

Supplementary analyses DWT dataset (medication analysis)

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Introduction

The following analysis has the goal of examining the effect medication (`CNS_MED`), while controlling for other covariates, on each of the ERG-related dependent variables; i.e. `b20`, `b40`, `op80`, `op160`, `a20`, and `a40`.

The independent variables are (no order implied) medication (`CNS_MED`, `M`), flash strength (`Strength`, `FS`), vertical location (`VERT`, `V`), iris (`iris`, `I`), group (`group`, `G`), ethnicity (`ethnicity`, `E`) and interaction between flash strength and group (`FS · G`). Variables not listed here, aren't considered later on.

The models to consider will thus be:

$$DV \sim M + FS + V + I + G + E + FS \cdot G; \text{ where } DV \text{ is each of the ERG-related variables.}$$

The (explanatory) model is analysed via robust (fixed-effects) linear regression. The ultimate goal is to see if

medication has an effect on the *DVs*. Thus, the pairwise differences between the medication groups will be assessed at each *DV*.

First off, the data examination performed in other analyses is reproduced here.

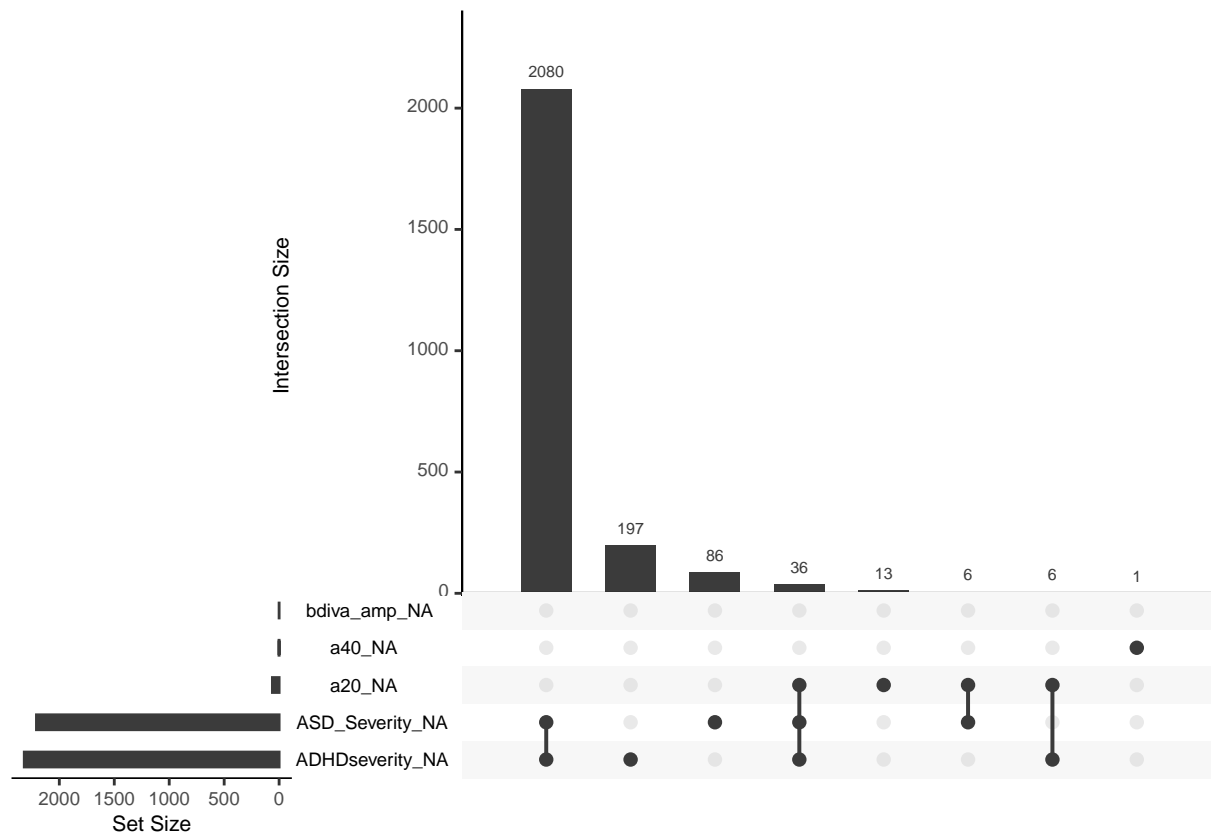
The following sections present the analyses applied to the DWT dataset.

The data set is 'DWTdata.xlsx'.

```
##### reading the data
library(readxl)
library(dplyr)

data <- read_excel("DWTdata.xlsx")
#View(data)

# checking missing values
library(naniar)
gg_miss_upset(data)
```



The results indicate ASD_Severity and ADHD severity have a large number of missing values so they'll be removed from further analyses.

```
# retaining the columns of interest
# variables were suggested by the leading researcher (paul constable)
data1 <- subset(data, select=c(
  participant, gender, group, VERT, `Sibling_of ASD`, Ethnicity,
  CNS_MED, eye, iris, Strength,

# numeric
  a20, a40, b20, b40, op80, op160, `%OPratio`, b40to20ratio
```

```
))
```

```
data1 <- data1 %>%  
  dplyr::rename(perc_op_ratio = `%OPratio`)
```

Let's amend the data...

```
# first fixing the data...  
str(data1)
```

```
## tibble [2,961 x 18] (S3: tbl_df/tbl/data.frame)  
## $ participant   : chr [1:2961] "AD01" "AD01" "AD01" "AD01" ...  
## $ gender       : num [1:2961] 0 0 0 0 0 0 0 0 0 0 ...  
## $ group        : num [1:2961] 3 3 3 3 3 3 3 3 3 3 ...  
## $ VERT         : num [1:2961] 2 2 2 2 2 2 2 2 2 2 ...  
## $ Sibling_of ASD: num [1:2961] 0 0 0 0 0 0 0 0 0 0 ...  
## $ Ethnicity    : num [1:2961] 4 4 4 4 4 4 4 4 4 4 ...  
## $ CNS_MED      : num [1:2961] 0 0 0 0 0 0 0 0 0 0 ...  
## $ eye          : num [1:2961] 0 0 0 0 0 0 0 1 1 1 ...  
## $ iris         : num [1:2961] 1.26 1.26 1.26 1.26 1.26 ...  
## $ Strength     : num [1:2961] -0.119 0.114 0.398 0.477 0.799 ...  
## $ a20          : num [1:2961] 14.1 9.2 NA 21.6 16.8 ...  
## $ a40          : num [1:2961] 12.21 17.67 22.72 7.78 12.7 ...  
## $ b20          : num [1:2961] 37.5 60.2 73.4 106.6 81.6 ...  
## $ b40          : num [1:2961] 32.1 43.6 97.5 87.1 67.9 ...  
## $ op80         : num [1:2961] 17.2 19.3 35.4 34.7 28.6 ...  
## $ op160        : num [1:2961] 8.76 11.2 19.42 13.58 12.68 ...  
## $ perc_op_ratio : num [1:2961] 60.2 56.2 63.5 53 56.3 ...  
## $ b40to20ratio : num [1:2961] 1.093 0.858 1.149 1.011 0.967 ...
```

```
# fixing the variables of interest  
# variables not listed are therefore in the right format
```

```
data.fixed <- data1 %>%  
  dplyr::mutate(  
    participant = as.factor(participant),  
    gender = as.factor(gender),  
    group = as.factor(group),  
    Ethnicity = as.factor(Ethnicity),  
    VERT = as.factor(VERT),  
    `Sibling_of ASD` = as.factor(`Sibling_of ASD`),  
    CNS_MED = as.factor(CNS_MED),  
    eye = as.factor(eye),  
    iris = as.numeric(iris),  
    Strength = as.factor(Strength)  
  )
```

```
# releveling VERT  
data.fixed$VERT <- relevel(data.fixed$VERT, ref = "2")
```

```
# retaining complete cases  
dim(data.fixed)
```

```
## [1] 2961 18
```

```
# Note: We'll stick to all cases for now  
data.fixed <- data.fixed[complete.cases(data.fixed), ]
```

```
dim(data.fixed)
```

```
## [1] 2899 18
```

```
str(data.fixed)
```

```
## tibble [2,899 x 18] (S3: tbl_df/tbl/data.frame)
## $ participant : Factor w/ 155 levels "a10","a100","a20",...: 30 30 30 30 30 30 30 30 30 30 30 ...
## $ gender      : Factor w/ 2 levels "0","1": 1 1 1 1 1 1 1 1 1 1 ...
## $ group       : Factor w/ 3 levels "0","1","3": 3 3 3 3 3 3 3 3 3 3 ...
## $ VERT        : Factor w/ 5 levels "2","0","1","3",...: 1 1 1 1 1 1 1 1 1 1 ...
## $ Sibling_of ASD: Factor w/ 3 levels "0","1","2": 1 1 1 1 1 1 1 1 1 1 ...
## $ Ethnicity   : Factor w/ 5 levels "1","2","3","4",...: 4 4 4 4 4 4 4 4 4 4 ...
## $ CNS_MED     : Factor w/ 2 levels "0","1": 1 1 1 1 1 1 1 1 1 1 ...
## $ eye        : Factor w/ 2 levels "0","1": 1 1 1 1 1 1 2 2 2 2 ...
## $ iris       : num [1:2899] 1.26 1.26 1.26 1.26 1.26 1.26 ...
## $ Strength    : Factor w/ 10 levels "-0.367","-0.119",...: 2 3 5 7 8 9 3 4 5 7 ...
## $ a20        : num [1:2899] 14.1 9.2 21.6 16.8 29.1 ...
## $ a40        : num [1:2899] 12.21 17.67 7.78 12.7 17.31 ...
## $ b20        : num [1:2899] 37.5 60.2 106.6 81.6 90.6 ...
## $ b40        : num [1:2899] 32.1 43.6 87.1 67.9 92.6 ...
## $ op80       : num [1:2899] 17.2 19.3 34.7 28.6 27.8 ...
## $ op160      : num [1:2899] 8.76 11.2 13.58 12.68 12.47 ...
## $ perc_op_ratio : num [1:2899] 60.2 56.2 53 56.3 53.8 ...
## $ b40to20ratio : num [1:2899] 1.093 0.858 1.011 0.967 0.908 ...
```

