Surprise Study Pilot 9 Analysis

Marjan Biria

Study description

Pilot 9: prediction + with feedback (bigger PE) + incorporating feedback from YPAG (OCT 2023)

Goal: We used the task version from pilot 6 (bigger positive feedback being 20-30 points bigger than histogram mean), as this showed better relationship between PE, anxiety and mood. We took some of the feedback we received from the YPAG members into account here: 1) added a progress bar so that people know how much longer is left from the session, 2) make timing of feedback presentation more variable (1-4s) to make it more believable that someone is writing the rating, 3) changing the way we ask the question about emotion ratings, instead of "at the moment" we ask "right now": how happy do you feel right now, 4) we have replaced the word "anxious" with "nervous or uncomfortable": how nervous or uncomfortable fo you feel at the moment? Participants were not screened for social anxiety. Experiment can be found here: https://app.gorilla.sc/admin/experiment/150440/design, the task can be found here: https://app.gorilla.sc/admin/task/693731/editor?version=7

Histogram and prediction relationship

Subject “SUPPRF66080” was excluded since they had not done all the trials.

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## [1] "average correlation between prediction and m_hist: 0.51799289508939"
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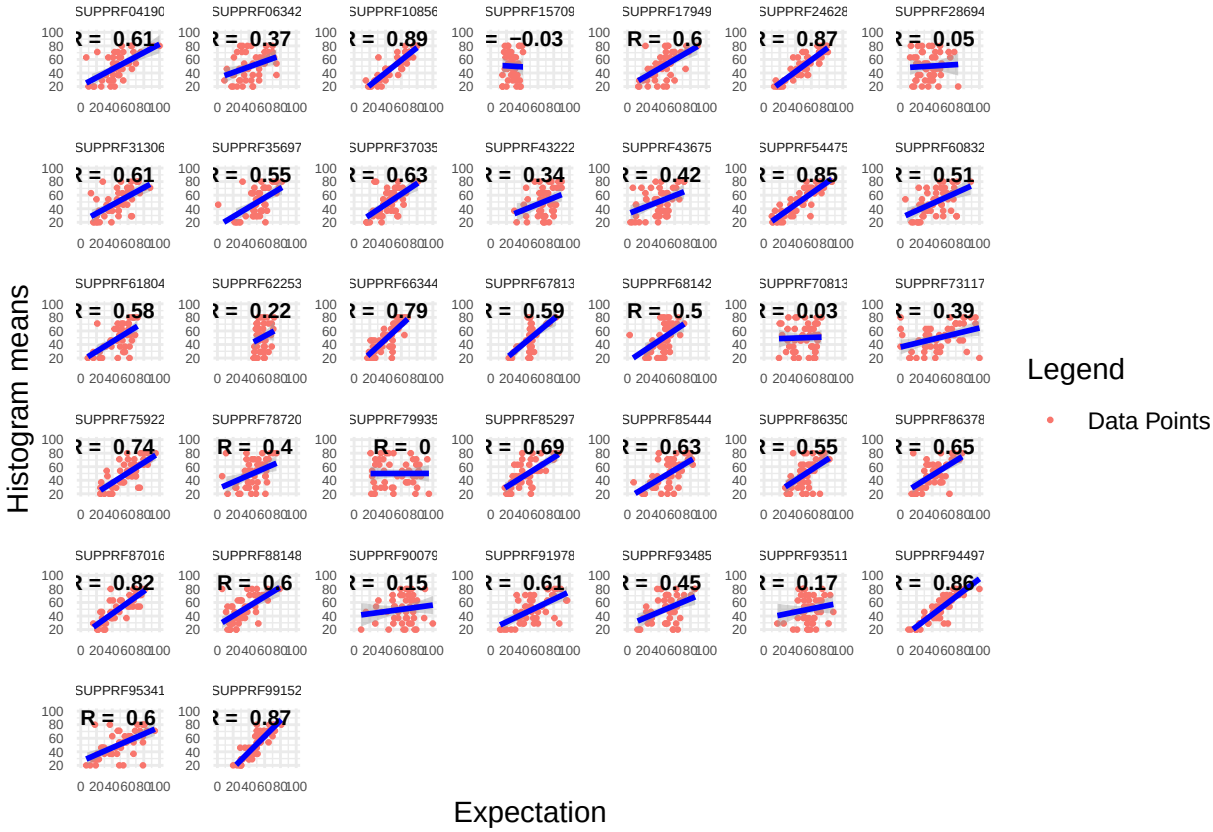

Below we can see the average correlation between hist_mean and prediction and the histogram of the individual correlations.

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## [1] "average of correlations: 0.51799289508939"
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## [1] "sd of correlations: 0.259388281008356"
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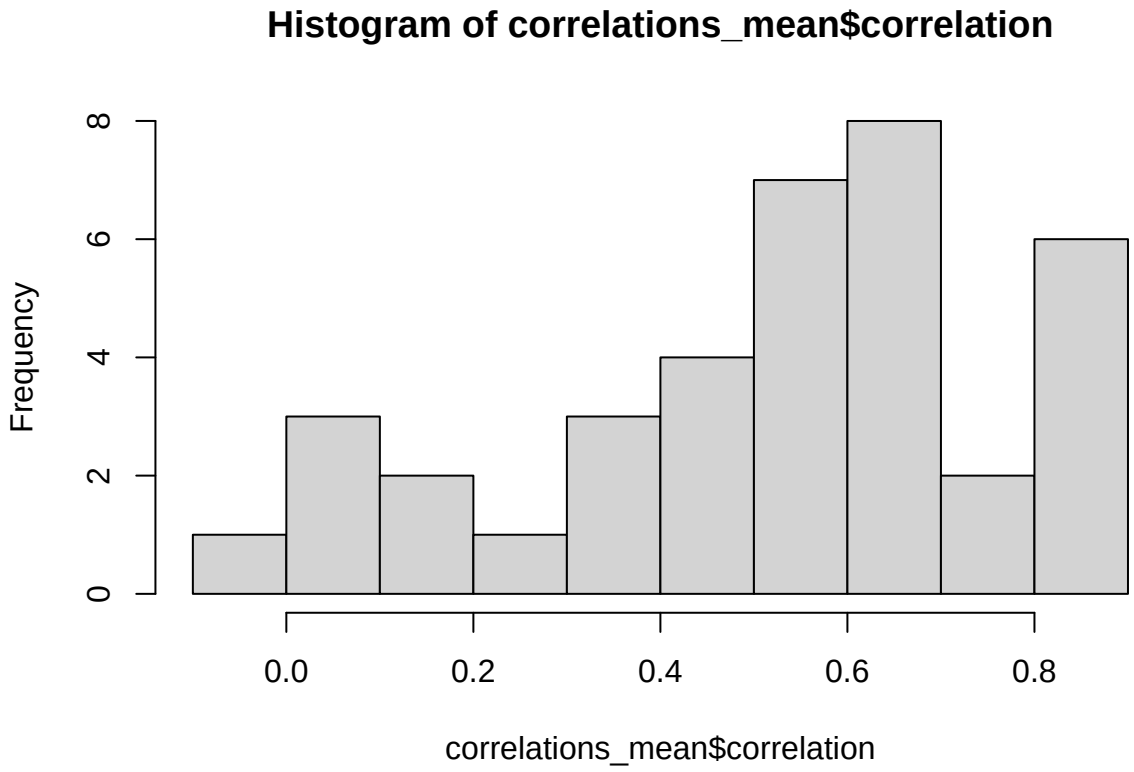
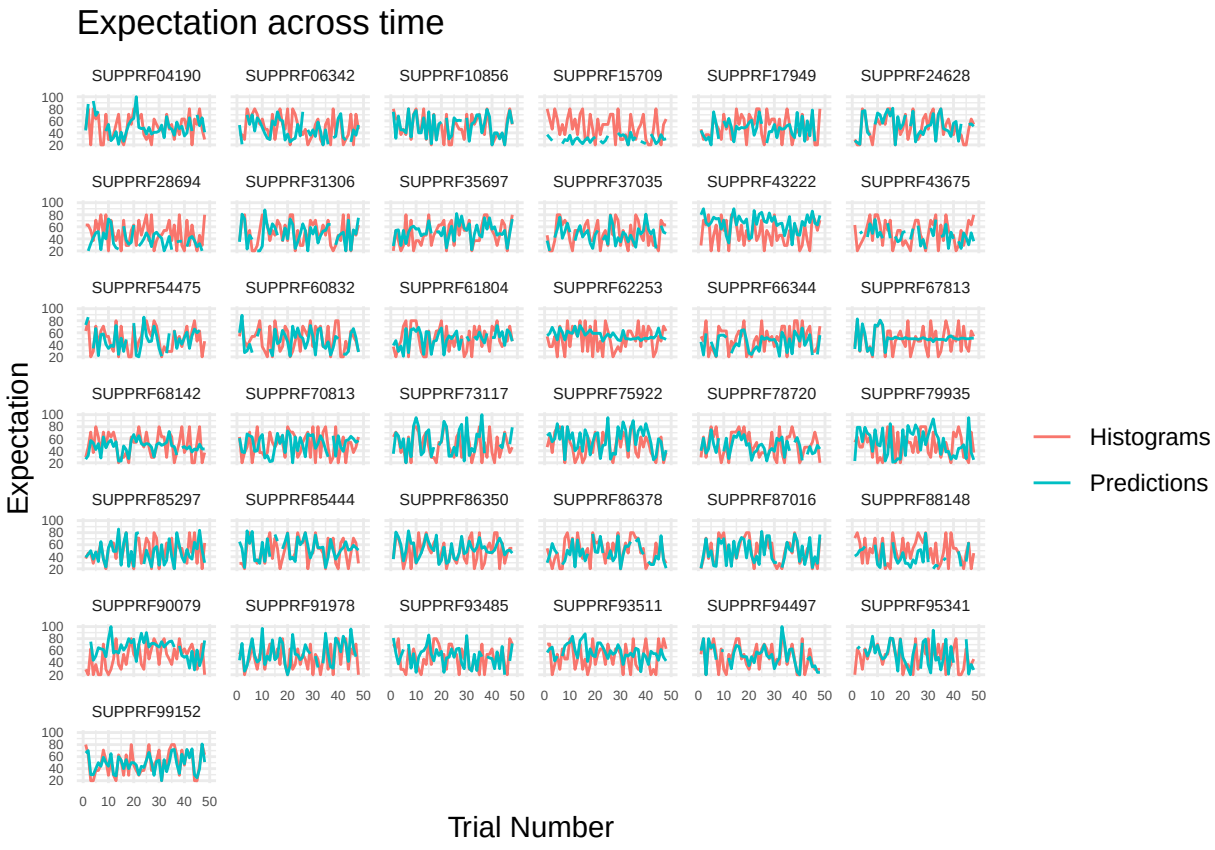
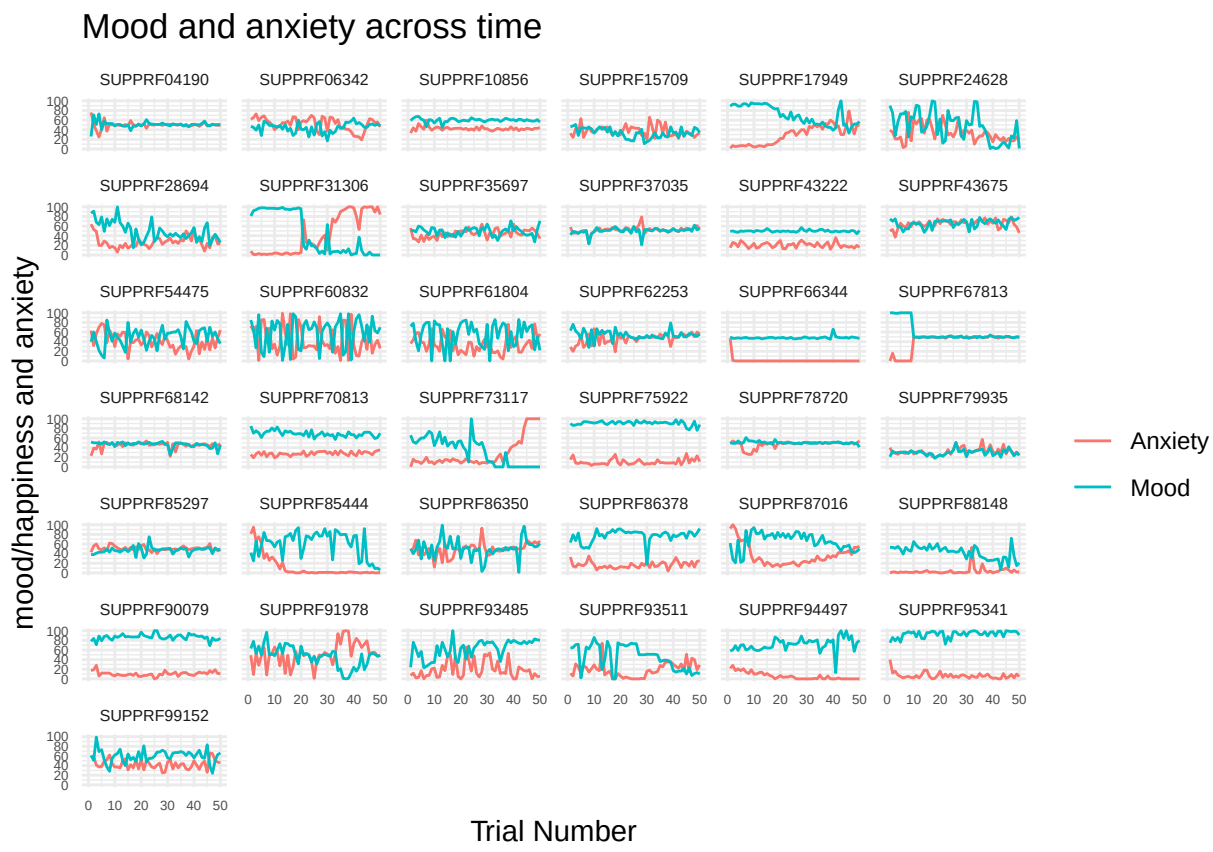


Histogram and prediction across trials

The figure below shows the histogram and expectation values over time and across trials. So we have less overlap between histogram and predictions which makes sense, it would be interesting to see its impact on mood and anxiety.

