

Nature and DRT Report

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Examining Accuracy and Reaction Time in a Go-NoGo Detection Response Task

27 Participants responded to a vibro-tactile patch attached to their right hand while ingoring a vibro-tactile patch on their left hand. Participants responded by pressing a button in their left hand. These participants repeated this task 3 times:

Indoors

Outdoors, during exposure to Nature

Indoors, Post exposure to Nature

We analysed the Accuracy and Reaction Time in responding to the Go-NoGo task as a measure of attention capacity during these three periods. We hypothesized that exposure to Nature and deprivation from technology may increase performance in this simple task and furthermore, should correlate with EEG measurements in oscillations of the midline frontal nodes at the Theta frequency.

```
source("Load_Data.R") #Get the functions for loading the data
combined.data <- CombineData() #Save output of function for combining csv files
clean.data <- CleanData(combined.data) #Save output of function for cleaning data

clean <- clean.data %>%
  filter(isPractice == "no") %>%
  group_by(subid,condition,r1g0) %>%
  dplyr::mutate(falsealarm = ifelse(pressCount == 1 & r1g0 == "r", 1,0)) %>%
  dplyr::mutate(miss = ifelse(pressCount == 0 & r1g0 == "g", 1,0)) %>%
  dplyr::mutate(totalerrors = miss + falsealarm) %>%
  dplyr::mutate(correct = ifelse(totalerrors == 0, 1,0))

cleanrt <- clean %>%
  filter(rt > 100 & rt < 2000)

#summary of Signal, Noise, Hits and False Alarms
aprime <- clean %>%
  select(subid,condition,r1g0,correct,falsealarm)%>%
  group_by(subid,condition,r1g0) %>%
  dplyr::summarise(hitrate = mean(correct), farate = mean(falsealarm)) #Get summaries of hitrate and fa
hitrate1 <- aprime[c(TRUE,FALSE),]$hitrate #Get just the hits to green light
farate1 <- aprime[aprime$r1g0 == "r",] #Get just the false alarms to red light (next line too)
farate2 <- farate1$farate
```

```

aprimel <- aprime %>%
  group_by(subid,condition) %>%
  summarise(hitrate = mean(hitrate),farate = mean(farate)) #Prepare a dataframe for hitrate1 and farate1
aprimel$hitrate <- hitrate1 #update the hitrate column with correct hitrates
aprimel$farate <- farate2 #update the false alarm column with correct false alarm rates
aprimel2 <- Getaprimel(aprimel) #Run the function Getaprimel to append A' scores to the dataframe
aprimelclean <- aprimel2 %>%
  filter(aprimescore > .5) #Get rid of the bad participants

# Get some summaries with Error Bars -----
#Accuracy by light and condition
datac <- summarySEwithin(clean, measurevar ="correct", withinvars = c("condition","r1g0"), idvar = "subid")
#Accuracy by condition
datac1 <- summarySEwithin(clean, measurevar ="correct", withinvars = c("condition"), idvar = "subid")
#A' Score by condition
dataca <- summarySE(aprimelclean, measurevar = "aprimescore", groupvars = "condition", na.rm = TRUE)
#Reaction time by correct response and condition
datart <- summarySEwithin(cleanrt, measurevar ="rt", withinvars = c("condition","correct"), idvar = "subid")

```

Accuracy Plots

Participants had four possible responses in the DRT Go-NoGo task:

Correct Response to the Green Vibro-tactile device (Hit)

No Response to the Green Vibro-Tactile Device (Miss)

Incorrect Response to the Red Vibro-Tactile Device (False Alarm)

No Response to the Red Vibro-Tactile Device (Correct Rejection)

Below we have graphed the responses for the task by vibro-tactile device (R/G), by Condition, and the A' score by condition. Error bars are 95% confidence intervals.

```

figcap1 <- "Fig. 1. The percent of correct responses to the red vibro-tactile device, (Correct Rejection)

