Effect of beta and delta/theta frequencies of binaural beats on attention in a neutral and incongruent Stroop task or whatever

Data processing and reporting tools

A Ruby script was used to prepare for analysis the raw files returned by the EncephalApp. R was used to automatize the analysis of the data and R integrated with Sweave to build this report. Raw data and all R scripts used in the analysis and the reporting can be found at `https://github.com/xdurana/R/tree/master/binaural-beats`.

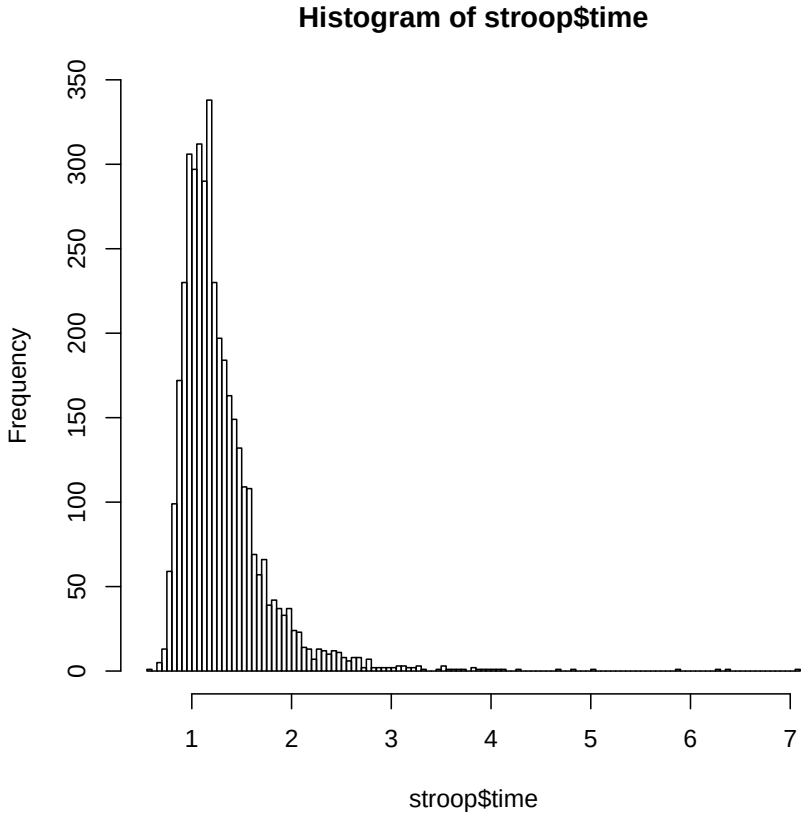
Analysis of the reaction time (RT)

1 Read the file with all the single measures and define the factors. For each group, calculate the descriptive statistics for the dependent variable RT: mean, standard deviation, median and median absolute deviation. A group is defined by a subject, a Stroop level (off, on) and a type of sound (a, b). The data file item.csv can be found at `https://github.com/xdurana/R/blob/master/binaural-beats/items.csv`.