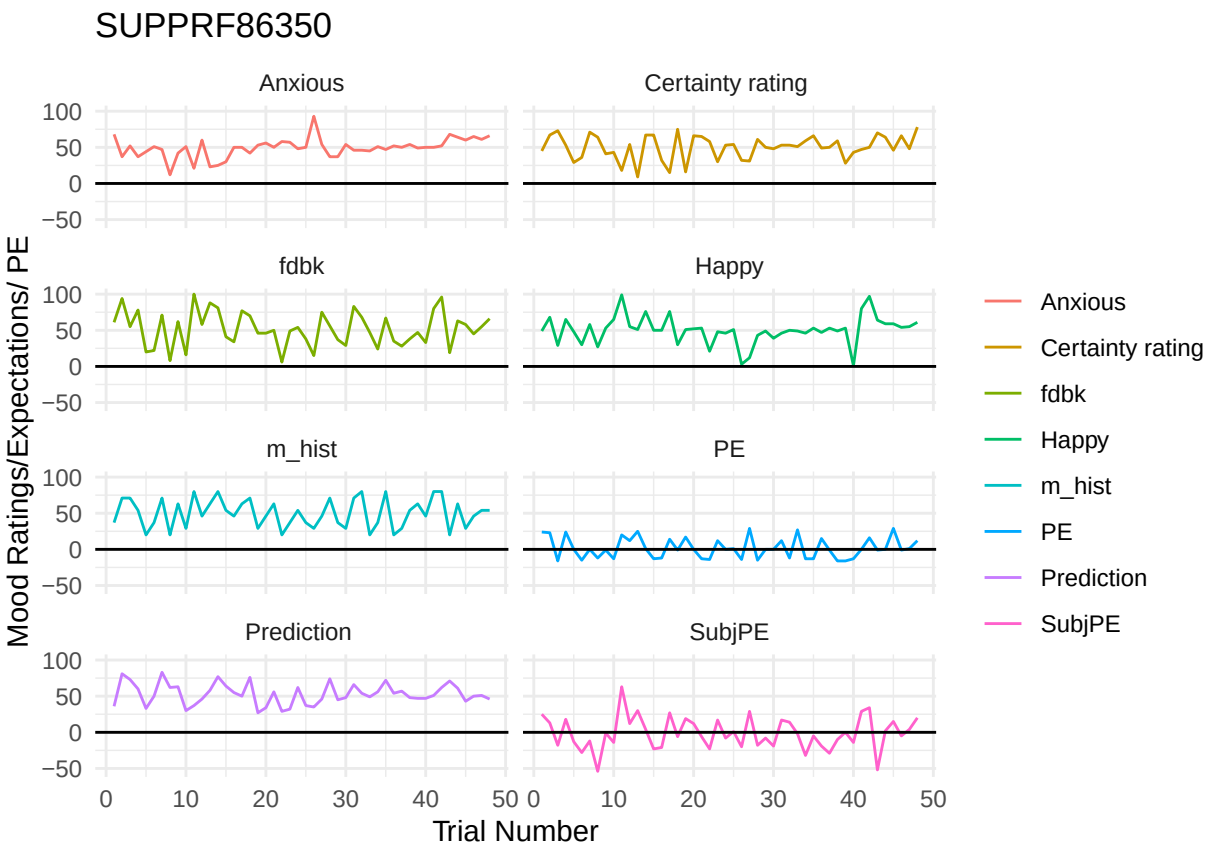


Anxiety and mood across trials



Plots for all variables per subject

Now let's make plots for each subject that show how prediction, feedback, histogram mean, anxiety, mood, confidence rating, PE (feedback - histogram), subj_PE (feedback-prediction): one plot per subject. Subject "SUPPRF66344" has a flat 0 line for anxiety. It seems below we have bigger variability in subjective ratings of mood and anxiety compared to our initial pilots which may be a coincidence/noise or related to the bigger PE or other changes we made (e.g. the way we ask the anxiety question now, using "nervous/uncomfortable" instead of "anxious", and "right now" instead of "at this moment").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Anxious
Certainty rating
fdbk
Happy
m_hist
PE
Prediction
SubjPE
Mood Ratings/Expectations/ PE
Trial Number
100
50
0
−50
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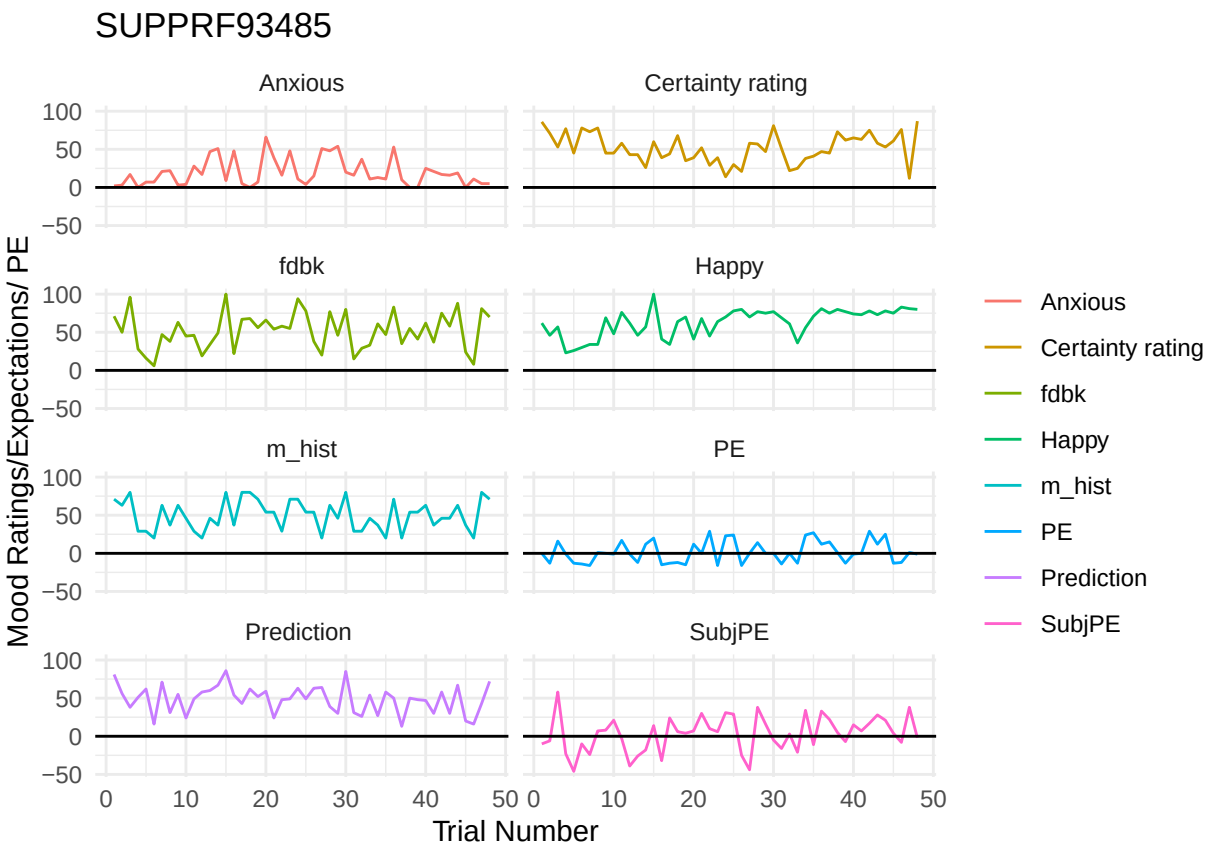
10
20
30
40
50
Anxious
Certainty rating
fdbk
Happy
m_hist
PE
Prediction
SubjPE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Certainty rating
fdbk
Happy
m_hist
PE
Prediction
SubjPE
Mood Ratings/Expectations/ PE
Trial Number
100
50
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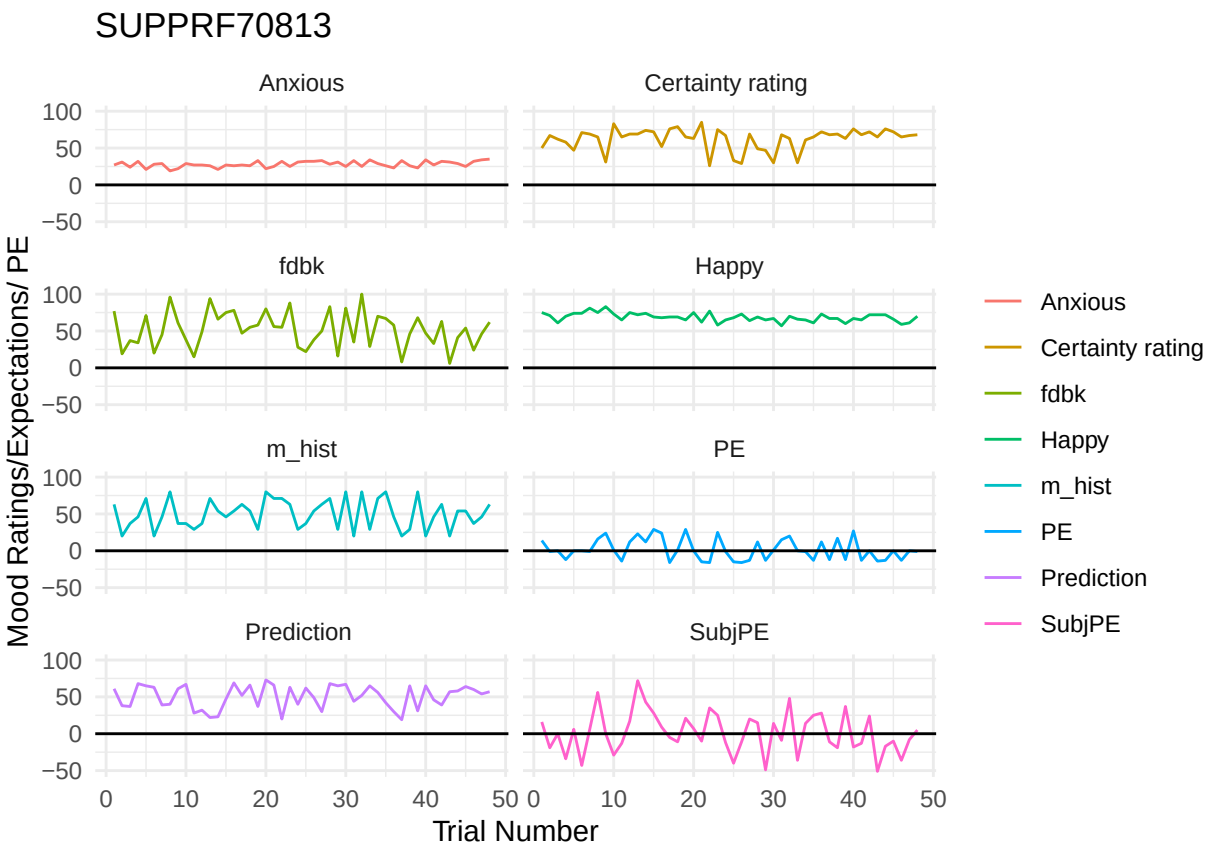
Anxious
Certainty rating
fdbk
Happy
m_hist
PE
Prediction
SubjPE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fdbk
Happy
m_hist
PE
Prediction
SubjPE
Mood Ratings/Expectations/ PE
Trial Number
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50
0
−50
0
10
20
30
40
50
Anxious
Certainty rating
fdbk
Happy
m_hist
PE
Prediction
SubjPE


SUPPRF86378
Anxious
Certainty rating
fdbk
Happy
m_hist
PE
Prediction
SubjPE
Mood Ratings/Expectations/ PE
Trial Number
100
50
0
0
10
20
30
40
50
Anxious
Certainty rating
fdbk
Happy
m_hist
PE
Prediction
SubjPE


SUPPRF66344
Anxious
Certainty rating
fdbk
Happy
m_hist
PE
Prediction
SubjPE
Mood Ratings/Expectations/ PE
Trial Number
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40
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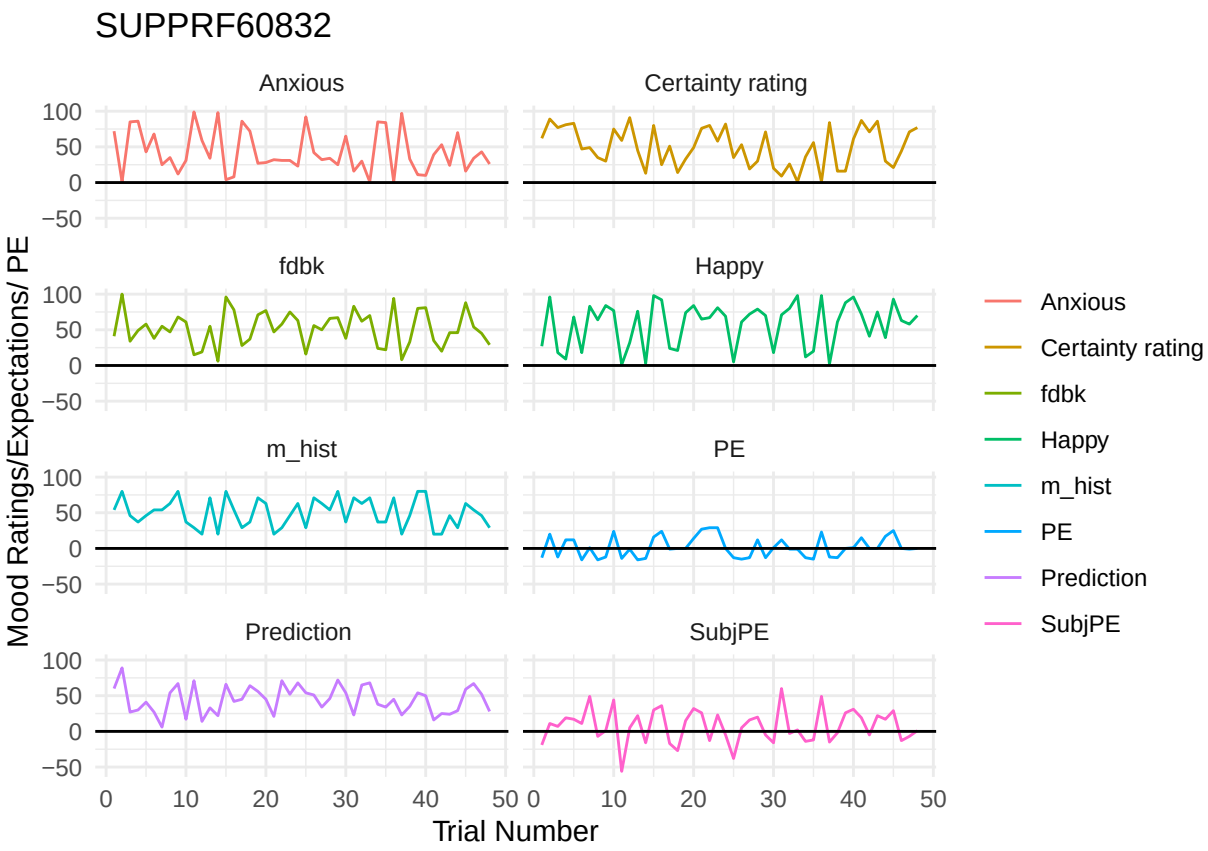
Anxious
Certainty rating
fdbk
Happy
m_hist
PE
Prediction
SubjPE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Certainty rating
fdbk
Happy
m_hist
PE
Prediction
SubjPE
Mood Ratings/Expectations/ PE
Trial Number
100
50
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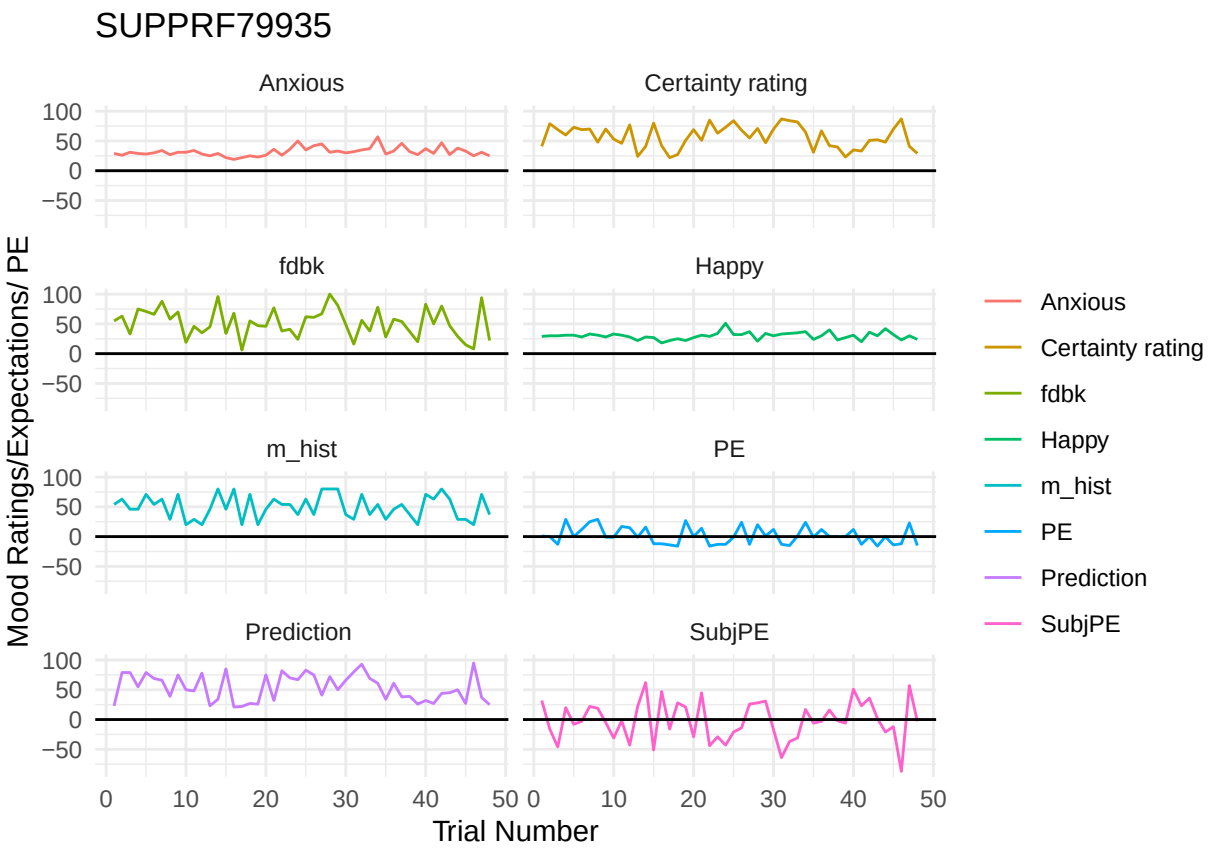
Anxious
Certainty rating
fdbk
Happy
m_hist
PE
Prediction
SubjPE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Anxious
Certainty rating
fdbk
Happy
m_hist
PE
Prediction
SubjPE
100
50
0
−50
0
10
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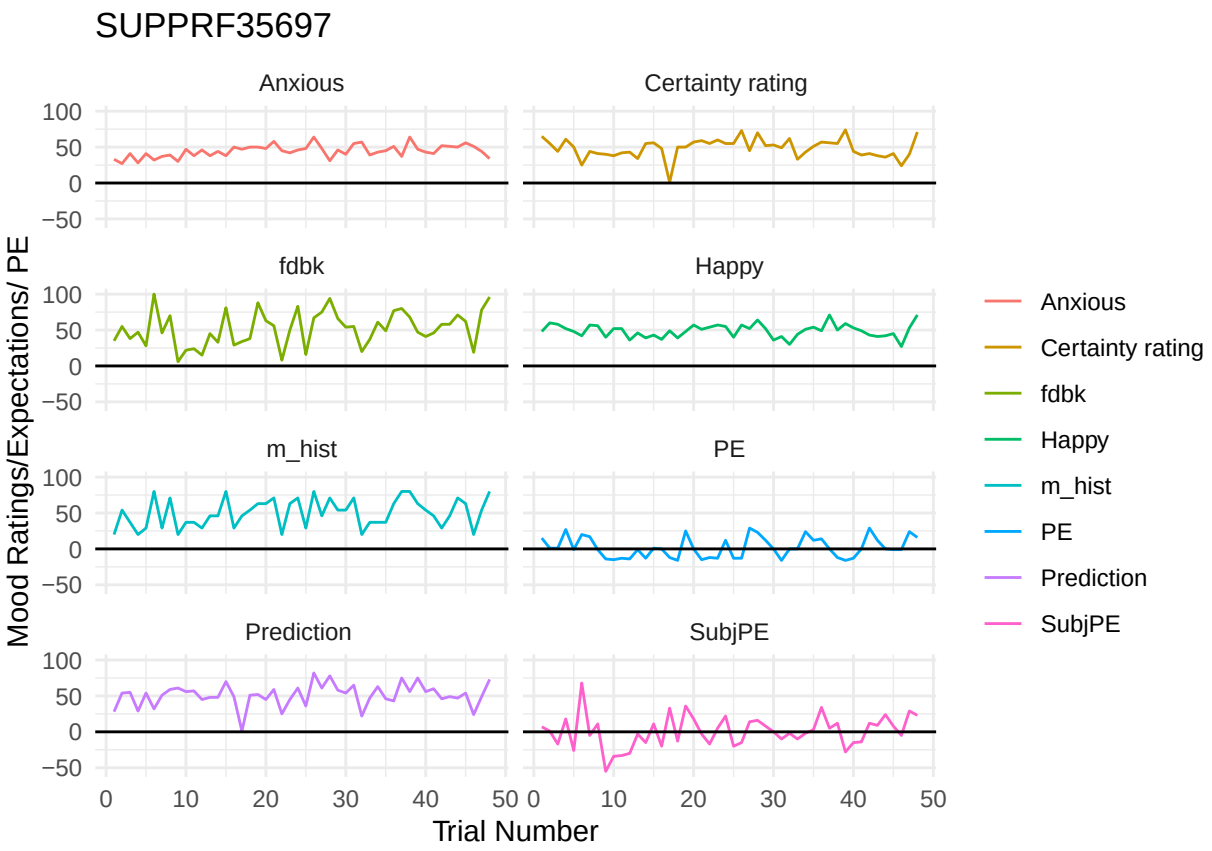
50
Mood Ratings/Expectations/ PE
Trial Number
Anxious
Certainty rating
fdbk
Happy
m_hist
PE
Prediction
SubjPE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Certainty rating
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Happy
m_hist
PE
Prediction
SubjPE
100
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10
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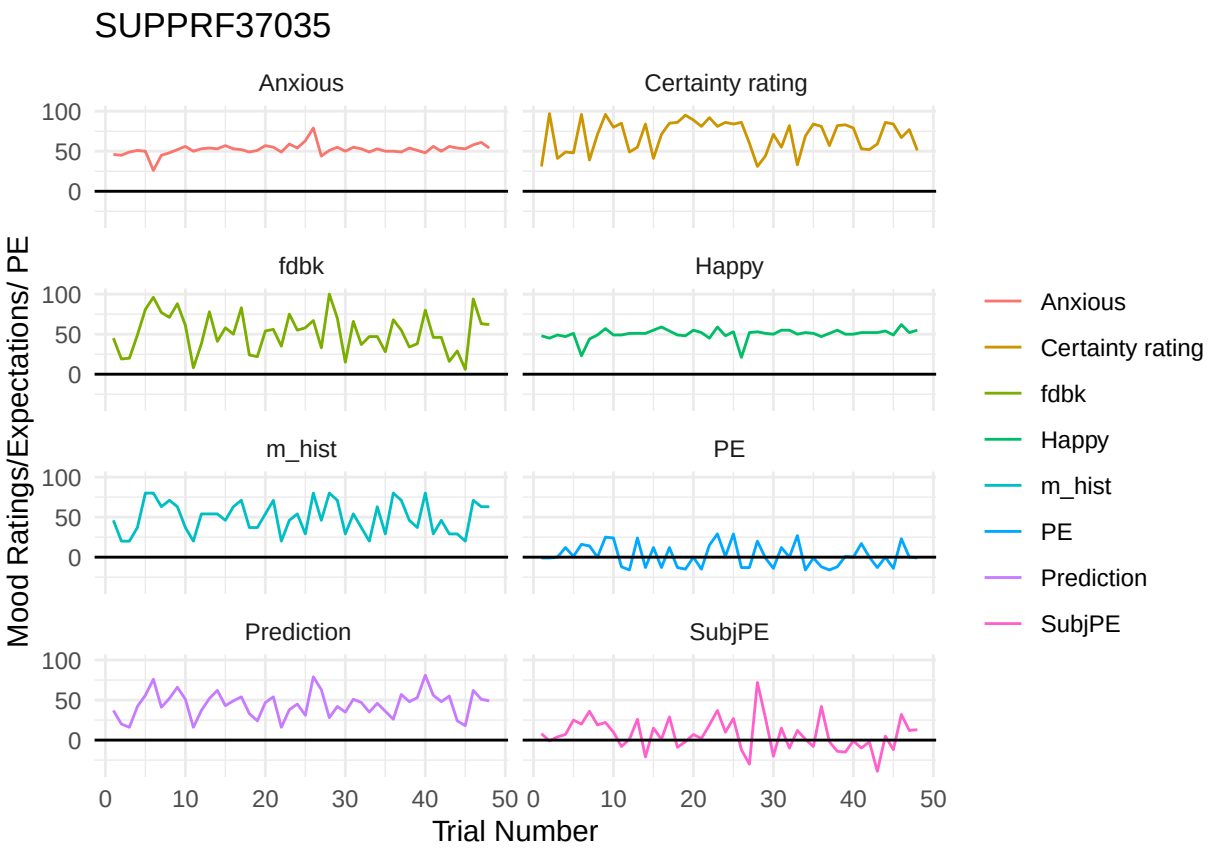
Mood Ratings/Expectations/ PE
Trial Number
Anxious
Certainty rating
fdbk
Happy
m_hist
PE
Prediction
SubjPE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Anxious
Certainty rating
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Happy
m_hist
PE
Prediction
SubjPE
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40
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Mood Ratings/Expectations/ PE
Trial Number
Anxious
Certainty rating
fdbk
Happy
m_hist
PE
Prediction
SubjPE