Let's clean up the column names with janitor:

```
data.fixed <- janitor::clean_names(data.fixed)
```

```
# relabeling some of the variables' levels
```

```
library(plyr)
```

```
data.fixed$gender <-  
mapvalues(data.fixed$gender,  
from = c('0','1'),  
to = c('Male','Female'))
```

```
data.fixed$group <-  
mapvalues(data.fixed$group,  
from = c('0','1','3'),  
to = c('ASD','Control','ADHD'))
```

```
data.fixed$ethnicity <-  
mapvalues(data.fixed$ethnicity,  
from = c('1','2','3','4','5'),  
to = c('Caucasian','Asian','Afro-Caribbean','Latino','Mixed'))
```

```
data.fixed$eye <-  
mapvalues(data.fixed$eye,  
from = c('0','1'),  
to = c('Right','Left'))
```

```
data.fixed$cns_med <-  
mapvalues(data.fixed$cns_med,  
from = c('0','1'),
```

```
to = c('not taken','taken'))
```

Statistical analyses

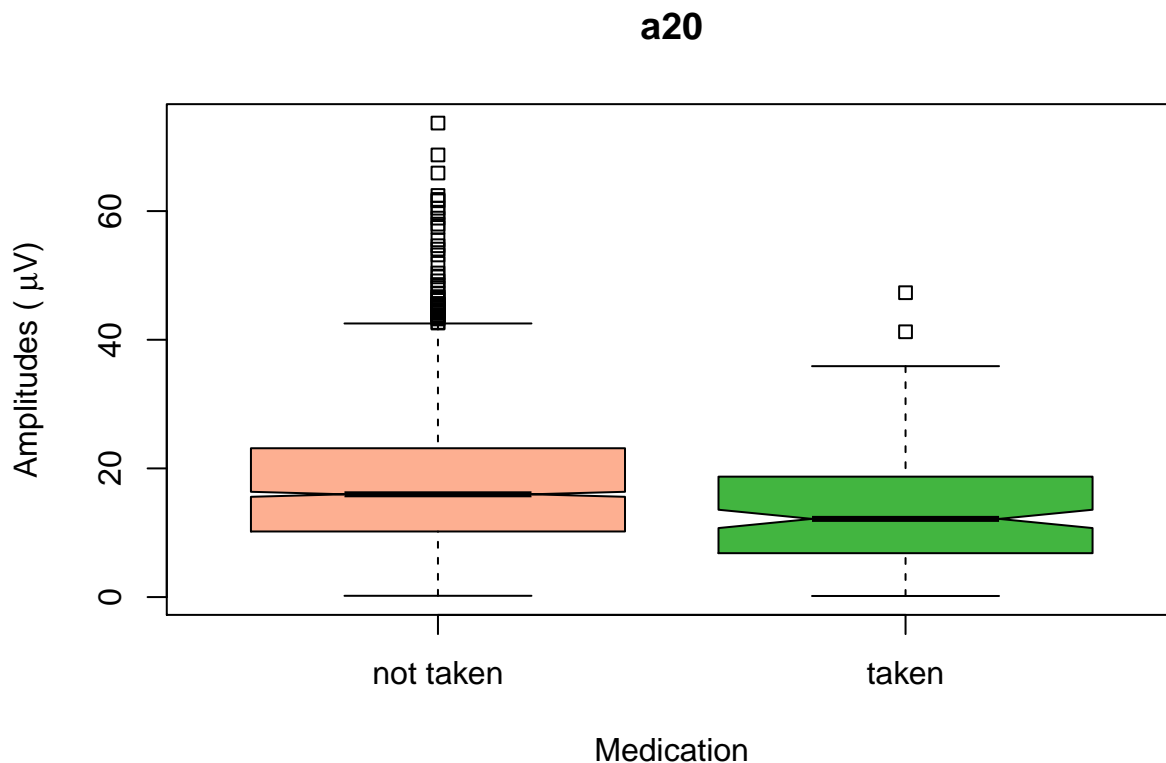
First off, the distribution of microvolts in each of the six ERG-related measures in each of the three groups is graphed.

Plots

```
# a library to get nice colour combinations
library(palettter)
# checking the colour codes from a selected package and colour range
# all colours are here: https://github.com/EmilHvitfeldt/r-color-palettes
palettter_d("ggsci::lanonc_lancet")

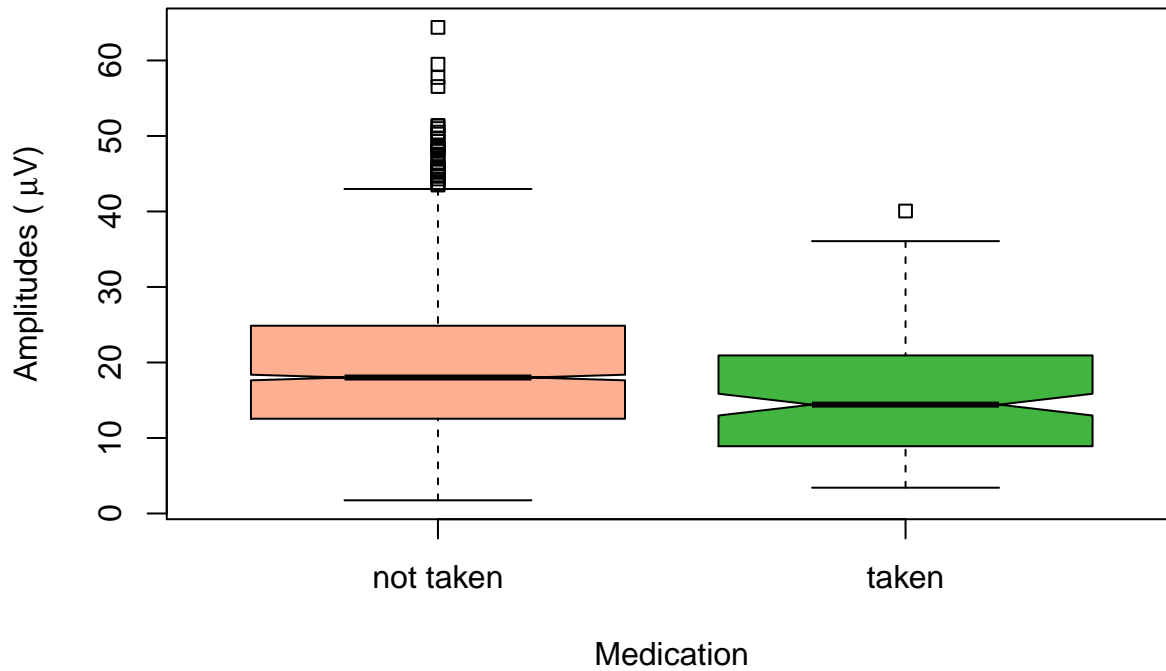
## <colors>
## #00468BFF #ED0000FF #42B540FF #0099B4FF #925E9FFF #FDAF91FF #AD002AFF #ADB6B6FF #1B1919FF
picked.colours <-c('#FDAF91FF','#42B540FF')

boxplot(a20 ~ cns_med,
main='a20',
notch=T, xlab='Medication',
ylab=expression(paste('Amplitudes ( ',mu,'V)'),
col=picked.colours,lwd=1, pch=22, data = data.fixed)
```



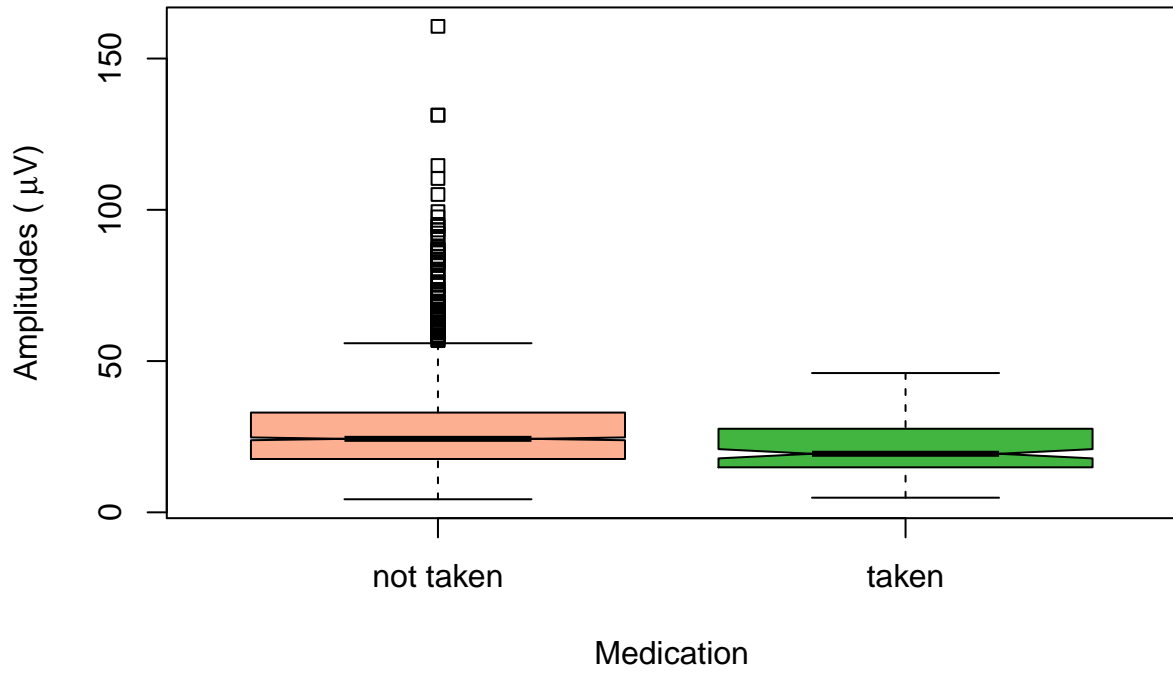
```
boxplot(a40 ~ cns_med,  
main='a40',  
notch=T, xlab='Medication',  
ylab=expression(paste('Amplitudes ( ',mu,'V)')),  
col=picked.colours,lwd=1, pch=22, data = data.fixed)
```

