4.188e-03  3.054e+02   0.130   0.8965
## AvePain_Change -2.811e-01  1.500e-02  4.035e+03 -18.745   <2e-16 ***
## Mood_Change    -1.532e-01  1.395e-02  3.950e+03 -10.984   <2e-16 ***
## Sleep          -3.196e-01  1.281e-02  2.308e+03 -24.941   <2e-16 ***
## Day            -8.067e-03  3.620e-03  2.251e+02  -2.229   0.0268 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##             (Intr) B_Dm_A AvPn_C Md_Chn Sleep
## B_Demog_Age -0.916
## AvePan_Chng  0.067 -0.021
## Mood_Change  0.024 -0.009 -0.207
## Sleep       -0.331  0.096 -0.186 -0.062
## Day         -0.191 -0.021 -0.013 -0.003  0.031
## optimizer (nloptwrap) convergence code: 0 (OK)
## Model failed to converge with max|grad| = 0.0059806 (tol = 0.002, component 1)
```

```
model_test3 <- lmer(GlobalImprovement ~ B_Psych_PCS + Day + (Day|ID),
                    data = df_new)
summary(model_test3)
```

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

```
## Formula: GlobalImprovement ~ B_Psych_PCS + Day + (Day | ID)
##    Data: df_new
##
## REML criterion at convergence: 16744.1
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -4.4168 -0.4400  0.0031  0.4337  4.9132
##
## Random effects:
##  Groups   Name        Variance Std.Dev. Corr
##  ID       (Intercept) 0.994687 0.99734
##           Day         0.001185 0.03443  -0.21
##  Residual             1.995544 1.41264
## Number of obs: 4552, groups:  ID, 222
##
## Fixed effects:
##               Estimate Std. Error         df t value Pr(>|t|)
## (Intercept)   6.585969   0.131239 238.585756  50.183  < 2e-16 ***
## B_Psych_PCS  -0.025485   0.005415 219.078072  -4.707 4.47e-06 ***
## Day          -0.004828   0.003443 190.828246  -1.402    0.163
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##             (Intr) B_P_PC
## B_Psych_PCS -0.799
## Day         -0.274  0.004
```

```
model_test4 <- lmer(GlobalImprovement ~ B_Psych_PCS + AvePain_Change + Mood_Change + Sleep + Day + (Day
                    data = df_new)
```

```
## Warning in checkConv(attr(opt, "derivs"), opt$par, ctrl = control$checkConv, :
## Model failed to converge with max|grad| = 0.121871 (tol = 0.002, component 1)
```

```
summary(model_test4)
```

```
## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula: GlobalImprovement ~ B_Psych_PCS + AvePain_Change + Mood_Change +
##     Sleep + Day + (Day | ID)
##    Data: df_new
##
## REML criterion at convergence: 11140
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -4.6167 -0.4531 -0.0193  0.4315  5.6667
##
## Random effects:
##  Groups   Name        Variance Std.Dev. Corr
##  ID       (Intercept) 1.270650 1.127
##           Day         0.001681 0.041    -0.50
##  Residual             1.387693 1.178
## Number of obs: 3300, groups:  ID, 221
```

```
##
## Fixed effects:
##                  Estimate Std. Error         df t value Pr(>|t|)
## (Intercept)     7.499e+00  1.456e-01  2.793e+02  51.486   <2e-16 ***
## B_Psych_PCS    -3.731e-03  5.544e-03  2.171e+02  -0.673   0.5017
## AvePain_Change -2.560e-01  1.672e-02  3.045e+03 -15.309   <2e-16 ***
## Mood_Change    -1.471e-01  1.617e-02  2.982e+03  -9.093   <2e-16 ***
## Sleep          -3.048e-01  1.557e-02  1.648e+03 -19.576   <2e-16 ***
## Day            -8.990e-03  3.979e-03  1.611e+02  -2.259   0.0252 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##             (Intr) B_P_PC AvPn_C Md_Chn Sleep
## B_Psych_PCS -0.654
## AvePan_Chng  0.060  0.039
## Mood_Change  0.013  0.009 -0.178
## Sleep       -0.305 -0.199 -0.184 -0.036
## Day         -0.384  0.008 -0.008 -0.006  0.010
## optimizer (nloptwrap) convergence code: 0 (OK)
## Model failed to converge with max|grad| = 0.121871 (tol = 0.002, component 1)
```

