REWOD_HEDO_RM

R code for FOR REWOD_HED

last modified on Nov 2018 by David

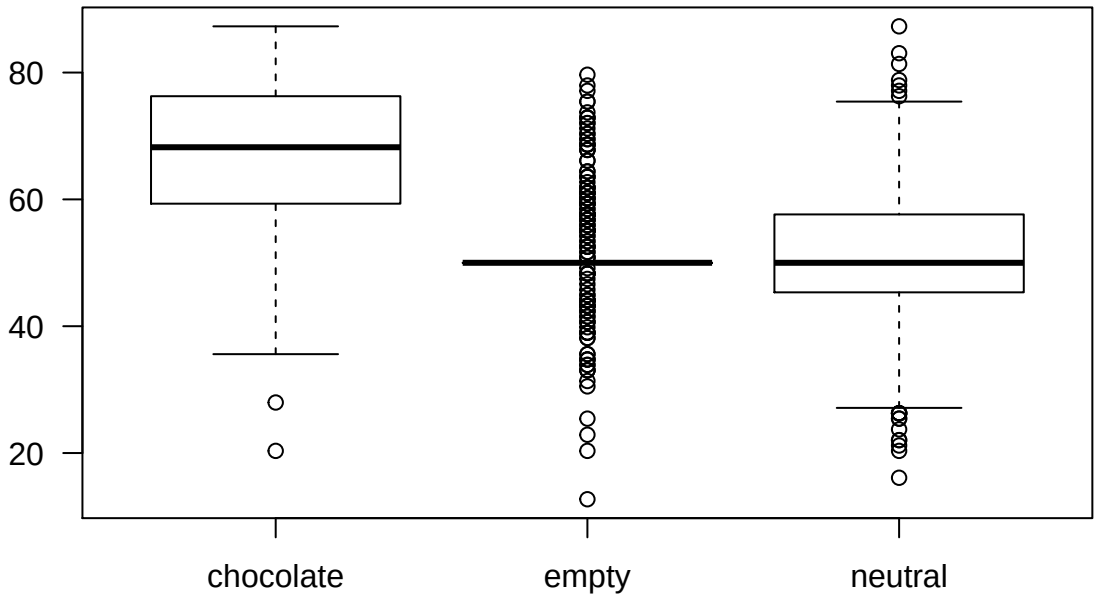
SETUP

```
# Set working directory
analysis_path <- '~/rewod/DATABASES/'# for this to work the script needs to be sourced
setwd(analysis_path)

# open dataset (session two only)
REWOD_HED <- read.delim(file.path(analysis_path,'REWOD_HEDONIC_ses_second.txt'), header = T, sep ='') #

# define factors
REWOD_HED$id               <- factor(REWOD_HED$id)
#REWOD_HED$trial            <- factor(REWOD_HED$trial)
REWOD_HED$session          <- factor(REWOD_HED$session)
REWOD_HED$condition        <- factor(REWOD_HED$condition)

## remove sub 1 & 8
REWOD_HED <- filter(REWOD_HED, id != "1" & id != "8")
```

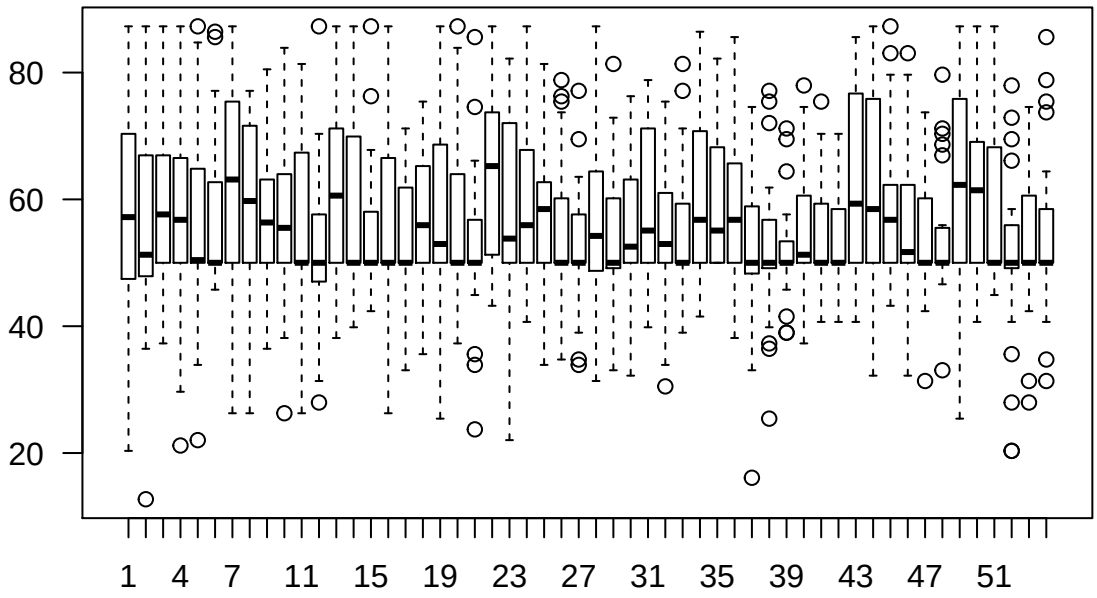
PLOTS

plot (non-averaged per participant)

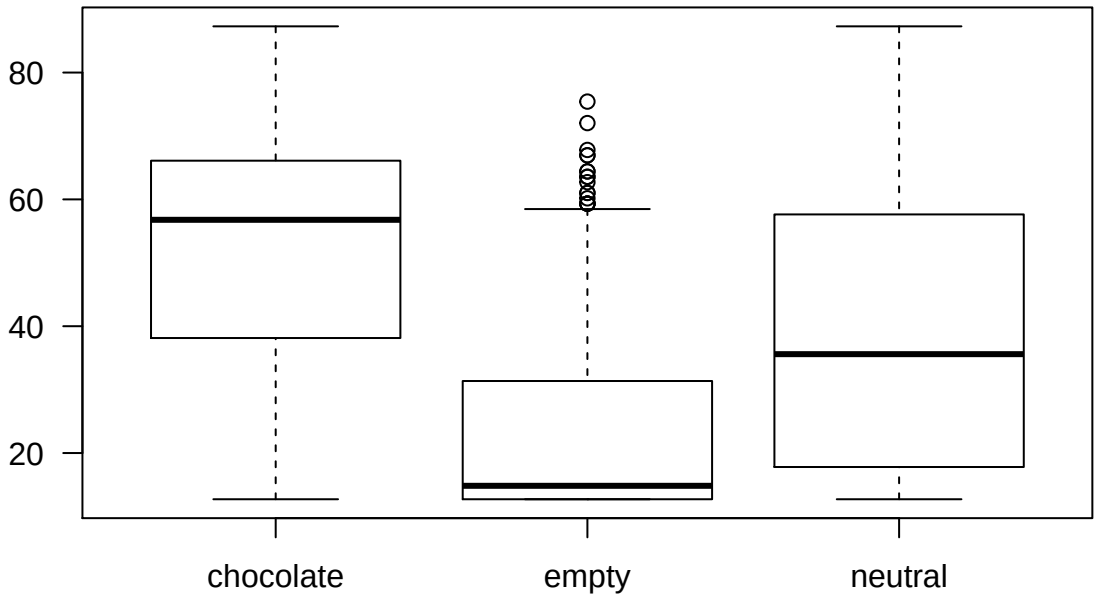
```
# liking boxplot by condition
boxplot(REWOD_HED$perceived_liking ~ REWOD_HED$condition, las = 1)
```



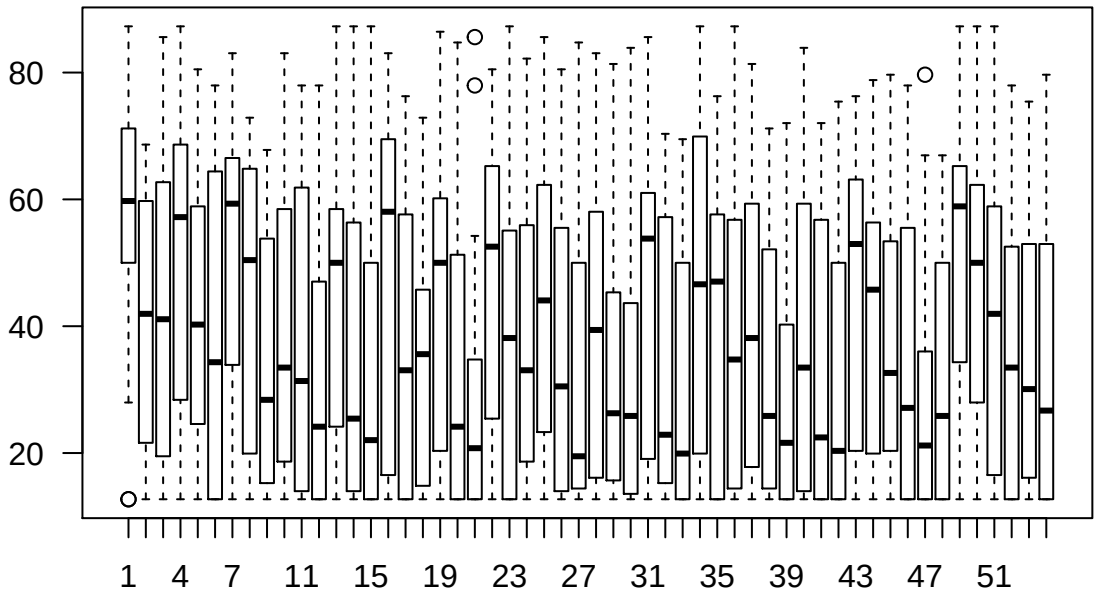

```
# liking boxplot by time
boxplot(REWOD_HED$perceived_liking ~ REWOD_HED$trial, las = 1)
```




```
# intensity boxplot by condition
boxplot(REWOD_HED$perceived_intensity ~ REWOD_HED$condition, las = 1)
```



