

# Feelings\_initial

2025-04-13

```
feelings_initial <- load("feelings_initial.RData")
ls()
```

```
## [1] "dat"                "feelings_initial" "Iaro_wide"        "Ineg_wide"
## [5] "Ipos_wide"
```

```
summary(feelings_initial)
```

```
##      Length      Class      Mode
##      4 character character
```

```
str(dat)
```

```
## 'data.frame':    16380 obs. of  9 variables:
## $ subj      : Factor w/ 156 levels "f001","f002",...: 1 1 1 1 1 1 1 1 1 1 ...
## $ trial.num: int   1 2 3 4 5 6 7 8 9 10 ...
## $ trial.val: Factor w/ 3 levels "neg","neu","pos": 3 1 1 3 3 2 2 1 1 3 ...
## $ sex       : Factor w/ 3 levels "male","female",...: 2 2 2 2 2 2 2 2 2 2 ...
## $ age       : int   19 19 19 19 19 19 19 19 19 19 ...
## $ ethn      : Factor w/ 7 levels "Asian or Pacific Islander",...: 1 1 1 1 1 1 1 1 1 1 ...
## $ Ineg      : num   1 4 2 1 1 1 1 3 5 1 ...
## $ Ipos      : num   3.69 1 1 1 4 ...
## $ Iaro      : num   2.86 3 2 2 3 ...
```

## Descriptive statistics

```
summary(dat[, c("Ineg", "Ipos", "Iaro")])
```

	Ineg	Ipos	Iaro
## Min.	:1.000	Min. :1.000	Min. :1.000
## 1st Qu.:	:1.000	1st Qu.:1.000	1st Qu.:1.000
## Median :	:2.000	Median :2.000	Median :3.000
## Mean   :	:3.075	Mean   :3.066	Mean   :3.265
## 3rd Qu.:	:5.000	3rd Qu.:5.000	3rd Qu.:5.000
## Max.   :	:9.000	Max.   :9.000	Max.   :9.000

```
# identify NAs
colSums(is.na(dat))
```

```
##      subj trial.num trial.val      sex      age      ethn      Ineg      Ipos
##      0         0         0         0         0         0         0         0
##      Iaro
##      0
```

There are no NAs in the dataset.

```
# identify outliers using z-score

# Calculate Z-scores for Ineg, Ipos, and Iaro
dat$z_Ineg <- scale(dat$Ineg)
dat$z_Ipos <- scale(dat$Ipos)
dat$z_Iaro <- scale(dat$Iaro)

# Identify outliers (Z-score > 3 or < -3)
outliers_Ineg <- dat[abs(dat$z_Ineg) > 3, ]
outliers_Ineg
```

```
## [1] subj      trial.num trial.val sex      age      ethn      Ineg
## [8] Ipos      Iaro      z_Ineg    z_Ipos    z_Iaro
## <0 rows> (or 0-length row.names)
```

```
outliers_Ipos <- dat[abs(dat$z_Ipos) > 3, ]
outliers_Ipos
```

```
## [1] subj      trial.num trial.val sex      age      ethn      Ineg
## [8] Ipos      Iaro      z_Ineg    z_Ipos    z_Iaro
## <0 rows> (or 0-length row.names)
```

```
outliers_Iaro <- dat[abs(dat$z_Iaro) > 3, ]
outliers_Iaro
```

```
## [1] subj      trial.num trial.val sex      age      ethn      Ineg
## [8] Ipos      Iaro      z_Ineg    z_Ipos    z_Iaro
## <0 rows> (or 0-length row.names)
```

There are no outliers.