```

```

accplot2 <- ggplot(datac, aes(x = condition, y=correct, colour = r1g0, group = r1g0)) +
  geom_point(stat = "identity") +
  geom_line() +
  theme_classic() + my.axis.font + xlab("Condition") + coord_cartesian(ylim=c(.7,1)) +
  geom_errorbar(width = .1,
    aes(ymin=correct-ci, ymax=correct+ci)) + xlab("") +
  ggtitle("Percent \n Correct Responses in a \n Go-NoGo DRT Task \n") +
  scale_color_brewer(type = "qual", palette = 2,direction = 1) +
  scale_x_discrete(labels = c("University (Pre)", "In the Desert", "University (Post)"))

```

```

accplot2

```

```

figcap2 <- "Fig. 2. The percent of correct responses (either correct rejections or hits) to the Go-NoGo

```

```

accplot3 <- ggplot(datac1, aes(x = condition, y=correct, group = 1)) +
  geom_line() +
  geom_point(stat = "identity") +
  theme_classic() + my.axis.font + xlab("Condition") + coord_cartesian(ylim=c(.9,1)) +
  geom_errorbar(width = .1,

```

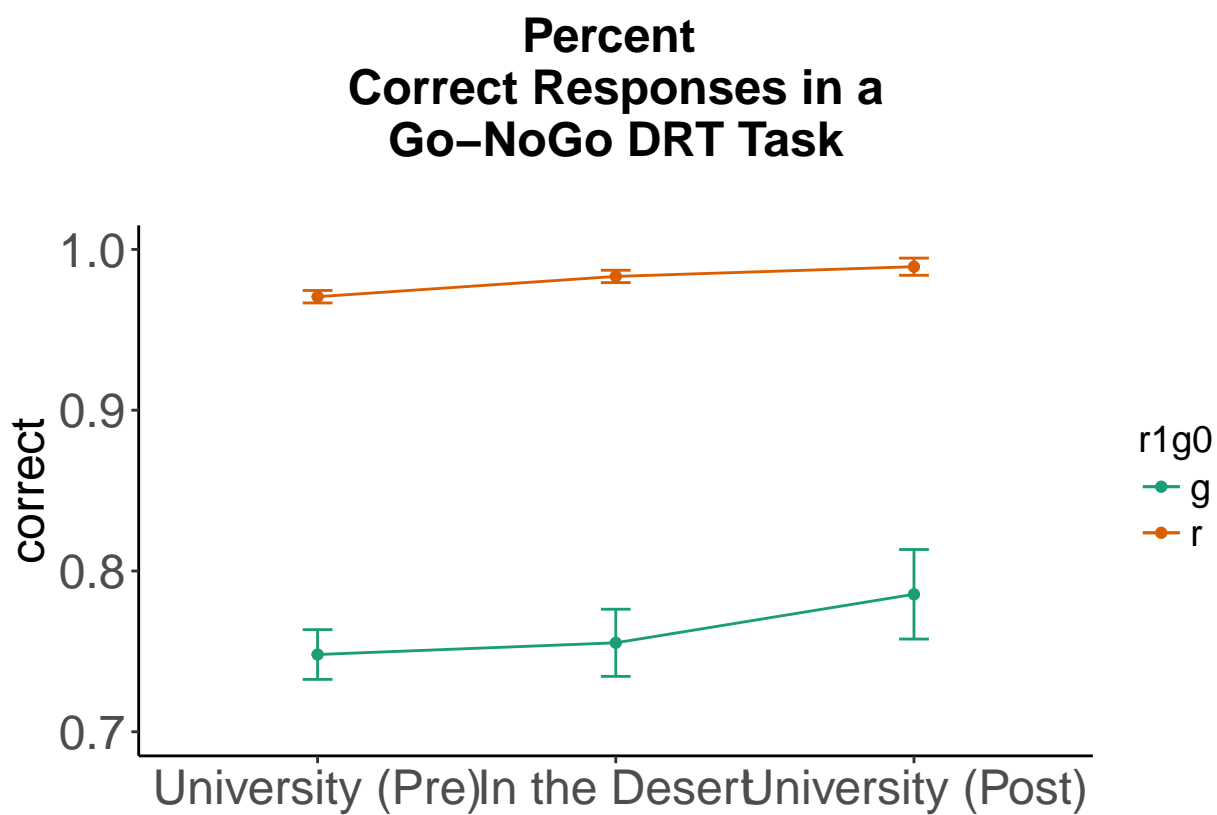


Figure 1: Fig. 1. The percent of correct responses to the red vibro-tactile device, (Correct Rejections) and the green vibro-tactile device (Hits).