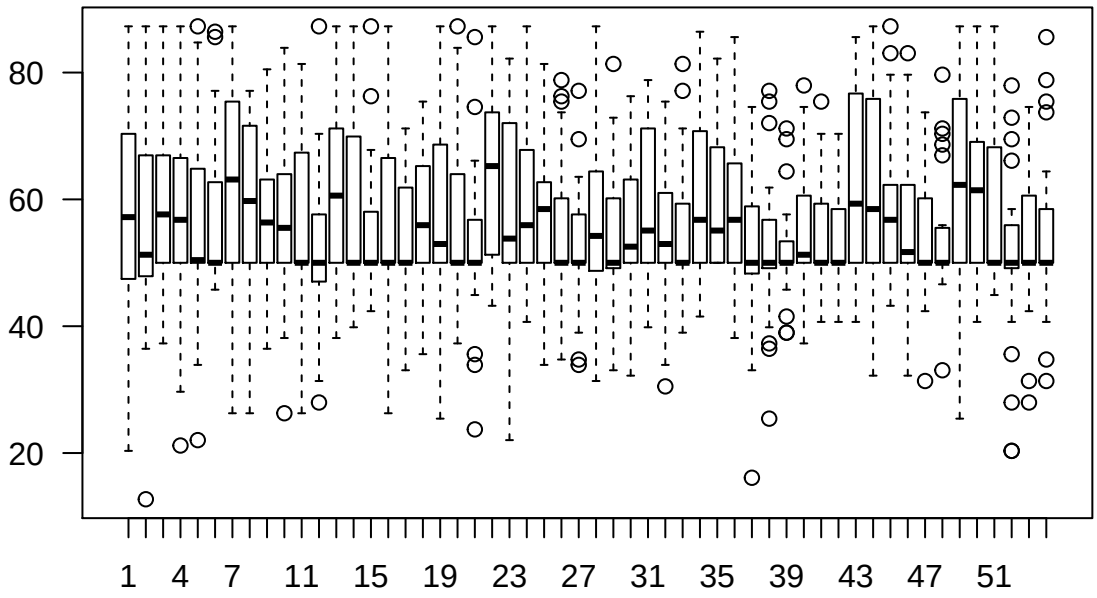

```
# intensity boxplot by time
boxplot(REWOD_HED$perceived_intensity ~ REWOD_HED$trial, las = 1)
```



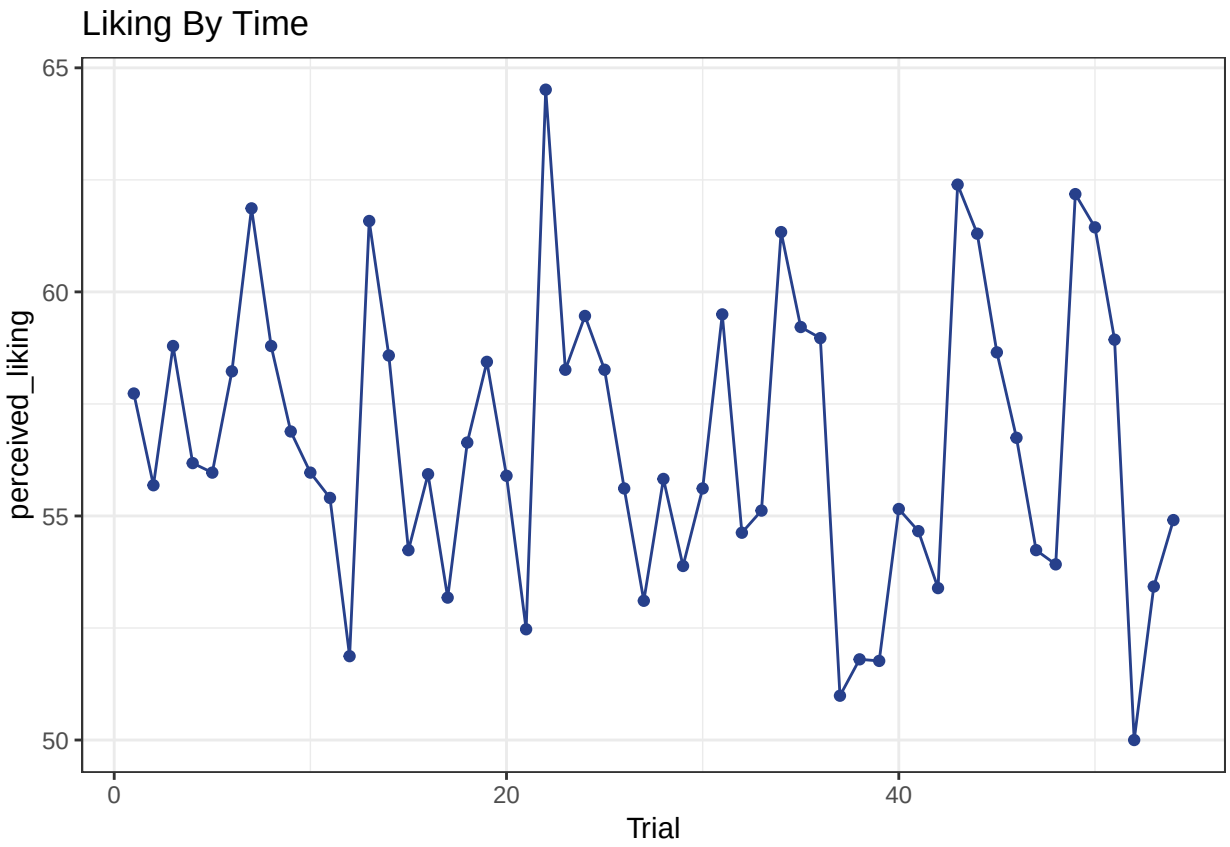

```
# get means by condition
bt = ddply(REWOD_HED, .(trial), summarise,  perceived_liking = mean(perceived_liking, na.rm = TRUE), pe
# get means by condition and trial
bct = ddply(REWOD_HED, .(condition, trial), summarise,  perceived_liking = mean(perceived_liking, na.rm

# get means by participant
bs = ddply(REWOD_HED, .(id, trial), summarise, perceived_liking = mean(perceived_liking, na.rm = TRUE),
```