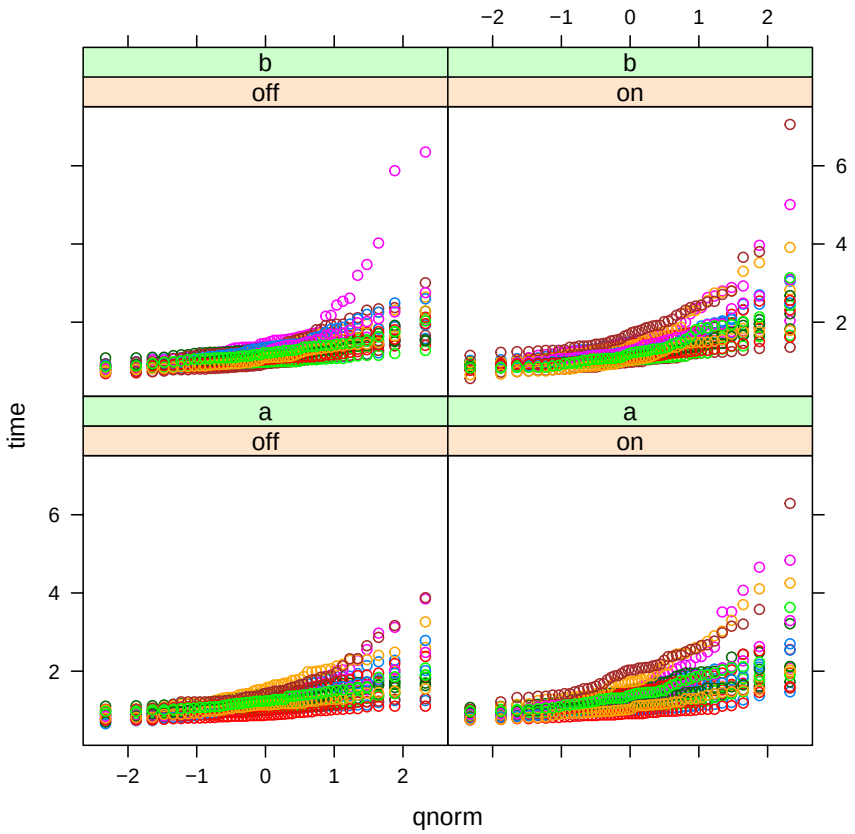
2 Plot the histogram, the summary of the data and the QQPlot for each condition.

```
> hist(stroop$time, breaks=200)
> ddply(stroop, .(sound), summarise, mean=mean(time), sd=sd(time))

  sound     mean        sd
1     a 1.305767 0.4511453
2     b 1.280535 0.4530630

> ddply(stroop, .(level), summarise, mean=mean(time), sd=sd(time))
```

```
  level     mean        sd
1   off 1.238730 0.3848125
2    on 1.347572 0.5050838
```

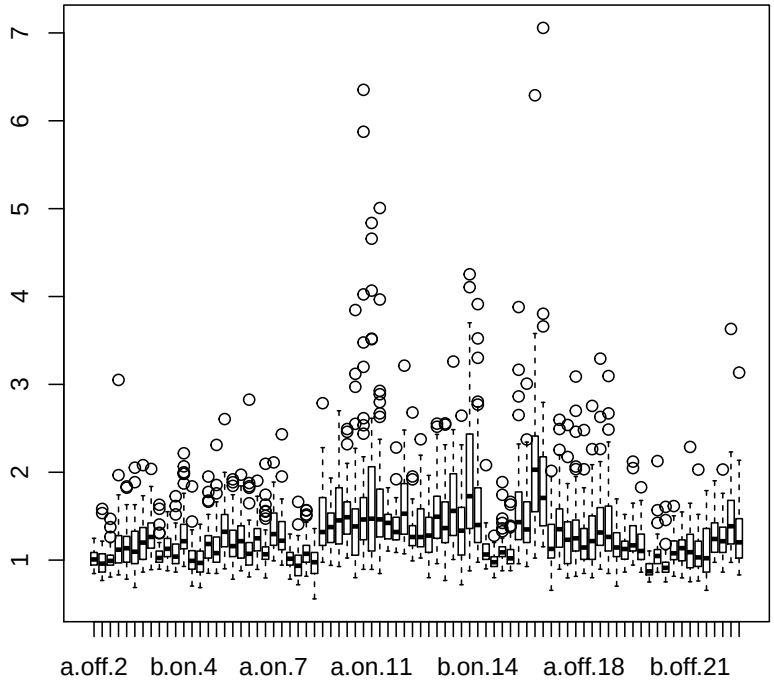



```
> qqmath(~time|level*sound, groups=subject, data=stroop)
```