SUPPRF68142
Anxious
Certainty rating
fdbk
Happy
m_hist
PE
Prediction
SubjPE
100
50
0
0
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20
30
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50
Mood Ratings/Expectations/ PE
Trial Number
Anxious
Certainty rating
fdbk
Happy
m_hist
PE
Prediction
SubjPE


SUPPRF88148
Anxious
Certainty rating
fdbk
Happy
m_hist
PE
Prediction
SubjPE
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20
30
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Mood Ratings/Expectations/ PE
Trial Number
Anxious
Certainty rating
fdbk
Happy
m_hist
PE
Prediction
SubjPE


SUPPRF99152
Anxious
Certainty rating
fdbk
Happy
m_hist
PE
Prediction
SubjPE
Mood Ratings/Expectations/ PE
Trial Number
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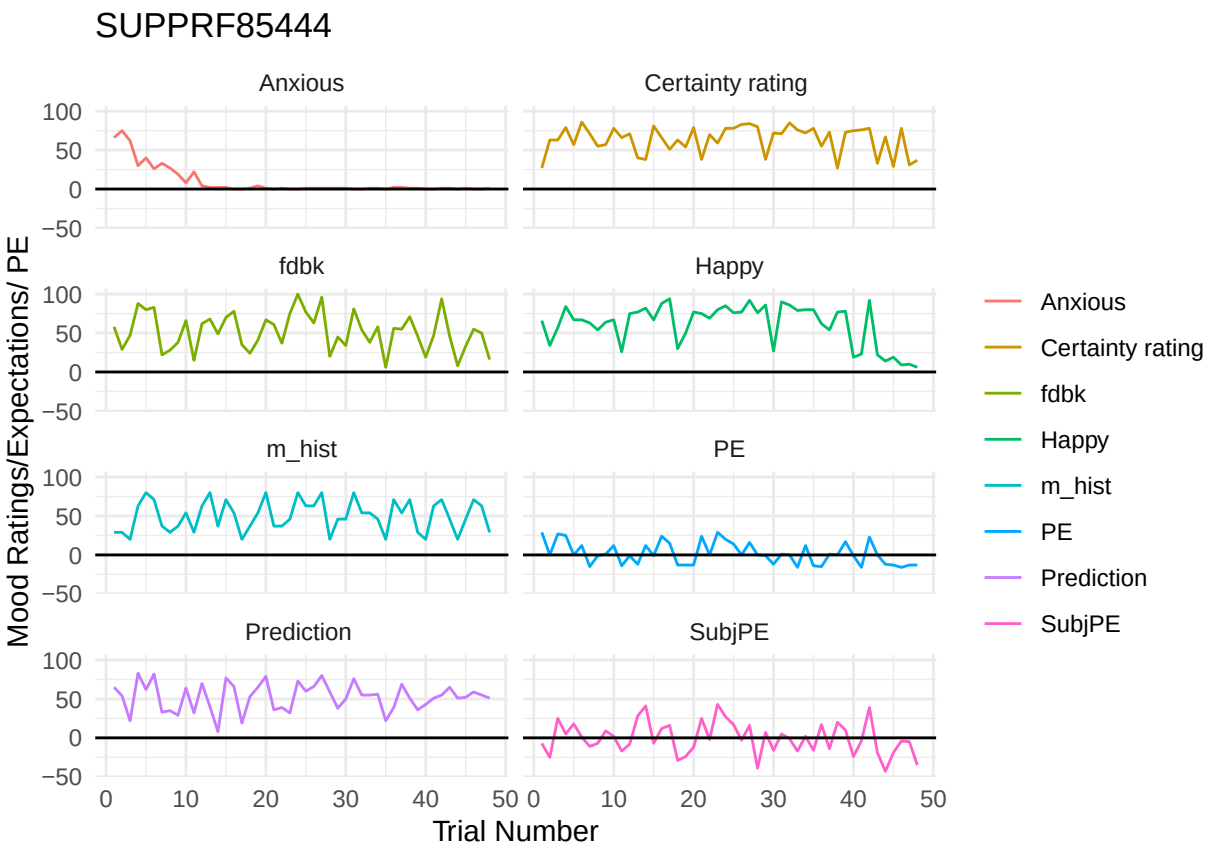
Anxious
Certainty rating
fdbk
Happy
m_hist
PE
Prediction
SubjPE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Happy
m_hist
PE
Prediction
SubjPE
Mood Ratings/Expectations/ PE
Trial Number
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0
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20
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40
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Anxious
Certainty rating
fdbk
Happy
m_hist
PE
Prediction
SubjPE


SUPPRF85297
Anxious
Certainty rating
fdbk
Happy
m_hist
PE
Prediction
SubjPE
100
50
0
0
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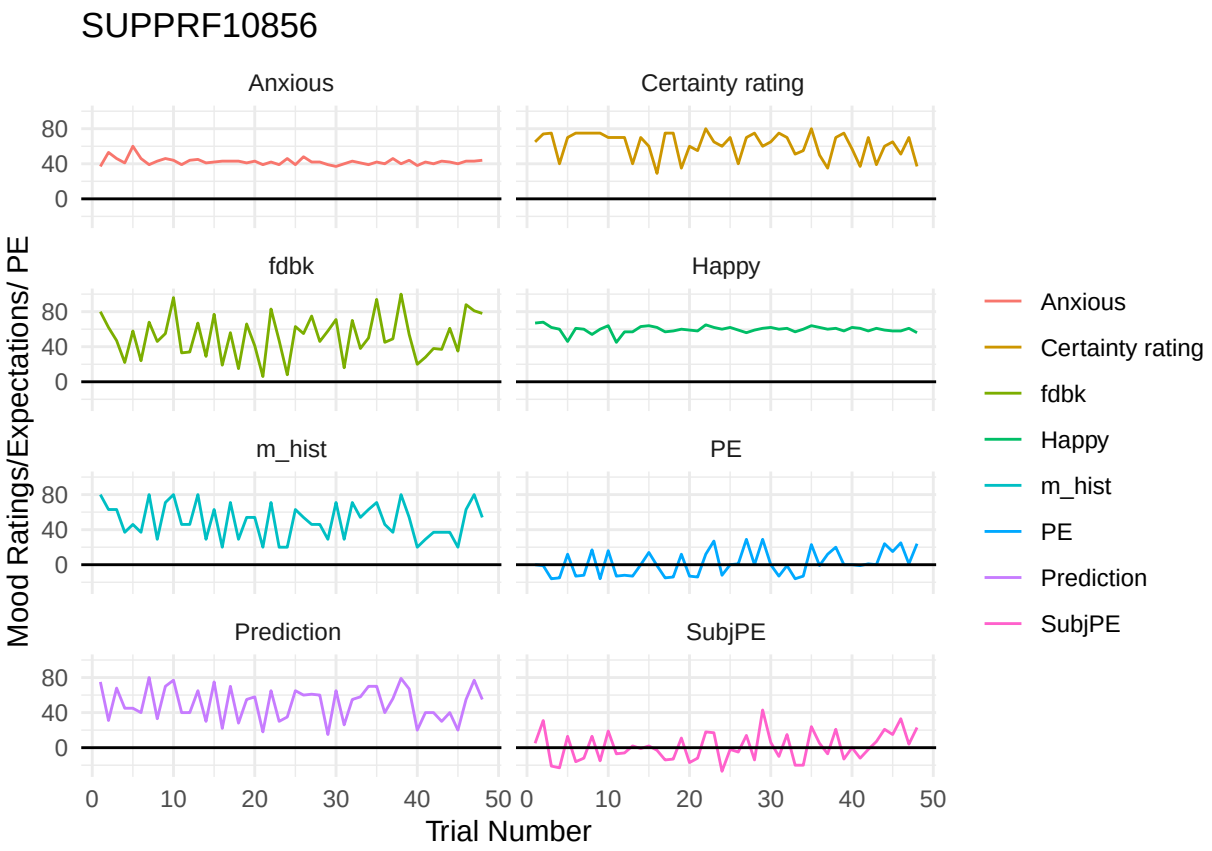
Mood Ratings/Expectations/ PE
Trial Number
Anxious
Certainty rating
fdbk
Happy
m_hist
PE
Prediction
SubjPE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Certainty rating
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m_hist
PE
Prediction
SubjPE
Mood Ratings/Expectations/ PE
Trial Number
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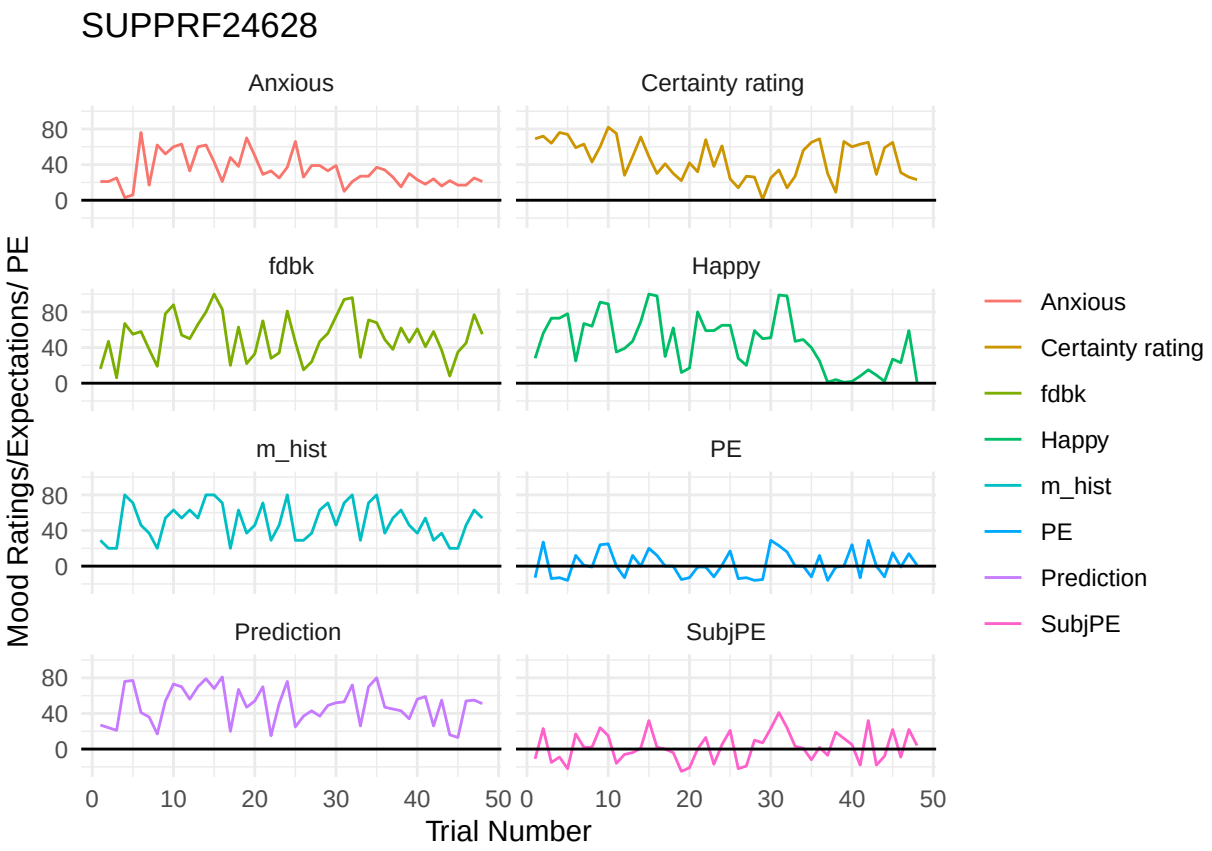
Anxious
Certainty rating
fdbk
Happy
m_hist
PE
Prediction
SubjPE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Certainty rating
fdbk
Happy
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Prediction
SubjPE
Mood Ratings/Expectations/ PE
Trial Number
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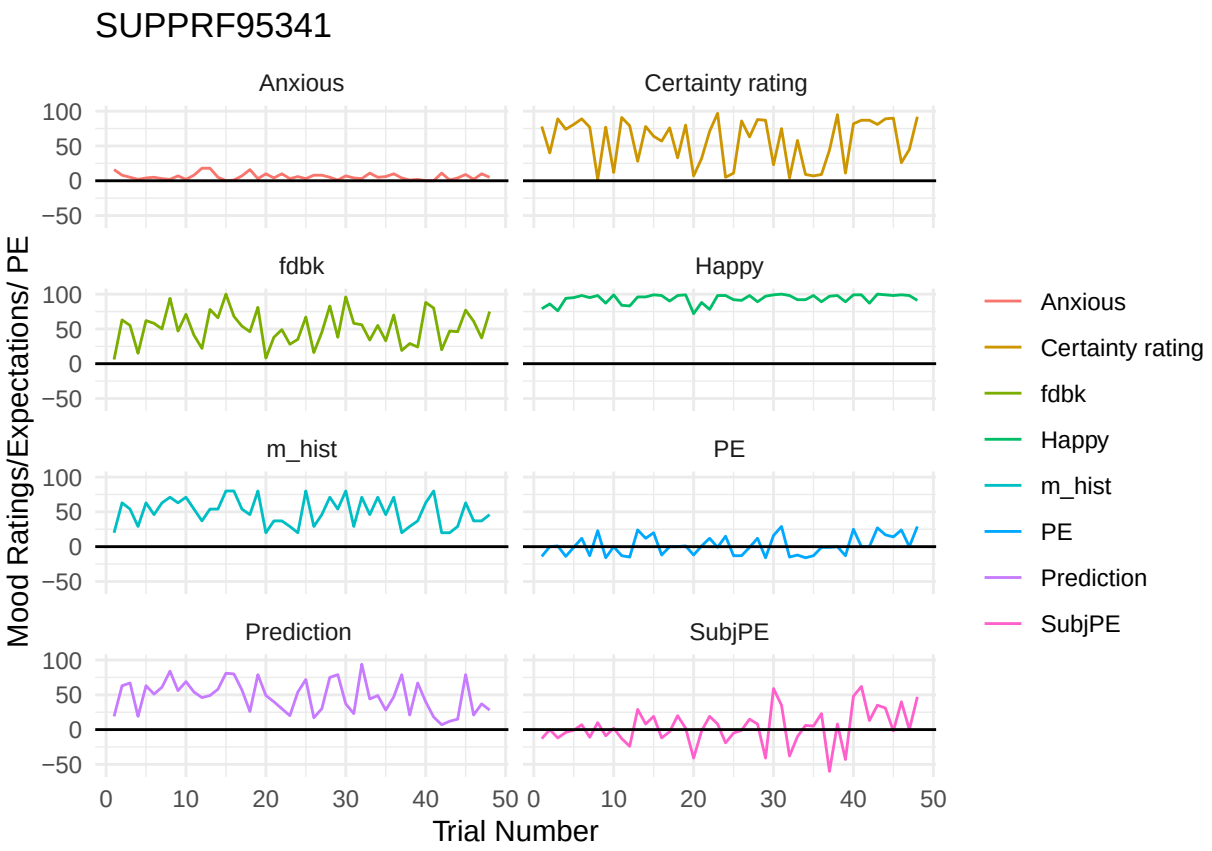
Anxious
Certainty rating
fdbk
Happy
m_hist
PE
Prediction
SubjPE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Certainty rating
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Happy
m_hist
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Prediction
SubjPE
Mood Ratings/Expectations/ PE
Trial Number
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Anxious
Certainty rating
fdbk
Happy
m_hist
PE
Prediction
SubjPE