## Mixed-effects model: analyze data with repeated measures

- Each participant has multiple trials, so the trials within a participant are likely correlated
- Data is nested
- Each participant may have their own baseline level of emotional responses
- fixed effects (trial.val, sex, age, ethn) explain the variation between individuals
- random effects (1|subj) explain the correlation of repeated measures within individuals

```
library(lme4)
```

```
## Loading required package: Matrix
```

```
# Mixed-effects model for predicting Ineg
```

```
model_ineg <- lmer(Ineg ~ trial.val + sex + age + ethn + (1|subj), data = dat)
summary(model_ineg)
```

```
## Linear mixed model fit by REML ['lmerMod']
```

```
## Formula: Ineg ~ trial.val + sex + age + ethn + (1 | subj)
```

```
## Data: dat
```

```
##
```

```
## REML criterion at convergence: 58969.5
```

```
##
```

```
## Scaled residuals:
```

```
##      Min       1Q   Median       3Q      Max
```

```
## -3.9915 -0.5714 -0.0487  0.5031  5.6660
```

```
##
```

```
## Random effects:
```

```
## Groups   Name      Variance Std.Dev.
```

```
## subj     (Intercept) 0.5259   0.7252
```

```
## Residual                2.0745   1.4403
```

```
## Number of obs: 16380, groups:  subj, 156
```

```
##
```

```
## Fixed effects:
```

```
##
```

```
## (Intercept)                Estimate Std. Error
```

```
## trial.valneu              -4.076439   0.034381
```

```
## trial.valpos              -4.086175   0.024311
```

```
## sexfemale                  0.317543   0.121858
```

```
## sexother                   -0.031652   0.747300
```

```
## age                        0.001809   0.021086
```

```
## ethnBlack/African American -0.060943   0.237892
```

```
## ethnLatino/Hispanic        -0.317652   0.232008
```

```
## ethnOther                   0.138570   0.290750
```

```
## ethnWhite/Caucasian         0.070420   0.155354
```

```
## ethnAmerican Indian/Native American or Alaskan Native -0.692261   0.393608
```

```
## ethnDecline to state       -0.275510   0.543413
```

```
##
```

```
## t value
```

```
## (Intercept)                11.759
```

```
## trial.valneu              -118.566
```

```
## trial.valpos             -168.079
```

```
## sexfemale                   2.606
```

```
## sexother                   -0.042
```

```
## age                         0.086
```

```
## ethnBlack/African American -0.256
```

```
## ethnLatino/Hispanic        -1.369
```

```
## ethnOther                   0.477
```

```
## ethnWhite/Caucasian         0.453
```

```
## ethnAmerican Indian/Native American or Alaskan Native -1.759
```

```
## ethnDecline to state       -0.507
```

```
##
```

```
## Correlation of Fixed Effects:
##          (Intr) trl.vln trl.vlp sexfml sexthr age    etB/AA ethL/H ethnOt
## trial.valne -0.019
## trial.valps -0.027  0.354
## sexfemale   -0.197  0.000  0.000
## sexother    -0.070  0.000  0.000  0.084
## age         -0.941  0.000  0.000  0.021  0.059
## ethnBlck/AA -0.026  0.000  0.000  0.072 -0.002 -0.149
## ethnLtn/Hsp  0.065  0.000  0.000  0.072 -0.008 -0.250  0.334
## ethnOther   -0.081  0.000  0.000 -0.044 -0.006 -0.038  0.234  0.244
## ethnWht/Ccs -0.091  0.000  0.000  0.107 -0.062 -0.171  0.468  0.496  0.357
## ethAI/NAoAN -0.141  0.000  0.000  0.123  0.012  0.029  0.176  0.178  0.134
## ethnDclntst -0.067  0.000  0.000  0.144  0.010 -0.027  0.139  0.145  0.096
##          ethW/C eIAoAN
## trial.valne
## trial.valps
## sexfemale
## sexother
## age
## ethnBlck/AA
## ethnLtn/Hsp
## ethnOther
## ethnWht/Ccs
## ethAI/NAoAN  0.271
## ethnDclntst  0.211  0.092
```