Percent Correct Responses in a Go-NoGo DRT Task

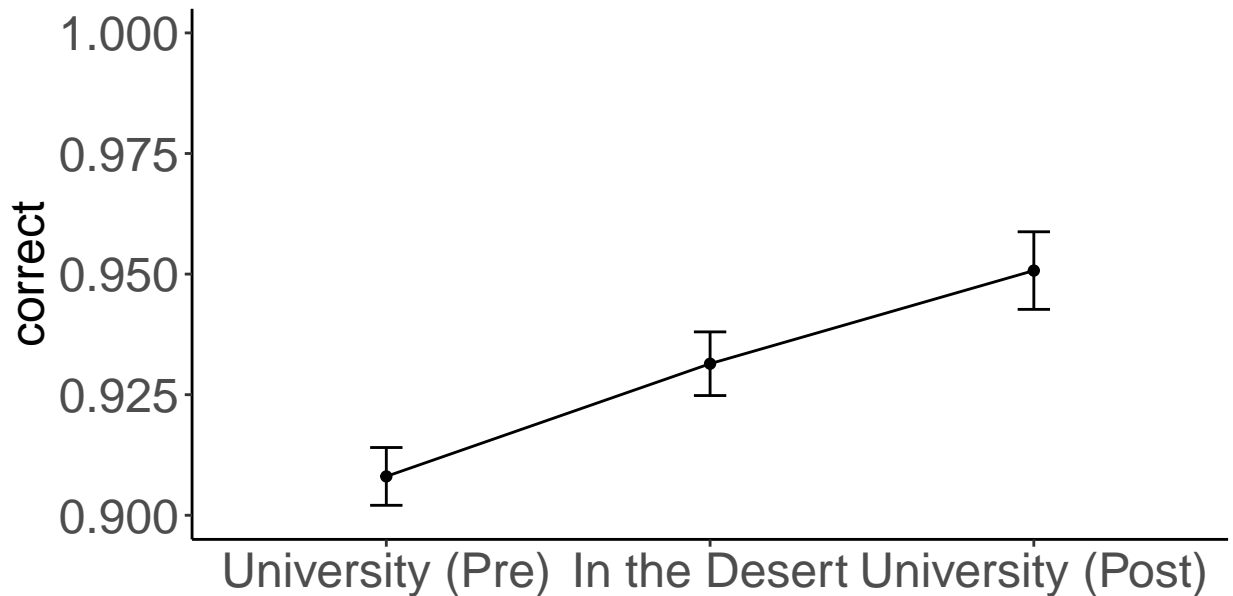


Figure 2: Fig. 2. The percent of correct responses (either correct rejections or hits) to the Go-NoGo task.

```

    aes(ymin=correct-ci, ymax=correct+ci)) + xlab("") +
  ggtitle("Percent \n Correct Responses in a \n Go-NoGo DRT Task \n") +
  scale_color_brewer(type = "qual", palette = 2,direction = 1) +
  scale_x_discrete(labels = c("University (Pre)", "In the Desert", "University (Post)"))
accplot3

```

```

figcap3 <- "Fig. 3. The average A' score for participants across the three conditions of pretest, test,

```

```

accplot5 <- ggplot(dataca, aes(x = condition, y=aprimescore, group = 1)) +
  geom_line() +
  geom_point(stat = "identity") + theme_minimal() +
  my.axis.font + ggtitle("A' \n by Condition") +
  geom_errorbar(position=position_dodge(.9), width = .25,
    aes(ymin=aprimescore-ci, ymax=aprimescore+ci))
accplot5