```
model_test5 <- lmer(GlobalImprovement ~ Mood_Change*B_Demog_Gender + Day + (Day|ID), data = df_new)
```

```
## Warning in checkConv(attr(opt, "derivs"), opt$par, ctrl = control$checkConv, :
## Model failed to converge with max|grad| = 0.00782746 (tol = 0.002, component 1)
```

```
summary(model_test5)
```

```
## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula: GlobalImprovement ~ Mood_Change * B_Demog_Gender + Day + (Day |
##     ID)
##    Data: df_new
##
## REML criterion at convergence: 16201.5
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -4.5066 -0.4503  0.0079  0.4262  4.2974
##
## Random effects:
##  Groups   Name        Variance Std.Dev. Corr
##  ID       (Intercept) 1.521019 1.23330
##           Day         0.001905 0.04365  -0.40
##  Residual             1.861099 1.36422
## Number of obs: 4418, groups:  ID, 334
##
## Fixed effects:
##                              Estimate Std. Error         df t value Pr(>|t|)
## (Intercept)                 5.621e+00  2.863e-01  3.304e+02  19.633  < 2e-16
## Mood_Change                -4.122e-01  6.286e-02  3.975e+03  -6.557  6.2e-11
## B_Demog_Gender              1.904e-01  1.568e-01  3.152e+02   1.214  0.22548
## Day                        -6.091e-03  3.820e-03  2.348e+02  -1.594  0.11218
## Mood_Change:B_Demog_Gender  9.457e-02  3.503e-02  3.976e+03   2.700  0.00696
```

```
##
## (Intercept)                ***
## Mood_Change                ***
## B_Demog_Gender
## Day
## Mood_Change:B_Demog_Gender **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##             (Intr) Md_Chn B_Dm_G Day
## Mood_Change -0.007
## B_Demg_Gndr -0.958  0.004
## Day         -0.156  0.009 -0.008
## Md_Ch:B_D_G  0.006 -0.970 -0.004 -0.010
## optimizer (nloptwrap) convergence code: 0 (OK)
## Model failed to converge with max|grad| = 0.00782746 (tol = 0.002, component 1)
```

```
model_test6 <- lmer(GlobalImprovement ~ B_Demog_Gender*AvePain_Change + Day + (Day|ID),
                    data = df_new)
```

```
## Warning in checkConv(attr(opt, "derivs"), opt$par, ctrl = control$checkConv, :
## Model failed to converge with max|grad| = 0.0340765 (tol = 0.002, component 1)
```

```
summary(model_test6)
```

```
## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula: GlobalImprovement ~ B_Demog_Gender * AvePain_Change + Day + (Day |
##     ID)
##    Data: df_new
##
## REML criterion at convergence: 15866.7
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -4.4128 -0.4554  0.0003  0.4378  5.0895
##
## Random effects:
##  Groups   Name        Variance Std.Dev. Corr
##  ID       (Intercept) 1.571227 1.25349
##           Day         0.002063 0.04542  -0.42
##  Residual             1.706245 1.30623
## Number of obs: 4418, groups:  ID, 334
##
## Fixed effects:
##                                Estimate Std. Error         df t value Pr(>|t|)
## (Intercept)                   5.594e+00  2.857e-01  3.306e+02  19.579  < 2e-16
## B_Demog_Gender                1.977e-01  1.564e-01  3.151e+02   1.264    0.207
## AvePain_Change               -4.678e-01  6.712e-02  3.929e+03  -6.969 3.72e-12
## Day                          -5.428e-03  3.822e-03  2.341e+02  -1.420    0.157
## B_Demog_Gender:AvePain_Change  4.284e-02  3.692e-02  3.940e+03   1.160    0.246
##
## (Intercept)                   ***
## B_Demog_Gender
```

```
## AvePain_Change                ***
## Day
## B_Demog_Gender:AvePain_Change
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##             (Intr) B_Dm_G AvPn_C Day
## B_Demg_Gndr -0.957
## AvePan_Chng  0.001 -0.002
## Day         -0.157 -0.008  0.006
## B_Dm_G:AP_C -0.001  0.003 -0.973 -0.008
## optimizer (nloptwrap) convergence code: 0 (OK)
## Model failed to converge with max|grad| = 0.0340765 (tol = 0.002, component 1)
```