- Random effects: each participant has a different baseline emotional response
  - (1|subj): represents the random effect
    - \* each participant (subj) has a different baseline deviation (intercept).
    - \* This accounts for the correlation between multiple trial results from the same participant
- REML score (residual maximum likelihood estimate): assess the model fit
- Fixed Effects:
  - Intercept: Negative trial
  - trial.valneu (Neutral trial): Estimate = -4.08, t = -118.57, a very significant negative value.
    - \* Compared to the baseline (negative trial), the neutral trial significantly decreases negative emotions (Ineg)
  - trial.valpos (Positive trial): Estimate = -4.09, t = -168.08, also significant.
    - \* the positive trial also significantly decreases negative emotions compared to the negative trial
  - sexfemale: Estimate = 0.317543, t = 2.606.
    - \* Females have significantly higher negative emotional responses (Ineg) compared to males
  - The effects of age and ethnicity are small and not significant

```
# Mixed-effects model for predicting Ipos
model_ipos <- lmer(Ipos ~ trial.val + sex + age + ethn + (1|subj), data = dat)
summary(model_ipos)
```

```
## Linear mixed model fit by REML ['lmerMod']
## Formula: Ipos ~ trial.val + sex + age + ethn + (1 | subj)
## Data: dat
##
```

```

## REML criterion at convergence: 60034.7
##
## Scaled residuals:
##      Min       1Q   Median       3Q      Max
## -3.8302 -0.5834 -0.0294  0.5335  5.4659
##
## Random effects:
##   Groups   Name      Variance Std.Dev.
##   subj      (Intercept) 0.5687   0.7541
##   Residual                2.2138   1.4879
## Number of obs: 16380, groups:  subj, 156
##
## Fixed effects:
##
##                                     Estimate Std. Error
## (Intercept)                       0.71768    0.46141
## trial.valneu                      0.33658    0.03552
## trial.valpos                      4.03432    0.02511
## sexfemale                        0.20020    0.12669
## sexother                       -1.13135    0.77693
## age                             0.02213    0.02192
## ethnBlack/African American       0.08731    0.24732
## ethnLatino/Hispanic             -0.33718    0.24121
## ethnOther                       -0.01740    0.30228
## ethnWhite/Caucasian              0.13375    0.16151
## ethnAmerican Indian/Native American or Alaskan Native -0.93997    0.40921
## ethnDecline to state             -0.33289    0.56496
##
##                                     t value
## (Intercept)                       1.555
## trial.valneu                      9.477
## trial.valpos                     160.642
## sexfemale                        1.580
## sexother                       -1.456
## age                             1.010
## ethnBlack/African American       0.353
## ethnLatino/Hispanic             -1.398
## ethnOther                       -0.058
## ethnWhite/Caucasian              0.828
## ethnAmerican Indian/Native American or Alaskan Native -2.297
## ethnDecline to state             -0.589
##
## Correlation of Fixed Effects:
##      (Intr) trl.vln trl.vlp sexfml sexthr age   etB/AA ethL/H ethnOt
## trial.valne -0.019
## trial.valps -0.027  0.354
## sexfemale   -0.197  0.000  0.000
## sexother    -0.070  0.000  0.000  0.084
## age         -0.941  0.000  0.000  0.021  0.059
## ethnBlck/AA -0.026  0.000  0.000  0.072 -0.002 -0.149
## ethnLtn/Hsp  0.065  0.000  0.000  0.072 -0.008 -0.250  0.334
## ethnOther    -0.081  0.000  0.000 -0.044 -0.006 -0.038  0.234  0.244
## ethnWht/Ccs  -0.091  0.000  0.000  0.107 -0.062 -0.171  0.468  0.496  0.357
## ethAI/NAoAN -0.141  0.000  0.000  0.123  0.012  0.029  0.176  0.178  0.134
## ethnDclntst -0.067  0.000  0.000  0.144  0.010 -0.027  0.139  0.145  0.096
##
##      ethW/C eIAoAN

```

```
## trial.valne
## trial.valps
## sexfemale
## sexother
## age
## ethnBlck/AA
## ethnLtn/Hsp
## ethnOther
## ethnWht/Ccs
## ethAI/NAoAN 0.271
## ethnDclntst 0.211 0.092
```