```

Statistical Analysis of Accuracy

Here we used a linear mixed model fit by Restricted Maximum Likelihood (REML), which bases estimates of likelihood from a transformed dataset so that nuisance parameters have no effect (Harville, 1977).

```

# Simple Statistics -----
require(lmerTest)

```

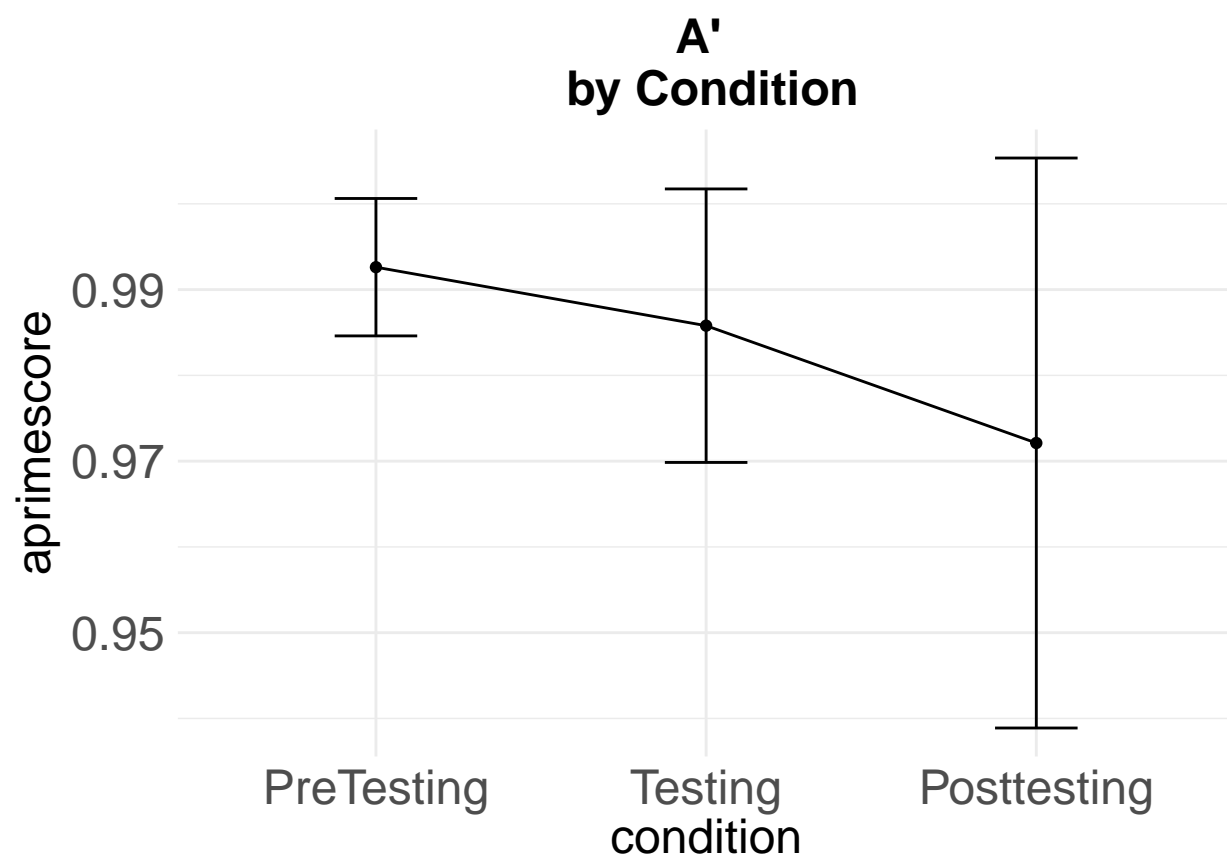


Figure 3: Fig. 3. The average A' score for participants across the three conditions of pretest, test, and posttest.

```

#Errors first
clean.mean <- clean %>%
  group_by(subid,condition) %>%
  dplyr::summarise(perc_correct = mean(correct)*100) %>%
  filter(perc_correct > 50)

acc.lm <- with(as.data.frame(clean.mean), lmer(perc_correct ~ condition + (1|subid)),na.omit())

summary(acc.lm)

## Linear mixed model fit by REML t-tests use Satterthwaite approximations
## to degrees of freedom [lmerMod]
## Formula: perc_correct ~ condition + (1 | subid)
##
## REML criterion at convergence: 474.6
##
## Scaled residuals:
##      Min       1Q   Median       3Q      Max
## -4.3483  0.0336  0.3826  0.5607  0.6612
##
## Random effects:
##   Groups   Name              Variance Std.Dev.
##   subid    (Intercept)    0.00      0.000
##   Residual                    40.93     6.397
## Number of obs: 74, groups:  subid, 26
##
## Fixed effects:
##              Estimate Std. Error    df t value Pr(>|t|)
## (Intercept)      99.286      1.334 71.000   74.430  <2e-16 ***
## conditionTesting    -2.873      1.848 71.000   -1.554   0.1246
## conditionPosttesting -3.516      1.831 71.000   -1.920   0.0589 .
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##              (Intr) cndtnT
## condtnTstng  -0.722
## cndtnPsttst  -0.728  0.526

with(as.data.frame(clean.mean), lmer(perc_correct ~ condition + (1|subid)),na.omit()) %>% anova()

## Analysis of Variance Table of type III with Satterthwaite
## approximation for degrees of freedom
##              Sum Sq Mean Sq NumDF DenDF F.value Pr(>F)
## condition 167.66  83.832      2     71  2.0483 0.1365

```

In summary, there are no significant effects of condition upon the percent of correct responses (either correct rejections or hits).

Reaction Time Plots

The following plots show Reaction Times for all Hits and False Alarms. The proportion of Hits to False Alarms is very large, which is reflected in the 95% confidence interval error bars.