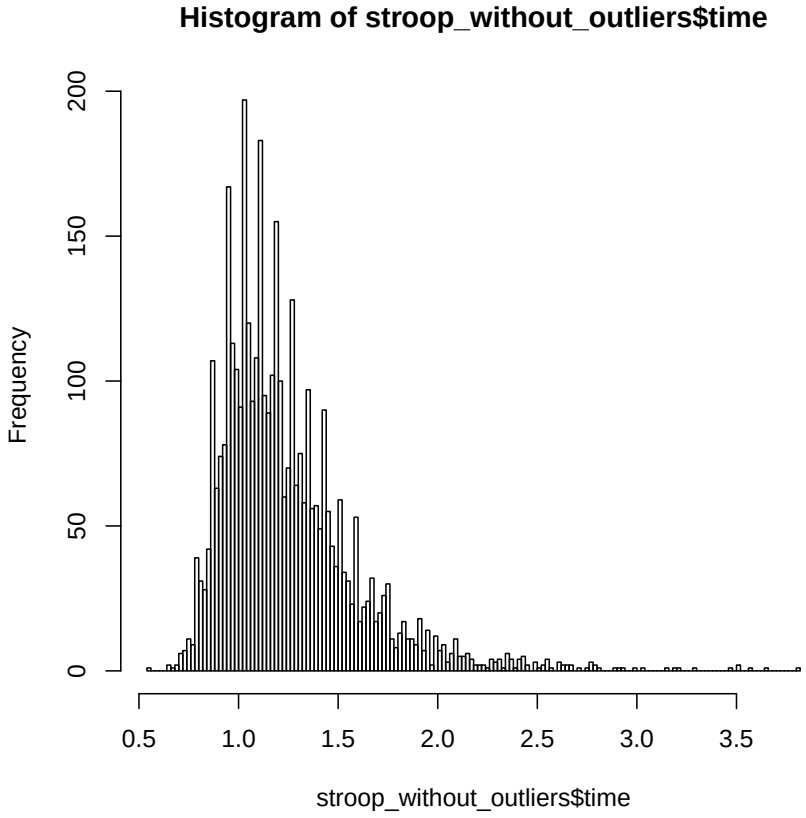
3 Boxplot for each group to see the outliers.

```
> boxplot(stroop$time~stroop$sound+stroop$level+stroop$subject)
```

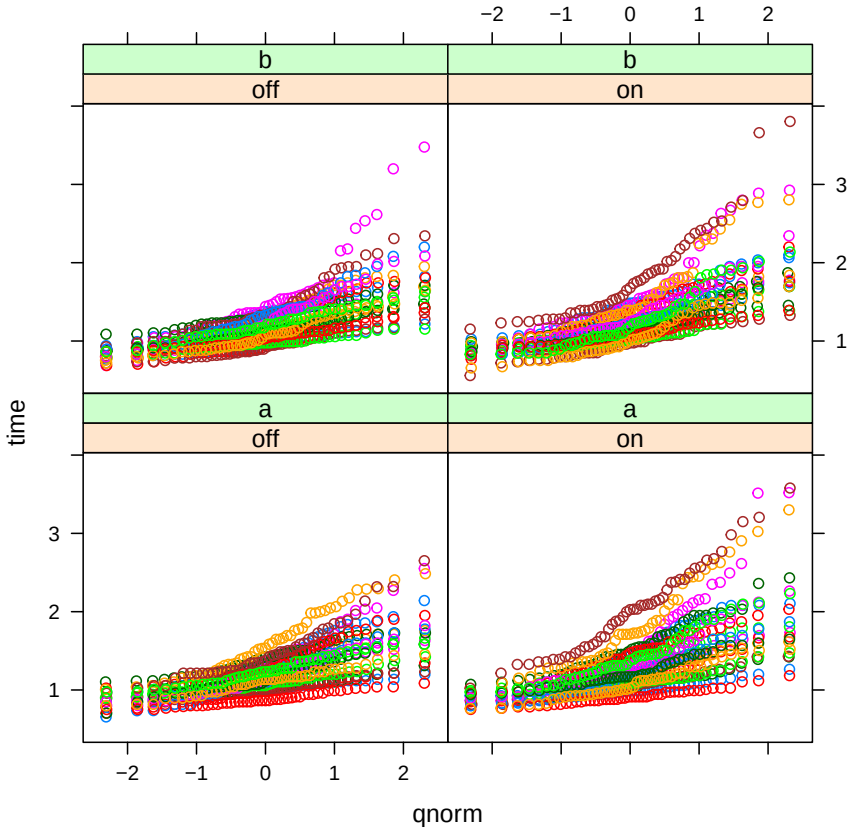


4 Remove the outliers that are beyond the mean + 2*sd of each group, and plot the graphics.

```
> hist(stroop_without_outliers$time, breaks=200)
> ddply(stroop_without_outliers, .(sound), summarise, mean=mean(time), sd=sd

  sound     mean        sd
1     a 1.263362 0.3617619
2     b 1.229600 0.3344639

> ddply(stroop_without_outliers, .(level), summarise, mean=mean(time), sd=sd

  level     mean        sd
1   off 1.198798 0.2917018
2    on 1.294286 0.3920836
```