- Intercept (negative trial): estimate = 0.72, t-value = 1.56. The effect of negative trial on positive emotions (Ipos) is small.
- trial.valneu: estimate = 0.34, t-value = 9.48. Compared to valneg, the neutral trial significantly increases positive emotions (Ipos).
- trial.valpos: estimate = 4.03, t-value = 160.64. Compared to valneg, the positive trial largely increases positive emotions (Ipos), and the effect is extremely significant.
- sexfemale: estimate = 0.20, t = 1.58. Females tend to have slightly higher positive emotional responses than males.
- ethnAmerican Indian/Native American or Alaskan Native: estimate = -0.94, t = -2.30. This ethnicity tends to have significantly lower positive emotional responses compared to the reference group.
- trial.valneu and trial.valpos have a correlation of 0.354, showing that the effects of neutral and positive trials are somewhat related.

```
# Mixed-effects model for predicting Iaro
model_aro <- lmer(Iaro ~ trial.val + sex + age + ethn + (1|subj), data = dat)
summary(model_aro)
```

```
## Linear mixed model fit by REML ['lmerMod']
## Formula: Iaro ~ trial.val + sex + age + ethn + (1 | subj)
## Data: dat
##
## REML criterion at convergence: 59841.3
##
## Scaled residuals:
## Min 1Q Median 3Q Max
## -4.4843 -0.6288 -0.1072 0.5760 4.8022
##
## Random effects:
## Groups Name Variance Std.Dev.
## subj (Intercept) 1.593 1.262
## Residual 2.168 1.472
## Number of obs: 16380, groups: subj, 156
##
## Fixed effects:
## Estimate Std. Error
## (Intercept) 2.92802 0.76311
## trial.valneu -2.25913 0.03515
## trial.valpos -0.30058 0.02485
## sexfemale 0.22642 0.20959
## sexother -1.53358 1.28529
```

```

## age                                0.02904    0.03627
## ethnBlack/African American         0.22313    0.40915
## ethnLatino/Hispanic                0.12385    0.39903
## ethnOther                          0.52839    0.50007
## ethnWhite/Caucasian                0.06932    0.26720
## ethnAmerican Indian/Native American or Alaskan Native -0.85245    0.67697
## ethnDecline to state                0.07313    0.93462
##                                     t value
## (Intercept)                        3.837
## trial.valneu                       -64.279
## trial.valpos                       -12.095
## sexfemale                           1.080
## sexother                           -1.193
## age                                 0.801
## ethnBlack/African American          0.545
## ethnLatino/Hispanic                 0.310
## ethnOther                           1.057
## ethnWhite/Caucasian                 0.259
## ethnAmerican Indian/Native American or Alaskan Native -1.259
## ethnDecline to state                0.078
##
## Correlation of Fixed Effects:
##      (Intr) trl.vln trl.vlp sexfml sexthr age   etB/AA ethL/H ethnOt
## trial.valne -0.012
## trial.valps -0.016  0.354
## sexfemale   -0.197  0.000  0.000
## sexother    -0.070  0.000  0.000  0.084
## age         -0.942  0.000  0.000  0.021  0.059
## ethnBlck/AA -0.026  0.000  0.000  0.072 -0.002 -0.149
## ethnLtn/Hsp  0.065  0.000  0.000  0.072 -0.008 -0.250  0.334
## ethnOther    -0.081  0.000  0.000 -0.044 -0.006 -0.038  0.234  0.244
## ethnWht/Ccs  -0.091  0.000  0.000  0.107 -0.062 -0.171  0.468  0.496  0.357
## ethAI/NAoAN -0.141  0.000  0.000  0.123  0.012  0.029  0.176  0.178  0.134
## ethnDclntst -0.067  0.000  0.000  0.144  0.010 -0.027  0.139  0.145  0.096
##      ethW/C eIAoAN
## trial.valne
## trial.valps
## sexfemale
## sexother
## age
## ethnBlck/AA
## ethnLtn/Hsp
## ethnOther
## ethnWht/Ccs
## ethAI/NAoAN  0.271
## ethnDclntst  0.211  0.092

```

- Intercept (negative trial): estimate = 2.93, t-value = 3.84. The effect of negative trial on arousal (Iaro) is moderate.
- trial.valneu: estimate -2.26, t-value = -64.28. Compared to valneg, the neutral trial significantly decreases arousal (Iaro), which can be expected.
- trial.valpos: estimate = -0.30, t-value = -12.10. Compared to valneg, the positive trial also significantly decreases arousal (Iaro), but the effect is small.
- Other fixed effects are not significant.