a40



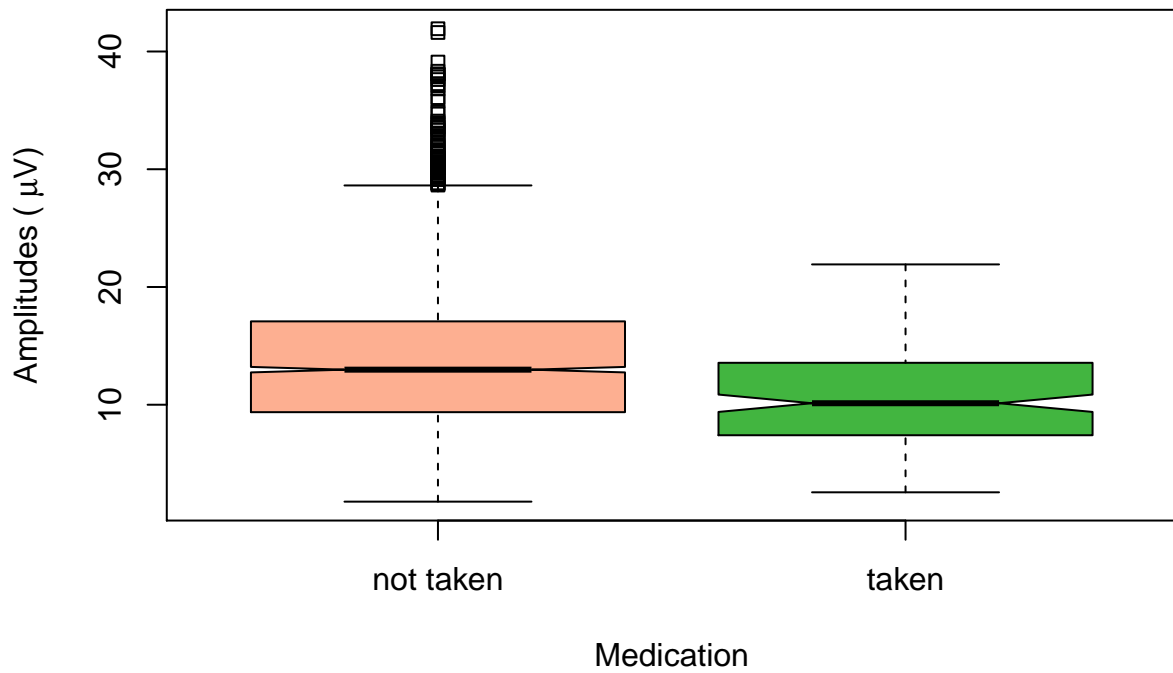
```
boxplot(op80 ~ cns_med,  
main='op80',  
notch=T, xlab='Medication',  
ylab=expression(paste('Amplitudes ( ',mu,'V)')),  
col=picked.colours,lwd=1, pch=22, data = data.fixed)
```

op80



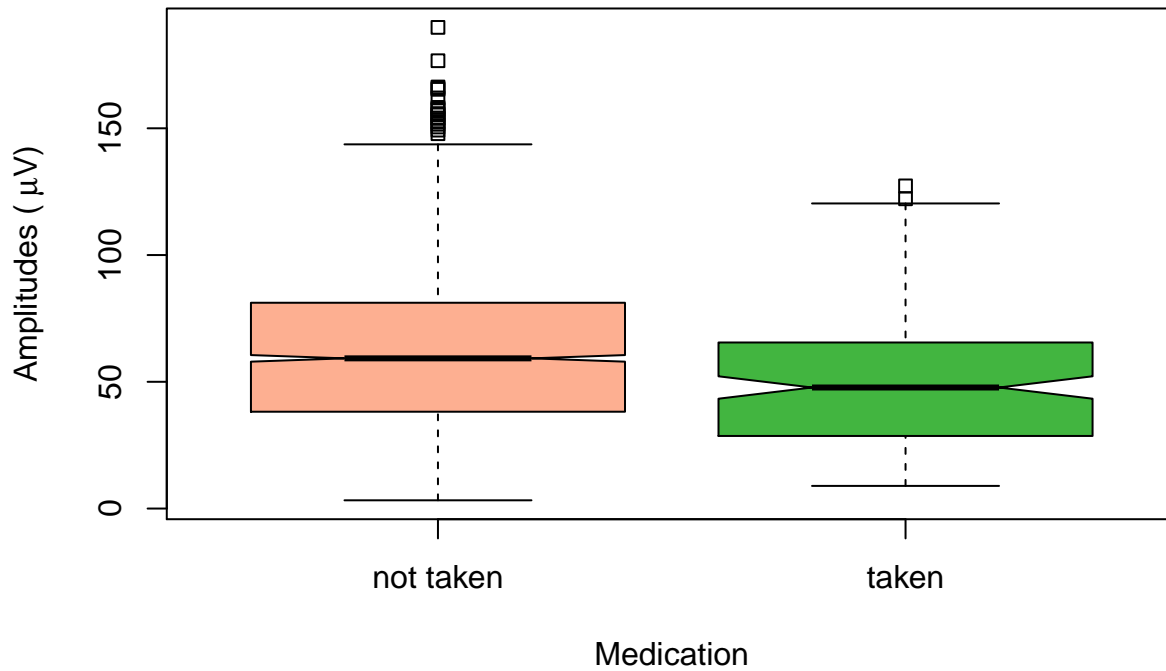
```
boxplot(op160 ~ cns_med,  
main='op160',  
notch=T, xlab='Medication',  
ylab=expression(paste('Amplitudes ( ',mu,'V)'),  
col=picked.colours,lwd=1, pch=22, data = data.fixed)
```

op160



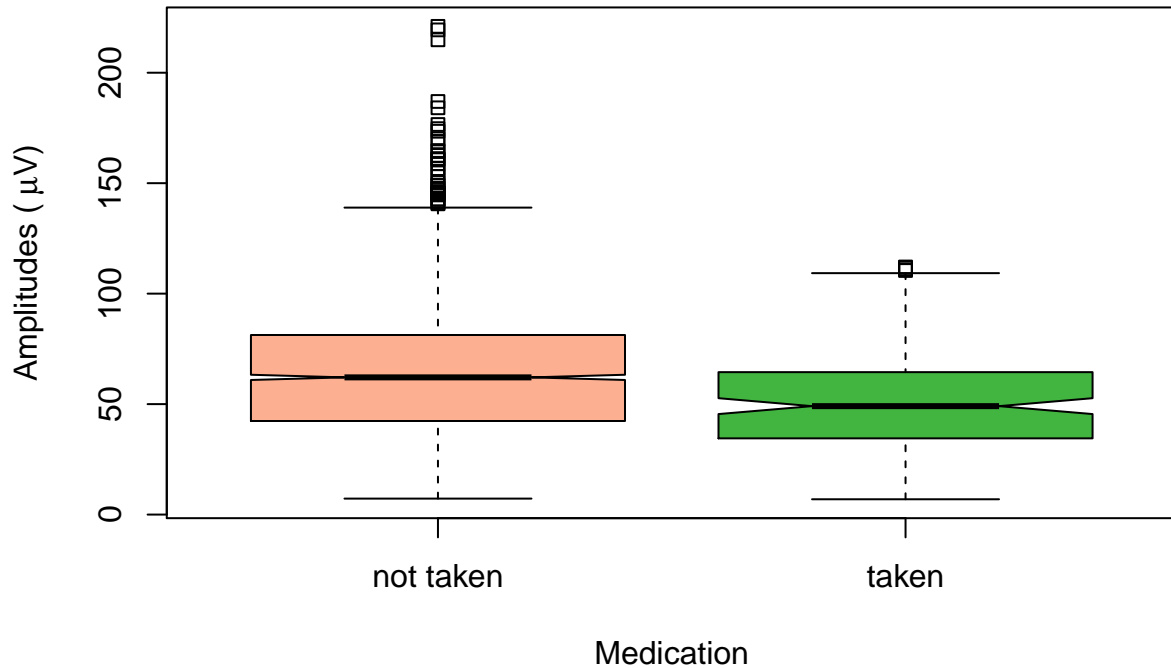

```
boxplot(b20 ~ cns_med,  
main='b20',  
notch=T, xlab='Medication',  
ylab=expression(paste('Amplitudes ( ',mu,'V)')),  
col=picked.colours,lwd=1, pch=22, data = data.fixed)
```

b20



```
boxplot(b40 ~ cns_med,  
main='b40',  
notch=T, xlab='Medication',  
ylab=expression(paste('Amplitudes ( ',mu,'V)')),  
col=picked.colours,lwd=1, pch=22, data = data.fixed)
```