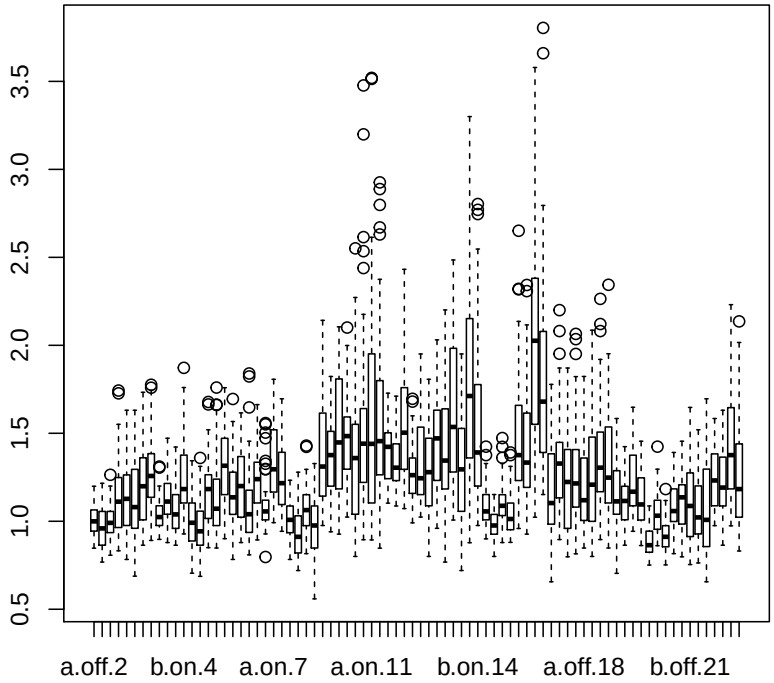



```
> qqmath(~time|level*sound, groups=subject, data=stroop_without_outliers)
```



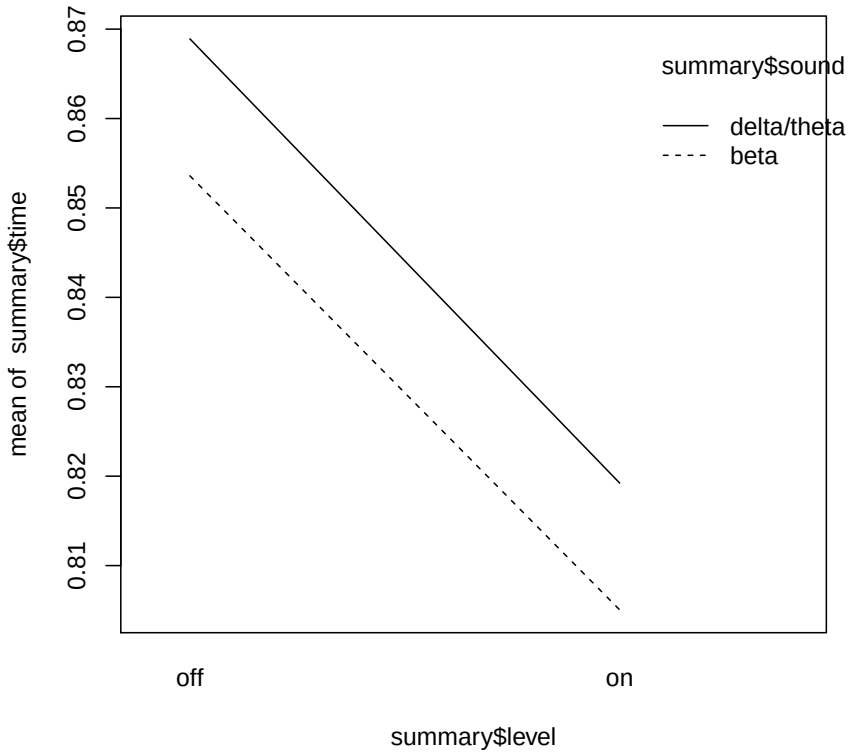
5 Another boxplot for each group.

```
> boxplot(stroop_without_outliers$time~stroop_without_outliers$sound+stroop_
```