## Autoregressive Modeling

Assign 1 overall inertia score for pos, neg, and aro for each participant:

```
library(dplyr)

##
## Attaching package: 'dplyr'

## The following objects are masked from 'package:stats':
##
##   filter, lag

## The following objects are masked from 'package:base':
##
##   intersect, setdiff, setequal, union

library(purrr)
library(broom)

# Create a function to return inertia (lag-1 beta value)
get_inertia <- function(x) {
  # Create lagged data
  lag_x <- dplyr::lag(x)
  df <- data.frame(current = x, lagged = lag_x)
  df <- na.omit(df)

  # Linear regression: current ~ lagged
  model <- lm(current ~ lagged, data = df)
  coef(model)["lagged"]
}

# find inertia scores for the 3 emotions for each participant
overall_inertia <- dat %>%
  group_by(subj) %>%
  summarise(
    pos_inertia = get_inertia(Ipos),
    neg_inertia = get_inertia(Ineg),
    aro_inertia = get_inertia(Iaro)
  )
overall_inertia

## # A tibble: 156 x 4
##   subj pos_inertia neg_inertia aro_inertia
##   <fct>      <dbl>      <dbl>      <dbl>
## 1 f001    -0.0956    -0.149    -0.139
## 2 f002     0.0187     0.0682     0.0974
## 3 f003    -0.0855    -0.143     0.0149
## 4 f004     0.0648    -0.0705     0.0150
## 5 f005    -0.0433    -0.0918    -0.0962
## 6 f006    -0.0750     0.160     0.175
## 7 f007     0.0834     0.0245     0.190
```



```
## 8 f008      -0.0125    -0.0254    0.00949
## 9 f009       0.0162     0.0865   -0.136
## 10 f010      0.164      0.110     0.0143
## # i 146 more rows
```

For each of the 3 emotional reactions (pos, neg, aro), assign 1 inertia score for each of the 3 trial type (pos, neg, neu)

```
library(tidyr)
```

```
##
```

```
## Attaching package: 'tidyr'
```

```
## The following objects are masked from 'package:Matrix':
```

```
##
```

```
##      expand, pack, unpack
```

```
# For each subj x trial.val x emotion
```

```
inertia_long <- dat %>%
```

```
  group_by(subj, trial.val) %>%
```

```
  summarise(
```

```
    pos_inertia = get_inertia(Ipos),
```

```
    neg_inertia = get_inertia(Ineg),
```

```
    aro_inertia = get_inertia(Iaro),
```

```
    .groups = "drop"
```

```
  )
```

```
# Reshape into wide format: 1 row per participant, 9 inertia scores
```

```
inertia_wide <- inertia_long %>%
```

```
  pivot_wider(
```

```
    names_from = trial.val,
```

```
    values_from = c(pos_inertia, neg_inertia, aro_inertia),
```

```
    names_glue = "{.value}_{trial.val}"
```

```
  )
```

```
inertia_wide
```

```
## # A tibble: 156 x 10
```

```
##   subj pos_inertia_neg pos_inertia_neu pos_inertia_pos neg_inertia_neg
```

```
##   <fct>      <dbl>      <dbl>      <dbl>      <dbl>
```

```
## 1 f001      -0.0233      NA          0.0214      -0.203
```

```
## 2 f002      -0.0233     -0.115     -0.00418     0.376
```

```
## 3 f003       0.131     -0.0939    -0.127     -0.106
```

```
## 4 f004     -0.0732    -0.0111     0.196     0.0689
```

```
## 5 f005       0.223     -0.0769     0.0571     0.107
```

```
## 6 f006     -0.0883    -0.161     0.239     0.416
```

```
## 7 f007     -0.0233    -0.0888     0.0636     0.191
```

```
## 8 f008       0.0422    -0.247     0.0363    -0.174
```

```
## 9 f009     -0.0560     0.0590     0.0652     0.0603
```

```
## 10 f010     -0.0233     0.0577     0.199     0.220
```

```
## # i 146 more rows
```

```
## # i 5 more variables: neg_inertia_neu <dbl>, neg_inertia_pos <dbl>,
```

```
## #   aro_inertia_neg <dbl>, aro_inertia_neu <dbl>, aro_inertia_pos <dbl>
```

```
# Find the reason of NAs
```

```
# Whether there's not enough data for each subj × trial.val group?
```

```
dat %>%  
  group_by(subj, trial.val) %>%  
  summarise(n = n()) %>%  
  filter(n < 5)
```

```
## 'summarise()' has grouped output by 'subj'. You can override using the  
## '.groups' argument.
```

```
## # A tibble: 0 x 3  
## # Groups:   subj [0]  
## # i 3 variables: subj <fct>, trial.val <fct>, n <int>
```

```
# Whether some emotion ratings for certain trial type are always the same?
```

```
dat %>%  
  group_by(subj, trial.val) %>%  
  summarise(  
    Ineg_var = var(Ineg),  
    Ipos_var = var(Ipos),  
    Iaro_var = var(Iaro)  
  ) %>%  
  filter(Ineg_var == 0 | Ipos_var == 0 | Iaro_var == 0)
```

```
## 'summarise()' has grouped output by 'subj'. You can override using the  
## '.groups' argument.
```

```
## # A tibble: 106 x 5  
## # Groups:   subj [80]  
##   subj trial.val Ineg_var Ipos_var Iaro_var  
##   <fct> <fct>      <dbl>   <dbl>   <dbl>  
## 1 f001 neu         0      0.267  0.352  
## 2 f001 pos         0      1.61   1.08  
## 3 f002 neu         0      1.26   1.35  
## 4 f002 pos         0      1.51   1.14  
## 5 f005 neu         0      0.267  0.0667  
## 6 f007 neu         0      0.0663  0  
## 7 f007 pos         0      0.786  0.382  
## 8 f013 neu         0      0.0659  0  
## 9 f019 neu        0.124  4.92   0  
## 10 f020 neu         0      2.52   1.55  
## # i 96 more rows
```