SUPPRF54475
Anxious
Certainty rating
fdbk
Happy
m_hist
PE
Prediction
SubjPE
Mood Ratings/Expectations/ PE
Trial Number
100
50
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Anxious
Certainty rating
fdbk
Happy
m_hist
PE
Prediction
SubjPE


SUPPRF06342
Anxious
Certainty rating
fdbk
Happy
m_hist
PE
Prediction
SubjPE
Mood Ratings/Expectations/ PE
Trial Number
100
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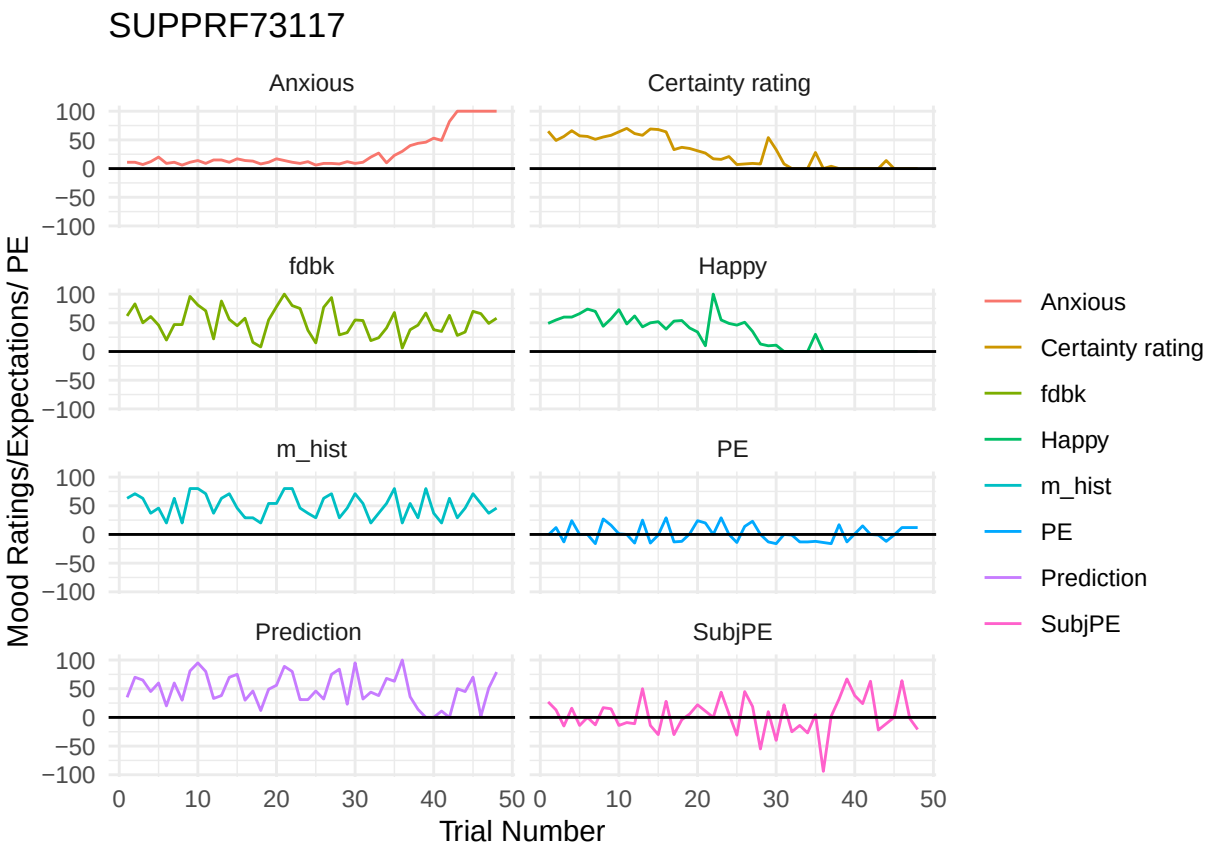
Certainty rating
fdbk
Happy
m_hist
PE
Prediction
SubjPE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Prediction
SubjPE
Mood Ratings/Expectations/ PE
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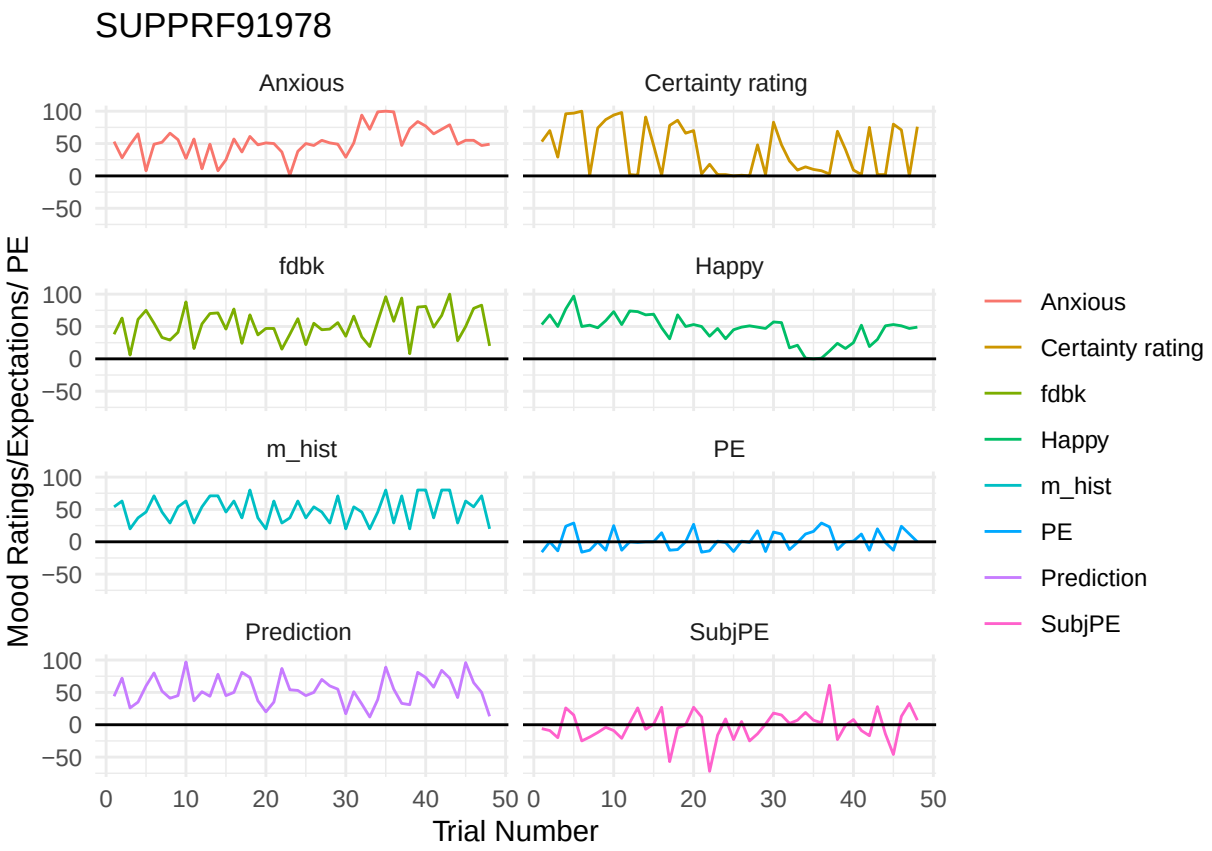
Anxious
Certainty rating
fdbk
Happy
m_hist
PE
Prediction
SubjPE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Certainty rating
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Happy
m_hist
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Prediction
SubjPE
Mood Ratings/Expectations/ PE
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40
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Anxious
Certainty rating
fdbk
Happy
m_hist
PE
Prediction
SubjPE


SUPPRF75922
Anxious
Certainty rating
fdbk
Happy
m_hist
PE
Prediction
SubjPE
Mood Ratings/Expectations/ PE
Trial Number
100
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Certainty rating
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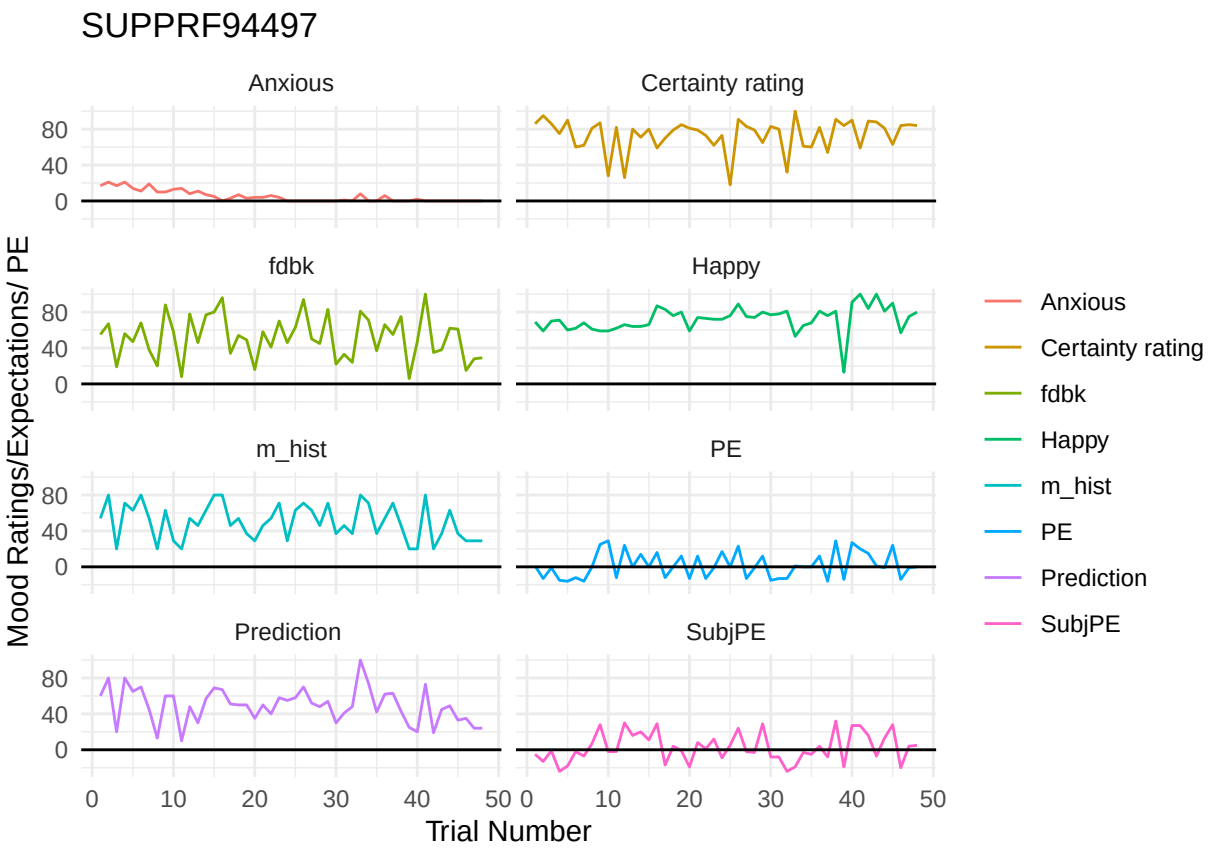
m_hist
PE
Prediction
SubjPE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Certainty rating
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Happy
m_hist
PE
Prediction
SubjPE
Mood Ratings/Expectations/ PE
Trial Number
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Anxious
Certainty rating
fdbk
Happy
m_hist
PE
Prediction
SubjPE


SUPPRF15709
Anxious
Certainty rating
fdbk
Happy
m_hist
PE
Prediction
SubjPE
Mood Ratings/Expectations/ PE
Trial Number
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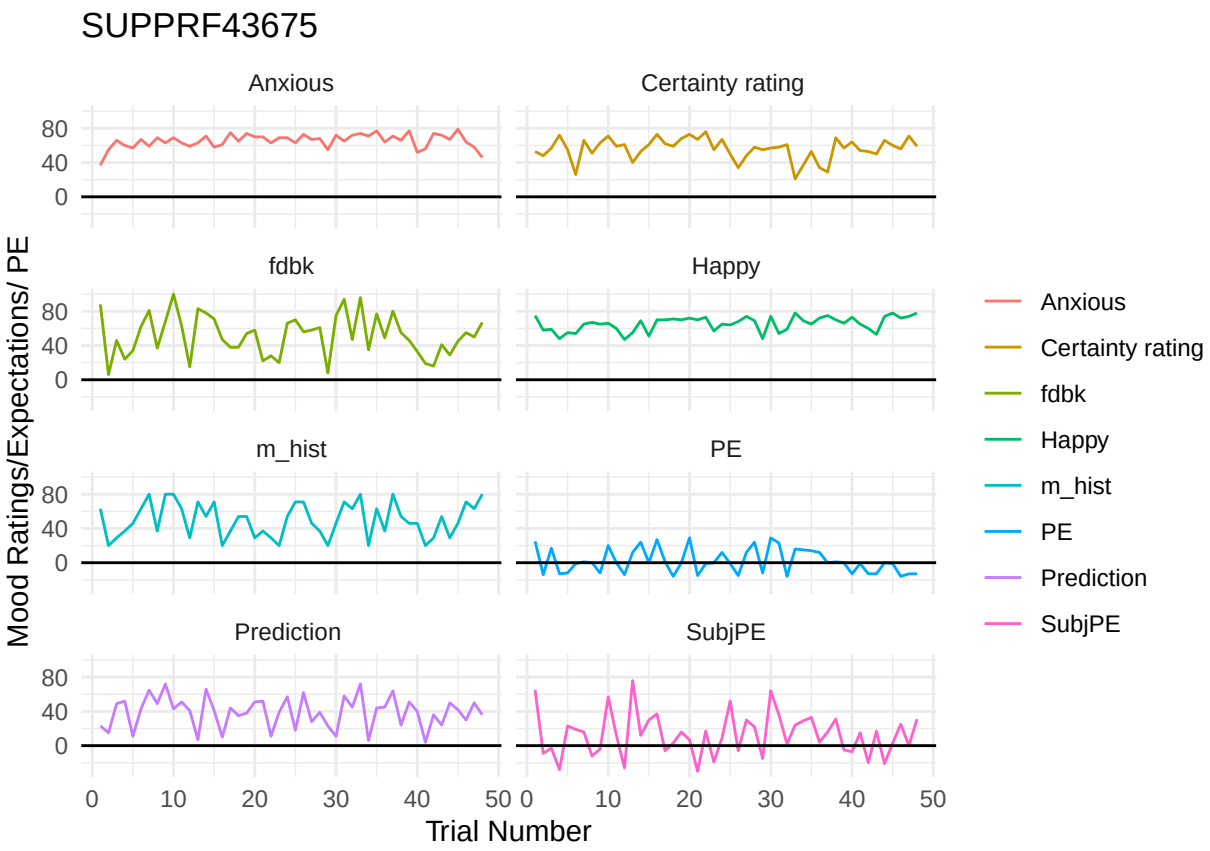
Certainty rating
fdbk
Happy
m_hist
PE
Prediction
SubjPE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Certainty rating
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m_hist
PE
Prediction
SubjPE
Mood Ratings/Expectations/ PE
Trial Number
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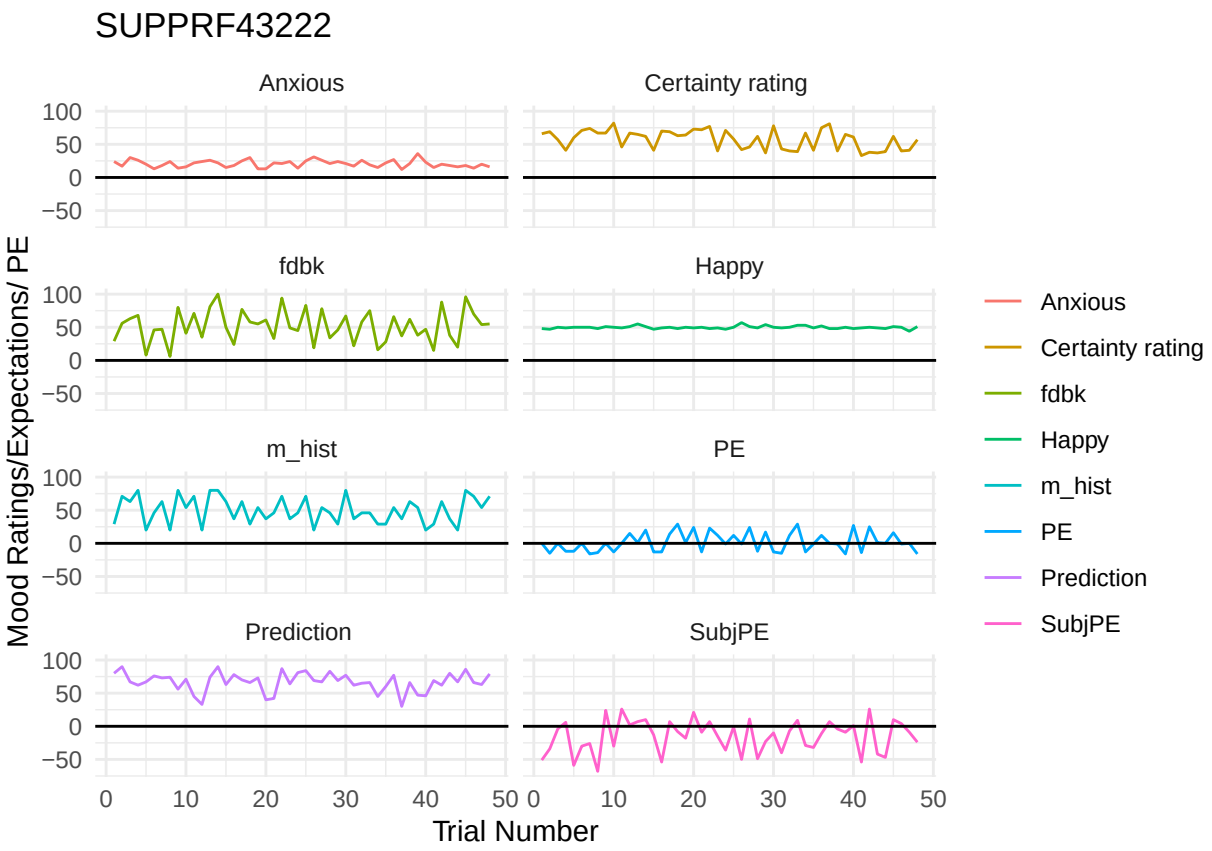
Certainty rating
fdbk
Happy
m_hist
PE
Prediction
SubjPE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m_hist
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Prediction
SubjPE
Mood Ratings/Expectations/ PE
Trial Number
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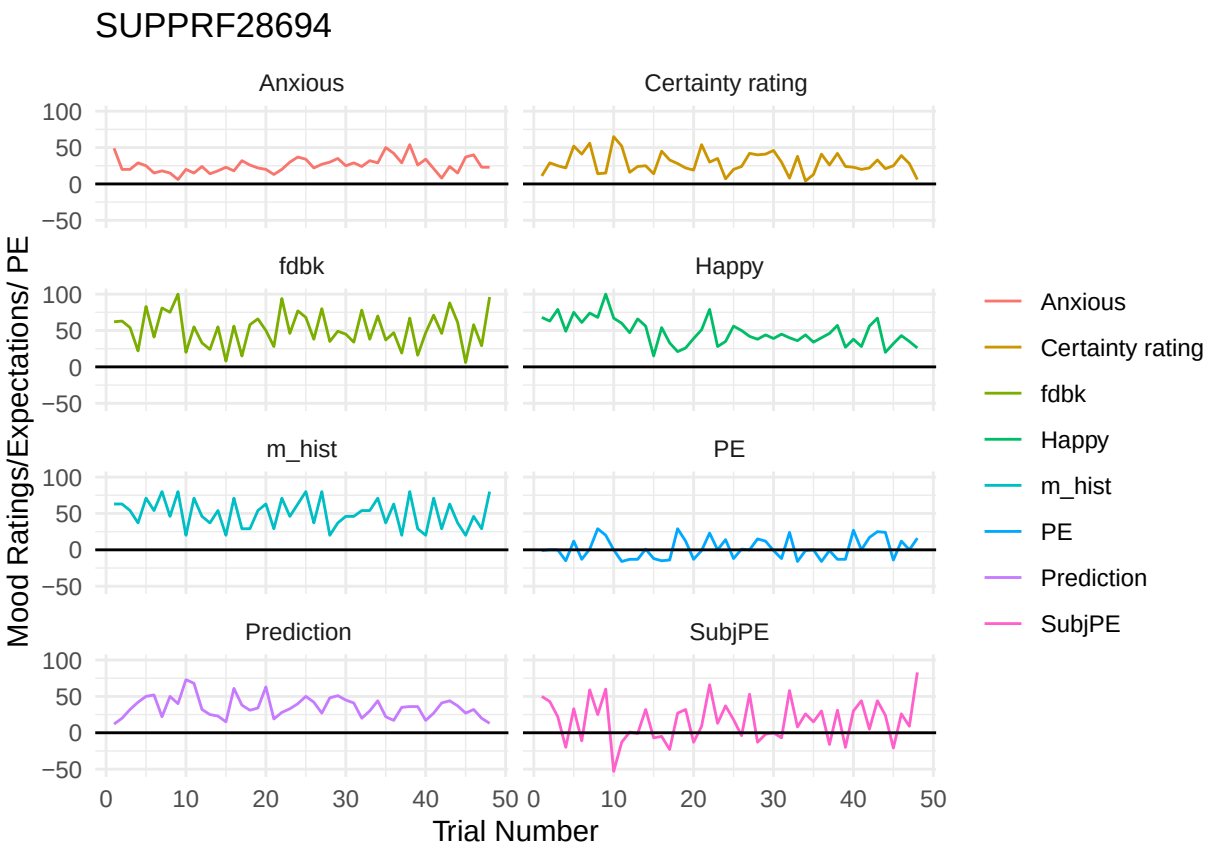
50
Anxious
Certainty rating
fdbk
Happy
m_hist
PE
Prediction
SubjPE