```
model_test7 <- lmer(GlobalImprovement ~ B_Demog_Age*AvePain_Change + Day + (Day|ID),
                    data = df_new)
```

```
## Warning in checkConv(attr(opt, "derivs"), opt$par, ctrl = control$checkConv, :
## Model failed to converge with max|grad| = 0.00875513 (tol = 0.002, component 1)
```

```
summary(model_test7)
```

```
## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula: GlobalImprovement ~ B_Demog_Age * AvePain_Change + Day + (Day |
##     ID)
##    Data: df_new
##
## REML criterion at convergence: 15878.7
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -4.4189 -0.4552 -0.0016  0.4362  5.1422
##
## Random effects:
##  Groups   Name        Variance Std.Dev. Corr
##  ID       (Intercept) 1.601984 1.26570
##           Day         0.002085 0.04566  -0.45
##  Residual             1.706185 1.30621
## Number of obs: 4418, groups:  ID, 334
##
## Fixed effects:
##                               Estimate Std. Error         df t value Pr(>|t|)
## (Intercept)                  5.415e+00  2.591e-01  3.303e+02  20.900  < 2e-16
## B_Demog_Age                  9.980e-03  4.673e-03  3.135e+02   2.136   0.0335
## AvePain_Change              -4.303e-01  5.630e-02  3.922e+03  -7.642 2.67e-14
## Day                         -5.484e-03  3.830e-03  2.342e+02  -1.432   0.1535
## B_Demog_Age:AvePain_Change  7.261e-04  1.034e-03  3.922e+03   0.702   0.4826
##
## (Intercept)                 ***
## B_Demog_Age                 *
## AvePain_Change              ***
## Day
## B_Demog_Age:AvePain_Change
```

```
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##             (Intr) B_Dm_A AvPn_C Day
## B_Demog_Age -0.947
## AvePan_Chng  0.002  0.000
## Day         -0.167 -0.022 -0.003
## B_Dm_A:AP_C  0.000 -0.001 -0.961  0.001
## optimizer (nloptwrap) convergence code: 0 (OK)
## Model failed to converge with max|grad| = 0.00875513 (tol = 0.002, component 1)
```

```
model_test8 <- lmer(GlobalImprovement ~ B_Demog_Age*Mood_Change + Day + (Day|ID),
                    data = df_new)
```

```
## Warning in checkConv(attr(opt, "derivs"), opt$par, ctrl = control$checkConv, :
## Model failed to converge with max|grad| = 0.0264044 (tol = 0.002, component 1)
```

```
summary(model_test8)
```

```
## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula: GlobalImprovement ~ B_Demog_Age * Mood_Change + Day + (Day |      ID)
##    Data: df_new
##
## REML criterion at convergence: 16219.5
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -4.5099 -0.4513  0.0097  0.4216  4.3075
##
## Random effects:
##  Groups   Name        Variance Std.Dev. Corr
##  ID       (Intercept) 1.554156 1.24666
##           Day         0.001933 0.04397  -0.43
##  Residual             1.863639 1.36515
## Number of obs: 4418, groups:  ID, 334
##
## Fixed effects:
##                             Estimate Std. Error         df t value Pr(>|t|)
## (Intercept)                5.439e+00  2.596e-01  3.297e+02  20.952  < 2e-16 ***
## B_Demog_Age                9.762e-03  4.684e-03  3.132e+02   2.084 0.037961 *
## Mood_Change               -2.154e-01  5.632e-02  3.973e+03  -3.824 0.000133 ***
## Day                       -6.099e-03  3.833e-03  2.348e+02  -1.591 0.112936
## B_Demog_Age:Mood_Change -6.277e-04  1.045e-03  3.956e+03  -0.600 0.548265
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##             (Intr) B_Dm_A Md_Chn Day
## B_Demog_Age -0.947
## Mood_Change  0.014 -0.012
## Day         -0.165 -0.022 -0.009
## B_Dmg_A:M_C -0.013  0.011 -0.962  0.009
## optimizer (nloptwrap) convergence code: 0 (OK)
```

```
## Model failed to converge with max|grad| = 0.0264044 (tol = 0.002, component 1)
```