- The reason of NAs is not due to insufficient data for each  $\text{subj} \times \text{trial.val}$  group
- NAs are also not likely to be caused by zero-variance of some emotion inertia ratings, since NAs from `inertia_wide` are more than the number of `Var = 0`.

```
# Merge all inertia scores (by subj)
inertia_all <- overall_inertia %>%
  left_join(inertia_wide, by = "subj")
inertia_all
```

```
## # A tibble: 156 x 13
##   subj pos_inertia neg_inertia aro_inertia pos_inertia_neg pos_inertia_neu
##   <fct>      <dbl>      <dbl>      <dbl>      <dbl>      <dbl>
## 1 f001    -0.0956    -0.149    -0.139    -0.0233      NA
## 2 f002     0.0187     0.0682     0.0974    -0.0233    -0.115
## 3 f003    -0.0855    -0.143     0.0149     0.131    -0.0939
## 4 f004     0.0648    -0.0705     0.0150    -0.0732    -0.0111
## 5 f005    -0.0433    -0.0918    -0.0962     0.223    -0.0769
## 6 f006    -0.0750     0.160     0.175    -0.0883    -0.161
## 7 f007     0.0834     0.0245     0.190    -0.0233    -0.0888
## 8 f008    -0.0125    -0.0254     0.00949    0.0422    -0.247
## 9 f009     0.0162     0.0865    -0.136    -0.0560     0.0590
## 10 f010     0.164     0.110     0.0143    -0.0233     0.0577
## # i 146 more rows
## # i 7 more variables: pos_inertia_pos <dbl>, neg_inertia_neg <dbl>,
## #   neg_inertia_neu <dbl>, neg_inertia_pos <dbl>, aro_inertia_neg <dbl>,
## #   aro_inertia_neu <dbl>, aro_inertia_pos <dbl>
```

```
library(ggplot2)
library(dplyr)
library(tidyr)
library(e1071) # for skewness
library(psych) # for describe()
```

```
##
## Attaching package: 'psych'

## The following objects are masked from 'package:ggplot2':
##
##   %+%, alpha
```