plot overall effect Liking

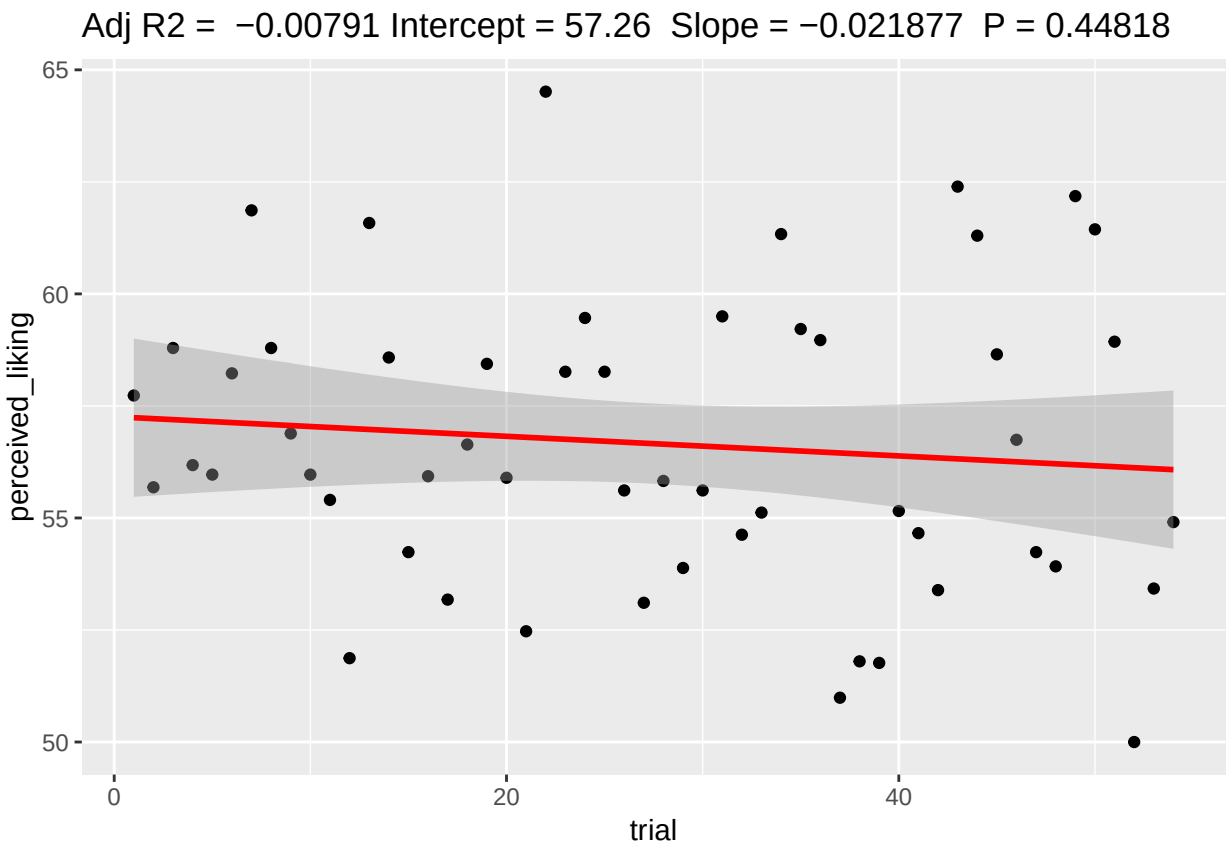
```
# perceived_liking average per trial and id
boxplot(bs$perceived_liking ~ bs$trial, las = 1)
```



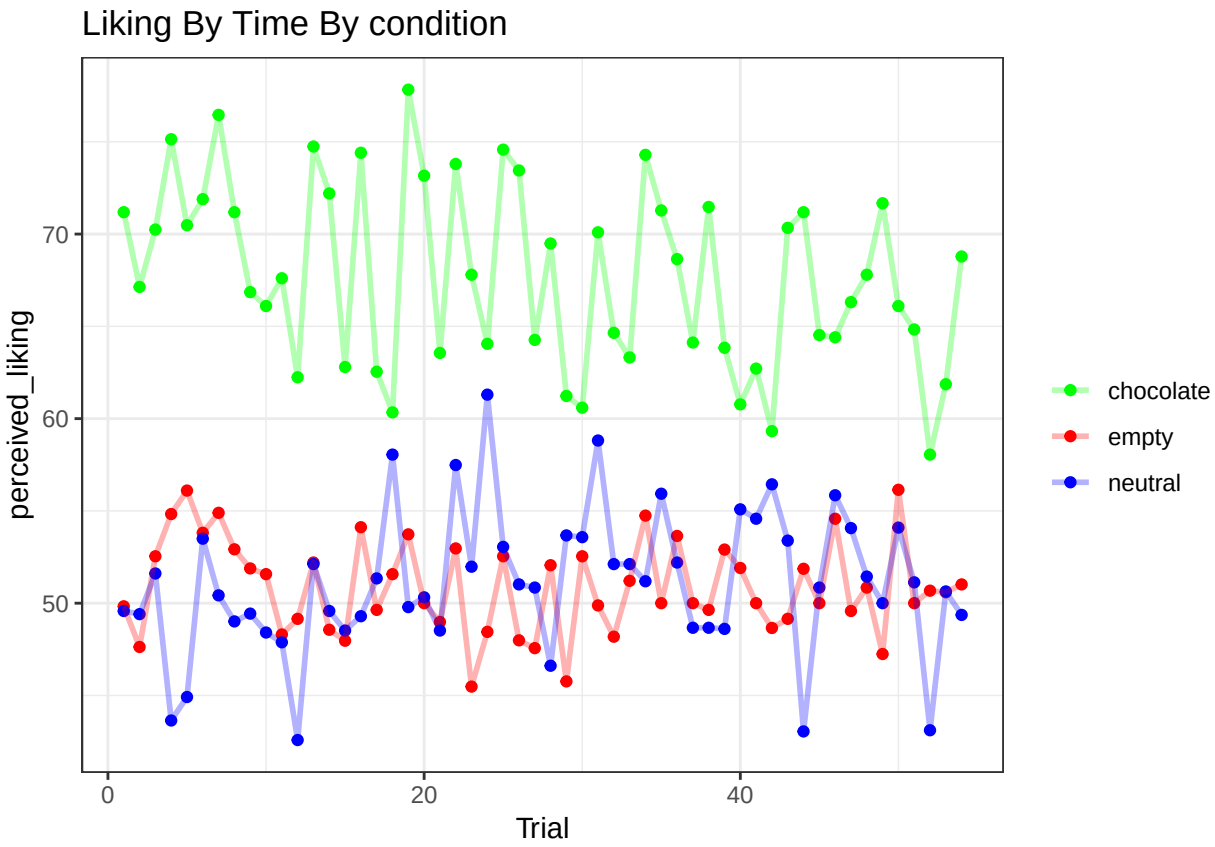

```
#plot perceived_liking to see the trajectory of learning ((overall average by trials)
ggplot(bt, aes(x = trial, y = perceived_liking, fill = I('royalblue1'), color = I('royalblue4'))) +
  geom_point() + geom_line(group=1) +
  guides(color = "none", fill = "none") +
  guides(color = "none", fill = "none") +
  theme_bw() +
  labs(
    title = "Liking By Time",
    x = "Trial",
    y = "perceived_liking"
  )
```



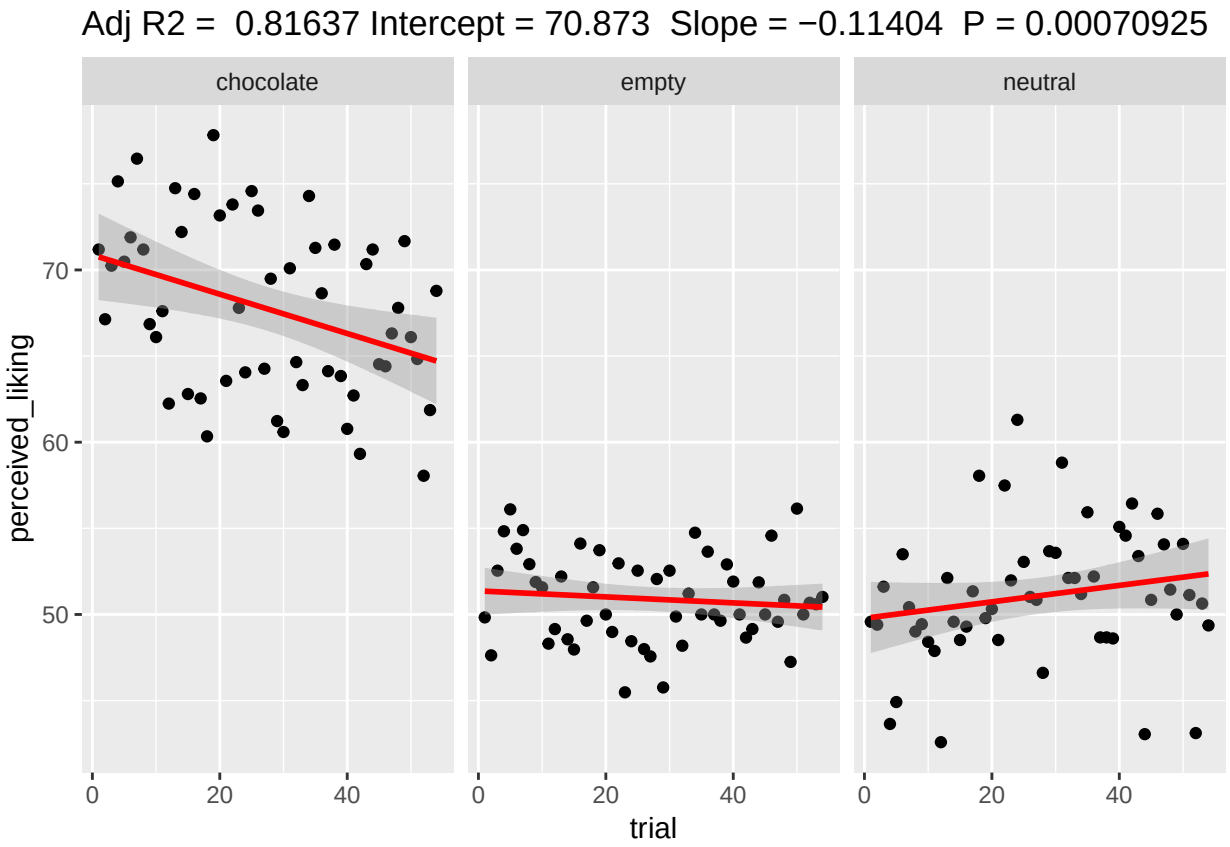

```
#OR different representation
ggplotRegression <- function (fit) {

  ggplot(fit$model, aes_string(x = names(fit$model)[2], y = names(fit$model)[1])) +
    geom_point() +
    stat_smooth(method = "lm", col = "red") +
    labs(title = paste("Adj R2 = ",signif(summary(fit)$adj.r.squared, 5),
                       "Intercept =",signif(fit$coef[[1]],5 ),
                       " Slope =",signif(fit$coef[[2]], 5),
                       " P =",signif(summary(fit)$coef[2,4], 5)))
}

# plot perceived_likings by time with regression lign
ggplotRegression(lm(perceived_liking ~ trial, data = bt))
```




```
#plot liking to see the trajectory of learning (by condition)
ggplot(bct, aes(x = trial, y = perceived_liking, color = condition)) +
  geom_point() +
  geom_line(aes(group = condition), alpha = .3, size = 1) +
  scale_colour_manual("",
                      values = c("chocolate"="green", "empty"="red", "neutral"="blue")) +
  theme_bw() +
  labs(
    title = "Liking By Time By condition",
    x = "Trial",
    y = "perceived_liking"
  )
```