```
#### PCS * AvePain_Change ####
model_test9 <- lmer(GlobalImprovement ~ B_Psych_PCS*AvePain_Change + Day + (Day|ID),
                    data = df_new)
```

```
## Warning in checkConv(attr(opt, "derivs"), opt$par, ctrl = control$checkConv, :
## Model failed to converge with max|grad| = 0.979496 (tol = 0.002, component 1)
```

```
summary(model_test9)
```

```
## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula: GlobalImprovement ~ B_Psych_PCS * AvePain_Change + Day + (Day |
##     ID)
##    Data: df_new
##
## REML criterion at convergence: 11591.6
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -4.6726 -0.4446 -0.0041  0.4220  5.5014
##
## Random effects:
##  Groups   Name        Variance Std.Dev. Corr
##  ID       (Intercept) 1.167685 1.08059
##           Day         0.001578 0.03972  -0.32
##  Residual             1.601078 1.26534
## Number of obs: 3302, groups:  ID, 221
##
## Fixed effects:
##                               Estimate Std. Error         df t value Pr(>|t|)
## (Intercept)                  6.628e+00  1.426e-01  2.474e+02  46.461  < 2e-16
## B_Psych_PCS                 -2.521e-02  5.765e-03  2.222e+02  -4.373 1.89e-05
## AvePain_Change              -2.900e-01  3.116e-02  2.972e+03  -9.305  < 2e-16
## Day                         -8.056e-03  4.051e-03  1.629e+02  -1.989   0.0484
## B_Psych_PCS:AvePain_Change -2.897e-03  1.334e-03  2.981e+03  -2.171   0.0300
##
## (Intercept)                 ***
## B_Psych_PCS                 ***
## AvePain_Change              ***
## Day                         *
## B_Psych_PCS:AvePain_Change *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##             (Intr) B_Ps_PCS AvPn_C Day
## B_Psych_PCS -0.787
## AvePan_Chng  0.012 -0.011
## Day         -0.325  0.003   -0.007
## B_P_PCS:AP_ -0.011  0.014   -0.831  0.003
## optimizer (nloptwrap) convergence code: 0 (OK)
## Model failed to converge with max|grad| = 0.979496 (tol = 0.002, component 1)
```

```
model_test10 <- lmer(GlobalImprovement ~ B_Psych_PCS*Mood_Change + Day + (Day|ID),
                     data = df_new)
```

```
## Warning in checkConv(attr(opt, "derivs"), opt$par, ctrl = control$checkConv, :
## Model failed to converge with max|grad| = 0.0413933 (tol = 0.002, component 1)
```

```
summary(model_test10)
```

```
## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula: GlobalImprovement ~ B_Psych_PCS * Mood_Change + Day + (Day |      ID)
##    Data: df_new
##
## REML criterion at convergence: 11826.5
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -4.7230 -0.4361  0.0041  0.4208  3.6454
##
## Random effects:
##  Groups   Name        Variance Std.Dev. Corr
##  ID       (Intercept) 1.218093 1.10367
##           Day         0.001518 0.03896  -0.33
##  Residual             1.729248 1.31501
## Number of obs: 3302, groups:  ID, 221
##
## Fixed effects:
##                              Estimate Std. Error         df t value Pr(>|t|)
## (Intercept)                 6.633e+00  1.457e-01  2.349e+02  45.517  < 2e-16 ***
## B_Psych_PCS                -2.506e-02  5.873e-03  2.114e+02  -4.268 2.98e-05 ***
## Mood_Change                -1.543e-01  3.797e-02  3.005e+03  -4.063 4.97e-05 ***
## Day                        -8.152e-03  4.086e-03  1.583e+02  -1.995   0.0477 *
## B_Psych_PCS:Mood_Change -2.518e-03  1.356e-03  3.026e+03  -1.857   0.0634 .
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##             (Intr) B_Ps_PCS Md_Chn Day
## B_Psych_PCS -0.785
## Mood_Change  0.007 -0.008
## Day         -0.333  0.004   -0.001
## B_P_PCS:M_C -0.007  0.011   -0.885 -0.003
## optimizer (nloptwrap) convergence code: 0 (OK)
## Model failed to converge with max|grad| = 0.0413933 (tol = 0.002, component 1)
```