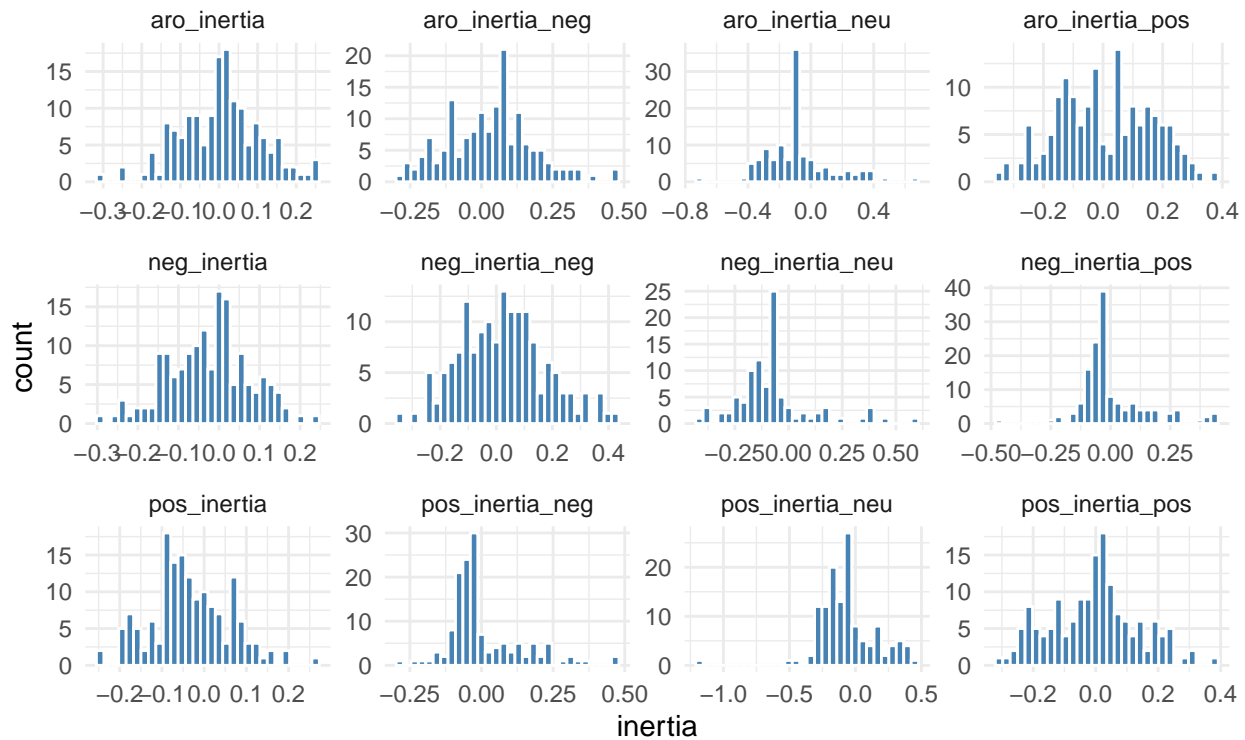
```
# Convert to inertia_long format
inertia_long <- inertia_all %>%
  pivot_longer(-subj, names_to = "inertia_type", values_to = "inertia")

# Distribution & Skewness
inertia_long %>%
  group_by(inertia_type) %>%
  mutate(
    skew = skewness(inertia, na.rm = TRUE),
    normality_p = shapiro.test(inertia)$p.value
  ) %>%
  ggplot(aes(x = inertia)) +
  geom_histogram(bins = 30, fill = "steelblue", color = "white") +
  facet_wrap(~ inertia_type, scales = "free") +
  theme_minimal() +
  labs(title = "Histogram of Inertia Scores across Participants",
       subtitle = "Check for skewness & normality visually")
```

```
## Warning: Removed 159 rows containing non-finite outside the scale range
## ('stat_bin()').
```

## Histogram of Inertia Scores across Participants

Check for skewness & normality visually



```
# describe_stats for all 3 + 9 = 12 types of inertia
```

```
describe_stats <- inertia_long %>%
  group_by(inertia_type) %>%
  summarise(
    n = sum(!is.na(inertia)),
    sd = sd(inertia, na.rm = TRUE),
    Q1 = quantile(inertia, 0.25, na.rm = TRUE),
    Q3 = quantile(inertia, 0.75, na.rm = TRUE),
    skewness = skewness(inertia, na.rm = TRUE),
    normality_p = shapiro.test(inertia)$p.value
  )
describe_stats
```

```
## # A tibble: 12 x 7
```

```
##   inertia_type      n      sd      Q1      Q3 skewness normality_p
##   <chr>          <int> <dbl>   <dbl>   <dbl>   <dbl>      <dbl>
## 1 aro_inertia    156  0.103 -0.0630  0.0666 -0.0809  6.10e- 1
## 2 aro_inertia_neg 156  0.150 -0.0772  0.124   0.230   1.39e- 1
## 3 aro_inertia_neu 117  0.208 -0.182 -0.00947 0.715   3.86e- 5
## 4 aro_inertia_pos 154  0.157 -0.117  0.134   0.0368  1.11e- 1
## 5 neg_inertia    156  0.0998 -0.0890  0.0316 -0.120   8.17e- 1
## 6 neg_inertia_neg 156  0.151 -0.0928  0.117   0.253   4.16e- 1
```