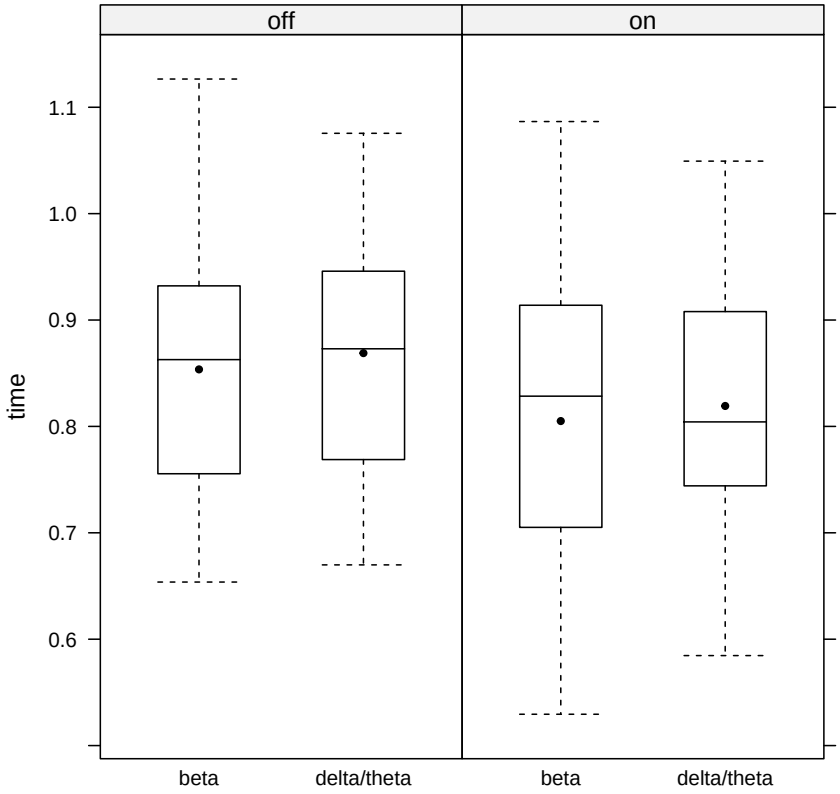


6 Summarize the mean reaction time of each group and plot the boxplots for each level and condition

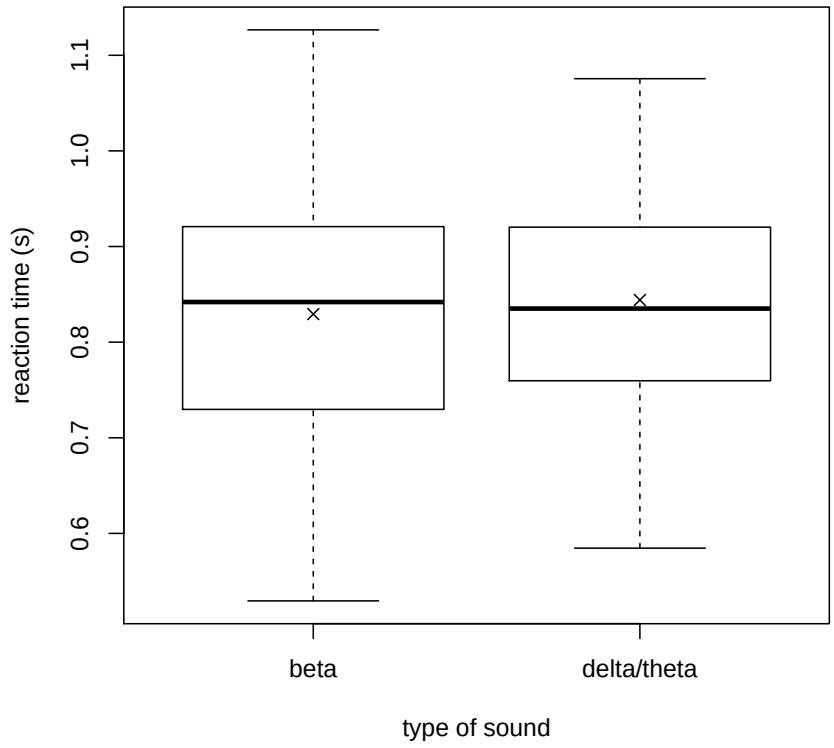
```
> interaction.plot(summary$level, summary$sound, summary$time)
```