SUPPRF78720
Anxious
Certainty rating
fdbk
Happy
m_hist
PE
Prediction
SubjPE
100
50
0
0
10
20
30
40
50
Mood Ratings/Expectations/ PE
Trial Number
Anxious
Certainty rating
fdbk
Happy
m_hist
PE
Prediction
SubjPE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Certainty rating
fdbk
Happy
m_hist
PE
Prediction
SubjPE
Mood Ratings/Expectations/ PE
Trial Number
100
50
0
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30
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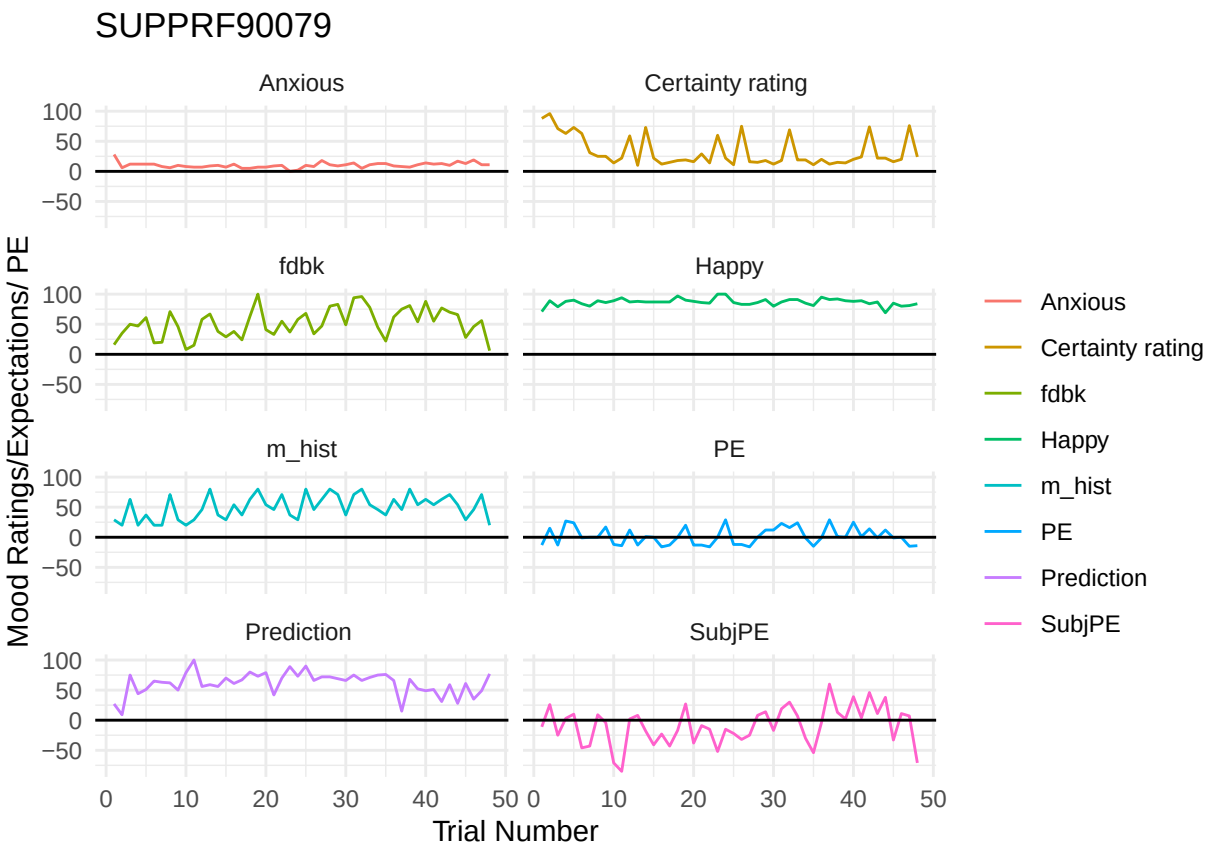
50
Anxious
Certainty rating
fdbk
Happy
m_hist
PE
Prediction
SubjPE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Certainty rating
fdbk
Happy
m_hist
PE
Prediction
SubjPE
Mood Ratings/Expectations/ PE
Trial Number
100
50
0
−50
0
10
20
30
40
50
Anxious
Certainty rating
fdbk
Happy
m_hist
PE
Prediction
SubjPE


SUPPRF04190
Anxious
Certainty rating
fdbk
Happy
m_hist
PE
Prediction
SubjPE
100
50
0
0
10
20
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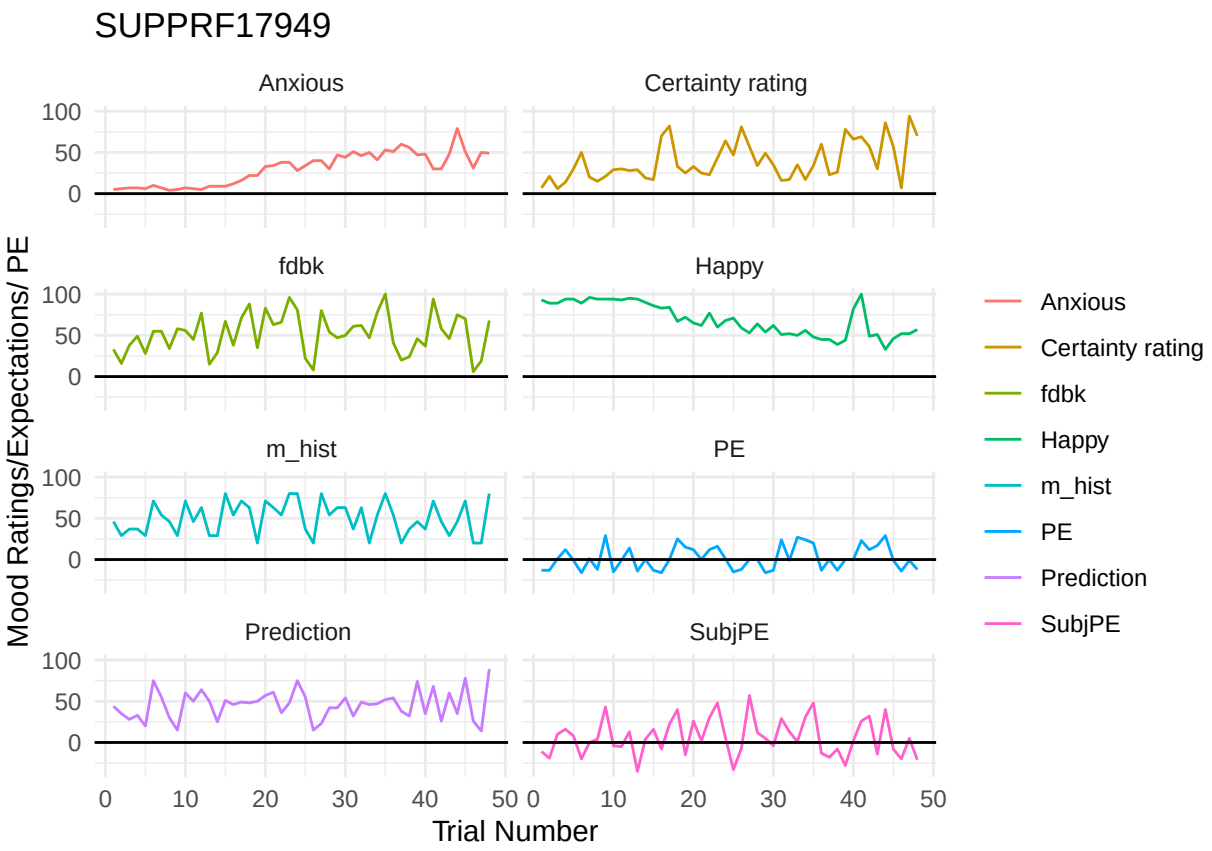
Mood Ratings/Expectations/ PE
Trial Number
Anxious
Certainty rating
fdbk
Happy
m_hist
PE
Prediction
SubjPE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fdbk
Happy
m_hist
PE
Prediction
SubjPE
Mood Ratings/Expectations/ PE
Trial Number
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Anxious
Certainty rating
fdbk
Happy
m_hist
PE
Prediction
SubjPE


SUPPRF62253
Anxious
Certainty rating
fdbk
Happy
m_hist
PE
Prediction
SubjPE
Mood Ratings/Expectations/ PE
Trial Number
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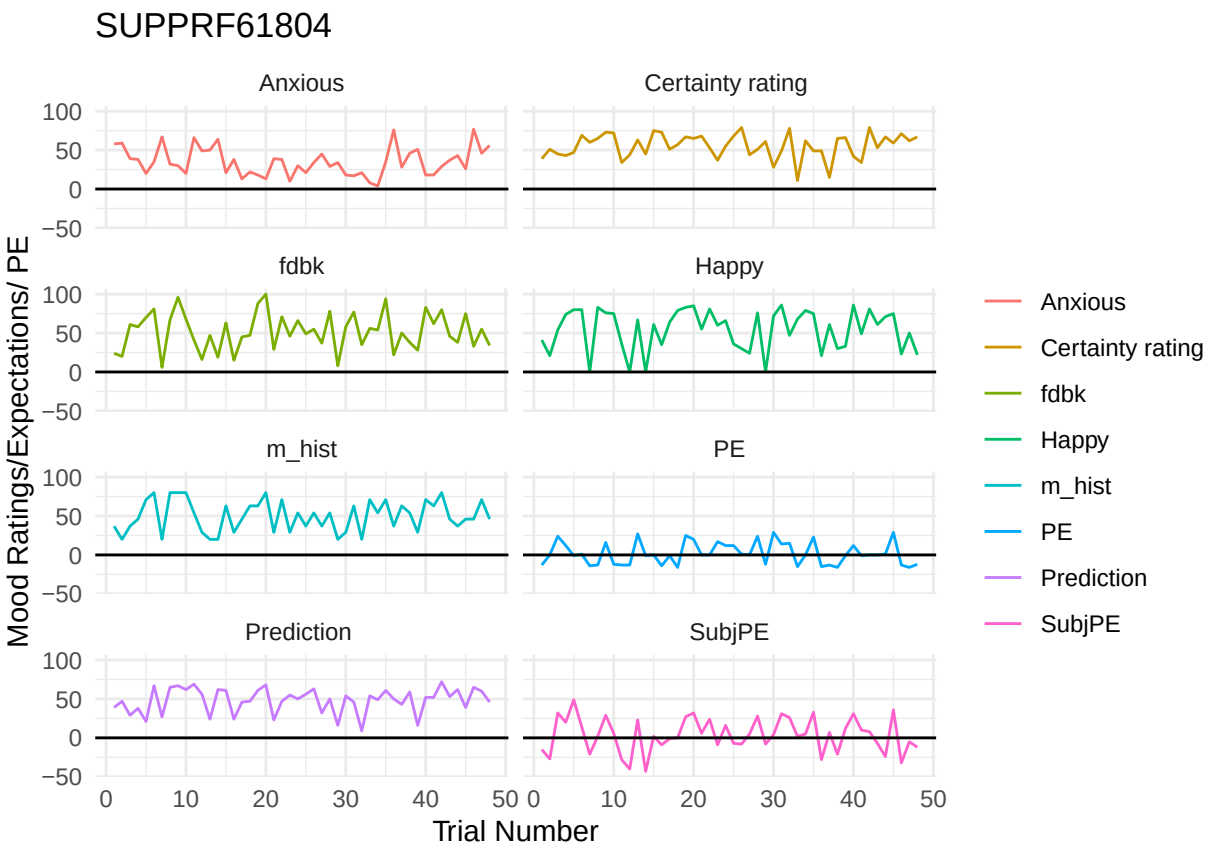
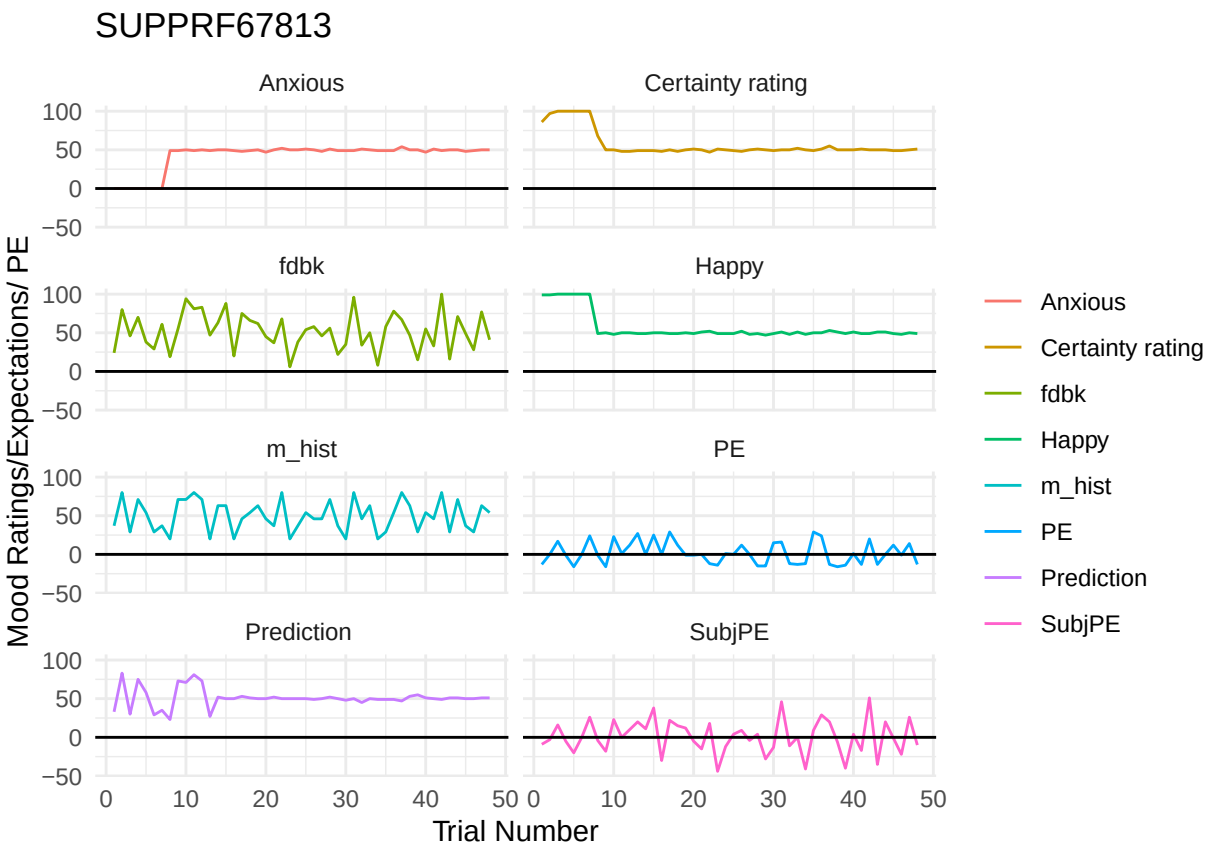
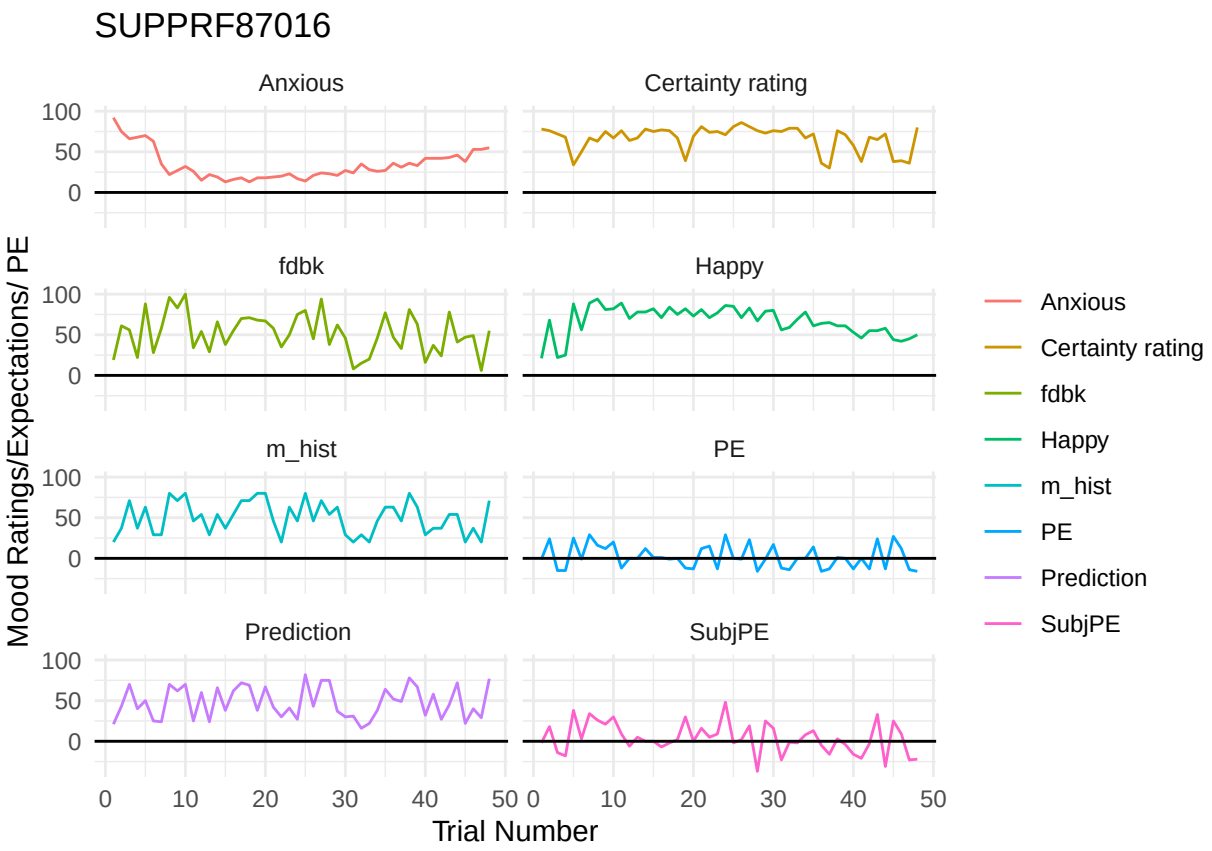
Anxious
Certainty rating
fdbk
Happy
m_hist
PE
Prediction
SubjPE