## 7	neg_inertia_neu	95	0.177	-0.166	-0.0635	1.30	1.30e- 7
## 8	neg_inertia_pos	141	0.139	-0.0694	0.0458	1.08	6.69e-10
## 9	pos_inertia	156	0.0927	-0.0889	0.0276	0.290	2.67e- 1
## 10	pos_inertia_neg	140	0.129	-0.0691	0.0479	1.27	2.32e- 9
## 11	pos_inertia_neu	130	0.216	-0.167	0.0242	-0.399	8.44e- 8
## 12	pos_inertia_pos	156	0.141	-0.119	0.0684	0.0816	1.17e- 1

Inertia scores that are not normal:

- neg\_inertia\_pos: normality\_p = 6.689087e-10; skewness = 1.07982750
  - Under positive stimuli, negative emotion inertia is right-skewed: a few individuals have unusually persistent negative emotions
- pos\_inertia\_neg: normality\_p = 2.318693e-09; skewness = 1.27067898
  - Under negative stimuli, positive emotion inertia is strongly right-skewed: most people have low inertia in positive feelings, with a few showing strong inertia
- pos\_inertia\_neu: normality\_p = 8.436415e-08; skewness = -0.39896752
  - For neutral stimuli, positive emotion inertia is slightly left-skewed
- neg\_inertia\_neu: normality\_p = 1.296106e-07; skewness = 1.29575508
  - For neutral stimuli, negative emotion inertia is strongly right-skewed
- aro\_inertia\_neu: normality\_p = 3.859573e-05; skewness = 0.71497318
  - For neutral stimuli, arousal inertia is right-skewed

```
# Transform the skewed inertia types to normal
library(bestNormalize)

skewed_vars <- c(
  "neg_inertia_pos", "pos_inertia_neg", "pos_inertia_neu",
  "neg_inertia_neu", "aro_inertia_neu"
)

inertia_long_normalized <- inertia_long %>%
  group_by(inertia_type) %>%
  mutate(
    inertia_trans = if_else(
      inertia_type %in% skewed_vars,
      orderNorm(inertia)$x.t, # transform only these
      inertia # leave others unchanged
    )
  )
```

```
## Warning: There were 6 warnings in 'mutate()'.
## The first warning was:
## i In argument: 'inertia_trans = if_else(...)'.
## i In group 3: 'inertia_type = "aro_inertia_neu"'.
## Caused by warning in 'orderNorm()':
## ! Ties in data, Normal distribution not guaranteed
## i Run 'dplyr::last_dplyr_warnings()' to see the 5 remaining warnings.
```

```
inertia_long_normalized
```

```
## # A tibble: 1,872 x 4
## # Groups:   inertia_type [12]
##   subj inertia_type    inertia inertia_trans
##   <fct> <chr>          <dbl>      <dbl>
## 1 f001 pos_inertia    -0.0956    -0.0956
## 2 f001 neg_inertia    -0.149     -0.149
## 3 f001 aro_inertia   -0.139     -0.139
## 4 f001 pos_inertia_neg -0.0233     0.244
## 5 f001 pos_inertia_neu NA          NA
## 6 f001 pos_inertia_pos 0.0214     0.0214
## 7 f001 neg_inertia_neg -0.203     -0.203
## 8 f001 neg_inertia_neu NA          NA
## 9 f001 neg_inertia_pos NA          NA
## 10 f001 aro_inertia_neg -0.187     -0.187
## # i 1,862 more rows
```