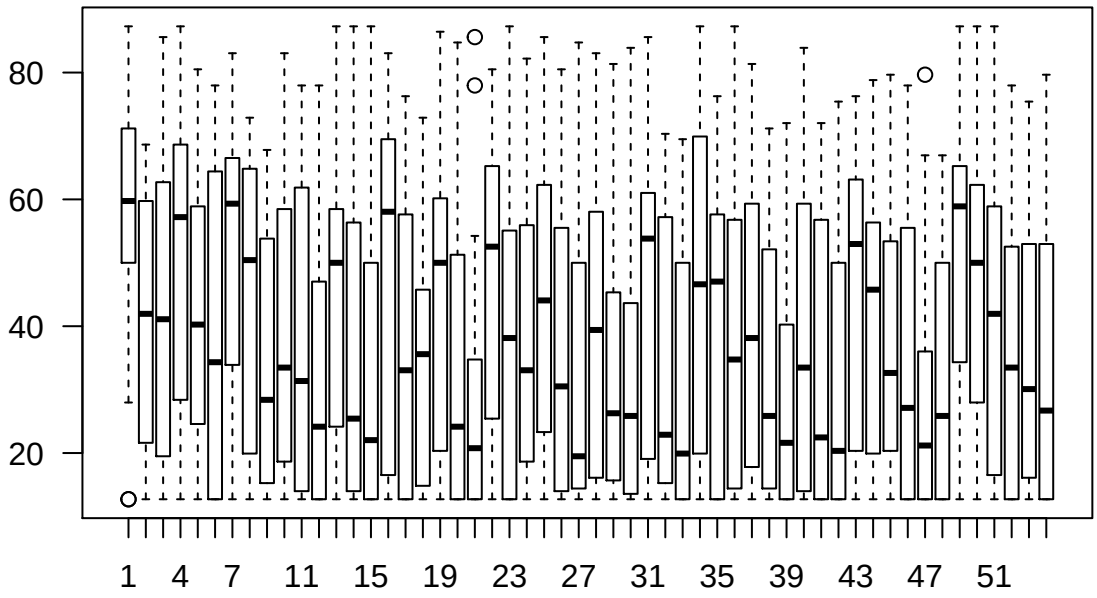



```
# plot liking by time by condition with regression lign
ggplotRegression(lm(perceived_liking ~ trial*condition, data = bct)) +
  facet_wrap(~condition)
```

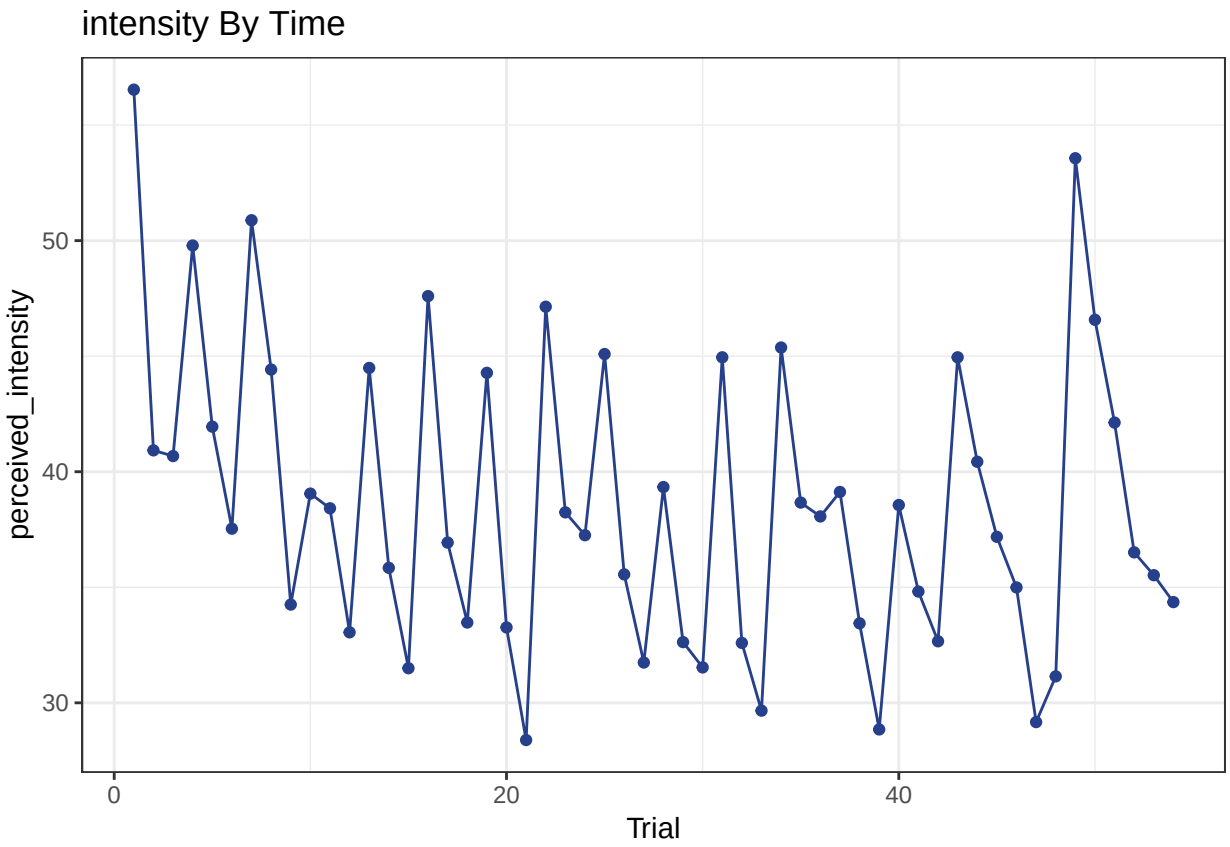


plot overall effect Intensity

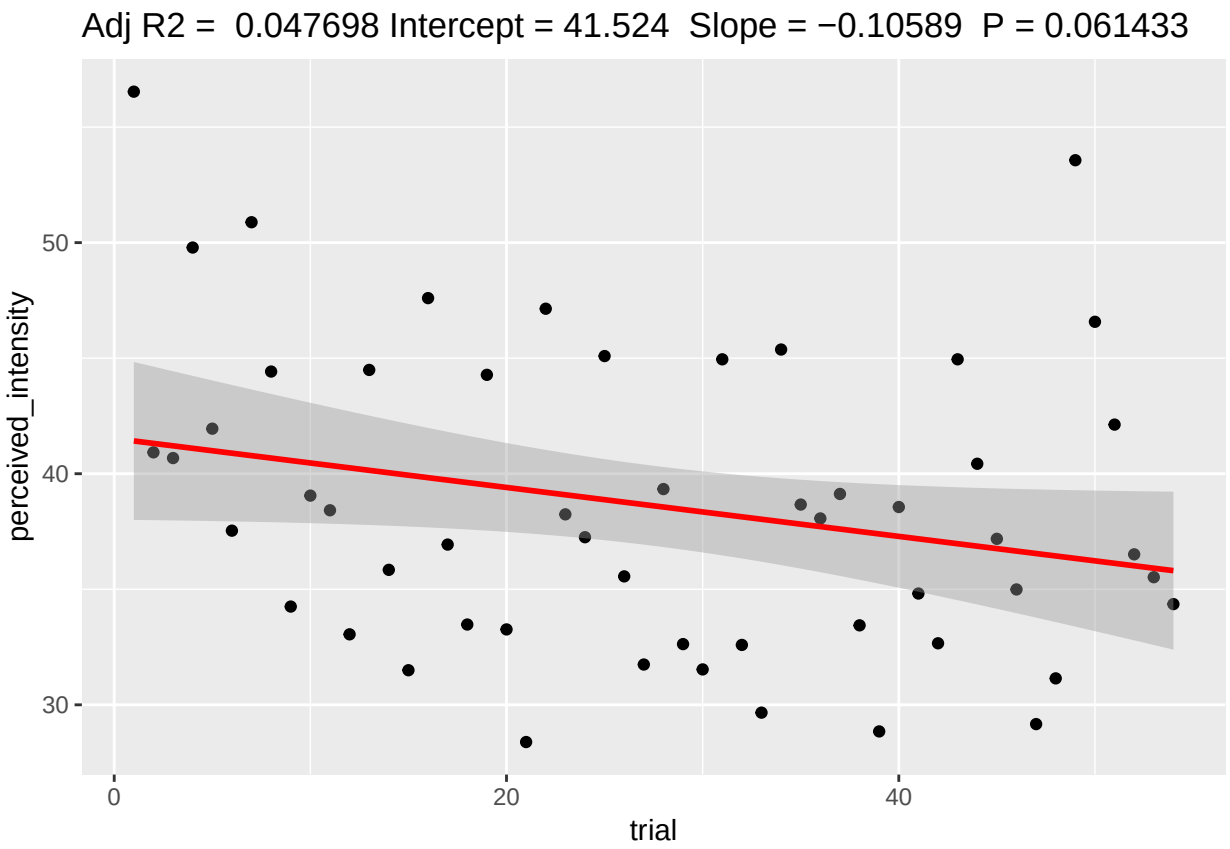
```
# perceived_intensity average per trial and id
boxplot(bs$perceived_intensity ~ bs$trial, las = 1)
```