b40

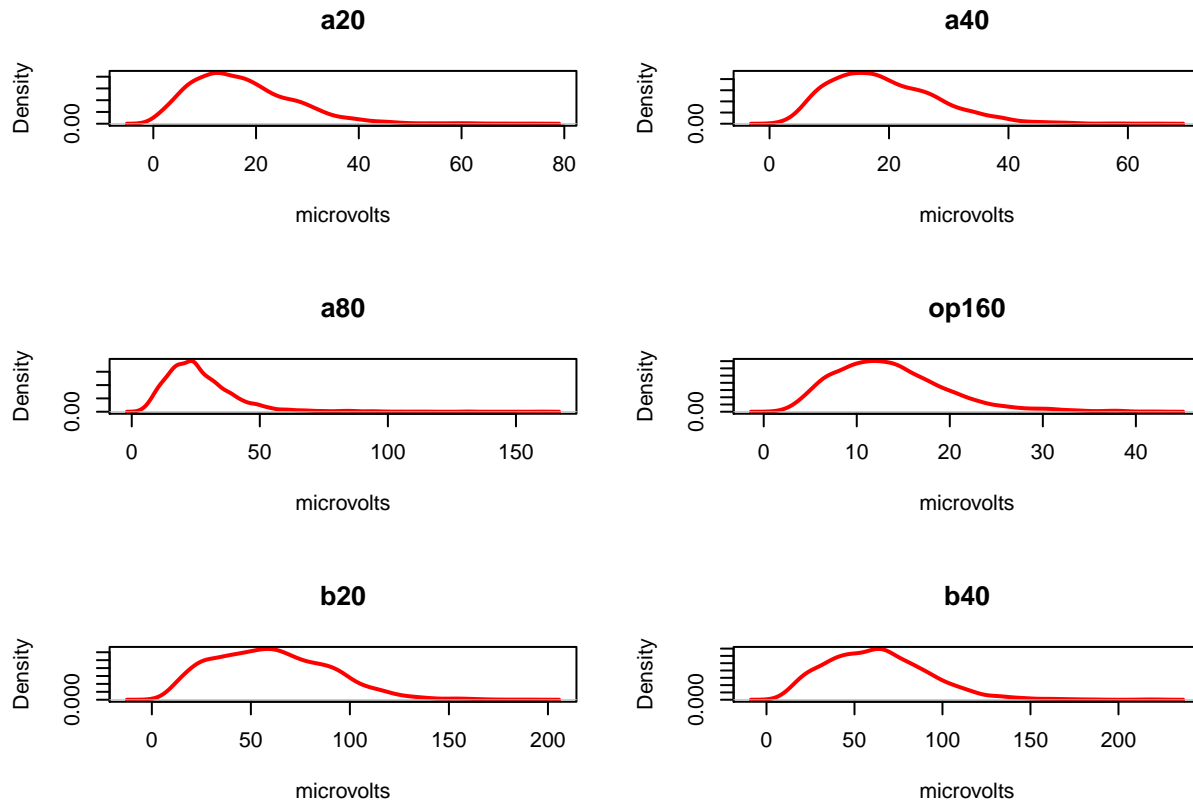


The notches, i.e. approximate 95%*CI*s, indicate large non-overlap between medication ‘not taken’ and ‘taken’ in all ERG-related metrics.

Statistical modelling

First off, let’s examine the shape of the dependent variables.

```
par(mfrow=c(3,2))
plot(density(data.fixed$a20), main='a20', xlab='microvolts', lwd=2, col='red')
plot(density(data.fixed$a40), main='a40', xlab='microvolts', lwd=2, col='red')
plot(density(data.fixed$op80), main='a80', xlab='microvolts', lwd=2, col='red')
plot(density(data.fixed$op160), main='op160', xlab='microvolts', lwd=2, col='red')
plot(density(data.fixed$b20), main='b20', xlab='microvolts', lwd=2, col='red')
plot(density(data.fixed$b40), main='b40', xlab='microvolts', lwd=2, col='red')
```



```
par(mfrow=c(1,1))
```

The results indicate a traditional linear regression will give biased results hence reinforcing the idea of a robust approach ¹

We'll use robust (fixed-effects linear regression) for each of the dependent variables.

```
library(robust)
library(knitr)

# a20

a20.model <- lmRob(a20 ~ cns_med + strength + vert + iris + group + ethnicity
                  + strength:group, data = data.fixed)

anova.a20 <- anova.lmRob(a20.model)

anova.a20 %>% kable()
```

	Chisq Df	RobustF	Pr(F)
(Intercept)	1	NA	NA
cns_med	1	18.522395	0.0000116
strength	9	1453.263245	0.0000000
vert	4	128.781078	0.0000000
iris	1	6.571249	0.0089955
group	2	42.108851	0.0000000
ethnicity	4	9.607613	0.0015853

¹Bear in mind that a robust regression is just one of the many possible regression models to use on the data. For example, quantile regression could've been another good option.

	Chisq Df	RobustF	Pr(F)
strength:group	18	32.255925	0.0000000

```
# a40
```

```
a40.model <- lmRob(a40 ~ cns_med + strength + vert + iris + group + ethnicity
+ strength:group, data = data.fixed)
```

```
anova.a40 <- anova.lmRob(a40.model)
```

```
anova.a40 %>% kable()
```

	Chisq Df	RobustF	Pr(F)
(Intercept)	1	NA	NA
cns_med	1	20.66106	3.60e-06
strength	9	1242.64462	0.00e+00
vert	4	172.41231	0.00e+00
iris	1	17.39546	2.14e-05
group	2	101.27019	0.00e+00
ethnicity	4	35.81619	0.00e+00
strength:group	18	25.79439	2.00e-07

```
# op80
```

```
op80.model <- lmRob(op80 ~ cns_med + strength + vert + iris + group + ethnicity
+ strength:group, data = data.fixed)
```

```
anova.op80 <- anova.lmRob(op80.model)
```

```
anova.op80 %>% kable()
```

	Chisq Df	RobustF	Pr(F)
(Intercept)	1	NA	NA
cns_med	1	18.01370	0.0000153
strength	9	1160.57205	0.0000000
vert	4	205.30352	0.0000000
iris	1	11.28574	0.0006185
group	2	287.78834	0.0000000
ethnicity	4	148.35340	0.0000000
strength:group	18	65.07080	0.0000000

```
# op160
```

```
op160.model <- lmRob(op160 ~ cns_med + strength + vert + iris + group + ethnicity
+ strength:group, data = data.fixed)
```

```
anova.op160 <- anova.lmRob(op160.model)
```

```
anova.op160 %>% kable()
```

	Chisq Df	RobustF	Pr(F)
(Intercept)	1	NA	NA
cns_med	1	28.62466	0.0000000
strength	9	988.89083	0.0000000
vert	4	199.56642	0.0000000
iris	1	11.91118	0.0004366
group	2	220.74405	0.0000000
ethnicity	4	198.18043	0.0000000
strength:group	18	59.44736	0.0000000

```
# b20
b20.model <- lmRob(b20 ~ cns_med + strength + vert + iris + group + ethnicity
  + strength:group, data = data.fixed)
anova.b20 <- anova.lmRob(b20.model)
anova.b20 %>% kable()
```

	Chisq Df	RobustF	Pr(F)
(Intercept)	1	NA	NA
cns_med	1	10.47827	0.0009716
strength	9	1493.19749	0.0000000
vert	4	282.97444	0.0000000
iris	1	30.64068	0.0000000
group	2	241.53786	0.0000000
ethnicity	4	95.44514	0.0000000
strength:group	18	77.35430	0.0000000

```
# b40
b40.model <- lmRob(b40 ~ cns_med + strength + vert + iris + group + ethnicity
  + strength:group, data = data.fixed)
anova.b40 <- anova.lmRob(b40.model)
anova.b40 %>% kable()
```

	Chisq Df	RobustF	Pr(F)
(Intercept)	1	NA	NA
cns_med	1	15.73341	5.3e-05
strength	9	1453.75301	0.0e+00
vert	4	228.56061	0.0e+00
iris	1	34.68790	0.0e+00
group	2	292.16171	0.0e+00
ethnicity	4	120.89246	0.0e+00
strength:group	18	69.16043	0.0e+00

In all cases, all covariates were significant. In the specific case of ‘medication’ it’s clear the pairwise differences were significant at all DVs and no extra pairwise test is needed (see also the boxplots above).

The question is then whether pairwise differences in medication occurred at each flash strength in each *DV*.
First a graphical display.

a20

```
boxplot(a20 ~ interaction(cns_med,strength),
        main='Interaction FS•Medication at a20',
        notch=T, xlab='Flash strength',
        ylab=expression(paste('Microvolts ( ',mu,'V)'),
        xaxt='n',
        col=picked.colours,lwd=1, pch=22, bg=picked.colours,
        data=data.fixed)

## Warning in bxp(list(stats = structure(c(0.199158740882181, 5.27792276887663, :
## some notches went outside hinges ('box'): maybe set notch=FALSE

## Warning in (function (main = NULL, sub = NULL, xlab = NULL, ylab = NULL, :
## conversion failure on 'Interaction FS•Medication at a20' in 'mbscsToSbcs': dot
## substituted for <e2>

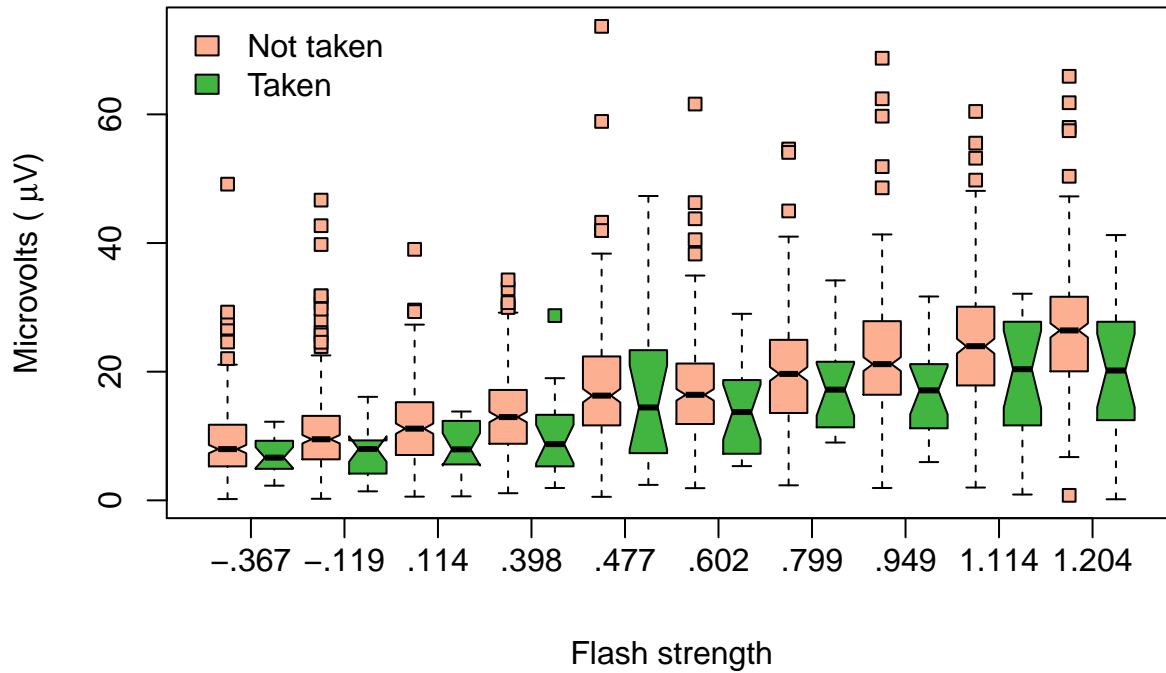
## Warning in (function (main = NULL, sub = NULL, xlab = NULL, ylab = NULL, :
## conversion failure on 'Interaction FS•Medication at a20' in 'mbscsToSbcs': dot
## substituted for <80>

## Warning in (function (main = NULL, sub = NULL, xlab = NULL, ylab = NULL, :
## conversion failure on 'Interaction FS•Medication at a20' in 'mbscsToSbcs': dot
## substituted for <a2>

# Changing x axis so that the labels for the flash strenght are shown
# underneath the second group for every flash strenght
xtick<-seq(from=1.5, to= ,
           by=2,length.out = 10)
axis(side=1, at=xtick, labels = FALSE)
text(x=xtick, y=-5, # tick location on the Y axis
     labels = c('- .367', '- .119', '.114', '.398',
                '.477', '.602', '.799', '.949', '1.114', '1.204'),
     # colour for flashes at which pairwise differences existed
     # see code below for the actual statistical analyses
     col=c('black'),
     srt = 0, pos = 1, xpd = TRUE)

# a legend
legend('topleft', border='black', bty='n',
      legend=c('Not taken','Taken'),
      fill=picked.colours,
      cex=1)
```