SUPPRF61804
Anxious
Certainty rating
fdbk
Happy
m_hist
PE
Prediction
SubjPE
Mood Ratings/Expectations/ PE
Trial Number
100
50
0
−50
0
10
20
30
40
50
Anxious
Certainty rating
fdbk
Happy
m_hist
PE
Prediction
SubjPE


SUPPRF67813
Anxious
Certainty rating
fdbk
Happy
m_hist
PE
Prediction
SubjPE
Mood Ratings/Expectations/ PE
Trial Number
100
50
0
−50
0
10
20
30
40
50
Anxious
Certainty rating
fdbk
Happy
m_hist
PE
Prediction
SubjPE

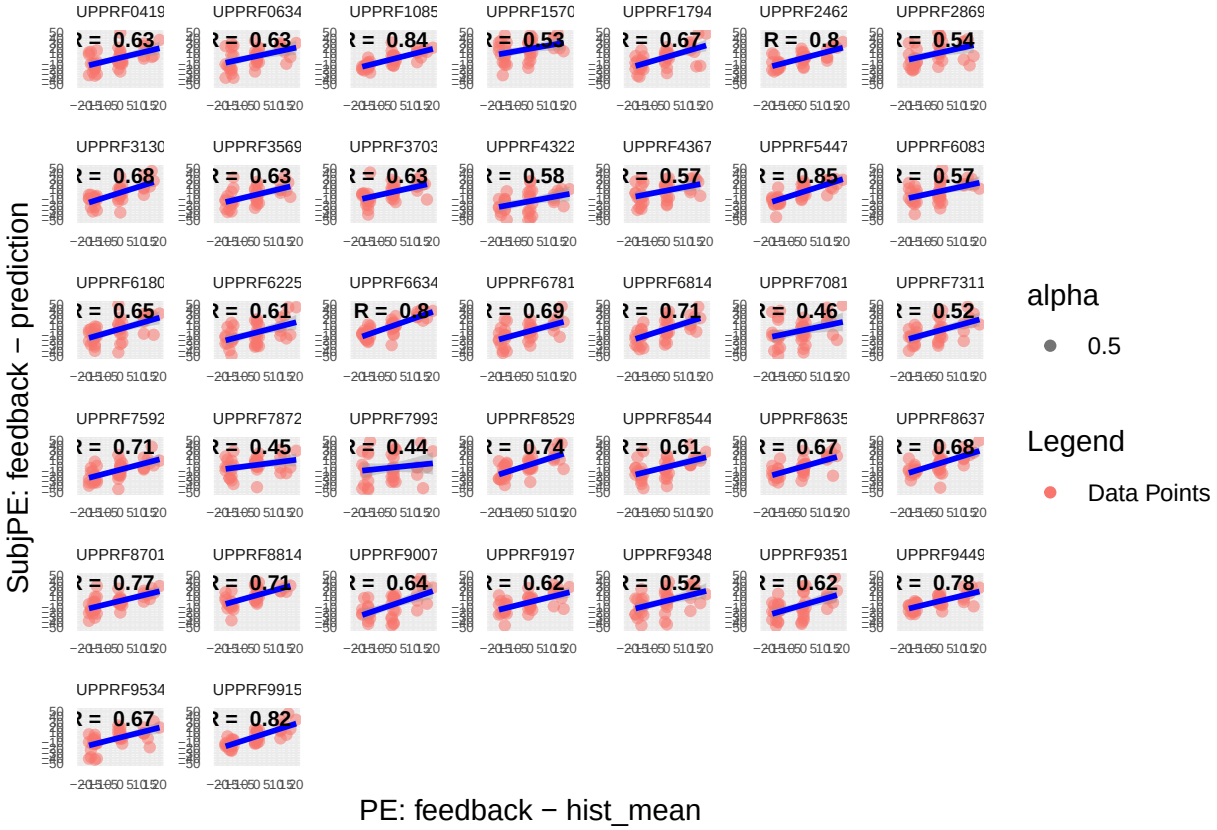

SUPPRF87016
Anxious
Certainty rating
fdbk
Happy
m_hist
PE
Prediction
SubjPE
Mood Ratings/Expectations/ PE
Trial Number
100
50
0
0
10
20
30
40
50
Anxious
Certainty rating
fdbk
Happy
m_hist
PE
Prediction
SubjPE


SUPPRF93511
Anxious
Certainty rating
fdbk
Happy
m_hist
PE
Prediction
SubjPE
Mood Ratings/Expectations/ PE
Trial Number
100
50
0
−50
0
10
20
30
40
50
Anxious
Certainty rating
fdbk
Happy
m_hist
PE
Prediction
SubjPE

PE and SubjPE relationship

We now look at the relationship between PE (feedback - histogram_mean) and SubjPE (feedback - prediction). The correlation between SubjPE and objective PE remain similar to previous pilots.

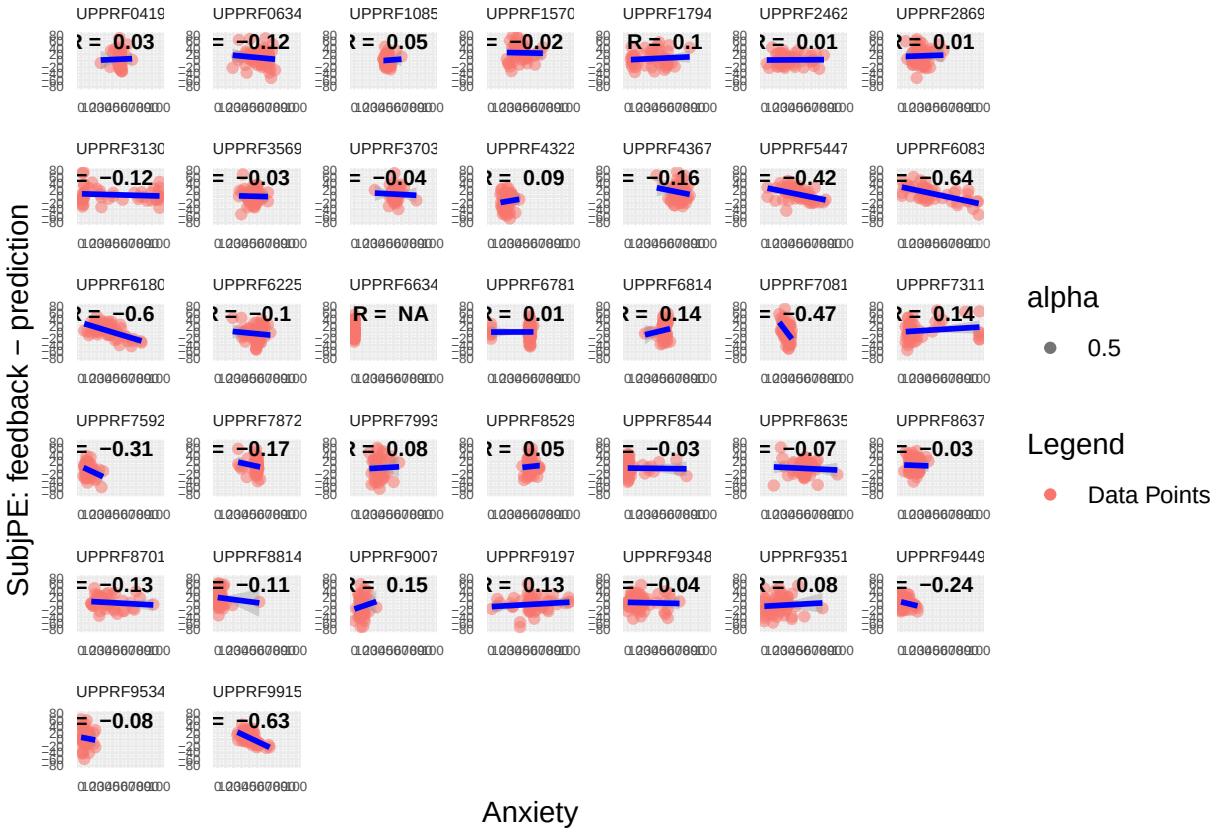
```
## [1] "average correlation between PE and SubjPE: 0.648669439173532"
```



SubjPE and Anxiety relationship

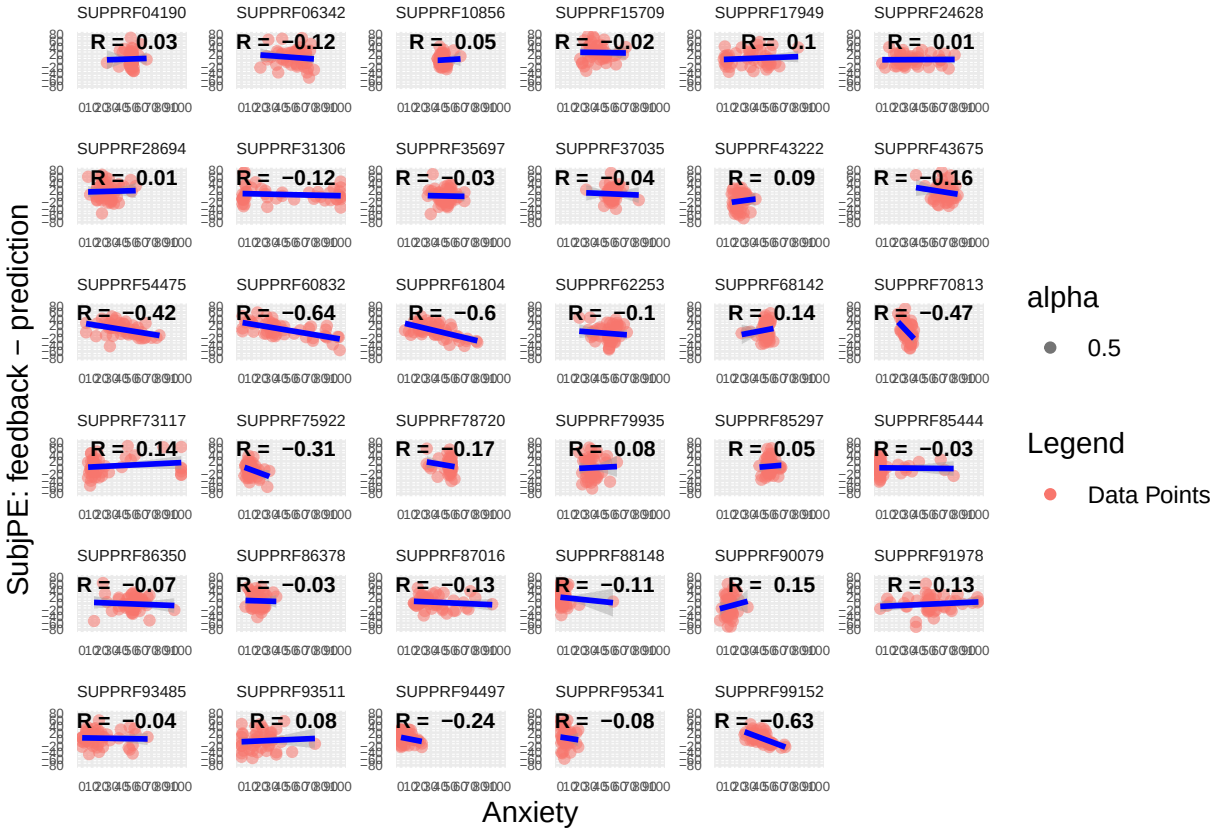
Let's now look at the relationship between SubjPE and Anxiety ratings:

```
## [1] "average correlation between Anxiety and SubjPE: -0.0966856250271289"
```



I will exclude subject “SUPPRF66344” and “SUPPRF67813”, who rated always 0 (or 50) for anxiety. After repeating the previous plot and correlations without them, the correlation becomes -0.10 from -0.09.

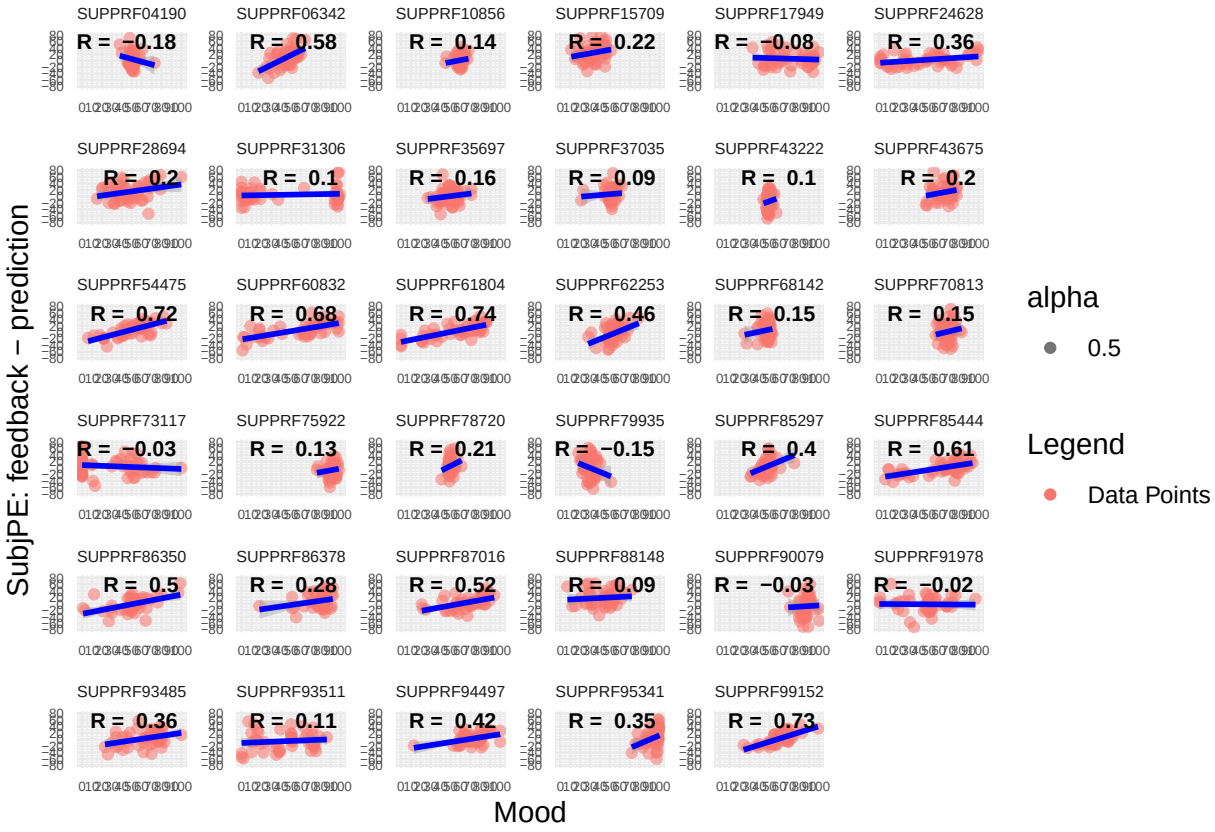
```
## [1] "average correlation between Anxiety and SubjPE: -0.0996141466312722"
```