Reaction Time by Condition in a Go-NoGo DRT Task

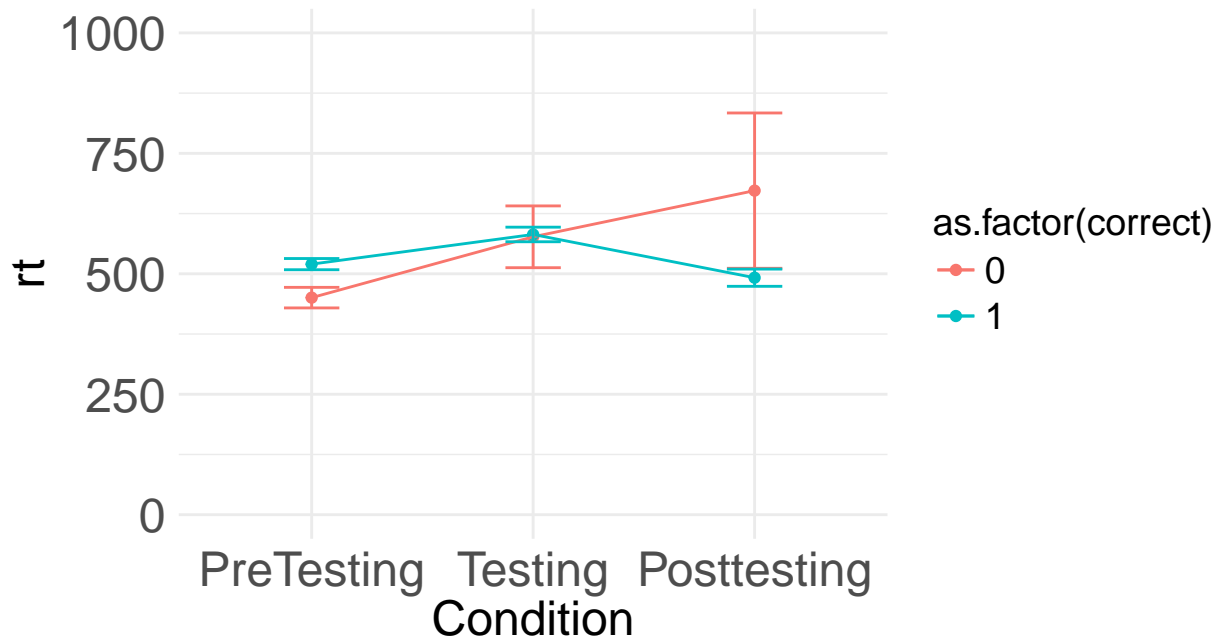


Figure 4: Fig. 4. The average RT for participants by condition, split by Hits (1) and false alarms (0).

```
#Reaction Time
figcap4 <- "Fig. 4. The average RT for participants by condition, split by Hits (1) and false al
rtplot2 <- ggplot(datart, aes(x = as.factor(condition),
                             y=rt, color = as.factor(correct), group = as.factor(correct))) +
  geom_point(stat = "identity", aes(color = as.factor(correct))) +
  geom_line() +
  ylim(0,1000) + theme_minimal() + my.axis.font +
  xlab("Condition") + scale_fill_brewer(type = "qual", palette = 2,direction = 1) +
  geom_errorbar(width = .25,
               aes(ymin=rt-ci, ymax=rt+ci)) +
  ggtitle("Reaction Time \n by Condition in a \n Go-NoGo DRT Task \n")
rtplot2

figcap5 <- "Fig. 5. The average RT for participants in Hits (1) and False Alarms (0) across
rtplot3 <- ggplot(datart, aes(x = as.factor(correct), y=rt,
                             color = as.factor(condition),
                             group = as.factor(condition))) +
  geom_point(stat = "identity",
            aes(color = as.factor(condition))) +
  geom_line() +
  ylim(0,1000) + theme_minimal() + my.axis.font +
  xlab("Correct") + scale_fill_brewer(type = "qual", palette = 2,direction = 1) +
  geom_errorbar(width = .25,
```