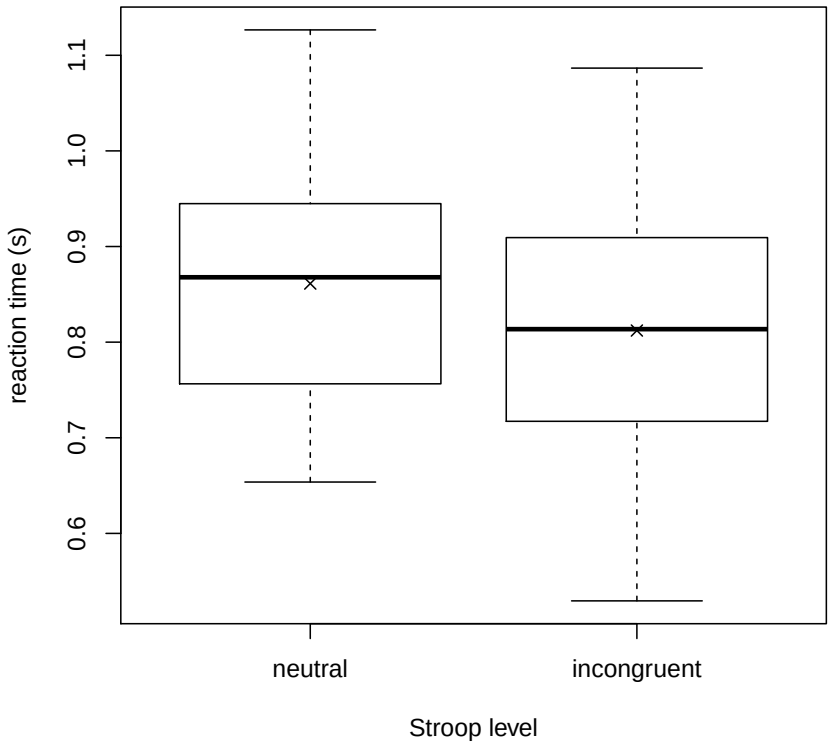

```
> bwplot(time ~ sound | level, data=summary, panel=f.mean, par.settings=bwth
> mean = ddply(summary, .(sound,level), summarise, mean=mean(time))
> ddply(summary, .(sound, level), summarise, mean=mean(time), sd=sd(time))

        sound level      mean        sd
1        beta   off 0.8535882 0.1223644
2        beta    on 0.8050480 0.1420953
3 delta/theta   off 0.8689046 0.1165105
4 delta/theta    on 0.8192260 0.1185384

> boxplot(summary$time~summary$sound+summary$level,
+ main = "Reaction time distribution for each condition",
+ xlab = "condition",
+ ylab = "reaction time (s)")
```