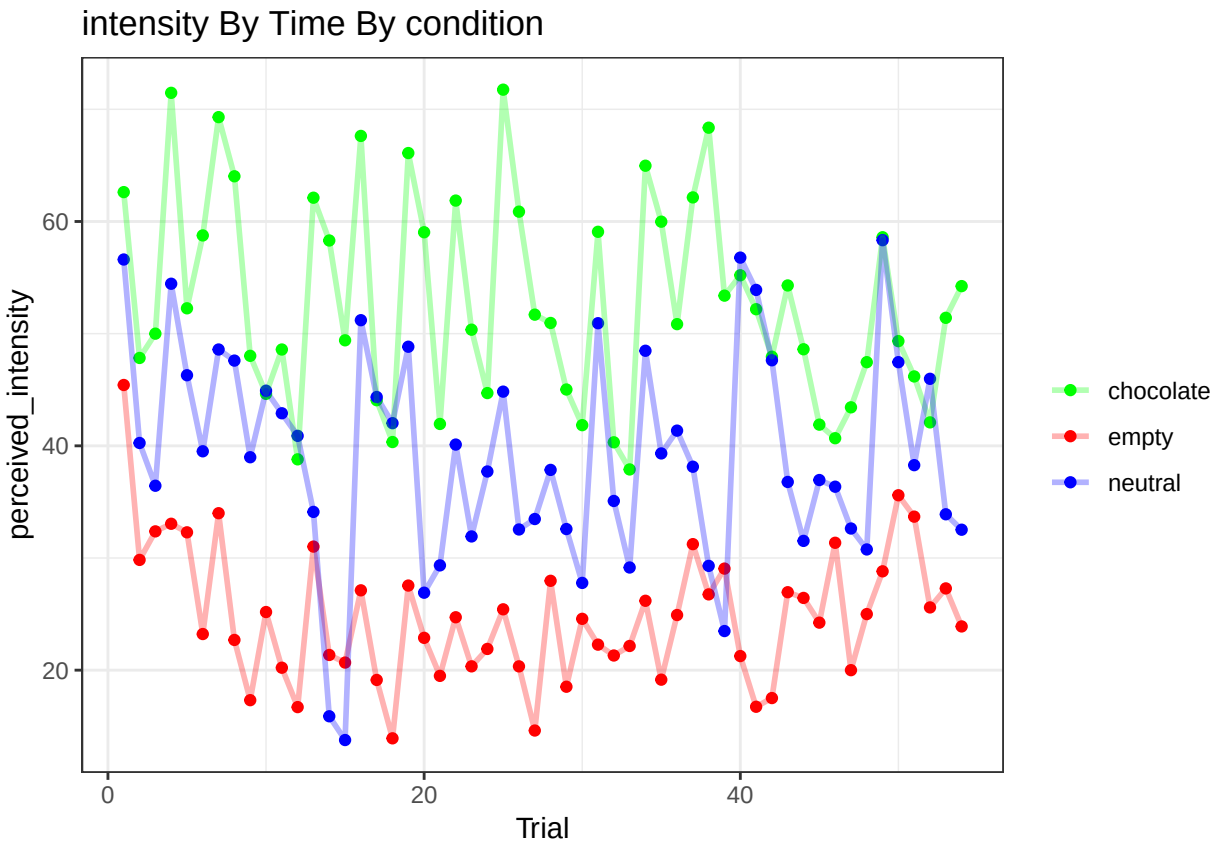

```
#plot perceived_intensity to see the trajectory of learning ((overall average by trials)
ggplot(bt, aes(x = trial, y = perceived_intensity, fill = I('royalblue1'), color = I('royalblue4'))) +
  geom_point() + geom_line(group=1) +
  guides(color = "none", fill = "none") +
  guides(color = "none", fill = "none") +
  theme_bw() +
  labs(
    title = "intensity By Time",
    x = "Trial",
    y = "perceived_intensity"
  )
```



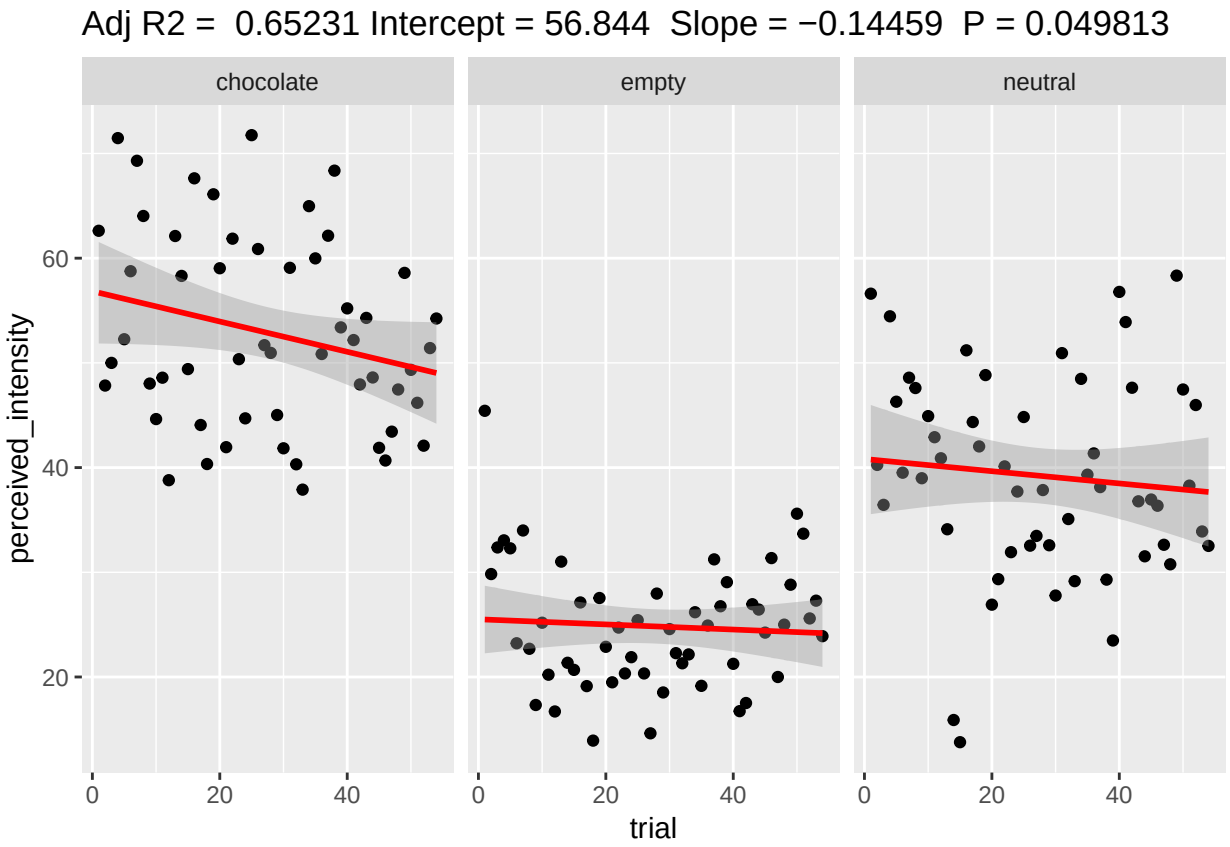

```
# plot perceived_likings by time with regression lign
ggplotRegression(lm(perceived_intensity ~ trial, data = bt))
```




```
#plot intensity to see the trajectory of learning (by condition)
ggplot(bct, aes(x = trial, y = perceived_intensity, color = condition)) +
  geom_point() +
  geom_line(aes(group = condition), alpha = .3, size = 1) +
  scale_colour_manual("",
                      values = c("chocolate"="green", "empty"="red", "neutral"="blue")) +
  theme_bw() +
  labs(
    title = "intensity By Time By condition",
    x = "Trial",
    y = "perceived_intensity"
  )
```




```
# plot liking by time by condition with regression lign
ggplotRegression(lm(perceived_intensity ~ trial*condition, data = bct)) +
  facet_wrap(~condition)
```