Interaction FS...Medication at a20



a40

```
boxplot(a40 ~ interaction(cns_med,strength),
        main='Interaction FS•Medication at a40',
        notch=T, xlab='Flash strength',
        ylab=expression(paste('Microvolts ( ',mu, 'V)')),
        xaxt='n',
        col=picked.colours,lwd=1, pch=22, bg=picked.colours,
        data=data.fixed)
```

```
## Warning in bxp(list(stats = structure(c(2.39507153386373, 7.03188619943391, :
## some notches went outside hinges ('box'): maybe set notch=FALSE
```

```
## Warning in (function (main = NULL, sub = NULL, xlab = NULL, ylab = NULL, :
## conversion failure on 'Interaction FS•Medication at a40' in 'mbscToSbcs': dot
## substituted for <e2>
```

```
## Warning in (function (main = NULL, sub = NULL, xlab = NULL, ylab = NULL, :
## conversion failure on 'Interaction FS•Medication at a40' in 'mbscToSbcs': dot
## substituted for <80>
```

```
## Warning in (function (main = NULL, sub = NULL, xlab = NULL, ylab = NULL, :
## conversion failure on 'Interaction FS•Medication at a40' in 'mbscToSbcs': dot
## substituted for <a2>
```

```
# Changing x axis so that the labels for the flash strenght are shown
# underneath the second group for every flash strenght
```

```
xtick<-seq(from=1.5, to= ,
           by=2,length.out = 10)
axis(side=1, at=xtick, labels = FALSE)
```

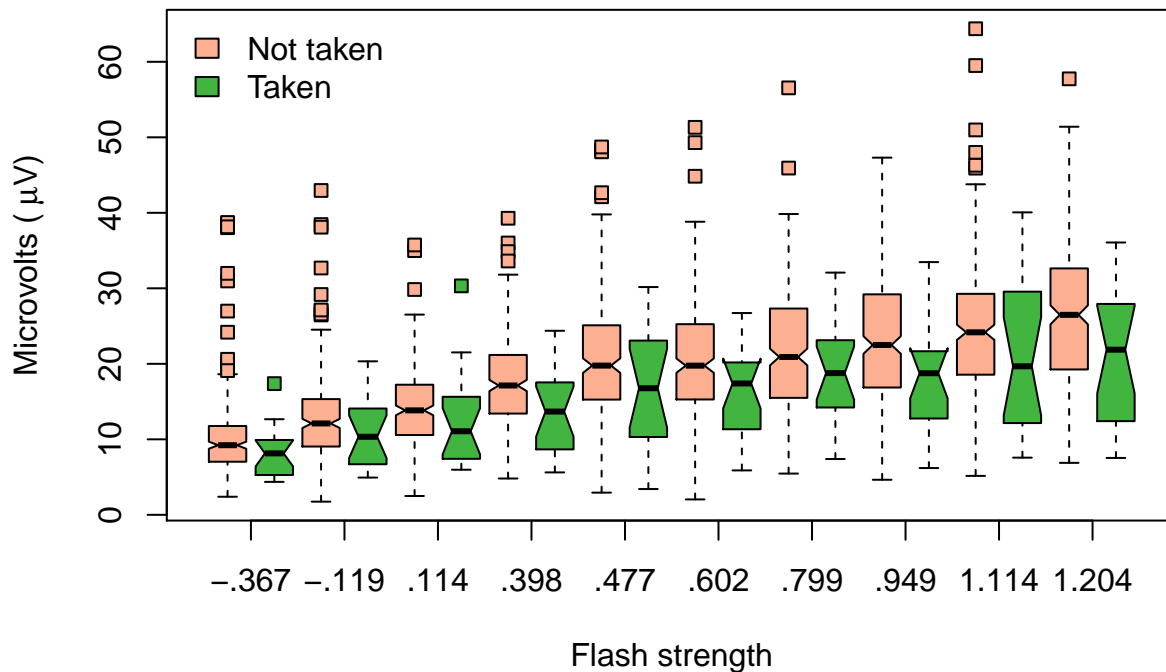
```

text(x=xtick, y=-5, # tick location on the Y axis
     labels = c('-0.367', '-0.119', '.114', '.398',
                '.477', '.602', '.799', '.949', '1.114', '1.204'),
     # colour for flashes at which pairwise differences existed
     # see code below for the actual statistical analyses
     col=c('black'),
     srt = 0, pos = 1, xpd = TRUE)

# a legend
legend('topleft', border='black', bty='n',
       legend=c('Not taken', 'Taken'),
       fill=picked.colours,
       cex=1)

```

Interaction FS...Medication at a40



op80

```

boxplot(op80 ~ interaction(cns_med, strength),
        main='Interaction FS•Medication at op80',
        notch=T, xlab='Flash strength',
        ylab=expression(paste('Microvolts ( ', mu, 'V)')),
        xaxt='n',
        col=picked.colours, lwd=1, pch=22, bg=picked.colours,
        data=data.fixed)

```

```

## Warning in bxp(list(stats = structure(c(4.37013640365297, 9.23245745835902, :
## some notches went outside hinges ('box'): maybe set notch=FALSE

## Warning in (function (main = NULL, sub = NULL, xlab = NULL, ylab = NULL, :
## conversion failure on 'Interaction FS•Medication at op80' in 'mbscsToSbscs': dot

```



```

## substituted for <e2>

## Warning in (function (main = NULL, sub = NULL, xlab = NULL, ylab = NULL, :
## conversion failure on 'Interaction FS•Medication at op80' in 'mbsToSbcs': dot
## substituted for <80>

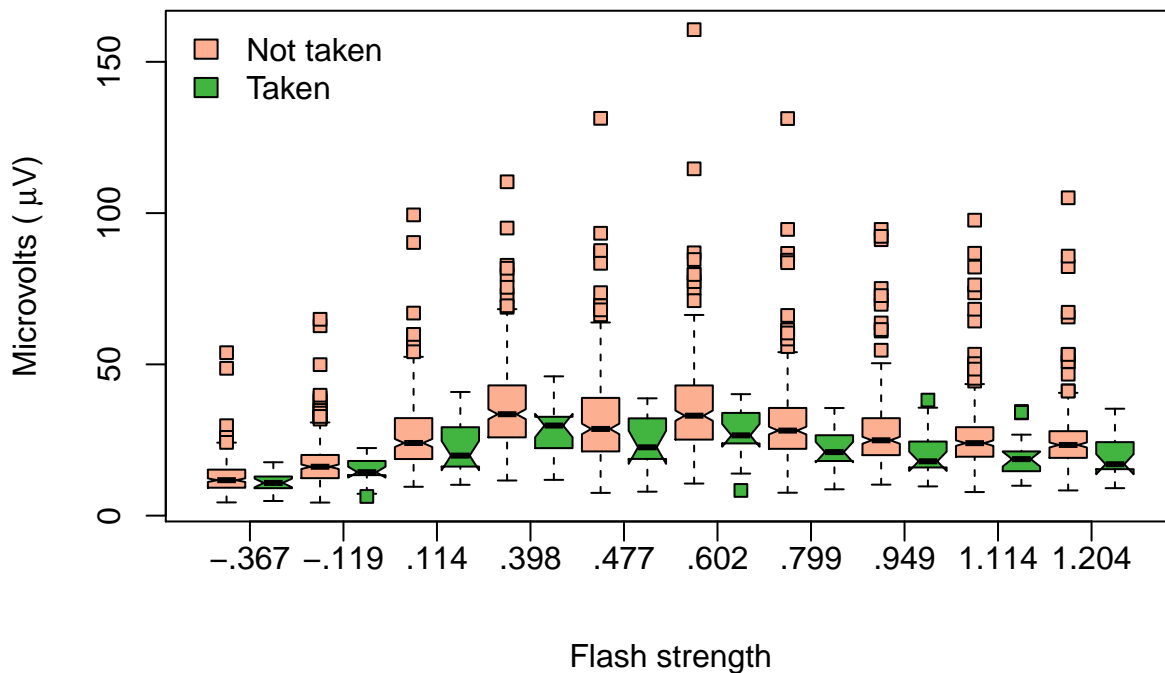
## Warning in (function (main = NULL, sub = NULL, xlab = NULL, ylab = NULL, :
## conversion failure on 'Interaction FS•Medication at op80' in 'mbsToSbcs': dot
## substituted for <a2>

# Changing x axis so that the labels for the flash strenght are shown
# underneath the second group for every flash strenght
xtick<-seq(from=1.5, to= ,
           by=2,length.out = 10)
axis(side=1, at=xtick, labels = FALSE)
text(x=xtick, y=-5, # tick location on the Y axis
     labels = c('-.367', '-.119', '.114', '.398',
                '.477', '.602', '.799', '.949', '1.114', '1.204'),
     # colour for flashes at which pairwise differences existed
     # see code below for the actual statistical analyses
     col=c('black'),
     srt = 0, pos = 1, xpd = TRUE)

# a legend
legend('topleft', border='black', bty='n',
       legend=c('Not taken', 'Taken'),
       fill=picked.colours,
       cex=1)