Reaction Time by Condition in a Go-NoGo DRT Task

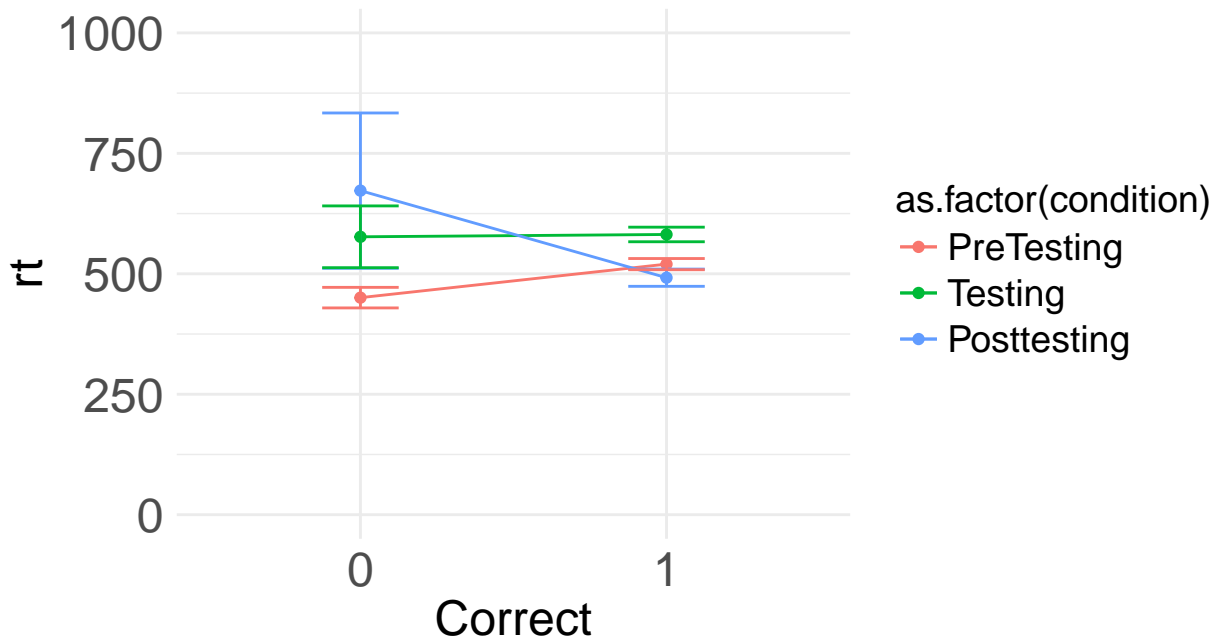


Figure 5: Fig. 5. The average RT for participants in Hits $\langle b \rangle(1)$ and False Alarms $\langle b \rangle(0)$ across the conditions of pretest, test, and posttest.

```

aes(ymin=rt-ci, ymax=rt+ci)) +
  ggtitle("Reaction Time \n by Condition in a \n Go-NoGo DRT Task \n")
rtplot3

```

Statistical Analysis of Reaction Time

Here we used a linear mixed model fit by Restricted Maximum Likelihood (REML), which bases estimates of likelihood from a transformed dataset so that nuisance parameters have no effect (Harville, 1977).

```

rt.lm <- with(as.data.frame(clean), lmer(rt ~ condition * correct + (1|subid)),na.omit())
summary(rt.lm)

```

```

## Linear mixed model fit by REML t-tests use Satterthwaite approximations
## to degrees of freedom [lmerMod]
## Formula: rt ~ condition * correct + (1 | subid)
##
## REML criterion at convergence: 226314.6
##
## Scaled residuals:
##      Min       1Q   Median       3Q      Max
## -1.5646 -0.3820 -0.2787 -0.1864 17.4555

```



```
##
## Random effects:
##   Groups   Name      Variance Std.Dev.
##   subid    (Intercept) 2754     52.47
##   Residual                97326   311.97
## Number of obs: 15798, groups: subid, 26
##
## Fixed effects:
##               Estimate Std. Error      df t value
## (Intercept)      106.486    20.247   287.000    5.259
## conditionTesting      8.121    23.070 15643.000    0.352
## conditionPosttesting 255.627    26.351 13846.000    9.701
## correct            14.350    18.521 