ANALYSIS

contrasts

```
REWOD_HED$cvalue[REWOD_HED$condition== 'chocolate']     <- 2
REWOD_HED$cvalue[REWOD_HED$condition== 'empty']     <- -1
REWOD_HED$cvalue[REWOD_HED$condition== 'neutral']     <- -1
REWOD_HED$cvalue       <- factor(REWOD_HED$cvalue)
```

1. Liking: do participants prefer to the reward (chocolate) condition?

```
# lmer analyis ~ cvalue
main.liking = lmer(perceived_liking ~ cvalue + (1+cvalue|id) + (1|trial), data = REWOD_HED, REML = FALSE
anova(main.liking)
```

```
## Type III Analysis of Variance Table with Satterthwaite's method
##        Sum Sq Mean Sq NumDF  DenDF F value    Pr(>F)
## cvalue  18783   18783     1 24.093   240.3 4.931e-14 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
# quick check with classical anova (! this is not reliable)
summary(aov(perceived_liking ~ cvalue + Error(id / (cvalue)), data = REWOD_HED))
```

```
##
## Error: id
##           Df Sum Sq Mean Sq F value Pr(>F)
## Residuals 23  23916    1040
##
## Error: id:cvalue
##           Df Sum Sq Mean Sq F value   Pr(>F)
## cvalue     1  82792   82792   232.2 1.64e-13 ***
## Residuals 23   8201     357
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Error: Within
##             Df Sum Sq Mean Sq F value Pr(>F)
## Residuals 1248  99994   80.12
```

```
# model comparison
main.liking.0 = lmer(perceived_liking ~ (1|id) + (1|trial), data = REWOD_HED, REML = FALSE)
anova(main.liking.0, main.liking, test = 'Chisq')
```

```
## Data: REWOD_HED
## Models:
## main.liking.0: perceived_liking ~ (1 | id) + (1 | trial)
## main.liking: perceived_liking ~ cvalue + (1 + cvalue | id) + (1 | trial)
##               Df     AIC     BIC  logLik deviance Chisq Chi Df Pr(>Chisq)
## main.liking.0  4 10216.8 10237.5 -5104.4  10208.8
## main.liking    7  9461.4  9497.6 -4723.7   9447.4 761.4      3  < 2.2e-16
##
## main.liking.0
## main.liking   ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
#sentence => main.liking is signifincatly better than the null model

# lmer analyis cvalue and trial
main.liking.1 = lmer(perceived_liking ~ cvalue + trial + (1+cvalue|id) + (1|trial), data = REWOD_HED, RE
anova(main.liking.1)
```

```
## Type III Analysis of Variance Table with Satterthwaite's method
##         Sum Sq Mean Sq NumDF  DenDF  F value    Pr(>F)
## cvalue 18806.2 18806.2     1 24.088 240.5877 4.886e-14 ***
## trial    145.6   145.6     1 52.738   1.8631    0.1781
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
# quick check with classical anova (! this is not reliable)
summary(aov(perceived_liking ~ cvalue + trial + Error(id / (cvalue)), data = REWOD_HED))
```

```
##
## Error: id
##           Df Sum Sq Mean Sq F value Pr(>F)
## Residuals 23  23916    1040
##
## Error: id:cvalue
```

```
##           Df Sum Sq Mean Sq F value   Pr(>F)
## cvalue     1  82792   82792 222.109 5.59e-13 ***
## trial      1      1       1   0.002    0.968
## Residuals 22   8201     373
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Error: Within
##             Df Sum Sq Mean Sq F value Pr(>F)
## trial        1    226  225.65    2.82 0.0933 .
## Residuals 1247  99768   80.01
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
# model comparison
anova(main.liking, main.liking.1, test = 'Chisq')
```

```
## Data: REWOD_HED
## Models:
## main.liking: perceived_liking ~ cvalue + (1 + cvalue | id) + (1 | trial)
## main.liking.1: perceived_liking ~ cvalue + trial + (1 + cvalue | id) + (1 |
## main.liking.1:     trial)
##               Df    AIC    BIC  logLik deviance  Chisq Chi Df Pr(>Chisq)
## main.liking    7 9461.4 9497.6 -4723.7   9447.4
## main.liking.1  8 9461.6 9502.9 -4722.8   9445.6 1.8304      1     0.1761
```

```
#sentence => main.liking1 is signifincatly better than main.liking (adding trial makes the model predic

# lmer analyis (+interaction) # should I have used the condition*trial variable instead?
main.liking.2 = lmer(perceived_liking ~ cvalue*trial + (1+cvalue|id) + (1|trial), data = REWOD_HED, REM
anova(main.liking.1)
```

```
## Type III Analysis of Variance Table with Satterthwaite's method
##         Sum Sq Mean Sq NumDF  DenDF  F value    Pr(>F)
## cvalue 18806.2 18806.2     1 24.088 240.5877 4.886e-14 ***
## trial    145.6   145.6     1 52.738   1.8631    0.1781
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
# quick check with classical anova (! this is not reliable)
summary(aov(perceived_liking ~ cvalue*trial + Error(id / (cvalue)), data = REWOD_HED))
```

```
##
## Error: id
##              Df Sum Sq Mean Sq F value Pr(>F)
## cvalue:trial  1    238   238.2   0.221  0.643
## Residuals    22  23677  1076.2
##
## Error: id:cvalue
##           Df Sum Sq Mean Sq F value   Pr(>F)
## cvalue     1  82792   82792 222.109 5.59e-13 ***
## trial      1      1       1   0.002    0.968
## Residuals 22   8201     373
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
```

```
## Error: Within
##                Df Sum Sq Mean Sq F value  Pr(>F)
## trial           1    226   225.6   2.837 0.09234 .
## cvalue:trial    1    681   681.4   8.568 0.00348 **
## Residuals    1246  99087    79.5
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
# model comparison
anova(main.liking.1, main.liking.2, test = 'Chisq')
```

```
## Data: REWOD_HED
## Models:
## main.liking.1: perceived_liking ~ cvalue + trial + (1 + cvalue | id) + (1 |
## main.liking.1:     trial)
## main.liking.2: perceived_liking ~ cvalue * trial + (1 + cvalue | id) + (1 |
## main.liking.2:     trial)
##               Df    AIC    BIC  logLik deviance  Chisq Chi Df Pr(>Chisq)
## main.liking.1  8 9461.6 9502.9 -4722.8   9445.6
## main.liking.2  9 9453.9 9500.4 -4718.0   9435.9 9.6586      1   0.001885
##
## main.liking.1
## main.liking.2 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
#sentence => main.liking2 is signifincatly better than main.liking1 (adding interaction helps the model
```