SubjPE and Anxiety

Let's look at the same relationship for mood and subjPE:

```
## [1] "average correlation between Mood and SubjPE: 0.264520722594966"
```



The correlation for mood is consistent (always around 0.23-0.28), and consistently higher than anxiety (varying more across different pilots, but always negative and between -0.09 to -0.18). We now will look whether the average correlations are significantly different from zero for both anxiety and mood.

```
## [1] "corr Anxiety and SubjPE"
```

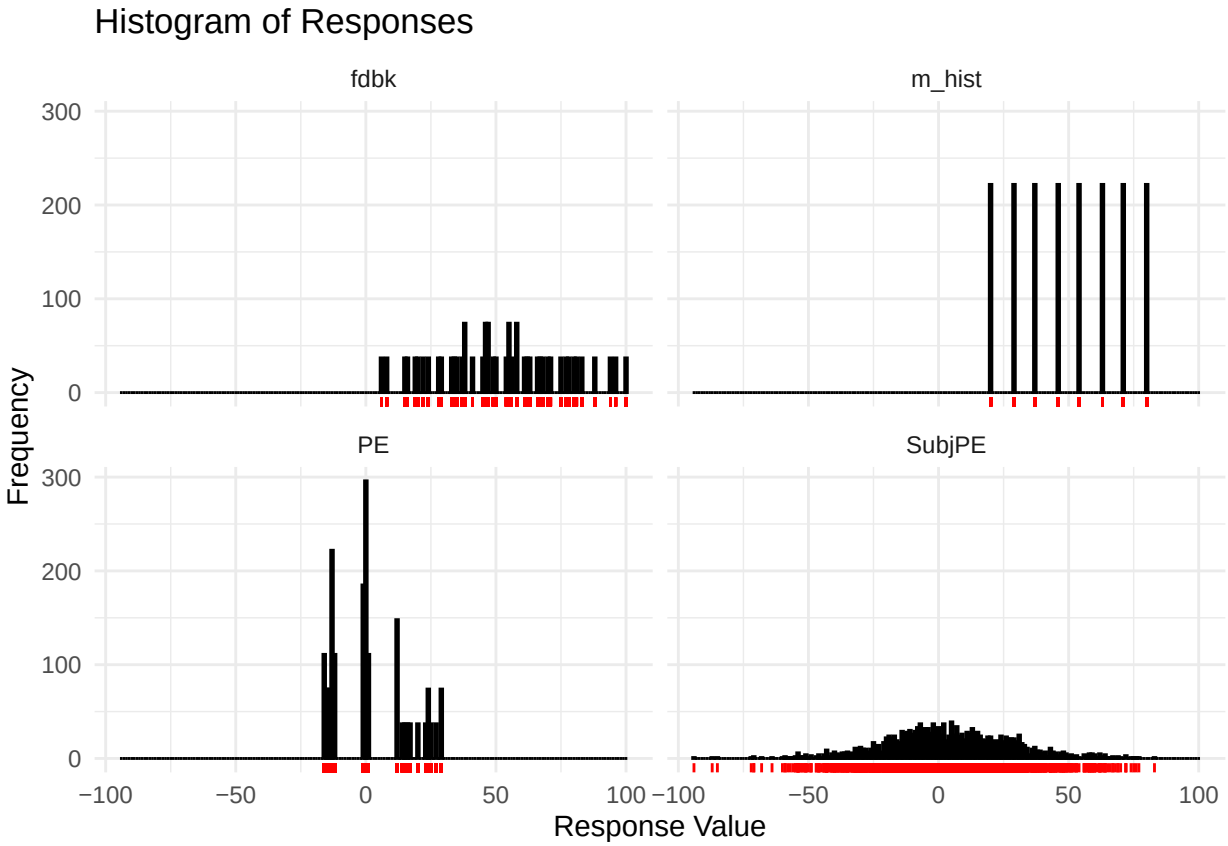
```
##
##  One Sample t-test
##
## data:  correlations_Ax_SubPE$correlation
## t = -2.6854, df = 34, p-value = 0.01112
## alternative hypothesis: true mean is not equal to 0
## 95 percent confidence interval:
##  -0.17500038 -0.02422792
## sample estimates:
##   mean of x
## -0.09961415
```

```
## [1] "corr happiness and SubjPE"
```

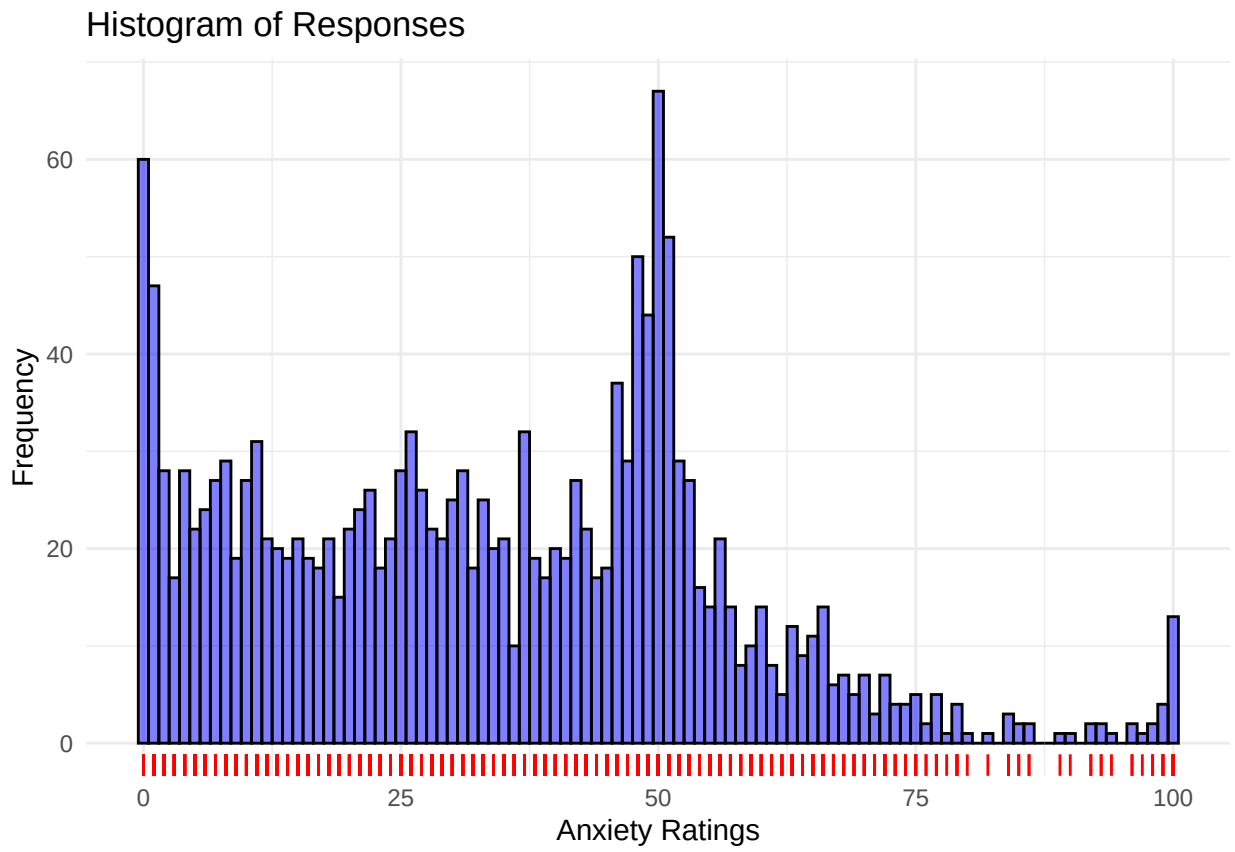
```
##
##  One Sample t-test
##
## data:  correlations_H_SubPE$correlation
## t = 6.0968, df = 34, p-value = 6.45e-07
## alternative hypothesis: true mean is not equal to 0
## 95 percent confidence interval:
##  0.1763485 0.3526929
## sample estimates:
## mean of x
## 0.2645207
```

Histogram for PE, SubjPE, feedback, hist_m

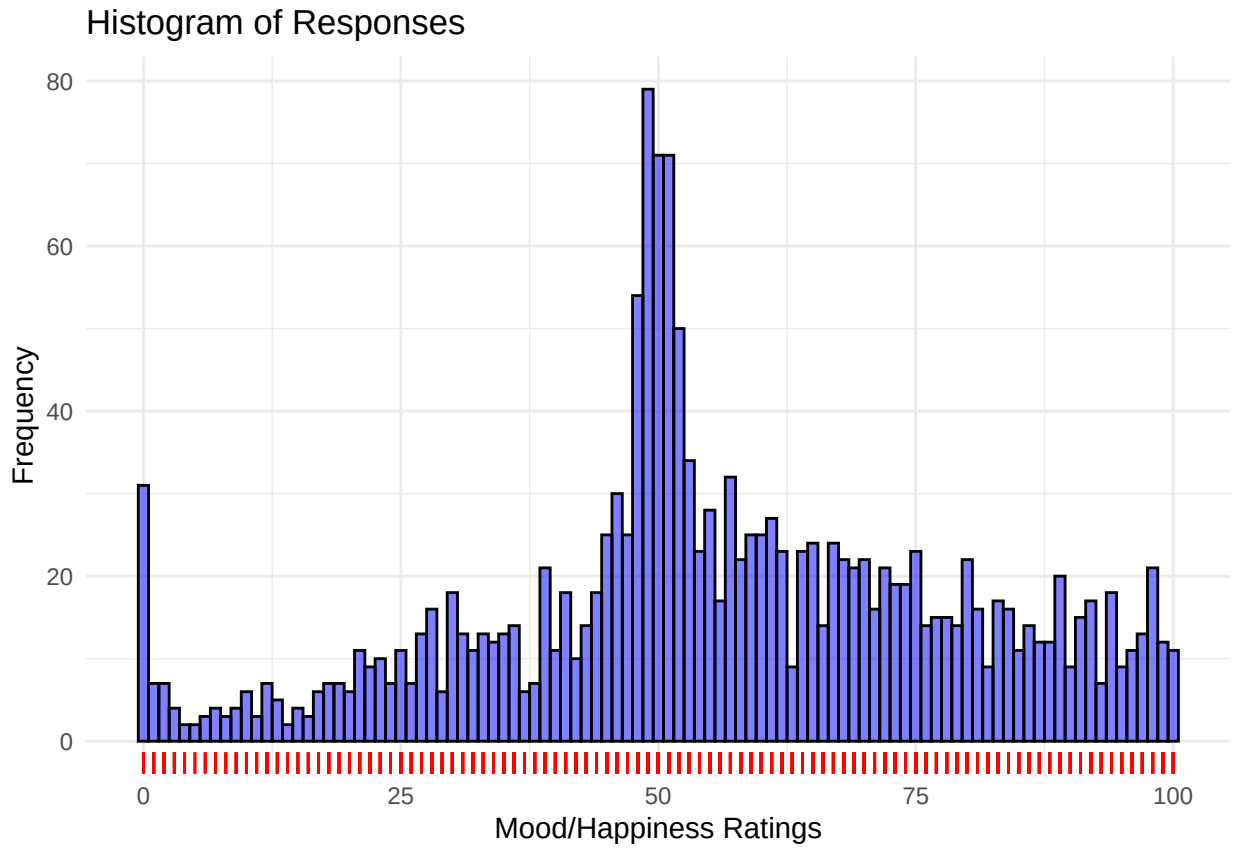
Let's have a look at histograms of SubjPE, PE, feedback and histogram means:



Histogram for anxiety ratings



Histogram for mood ratings



ICC and LME models for mood and anxiety

we will now look at the ICC outcome for anxiety The ICC is lower than the study without feedback (which was 0.80), it is moderate according to guidelines by Koo and Li (2016): below 0.50: poor between 0.50 and 0.75: moderate between 0.75 and 0.90: good above 0.90: excellent

```
## [1] "lmer for anxiety with just the intercept"
```

```
## [1] 0.5337354
```

```
##                2.5 %   97.5 %
## .sig01      12.76052 20.62685
## .sigma      14.61725 15.65126
## (Intercept) 28.03172 38.99090
```

```
## [1] 14035.34
```

```
## [1] 14037
```

```
## Data: final_df9
## Models:
## model1: Response_Ax ~ 1 + (1 | Random_ID)
## model2: Response_Ax ~ Response_PE + (1 | Random_ID)
##        npar   AIC   BIC  logLik deviance  Chisq Df Pr(>Chisq)
## model1    3 14039 14056 -7016.6    14033
## model2    4 14035 14057 -7013.7    14027 5.7927  1    0.01609 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
## [1] 14032.59
```

```
## Linear mixed model fit by REML ['lmerMod']
## Formula: Response_Ax ~ Response_SubjPE + (1 | Random_ID)
##    Data: final_df9
##
## REML criterion at convergence: 14024.6
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -3.4589 -0.4313 -0.0440  0.3079  4.9401
##
## Random effects:
##  Groups    Name        Variance Std.Dev.
##  Random_ID (Intercept) 264.4    16.26
##  Residual              227.1    15.07
## Number of obs: 1680, groups:  Random_ID, 35
##
## Fixed effects:
##                 Estimate Std. Error t value
## (Intercept)     33.70612    2.77373  12.152
## Response_SubjPE -0.05266    0.01570  -3.354
##
```

```
## Correlation of Fixed Effects:
##             (Intr)
## Rspns_SbjPE -0.021
```

```
## Data: final_df9
## Models:
## model1: Response_Ax ~ 1 + (1 | Random_ID)
## model3: Response_Ax ~ Response_SubjPE + (1 | Random_ID)
##        npar   AIC   BIC  logLik deviance  Chisq Df Pr(>Chisq)
## model1    3 14039 14056 -7016.6    14033
## model3    4 14030 14052 -7011.0    14022 11.206  1  0.0008153 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
## Data: final_df9
## Models:
## model2: Response_Ax ~ Response_PE + (1 | Random_ID)
## model3: Response_Ax ~ Response_SubjPE + (1 | Random_ID)
##        npar   AIC   BIC  logLik deviance  Chisq Df Pr(>Chisq)
## model2    4 14035 14057 -7013.7    14027
## model3    4 14030 14052 -7011.0    14022 5.4133  0
```

```
##                2.5 %   97.5 %
## .sig01      12.76052 20.62685
## .sigma      14.61725 15.65126
## (Intercept) 28.03172 38.99090
```

```
## [1] "lmer for anxiety with just the intercept"
```

```
## [1] 0.5337354
```

The ICC outcome for mood: The ICC is poor according to guidelines by Koo and Li (2016).

```
## [1] "lmer for mood with just the intercept"
```

```
## [1] 0.4315339
```

```
##                2.5 %   97.5 %
## .sig01      11.95397 19.41046
## .sigma      16.86174 18.05454
## (Intercept) 50.60661 60.94816
```

```
## [1] 14501.35
```

```
## [1] 14418.87
```

```
## Data: final_df9
## Models:
## model0: Response_H ~ 1 + (1 | Random_ID)
## model1: Response_H ~ Response_SubjPE + (1 | Random_ID)
##        npar   AIC   BIC  logLik deviance  Chisq Df Pr(>Chisq)
## model0    3 14505 14521 -7249.5    14499
## model1    4 14416 14438 -7204.2    14408 90.666  1  < 2.2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
## Linear mixed model fit by maximum likelihood  ['lmerMod']
## Formula: Response_H ~ Response_SubjPE + (Response_SubjPE | Random_ID)
##    Data: final_df9
## Control: lmerControl(optimizer = "bobyqa")
##
##      AIC      BIC   logLik deviance df.resid
##  14302.4  14334.9  -7145.2  14290.4     1674
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -3.6215 -0.3651  0.0521  0.4061  4.2609
##
## Random effects:
##  Groups    Name            Variance Std.Dev. Corr
##  Random_ID (Intercept)     230.623  15.186
##            Response_SubjPE   0.062   0.249   -0.02
##  Residual                  256.920  16.029
## Number of obs: 1680, groups:  Random_ID, 35
##
## Fixed effects:
##                 Estimate Std. Error t value
## (Intercept)      54.9329     2.5997  21.131
## Response_SubjPE   0.2059     0.0456   4.516
##
## Correlation of Fixed Effects:
##             (Intr)
## Rspns_SbjPE -0.028
```

```
## [1] 14302.39
```

1st and last trial correlations for anxiety and mood

```
## [1] "Correlation between first and last anxiety rating"
```

```
##
##  Pearson's product-moment correlation
##
## data:  final_df9[final_df9$Trial.Number == 1, ]$Response_Ax and final_df9[final_df9$Trial.Number == 4
## t = 1.3931, df = 33, p-value = 0.1729
## alternative hypothesis: true correlation is not equal to 0
## 95 percent confidence interval:
##  -0.1058905  0.5274913
## sample estimates:
##       cor
## 0.2356724
```

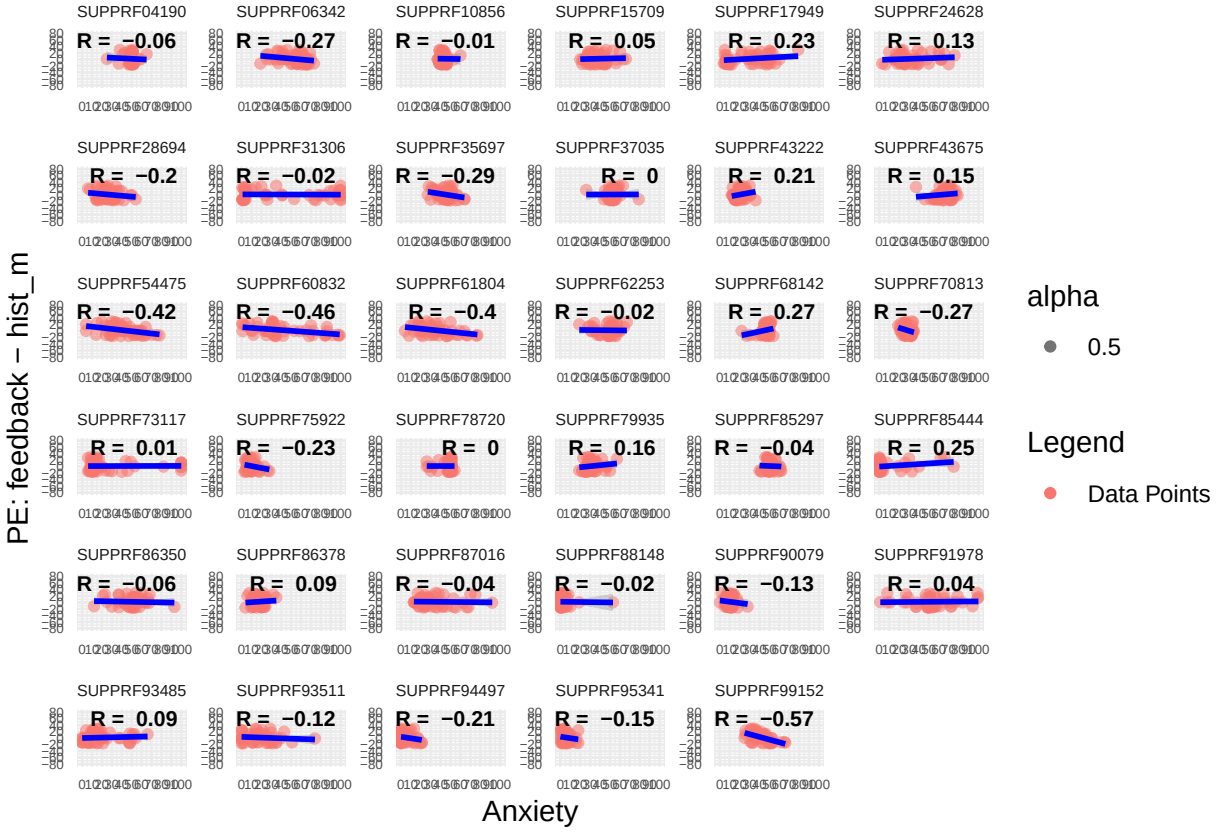
```
## [1] "Correlation between first and last mood rating"
```

```
##
##  Pearson's product-moment correlation
##
## data:  final_df9[final_df9$Trial.Number == 1, ]$Response_H and final_df9[final_df9$Trial.Number == 48
## t = 1.671, df = 33, p-value = 0.1042
## alternative hypothesis: true correlation is not equal to 0
## 95 percent confidence interval:
##  -0.05946755  0.56039862
## sample estimates:
##       cor
## 0.2793143
```

Objective PE and anxiety relationship

We now will run everything again but this time using the objective PE (feedback - histogram_mean) instead of the subjective one (feedback - prediction). The correlation between subjective_PE and anxiety was higher than objective_PE and anxiety (-0.10 vs -0.06). However, we will see below that the correlation between anxiety and feedback is the highest (-0.13 vs -0.10).