```

Interaction FS...Medication at op80



op160

```
boxplot(op160 ~ interaction(cns_med,strength),
        main='Interaction FS•Medication at op160',
        notch=T, xlab='Flash strength',
        ylab=expression(paste('Microvolts ( ',mu,'V)'),
        xaxt='n',
        col=picked.colours,lwd=1, pch=22, bg=picked.colours,
        data=data.fixed)

## Warning in bxp(list(stats = structure(c(2.11186394238651, 4.9919186856711, :
## some notches went outside hinges ('box'): maybe set notch=FALSE

## Warning in (function (main = NULL, sub = NULL, xlab = NULL, ylab = NULL, :
## conversion failure on 'Interaction FS•Medication at op160' in 'mbscsToSbcs': dot
## substituted for <e2>

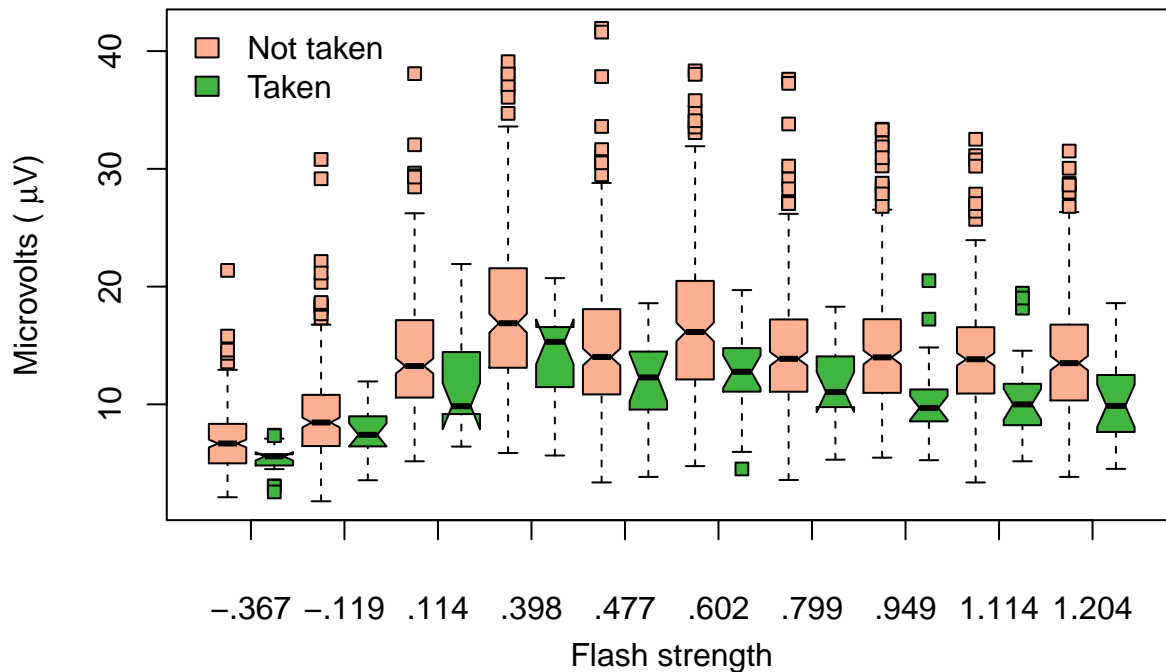
## Warning in (function (main = NULL, sub = NULL, xlab = NULL, ylab = NULL, :
## conversion failure on 'Interaction FS•Medication at op160' in 'mbscsToSbcs': dot
## substituted for <80>

## Warning in (function (main = NULL, sub = NULL, xlab = NULL, ylab = NULL, :
## conversion failure on 'Interaction FS•Medication at op160' in 'mbscsToSbcs': dot
## substituted for <a2>

# Changing x axis so that the labels for the flash strenght are shown
# underneath the second group for every flash strenght
xtick<-seq(from=1.5, to= ,
           by=2,length.out = 10)
axis(side=1, at=xtick, labels = FALSE)
text(x=xtick, y=-5, # tick location on the Y axis
     labels = c('-.367', '-.119', '.114', '.398',
                '.477', '.602', '.799', '.949', '1.114', '1.204'),
     # colour for flashes at which pairwise differences existed
     # see code below for the actual statistical analyses
     col=c('black'),
     srt = 0, pos = 1, xpd = TRUE)

# a legend
legend('topleft', border='black', bty='n',
       legend=c('Not taken','Taken'),
       fill=picked.colours,
       cex=1)
```

Interaction FS...Medication at op160



b20

```
boxplot(b20 ~ interaction(cns_med,strength),
  main='Interaction FS•Medication at b20',
  notch=T, xlab='Flash strength',
  ylab=expression(paste('Microvolts ( ',mu,'V)')),
  xaxt='n',
  col=picked.colours,lwd=1, pch=22, bg=picked.colours,
  data=data.fixed)
```

```
## Warning in bxp(list(stats = structure(c(3.25322556362849, 18.3908581128859, :
## some notches went outside hinges ('box'): maybe set notch=FALSE
```

```
## Warning in (function (main = NULL, sub = NULL, xlab = NULL, ylab = NULL, :
## conversion failure on 'Interaction FS•Medication at b20' in 'mbscsToSbcs': dot
## substituted for <e2>
```

```
## Warning in (function (main = NULL, sub = NULL, xlab = NULL, ylab = NULL, :
## conversion failure on 'Interaction FS•Medication at b20' in 'mbscsToSbcs': dot
## substituted for <80>
```

```
## Warning in (function (main = NULL, sub = NULL, xlab = NULL, ylab = NULL, :
## conversion failure on 'Interaction FS•Medication at b20' in 'mbscsToSbcs': dot
## substituted for <a2>
```

```
# Changing x axis so that the labels for the flash strenght are shown
# underneath the second group for every flash strenght
```

```
xtick<-seq(from=1.5, to= ,
  by=2,length.out = 10)
axis(side=1, at=xtick, labels = FALSE)
```

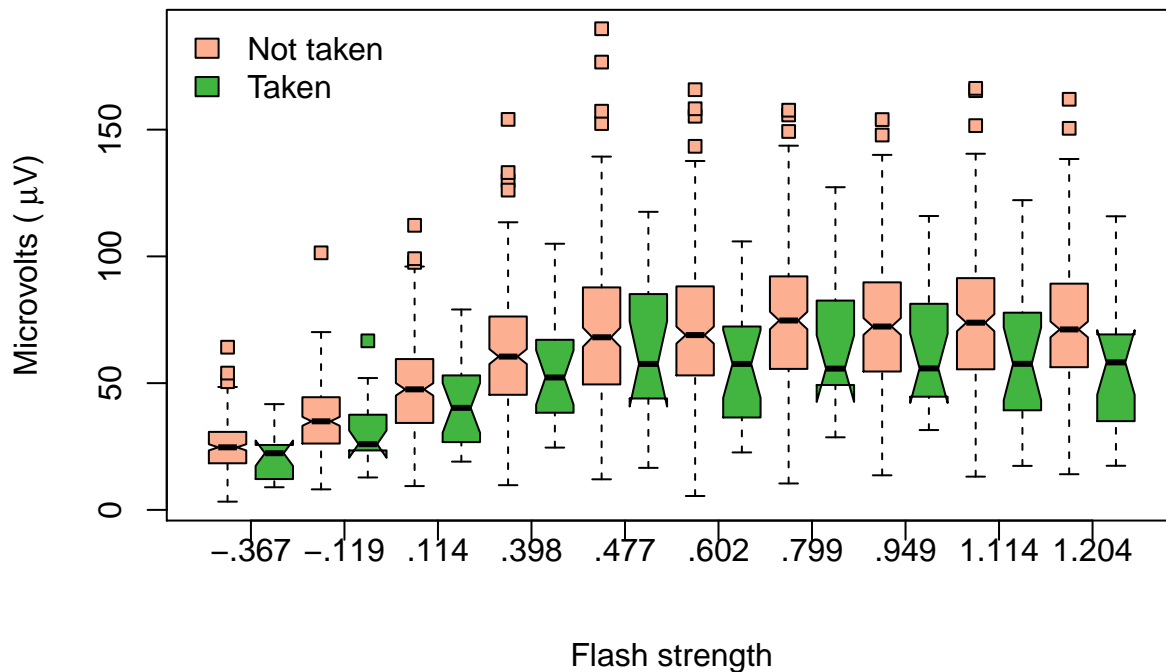
```

text(x=xtick, y=-5, # tick location on the Y axis
     labels = c('-0.367', '-0.119', '.114', '.398',
                '.477', '.602', '.799', '.949', '1.114', '1.204'),
     # colour for flashes at which pairwise differences existed
     # see code below for the actual statistical analyses
     col=c('black'),
     srt = 0, pos = 1, xpd = TRUE)

# a legend
legend('topleft', border='black', bty='n',
       legend=c('Not taken', 'Taken'),
       fill=picked.colours,
       cex=1)

```

Interaction FS...Medication at b20



b40

```

boxplot(b40 ~ interaction(cns_med, strength),
        main='Interaction FS•Medication at b40',
        notch=T, xlab='Flash strength',
        ylab=expression(paste('Microvolts ( ', mu, 'V)')),
        xaxt='n',
        col=picked.colours, lwd=1, pch=22, bg=picked.colours,
        data=data.fixed)

```

```

## Warning in bxp(list(stats = structure(c(8.48774007217848, 18.3981283246125, :
## some notches went outside hinges ('box'): maybe set notch=FALSE

```

```

## Warning in (function (main = NULL, sub = NULL, xlab = NULL, ylab = NULL, :
## conversion failure on 'Interaction FS•Medication at b40' in 'mbcsToSbcs': dot