2. Intensity: do participants find the reward (chocolate) condition more intense?

```
# factorise trial
REWOD_HED$trial            <- factor(REWOD_HED$trial)

# lmer analyis ~ condition
main.intensity = lmer(perceived_intensity ~ cvalue + (1+cvalue|id) + (1|trial), data = REWOD_HED, REML =
anova(main.intensity)
```

```
## Type III Analysis of Variance Table with Satterthwaite's method
##        Sum Sq Mean Sq NumDF  DenDF F value    Pr(>F)
## cvalue  22556   22556     1 24.149  78.032 4.957e-09 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
# quick check with classical anova (! this is not reliable)
summary(aov(perceived_intensity ~ cvalue + Error(id / (cvalue)), data = REWOD_HED))
```

```
##
## Error: id
##           Df Sum Sq Mean Sq F value Pr(>F)
## Residuals 23 114163    4964
##
## Error: id:cvalue
##           Df Sum Sq Mean Sq F value   Pr(>F)
## cvalue     1 125459  125459   79.81 6.14e-09 ***
## Residuals 23  36157    1572
```

```
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Error: Within
##             Df Sum Sq Mean Sq F value Pr(>F)
## Residuals 1248 390857   313.2
```

```
# model comparison
main.intensity.0 = lmer(perceived_intensity ~ (1|id) + (1|trial), data = REWOD_HED, REML = FALSE)
anova(main.intensity.0, main.intensity, test = 'Chisq')
```

```
## Data: REWOD_HED
## Models:
## main.intensity.0: perceived_intensity ~ (1 | id) + (1 | trial)
## main.intensity: perceived_intensity ~ cvalue + (1 + cvalue | id) + (1 | trial)
##                   Df   AIC   BIC  logLik deviance Chisq Chi Df Pr(>Chisq)
## main.intensity.0  4 11587 11608 -5789.6    11579
## main.intensity    7 11201 11237 -5593.4    11187 392.3      3  < 2.2e-16
##
## main.intensity.0
## main.intensity   ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
#sentence => main.liking is signifincatly better than the null model

# lmer analyis condition and trial
main.intensity.1 = lmer(perceived_intensity ~ cvalue + trial + (1+cvalue|id) + (1|trial), data = REWOD_
anova(main.intensity.1)
```

```
## Type III Analysis of Variance Table with Satterthwaite's method
##        Sum Sq Mean Sq NumDF   DenDF F value    Pr(>F)
## cvalue  20854 20854.4     1   24.22  75.374 6.681e-09 ***
## trial   45136   851.6    53 1250.44   3.078 3.832e-12 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
# quick check with classical anova (! this is not reliable)
summary(aov(perceived_intensity ~ cvalue + trial + Error(id / (cvalue)), data = REWOD_HED))
```

```
##
## Error: id
##           Df Sum Sq Mean Sq F value Pr(>F)
## Residuals 23 114163    4964
##
## Error: id:cvalue
##           Df Sum Sq Mean Sq F value   Pr(>F)
## cvalue     1 125459  125459 102.662 6.48e-07 ***
## trial     12  22715    1893   1.549    0.238
## Residuals 11  13443    1222
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Error: Within
##             Df Sum Sq Mean Sq F value   Pr(>F)
## trial       53  45623   860.8    2.98 2.06e-11 ***
```

```
## Residuals 1195 345234   288.9
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
# model comparison
anova(main.intensity, main.intensity.1, test = 'Chisq')
```

```
## Data: REWOD_HED
## Models:
## main.intensity: perceived_intensity ~ cvalue + (1 + cvalue | id) + (1 | trial)
## main.intensity.1: perceived_intensity ~ cvalue + trial + (1 + cvalue | id) + (1 |
## main.intensity.1:     trial)
##                   Df   AIC   BIC  logLik deviance  Chisq Chi Df Pr(>Chisq)
## main.intensity     7 11201 11237 -5593.4    11187
## main.intensity.1 60 11196 11506 -5537.8    11076 111.28     53  5.046e-06
##
## main.intensity
## main.intensity.1 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
#sentence => main.liking1 is signifincatly better than main.liking (adding trial makes the model predic

# lmer analyis (+interaction) # should I have used the condition*trial variable instead?
main.intensity.2 = lmer(perceived_intensity ~ cvalue*trial + (1+cvalue|id) + (1|trial), data = REWOD_HE
anova(main.intensity.1)
```

```
## Type III Analysis of Variance Table with Satterthwaite's method
##        Sum Sq Mean Sq NumDF   DenDF F value    Pr(>F)
## cvalue  20854 20854.4     1   24.22  75.374 6.681e-09 ***
## trial   45136   851.6    53 1250.44   3.078 3.832e-12 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
# quick check with classical anova (! this is not reliable)
summary(aov(perceived_intensity ~ cvalue*trial + Error(id / (cvalue)), data = REWOD_HED))
```

```
##
## Error: id
##              Df Sum Sq Mean Sq F value Pr(>F)
## cvalue:trial 12  24550    2046   0.251  0.987
## Residuals    11  89613    8147
##
## Error: id:cvalue
##           Df Sum Sq Mean Sq F value   Pr(>F)
## cvalue     1 125459  125459 102.662 6.48e-07 ***
## trial     12  22715    1893   1.549    0.238
## Residuals 11  13443    1222
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Error: Within
##                Df Sum Sq Mean Sq F value   Pr(>F)
## trial          53  45623   860.8   2.981 2.19e-11 ***
## cvalue:trial   53  15501   292.5   1.013     0.45
## Residuals    1142 329733   288.7
```

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

```
# model comparison
anova(main.intensity.1, main.intensity.2, test = 'Chisq')
```

```
## Data: REWOD_HED
## Models:
## main.intensity.1: perceived_intensity ~ cvalue + trial + (1 + cvalue | id) + (1 |
## main.intensity.1:     trial)
## main.intensity.2: perceived_intensity ~ cvalue * trial + (1 + cvalue | id) + (1 |
## main.intensity.2:     trial)
##                   Df   AIC   BIC  logLik deviance  Chisq Chi Df Pr(>Chisq)
## main.intensity.1  60 11196 11506 -5537.8    11076
## main.intensity.2 113 11243 11827 -5508.5    11017 58.653     53     0.2759
```

```
#sentence => HOWEVER here main.liking2 is NOT signifincatly better than main.liking1 (adding interactio
```

3. Specific test without empty

```
#removing empty condition
REWOD_HED.woemp <- filter(REWOD_HED, cvalue != "empty")

#contrasts
REWOD_HED.woemp$cvalue[REWOD_HED.woemp$condition== 'chocolate']     <- 2
REWOD_HED.woemp$cvalue[REWOD_HED.woemp$condition== 'empty']     <- -1
REWOD_HED.woemp$cvalue[REWOD_HED.woemp$condition== 'neutral']     <- -1
REWOD_HED.woemp$cvalue       <- factor(REWOD_HED.woemp$cvalue)
```

3.1. Liking: do participants prefer to the reward (chocolate) condition?

```
# lmer analyis ~ condition
main.liking = lmer(perceived_liking ~ cvalue + (1+cvalue|id) + (1|trial), data = REWOD_HED.woemp, REML =
anova(main.liking)
```

```
## Type III Analysis of Variance Table with Satterthwaite's method
##        Sum Sq Mean Sq NumDF  DenDF F value    Pr(>F)
## cvalue  18783   18783     1 24.093   240.3 4.931e-14 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
# quick check with classical anova (! this is not reliable)
summary(aov(perceived_liking ~ cvalue + Error(id / (cvalue)), data = REWOD_HED.woemp))
```

```
##
## Error: id
##           Df Sum Sq Mean Sq F value Pr(>F)
## Residuals 23  23916    1040
##
## Error: id:cvalue
##           Df Sum Sq Mean Sq F value   Pr(>F)
## cvalue     1  82792   82792   232.2 1.64e-13 ***
## Residuals 23   8201     357
```

```
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Error: Within
##             Df Sum Sq Mean Sq F value Pr(>F)
## Residuals 1248  99994   80.12
```

```
# model comparison
main.liking.0 = lmer(perceived_liking ~ (1|id) + (1|trial), data = REWOD_HED.woemp, REML = FALSE)
anova(main.liking.0, main.liking, test = 'Chisq')
```

```
## Data: REWOD_HED.woemp
## Models:
## main.liking.0: perceived_liking ~ (1 | id) + (1 | trial)
## main.liking: perceived_liking ~ cvalue + (1 + cvalue | id) + (1 | trial)
##               Df     AIC     BIC  logLik deviance Chisq Chi Df Pr(>Chisq)
## main.liking.0  4 10216.8 10237.5 -5104.4  10208.8
## main.liking    7  9461.4  9497.6 -4723.7   9447.4 761.4      3  < 2.2e-16
##
## main.liking.0
## main.liking   ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
#sentence => main.liking is signifincatly better than the null model

# lmer analyis condition and trial
main.liking.1 = lmer(perceived_liking ~ cvalue + trial + (1+cvalue|id) + (1|trial), data = REWOD_HED.wo
anova(main.liking.1)
```

```
## Type III Analysis of Variance Table with Satterthwaite's method
##         Sum Sq Mean Sq NumDF   DenDF  F value    Pr(>F)
## cvalue 17845.5   17846     1   24.29 238.3422 4.643e-14 ***
## trial   6570.9     124    53 1248.93   1.6559   0.00248 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
# quick check with classical anova (! this is not reliable)
summary(aov(perceived_liking ~ cvalue + trial + Error(id / (cvalue)), data = REWOD_HED.woemp))
```

```
##
## Error: id
##           Df Sum Sq Mean Sq F value Pr(>F)
## Residuals 23  23916    1040
##
## Error: id:cvalue
##           Df Sum Sq Mean Sq F value   Pr(>F)
## cvalue     1  82792   82792 333.185 1.42e-09 ***
## trial     12   5468     456   1.834    0.162
## Residuals 11   2733     248
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Error: Within
##             Df Sum Sq Mean Sq F value  Pr(>F)
## trial       53   6577  124.10   1.587 0.00524 **
```

```
## Residuals 1195  93417   78.17
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
# model comparison
anova(main.liking, main.liking.1, test = 'Chisq')
```

```
## Data: REWOD_HED.woemp
## Models:
## main.liking: perceived_liking ~ cvalue + (1 + cvalue | id) + (1 | trial)
## main.liking.1: perceived_liking ~ cvalue + trial + (1 + cvalue | id) + (1 |
## main.liking.1:     trial)
##               Df    AIC    BIC  logLik deviance  Chisq Chi Df Pr(>Chisq)
## main.liking    7 9461.4 9497.6 -4723.7   9447.4
## main.liking.1 60 9488.9 9799.0 -4684.5   9368.9 78.478     53    0.01306 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
#sentence => main.liking1 is signifincatly better than main.liking (adding trial makes the model predic

# lmer analyis (+interaction) # should I have used the condition*trial variable instead?
main.liking.2 = lmer(perceived_liking ~ cvalue*trial + (1+cvalue|id) + (1|trial), data = REWOD_HED.woem
anova(main.liking.1)
```

```
## Type III Analysis of Variance Table with Satterthwaite's method
##         Sum Sq Mean Sq NumDF   DenDF  F value    Pr(>F)
## cvalue 17845.5   17846     1   24.29 238.3422 4.643e-14 ***
## trial   6570.9     124    53 1248.93   1.6559   0.00248 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
# quick check with classical anova (! this is not reliable)
summary(aov(perceived_liking ~ cvalue*trial + Error(id / (cvalue)), data = REWOD_HED.woemp))
```

```
##
## Error: id
##              Df Sum Sq Mean Sq F value Pr(>F)
## cvalue:trial 12  10237   853.1   0.686  0.737
## Residuals    11  13679  1243.5
##
## Error: id:cvalue
##           Df Sum Sq Mean Sq F value   Pr(>F)
## cvalue     1  82792   82792 333.185 1.42e-09 ***
## trial     12   5468     456   1.834    0.162
## Residuals 11   2733     248
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Error: Within
##                Df Sum Sq Mean Sq F value  Pr(>F)
## trial          53   6577  124.10   1.626 0.00352 **
## cvalue:trial   53   6254  118.01   1.546 0.00812 **
## Residuals    1142  87163   76.32
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```r
# model comparison
anova(main.liking.1, main.liking.2, test = 'Chisq')
```

```
## Data: REWOD_HED.woemp
## Models:
## main.liking.1: perceived_liking ~ cvalue + trial + (1 + cvalue | id) + (1 |
## main.liking.1:     trial)
## main.liking.2: perceived_liking ~ cvalue * trial + (1 + cvalue | id) + (1 |
## main.liking.2:     trial)
##                Df    AIC   BIC  logLik deviance  Chisq Chi Df Pr(>Chisq)
## main.liking.1  60 9488.9  9799 -4684.5   9368.9
## main.liking.2 113 9508.6 10092 -4641.3   9282.6 86.364     53   0.002572
##
## main.liking.1
## main.liking.2 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```r
#sentence => main.liking2 is signifincatly better than main.liking1 (adding interaction helps the model
```