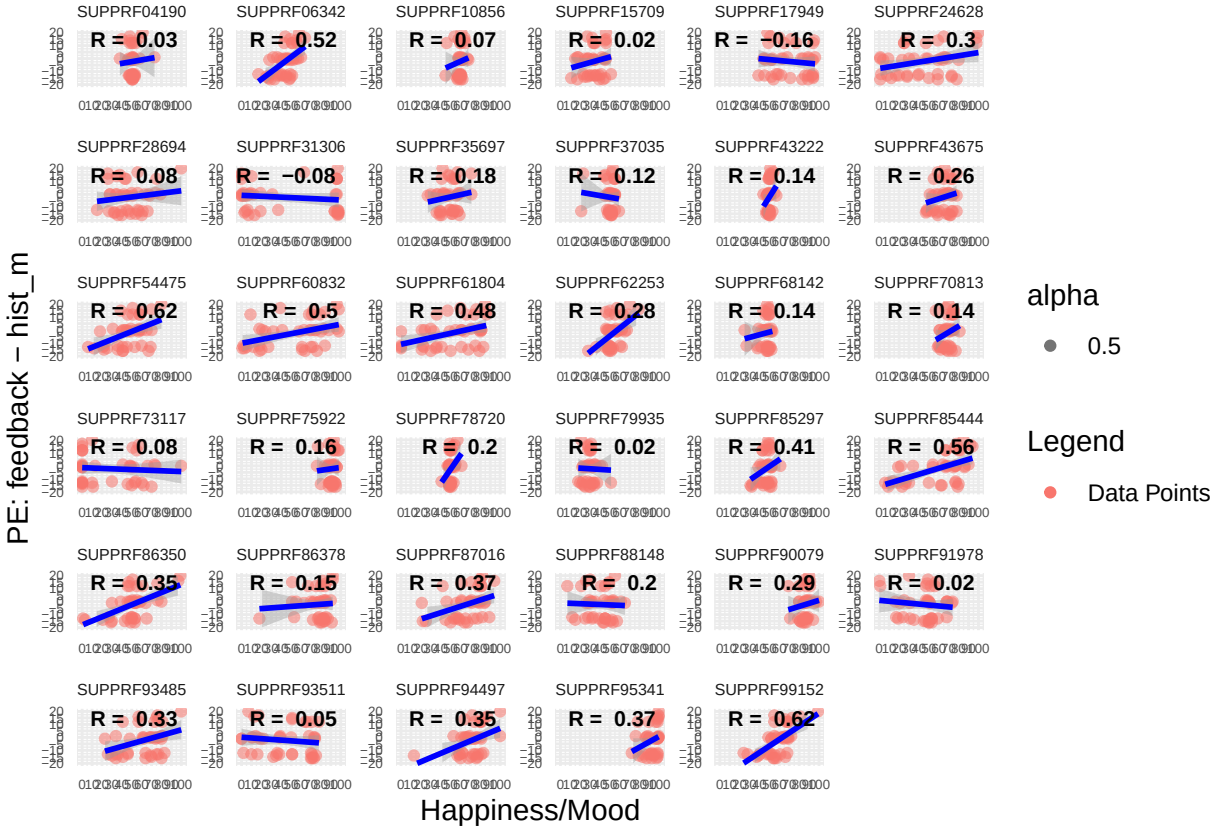
```
## [1] "average correlation between Anxiety and PE after excluding 1 outlier: -0.065830802099488"
```



Objective PE and mood relationship

We will repeat the same thing for the relationship between PE and mood. Same as anxiety, the relationship between the objective PE and mood is slightly lower than the Subj_PE (0.26 vs 0.23).

```
## [1] "average correlation between happiness and objective PE: 0.233615425675268"
```

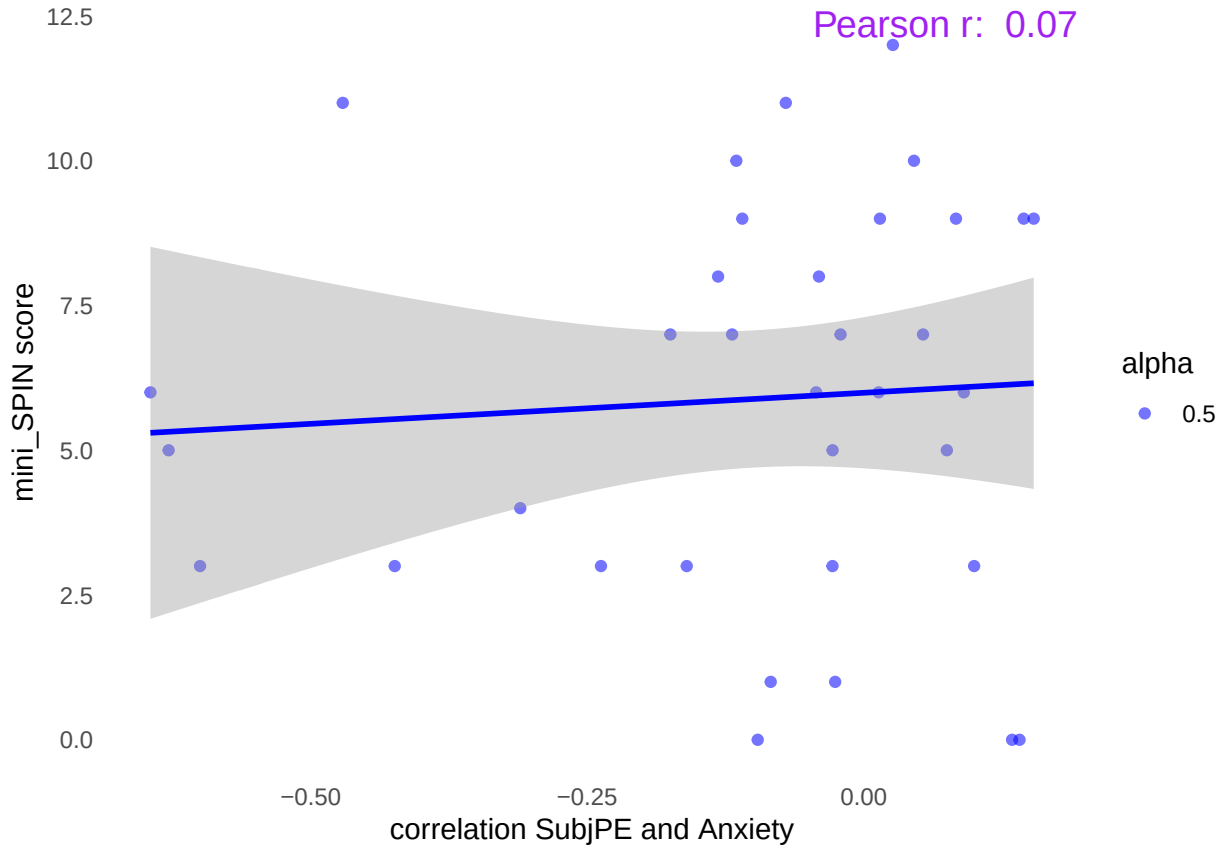


mini-SPIN count

Since these people were not screened for social anxiety, let's see how many of them had social anxiety scores higher than or equal to 6. The relationship between mini-SPIN and anxiety rating cannot be calculated within subjects since one of the variables (mini-SPIN total score) has a single value.

```
## [1] "Out of 38 people, these people had a mini_SPIN total score higher or equal to 6: 21"
```

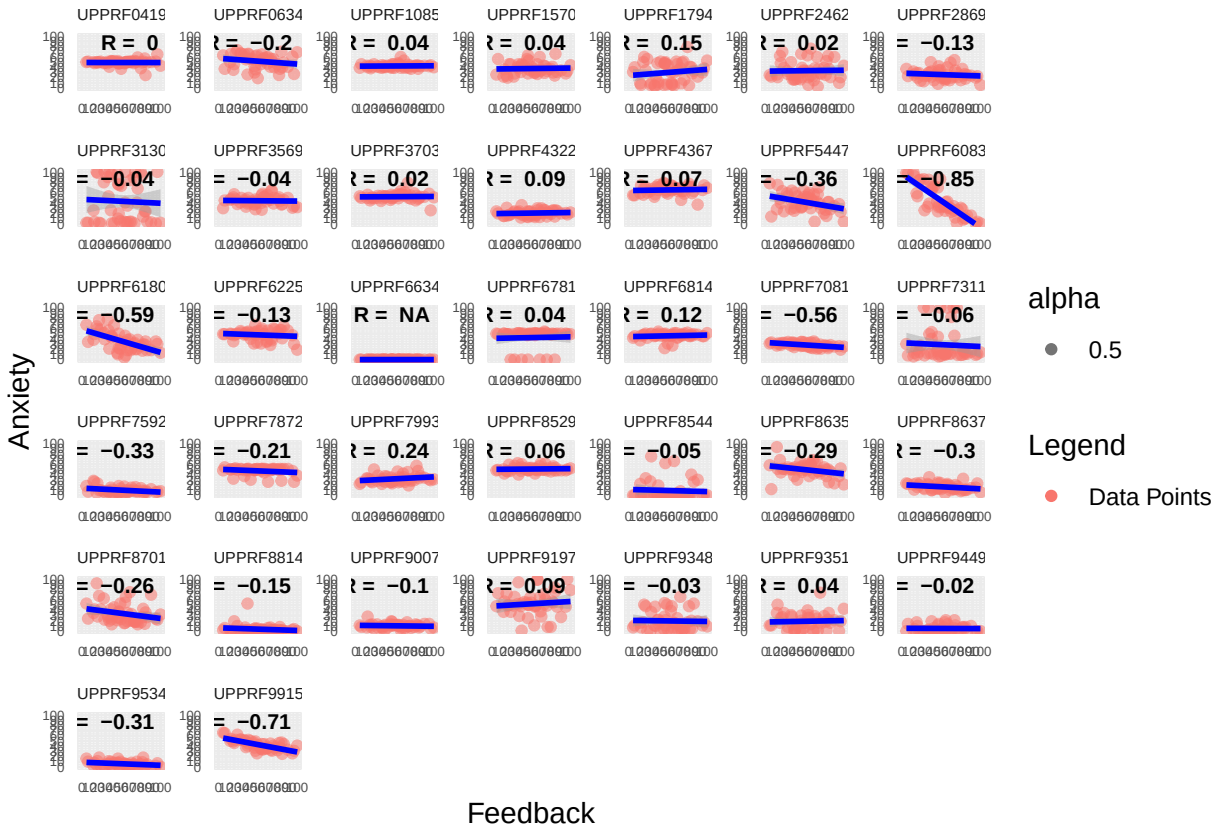
```
## [1] 0.06913388
```



Feedback and anxiety relationship

We will now look at the relationship between feedback and anxiety (so without taking prediction or histogram into account). The correlation of -0.13 which is higher than the Subj_PE correlation, may be caused by a strong negative correlation in only 3 people (SUPPRF99152, SUPPRF60832, SUPPRF61804; these people showed a similar strong relationship for mood below), almost 2/3rd of people had a correlation of almost zero. So not sure if based on this data we can conclude the feedback has a bigger impact on anxiety. I will look at the same thing in the next pilot.

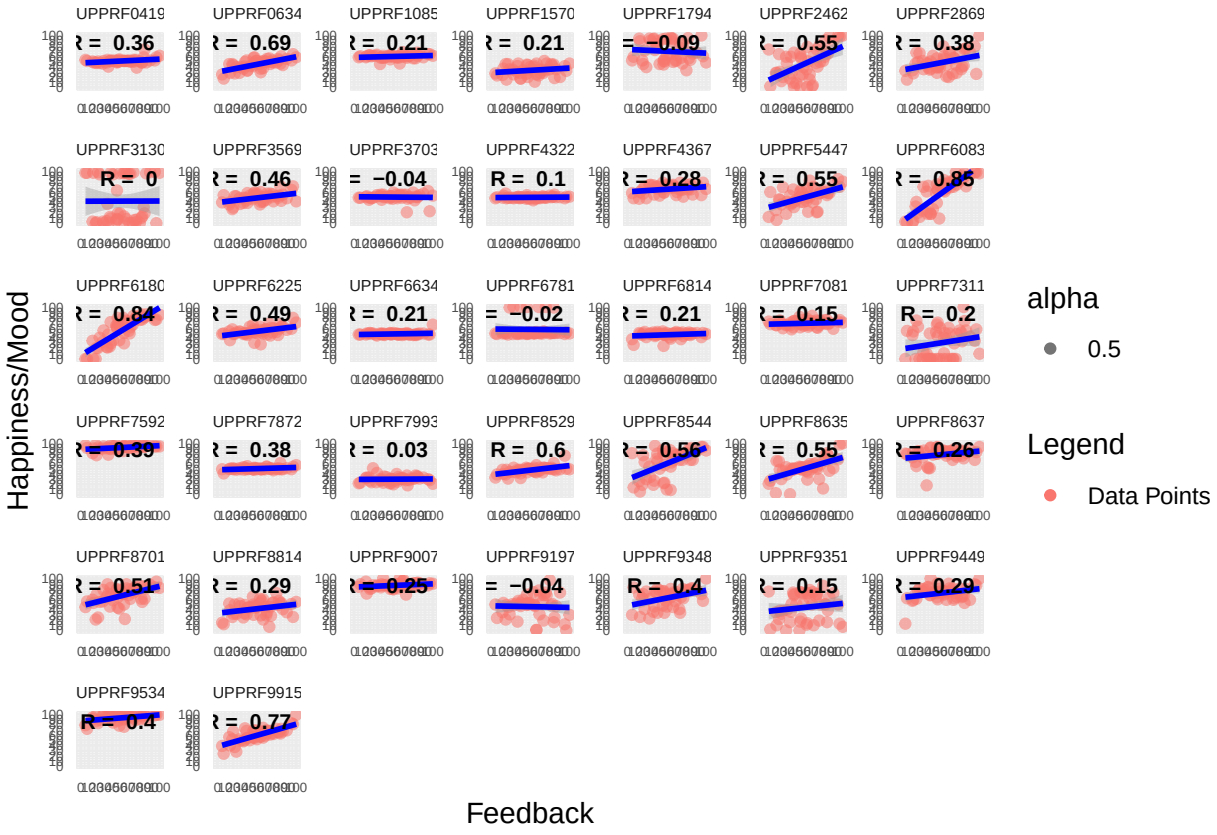
```
## [1] "average correlation between feedback and anxiety: -0.129732306826604"
```



Feedback and mood relationship

The relationship between feedback and happiness: this relationship is stronger than the one with Subj_PE (0.33 vs 0.26). However, similar to the anxiety, this stronger relationship may be mainly driven by the same 3 people: SUPPRF99152, SUPPRF60832, SUPPRF61804

```
## [1] "average correlation between feedback and happiness: 0.334898269958348"
```



ICC for anxiety

we will now look at the ICC outcome for anxiety The ICC for anxiety is 0.53, which is moderate according to guidelines by Koo and Li (2016): below 0.50: poor between 0.50 and 0.75: moderate between 0.75 and 0.90: good above 0.90: excellent

```
## [1] "lmer for anxiety with just the intercept"
```

```
## [1] 0.5337354
```

```
##                 2.5 %   97.5 %
## .sig01      12.76052 20.62685
## .sigma      14.61725 15.65126
## (Intercept) 28.03172 38.99090
```

ICC for mood

The ICC for mood is 0.43, which is lower than anxiety and is actually within the poor category, according to guidelines by Koo and Li (2016): below 0.50: poor between 0.50 and 0.75: moderate between 0.75 and 0.90: good above 0.90: excellent

```
## [1] "lmer for mood with just the intercept"
```

```
## [1] 0.4315339
```

```
##                 2.5 %   97.5 %
## .sig01      11.95397 19.41046
## .sigma      16.86174 18.05454
## (Intercept) 50.60661 60.94816
```