```

```

## substituted for <e2>

## Warning in (function (main = NULL, sub = NULL, xlab = NULL, ylab = NULL, :
## conversion failure on 'Interaction FS•Medication at b40' in 'mbscsToSbcs': dot
## substituted for <80>

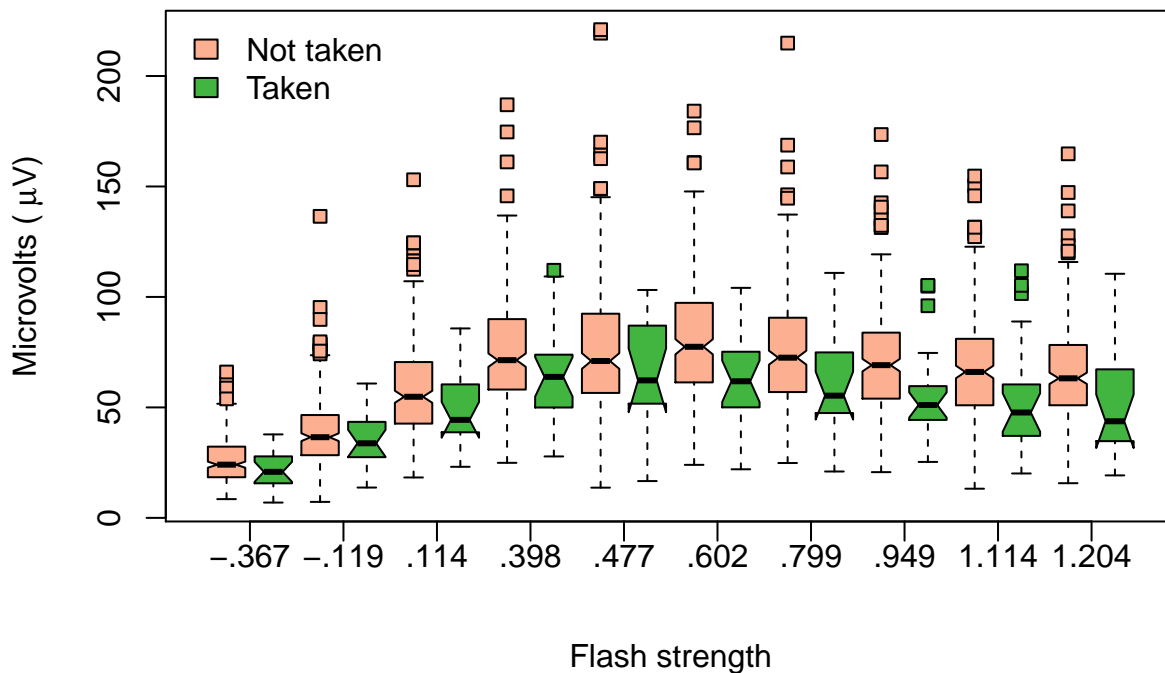
## Warning in (function (main = NULL, sub = NULL, xlab = NULL, ylab = NULL, :
## conversion failure on 'Interaction FS•Medication at b40' in 'mbscsToSbcs': dot
## substituted for <a2>

# Changing x axis so that the labels for the flash strenght are shown
# underneath the second group for every flash strenght
xtick<-seq(from=1.5, to= ,
           by=2,length.out = 10)
axis(side=1, at=xtick, labels = FALSE)
text(x=xtick, y=-5, # tick location on the Y axis
     labels = c('-0.367', '-0.119', '.114', '.398',
                '.477', '.602', '.799', '.949', '1.114', '1.204'),
     # colour for flashes at which pairwise differences existed
     # see code below for the actual statistical analyses
     col=c('black'),
     srt = 0, pos = 1, xpd = TRUE)

# a legend
legend('topleft', border='black', bty='n',
       legend=c('Not taken', 'Taken'),
       fill=picked.colours,
       cex=1)

```

Interaction FS...Medication at b40



Nonparametric multiple comparisons

In the following section we'll perform pairwise comparisons between the two medication groups at each flash strength for each ERG-related measure. We'll use the method proposed by Noguchi et al. (2020) ².

Because we're comparing two independent groups, the `npar.t.test` function is used (with the default parameters; i.e. Logit - Transformation method and with 95% CIs).

a20

```
library(nparcomp)

# creating subsets for each flash strength
flash1 <- subset(data.fixed, strength==0.367)
flash2 <- subset(data.fixed, strength==0.119)
flash3 <- subset(data.fixed, strength==0.114)
flash4 <- subset(data.fixed, strength==0.398)
flash5 <- subset(data.fixed, strength==0.477)
flash6 <- subset(data.fixed, strength==0.602)
flash7 <- subset(data.fixed, strength==0.799)
flash8 <- subset(data.fixed, strength==0.949)
flash9 <- subset(data.fixed, strength==1.114)
flash10 <- subset(data.fixed, strength==1.204)

# the tests...
f1 <- npar.t.test(a20 ~ cns_med , info=F, data=flash1)
f2 <- npar.t.test(a20 ~ cns_med , info=F, data=flash2)
f3 <- npar.t.test(a20 ~ cns_med , info=F, data=flash3)
f4<- npar.t.test(a20 ~ cns_med , info=F, data=flash4)
f5 <- npar.t.test(a20 ~ cns_med , info=F, data=flash5)
f6 <- npar.t.test(a20 ~ cns_med , info=F, data=flash6)
f7 <- npar.t.test(a20 ~ cns_med , info=F, data=flash7)
f8 <- npar.t.test(a20 ~ cns_med , info=F, data=flash8)
f9 <- npar.t.test(a20 ~ cns_med , info=F, data=flash9)
f10 <- npar.t.test(a20 ~ cns_med ,info=F, data=flash10)
```

flash -0.367

```
summary(f1)

##
## #-----Nonparametric Test Procedures and Confidence Intervals for relative effects-----#
##
## - Alternative Hypothesis: True relative effect p is less or equal than 1/2
## - Confidence level: 95 %
## - Method = Logit - Transformation
## #-----Interpretation-----#
## p(a,b) > 1/2 : b tends to be larger than a
```

²Noguchi, K., Abel, R., Marmolejo-Ramos, F., & Konietschke, F. (2020). Nonparametric multiple comparisons. *Behavior Research Methods*, 15 (2), 489-502.

```
## #-----#
##
## #---Data Info-----#
##           Sample Size
## not taken not taken 255
## taken         taken  18
##
## #---Analysis-----#
##           Effect Estimator Lower Upper      T p.Value
## 1 p(not taken,taken)    0.403   0.3 0.514 -1.714   0.087
```

flash -0.119

summary(f2)

```
##
## #-----Nonparametric Test Procedures and Confidence Intervals for relative effects-----#
##
## - Alternative Hypothesis: True relative effect p is less or equal than 1/2
## - Confidence level: 95 %
## - Method = Logit - Transformation
## #-----Interpretation-----#
## p(a,b) > 1/2 : b tends to be larger than a
## #-----#
##
## #---Data Info-----#
##           Sample Size
## not taken not taken 270
## taken         taken  17
##
## #---Analysis-----#
##           Effect Estimator Lower Upper      T p.Value
## 1 p(not taken,taken)    0.342 0.227 0.478 -2.263   0.024
```

flash 0.114

summary(f3)

```
##
## #-----Nonparametric Test Procedures and Confidence Intervals for relative effects-----#
##
## - Alternative Hypothesis: True relative effect p is less or equal than 1/2
## - Confidence level: 95 %
## - Method = Logit - Transformation
## #-----Interpretation-----#
## p(a,b) > 1/2 : b tends to be larger than a
## #-----#
##
## #---Data Info-----#
##           Sample Size
## not taken not taken 263
## taken         taken  18
```

```
##
## #----Analysis-----#
##           Effect Estimator Lower Upper      T p.Value
## 1 p(not taken,taken)      0.354 0.245 0.481 -2.247  0.025
```

flash 0.398

```
summary(f4)
```

```
##
## #-----Nonparametric Test Procedures and Confidence Intervals for relative effects-----#
##
## - Alternative Hypothesis: True relative effect p is less or equal than 1/2
## - Confidence level: 95 %
## - Method = Logit - Transformation
## #-----Interpretation-----#
## p(a,b) > 1/2 : b tends to be larger than a
## #-----#
##
## #----Data Info-----#
##           Sample Size
## not taken not taken  275
## taken         taken   18
##
## #----Analysis-----#
##           Effect Estimator Lower Upper      T p.Value
## 1 p(not taken,taken)      0.346 0.22 0.498 -1.987  0.047
```

flash 0.477

```
summary(f5)
```

```
##
## #-----Nonparametric Test Procedures and Confidence Intervals for relative effects-----#
##
## - Alternative Hypothesis: True relative effect p is less or equal than 1/2
## - Confidence level: 95 %
## - Method = Logit - Transformation
## #-----Interpretation-----#
## p(a,b) > 1/2 : b tends to be larger than a
## #-----#
##
## #----Data Info-----#
##           Sample Size
## not taken not taken  257
## taken         taken   15
##
## #----Analysis-----#
##           Effect Estimator Lower Upper      T p.Value
## 1 p(not taken,taken)      0.452 0.286 0.63 -0.518  0.604
```


flash 0.602

```
summary(f6)
```

```
##
## #-----Nonparametric Test Procedures and Confidence Intervals for relative effects-----#
##
## - Alternative Hypothesis: True relative effect p is less or equal than 1/2
## - Confidence level: 95 %
## - Method = Logit - Transformation
## #-----Interpretation-----#
## p(a,b) > 1/2 : b tends to be larger than a
## #-----#
## #----Data Info-----#
##           Sample Size
## not taken not taken 276
## taken      taken    18
##
## #----Analysis-----#
##           Effect Estimator Lower Upper      T p.Value
## 1 p(not taken,taken)    0.382 0.251 0.532 -1.543 0.123
```

flash 0.799

```
summary(f7)
```

```
##
## #-----Nonparametric Test Procedures and Confidence Intervals for relative effects-----#
##
## - Alternative Hypothesis: True relative effect p is less or equal than 1/2
## - Confidence level: 95 %
## - Method = Logit - Transformation
## #-----Interpretation-----#
## p(a,b) > 1/2 : b tends to be larger than a
## #-----#
## #----Data Info-----#
##           Sample Size
## not taken not taken 282
## taken      taken    16
##
## #----Analysis-----#
##           Effect Estimator Lower Upper      T p.Value
## 1 p(not taken,taken)    0.415 0.285 0.559 -1.157 0.247
```

flash 0.949

```
summary(f8)
```

```
##
## #-----Nonparametric Test Procedures and Confidence Intervals for relative effects-----#
```

```

##
## - Alternative Hypothesis: True relative effect p is less or equal than 1/2
## - Confidence level: 95 %
## - Method = Logit - Transformation
## #-----Interpretation-----#
## p(a,b) > 1/2 : b tends to be larger than a
## #-----#
##
## #----Data Info-----#
##           Sample Size
## not taken not taken 281
## taken      taken    18
##
## #----Analysis-----#
##           Effect Estimator Lower Upper      T p.Value
## 1 p(not taken,taken)    0.329 0.217 0.465 -2.435  0.015