3.2. Intensity: do participants find the reward (chocolate) condition more intense?

```r
# lmer analyis ~ condition
main.intensity = lmer(perceived_intensity ~ cvalue + (1+cvalue|id) + (1|trial), data = REWOD_HED.woemp,
anova(main.intensity)
```

```
## Type III Analysis of Variance Table with Satterthwaite's method
##        Sum Sq Mean Sq NumDF  DenDF F value    Pr(>F)
## cvalue  22556   22556     1 24.149  78.032 4.957e-09 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```r
# quick check with classical anova (! this is not reliable)
summary(aov(perceived_intensity ~ cvalue + Error(id / (cvalue)), data = REWOD_HED.woemp))
```

```
##
## Error: id
##           Df Sum Sq Mean Sq F value Pr(>F)
## Residuals 23 114163    4964
##
## Error: id:cvalue
##           Df Sum Sq Mean Sq F value   Pr(>F)
## cvalue     1 125459  125459   79.81 6.14e-09 ***
## Residuals 23  36157    1572
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Error: Within
##             Df Sum Sq Mean Sq F value Pr(>F)
## Residuals 1248 390857   313.2
```

```r
# model comparison
main.intensity.0 = lmer(perceived_intensity ~ (1|id) + (1|trial), data = REWOD_HED.woemp, REML = FALSE)
```

```r
anova(main.intensity.0, main.intensity, test = 'Chisq')
```

```
## Data: REWOD_HED.woemp
## Models:
## main.intensity.0: perceived_intensity ~ (1 | id) + (1 | trial)
## main.intensity: perceived_intensity ~ cvalue + (1 + cvalue | id) + (1 | trial)
##                   Df   AIC   BIC  logLik deviance Chisq Chi Df Pr(>Chisq)
## main.intensity.0   4 11587 11608 -5789.6    11579
## main.intensity     7 11201 11237 -5593.4    11187 392.3      3  < 2.2e-16
##
## main.intensity.0
## main.intensity   ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```r
#sentence => main.liking1 is signifincatly better than the null model

# lmer analyis condition and trial
main.intensity.1 = lmer(perceived_intensity ~ cvalue + trial + (1+cvalue|id) + (1|trial), data = REWOD_
anova(main.intensity.1)
```

```
## Type III Analysis of Variance Table with Satterthwaite's method
##        Sum Sq Mean Sq NumDF   DenDF F value    Pr(>F)
## cvalue  20854 20854.4     1   24.22  75.374 6.681e-09 ***
## trial   45136   851.6    53 1250.44   3.078 3.832e-12 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```r
# quick check with classical anova (! this is not reliable)
summary(aov(perceived_intensity ~ cvalue + trial + Error(id / (cvalue)), data = REWOD_HED.woemp))
```

```
##
## Error: id
##           Df Sum Sq Mean Sq F value Pr(>F)
## Residuals 23 114163    4964
##
## Error: id:cvalue
##           Df Sum Sq Mean Sq F value   Pr(>F)
## cvalue     1 125459  125459 102.662 6.48e-07 ***
## trial     12  22715    1893   1.549    0.238
## Residuals 11  13443    1222
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Error: Within
##             Df Sum Sq Mean Sq F value   Pr(>F)
## trial       53  45623   860.8    2.98 2.06e-11 ***
## Residuals 1195 345234   288.9
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```r
# model comparison
anova(main.intensity, main.intensity.1, test = 'Chisq')
```

```
## Data: REWOD_HED.woemp
## Models:
```

```
## main.intensity: perceived_intensity ~ cvalue + (1 + cvalue | id) + (1 | trial)
## main.intensity.1: perceived_intensity ~ cvalue + trial + (1 + cvalue | id) + (1 |
## main.intensity.1:     trial)
##                  Df   AIC   BIC  logLik deviance  Chisq Chi Df Pr(>Chisq)
## main.intensity    7 11201 11237 -5593.4    11187
## main.intensity.1 60 11196 11506 -5537.8    11076 111.28     53  5.046e-06
##
## main.intensity
## main.intensity.1 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
#sentence => main.liking1 is signifincatly better than main.liking (adding trial makes the model predic

# lmer analyis (+interaction) # should I have used the condition*trial variable instead?
main.intensity.2 = lmer(perceived_intensity ~ cvalue*trial + (1+cvalue|id) + (1|trial), data = REWOD_HE
anova(main.intensity.1)
```

```
## Type III Analysis of Variance Table with Satterthwaite's method
##        Sum Sq Mean Sq NumDF   DenDF F value    Pr(>F)
## cvalue  20854 20854.4     1   24.22  75.374 6.681e-09 ***
## trial   45136   851.6    53 1250.44   3.078 3.832e-12 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
# quick check with classical anova (! this is not reliable)
summary(aov(perceived_intensity ~ cvalue*trial + Error(id / (cvalue)), data = REWOD_HED.woemp))
```

```
##
## Error: id
##              Df Sum Sq Mean Sq F value Pr(>F)
## cvalue:trial 12  24550    2046   0.251  0.987
## Residuals    11  89613    8147
##
## Error: id:cvalue
##           Df Sum Sq Mean Sq F value   Pr(>F)
## cvalue     1 125459  125459 102.662 6.48e-07 ***
## trial     12  22715    1893   1.549    0.238
## Residuals 11  13443    1222
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Error: Within
##                Df Sum Sq Mean Sq F value   Pr(>F)
## trial          53  45623   860.8   2.981 2.19e-11 ***
## cvalue:trial   53  15501   292.5   1.013     0.45
## Residuals    1142 329733   288.7
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
# model comparison
anova(main.intensity.1, main.intensity.2, test = 'Chisq')
```

```
## Data: REWOD_HED.woemp
## Models:
## main.intensity.1: perceived_intensity ~ cvalue + trial + (1 + cvalue | id) + (1 |
```

```
## main.intensity.1:     trial)
## main.intensity.2: perceived_intensity ~ cvalue * trial + (1 + cvalue | id) + (1 |
## main.intensity.2:     trial)
##                   Df   AIC   BIC  logLik deviance  Chisq Chi Df Pr(>Chisq)
## main.intensity.1  60 11196 11506 -5537.8    11076
## main.intensity.2 113 11243 11827 -5508.5    11017 58.653     53     0.2759
```

```
#sentence => HOWEVER here main.liking2 is NOT signifincatly better than main.liking1 (adding interactio
```