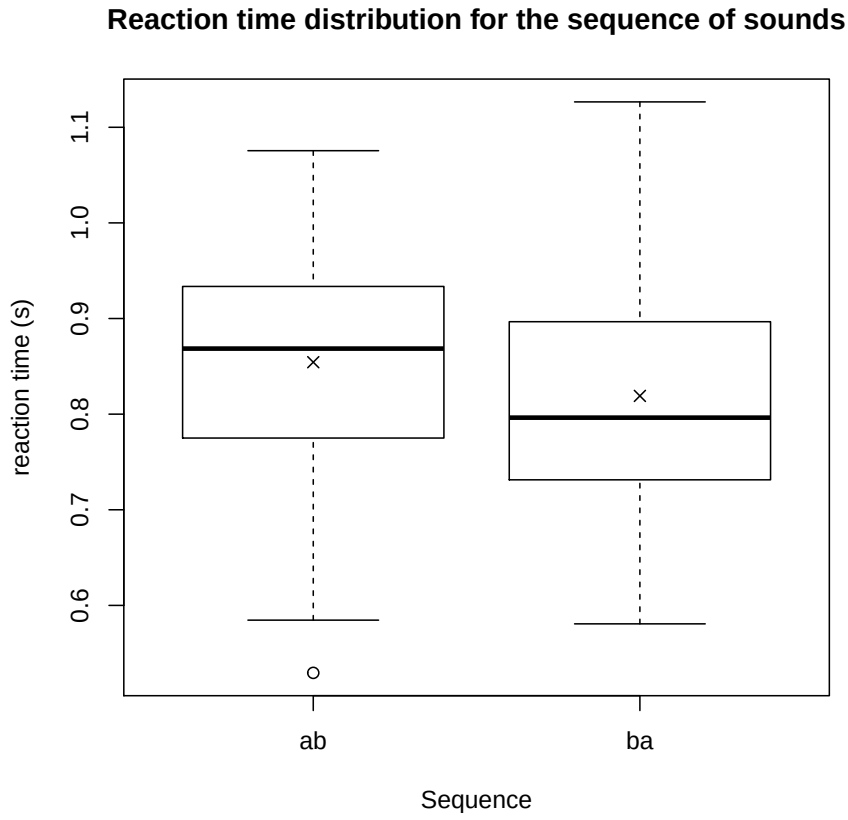

```
> mean = ddply(summary, .(sound), summarise, mean=mean(time))
> ddply(summary, .(sound), summarise, mean=mean(time), sd=sd(time))

        sound      mean        sd
1        beta 0.8293181 0.1331743
2 delta/theta 0.8440653 0.1187083

> boxplot(summary$time~summary$sound,
+ main = "Reaction time distribution for each sound",
+ names = c("beta","delta/theta"),
+ xlab = "type of sound",
+ ylab = "reaction time (s)")
> points(mean, pch = 4)
```




```
> mean = ddply(summary, .(level), summarise, mean=mean(time))
> ddply(summary, .(level), summarise, mean=mean(time), sd=sd(time))

  level      mean        sd
1   off 0.8612464 0.1181864
2    on 0.8121370 0.1293590

> boxplot(summary$time~summary$level,
+ main = "Reaction time distribution for each Stroop level",
+ names = c("neutral","incongruent"),
+ xlab = "Stroop level",
+ ylab = "reaction time (s)")
> points(mean, pch = 4)
```




```
> mean = ddply(summary, .(sequence), summarise, mean=mean(time))
> ddply(summary, .(sequence), summarise, mean=mean(time), sd=sd(time))

  sequence      mean        sd
1       ab 0.8543157 0.1238259
2       ba 0.8190677 0.1263669

> boxplot(summary$time~summary$sequence,
+ main = "Reaction time distribution for the sequence of sounds",
+ xlab = "Sequence",
+ ylab = "reaction time (s)")
> points(mean, pch = 4)
```



7 Two-way repeated measures ANOVA

```
> print(anova.table, floating=FALSE)
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Residuals	19	1.02	0.05		
sound	1	0.00	0.00	0.74	0.3999
Residuals1	19	0.11	0.01		
level	1	0.05	0.05	20.54	0.0002
Residuals2	19	0.04	0.00		
sound:level	1	0.00	0.00	0.01	0.9355
Residuals	19	0.02	0.00		

8 Post-hoc comparison for the binaural beats

```
> print(test)

        Paired t-test
```

```
data:  mean by sound
t = -0.8611, df = 19, p-value = 0.3999
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -0.05059156  0.02109713
sample estimates:
mean of the differences
            -0.01474721
```