10519.000    0.775
## conditionTesting:correct -14.840    24.162 15586.000   -0.614
## conditionPosttesting:correct -282.702    27.359 13660.000  -10.333
##               Pr(>|t|)
## (Intercept)      2.83e-07 ***
## conditionTesting      0.725
## conditionPosttesting < 2e-16 ***
## correct            0.438
## conditionTesting:correct 0.539
## conditionPosttesting:correct < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##      (Intr) cndtnT cndtnP corrcT cndtT:
## cndtnTstng -0.529
## cndtnPsttst -0.585  0.407
## correct    -0.833  0.586  0.654
## cndtnTstng: 0.515 -0.962 -0.392 -0.620
## cndtnPstts: 0.578 -0.398 -0.972 -0.691  0.417
```

Here we have a significant effect of the posttest being significantly faster than the pretest and a large effect of interaction between the RT of correct responses (Hits) and incorrect responses (False Alarms).

```
with(as.data.frame(clean), lmer(rt ~ condition * correct + (1|subid)),na.omit()) %>% anova()
```

```
## Analysis of Variance Table of type III with Satterthwaite
## approximation for degrees of freedom
##               Sum Sq Mean Sq NumDF DenDF F.value    Pr(>F)
## condition      10669185 5334592      2 14736  54.812 < 2.2e-16 ***
## correct         5228641 5228641      1 12031  53.723 2.456e-13 ***
## condition:correct 11995654 5997827      2 14617  61.626 < 2.2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

When we analyze the linear mixed model using an analysis of variance we find significant effects of condition, correctness of response, and a condition by correct response interaction.