```

flash 1.114

```
summary(f9)
```

```

##
## #-----Nonparametric Test Procedures and Confidence Intervals for relative effects-----#
##
## - Alternative Hypothesis: True relative effect p is less or equal than 1/2
## - Confidence level: 95 %
## - Method = Logit - Transformation
## #-----Interpretation-----#
## p(a,b) > 1/2 : b tends to be larger than a
## #-----#
##
## #----Data Info-----#
##           Sample Size
## not taken not taken 283
## taken      taken    18
##
## #----Analysis-----#
##           Effect Estimator Lower Upper      T p.Value
## 1 p(not taken,taken)    0.363 0.245  0.5 -1.964  0.049

```

flash 1.204

```
summary(f10)
```

```

##
## #-----Nonparametric Test Procedures and Confidence Intervals for relative effects-----#
##
## - Alternative Hypothesis: True relative effect p is less or equal than 1/2
## - Confidence level: 95 %
## - Method = Logit - Transformation
## #-----Interpretation-----#
## p(a,b) > 1/2 : b tends to be larger than a

```

```

## #-----#
##
## #---Data Info-----#
##           Sample Size
## not taken not taken 283
## taken         taken  18
##
## #---Analysis-----#
##           Effect Estimator Lower Upper      T p.Value
## 1 p(not taken,taken)    0.343 0.217 0.495 -2.017  0.044

```

a40

```

# the tests...
f1.a40 <- npar.t.test(a40 ~ cns_med , info=F, data=flash1)
f2.a40 <- npar.t.test(a40 ~ cns_med , info=F, data=flash2)
f3.a40 <- npar.t.test(a40 ~ cns_med , info=F, data=flash3)
f4.a40 <- npar.t.test(a40 ~ cns_med , info=F, data=flash4)
f5.a40 <- npar.t.test(a40 ~ cns_med , info=F, data=flash5)
f6.a40 <- npar.t.test(a40 ~ cns_med , info=F, data=flash6)
f7.a40 <- npar.t.test(a40 ~ cns_med , info=F, data=flash7)
f8.a40 <- npar.t.test(a40 ~ cns_med , info=F, data=flash8)
f9.a40 <- npar.t.test(a40 ~ cns_med , info=F, data=flash9)
f10.a40 <- npar.t.test(a40 ~ cns_med , info=F, data=flash10)

```

flash -0.367

```
summary(f1.a40)
```

```

##
## #-----Nonparametric Test Procedures and Confidence Intervals for relative effects-----#
##
## - Alternative Hypothesis: True relative effect p is less or equal than 1/2
## - Confidence level: 95 %
## - Method = Logit - Transformation
## #-----Interpretation-----#
## p(a,b) > 1/2 : b tends to be larger than a
## #-----#
##
## #---Data Info-----#
##           Sample Size
## not taken not taken 255
## taken         taken  18
##
## #---Analysis-----#
##           Effect Estimator Lower Upper      T p.Value
## 1 p(not taken,taken)    0.379 0.257 0.518 -1.716  0.086

```

flash -0.119

```
summary(f2.a40)
```

```
##
## #-----Nonparametric Test Procedures and Confidence Intervals for relative effects-----#
##
## - Alternative Hypothesis: True relative effect p is less or equal than 1/2
## - Confidence level: 95 %
## - Method = Logit - Transformation
## #-----Interpretation-----#
## p(a,b) > 1/2 : b tends to be larger than a
## #-----#
## #----Data Info-----#
##           Sample Size
## not taken not taken 270
## taken      taken    17
##
## #----Analysis-----#
##           Effect Estimator Lower Upper      T p.Value
## 1 p(not taken,taken)    0.392 0.256 0.547 -1.365 0.172
```

flash 0.114

```
summary(f3.a40)
```

```
##
## #-----Nonparametric Test Procedures and Confidence Intervals for relative effects-----#
##
## - Alternative Hypothesis: True relative effect p is less or equal than 1/2
## - Confidence level: 95 %
## - Method = Logit - Transformation
## #-----Interpretation-----#
## p(a,b) > 1/2 : b tends to be larger than a
## #-----#
## #----Data Info-----#
##           Sample Size
## not taken not taken 263
## taken      taken    18
##
## #----Analysis-----#
##           Effect Estimator Lower Upper      T p.Value
## 1 p(not taken,taken)    0.401 0.257 0.564 -1.195 0.232
```

flash 0.398

```
summary(f4.a40)
```

```
##
## #-----Nonparametric Test Procedures and Confidence Intervals for relative effects-----#
```

```

##
## - Alternative Hypothesis: True relative effect p is less or equal than 1/2
## - Confidence level: 95 %
## - Method = Logit - Transformation
## #-----Interpretation-----#
## p(a,b) > 1/2 : b tends to be larger than a
## #-----#
##
## #----Data Info-----#
##           Sample Size
## not taken not taken 275
## taken         taken  18
##
## #----Analysis-----#
##           Effect Estimator Lower Upper      T p.Value
## 1 p(not taken,taken)    0.317 0.203 0.459 -2.493  0.013

```

flash 0.477

```
summary(f5.a40)
```

```

##
## #-----Nonparametric Test Procedures and Confidence Intervals for relative effects-----#
##
## - Alternative Hypothesis: True relative effect p is less or equal than 1/2
## - Confidence level: 95 %
## - Method = Logit - Transformation
## #-----Interpretation-----#
## p(a,b) > 1/2 : b tends to be larger than a
## #-----#
##
## #----Data Info-----#
##           Sample Size
## not taken not taken 257
## taken         taken  15
##
## #----Analysis-----#
##           Effect Estimator Lower Upper      T p.Value
## 1 p(not taken,taken)    0.405 0.254 0.576 -1.092  0.275

```

flash 0.602

```
summary(f6.a40)
```

```

##
## #-----Nonparametric Test Procedures and Confidence Intervals for relative effects-----#
##
## - Alternative Hypothesis: True relative effect p is less or equal than 1/2
## - Confidence level: 95 %
## - Method = Logit - Transformation
## #-----Interpretation-----#
## p(a,b) > 1/2 : b tends to be larger than a

```

```

## #-----#
##
## #---Data Info-----#
##           Sample Size
## not taken not taken 276
## taken         taken  18
##
## #---Analysis-----#
##           Effect Estimator Lower Upper      T p.Value
## 1 p(not taken,taken)    0.343 0.229 0.479 -2.257  0.024

```

flash 0.799

```
summary(f7.a40)
```

```

##
## #-----Nonparametric Test Procedures and Confidence Intervals for relative effects-----#
##
## - Alternative Hypothesis: True relative effect p is less or equal than 1/2
## - Confidence level: 95 %
## - Method = Logit - Transformation
## #-----Interpretation-----#
## p(a,b) > 1/2 : b tends to be larger than a
## #-----#
##
## #---Data Info-----#
##           Sample Size
## not taken not taken 282
## taken         taken  16
##
## #---Analysis-----#
##           Effect Estimator Lower Upper      T p.Value
## 1 p(not taken,taken)    0.395 0.273 0.531 -1.517  0.129

```

flash 0.949

```
summary(f8.a40)
```

```

##
## #-----Nonparametric Test Procedures and Confidence Intervals for relative effects-----#
##
## - Alternative Hypothesis: True relative effect p is less or equal than 1/2
## - Confidence level: 95 %
## - Method = Logit - Transformation
## #-----Interpretation-----#
## p(a,b) > 1/2 : b tends to be larger than a
## #-----#
##
## #---Data Info-----#
##           Sample Size
## not taken not taken 281
## taken         taken  18

```

```
##
## #----Analysis-----#
##           Effect Estimator Lower Upper      T p.Value
## 1 p(not taken,taken)      0.314 0.204  0.45 -2.645   0.008
```

flash 1.114

```
summary(f9.a40)
```

```
##
## #-----Nonparametric Test Procedures and Confidence Intervals for relative effects-----#
##
## - Alternative Hypothesis: True relative effect p is less or equal than 1/2
## - Confidence level: 95 %
## - Method = Logit - Transformation
## #-----Interpretation-----#
## p(a,b) > 1/2 : b tends to be larger than a
## #-----#
##
## #----Data Info-----#
##           Sample Size
## not taken not taken  283
## taken         taken   18
##
## #----Analysis-----#
##           Effect Estimator Lower Upper      T p.Value
## 1 p(not taken,taken)      0.389 0.248 0.552 -1.337   0.181
```

flash 1.204

```
summary(f10.a40)
```

```
##
## #-----Nonparametric Test Procedures and Confidence Intervals for relative effects-----#
##
## - Alternative Hypothesis: True relative effect p is less or equal than 1/2
## - Confidence level: 95 %
## - Method = Logit - Transformation
## #-----Interpretation-----#
## p(a,b) > 1/2 : b tends to be larger than a
## #-----#
##
## #----Data Info-----#
##           Sample Size
## not taken not taken  283
## taken         taken   18
##
## #----Analysis-----#
##           Effect Estimator Lower Upper      T p.Value
## 1 p(not taken,taken)      0.336 0.216 0.482 -2.195   0.028
```

op80

```
# the tests...
f1.op80 <- npar.t.test(op80 ~ cns_med , info=F, data=flash1)
f2.op80 <- npar.t.test(op80 ~ cns_med , info=F, data=flash2)
f3.op80 <- npar.t.test(op80 ~ cns_med , info=F, data=flash3)
f4.op80 <- npar.t.test(op80 ~ cns_med , info=F, data=flash4)
f5.op80 <- npar.t.test(op80 ~ cns_med , info=F, data=flash5)
f6.op80 <- npar.t.test(op80 ~ cns_med , info=F, data=flash6)
f7.op80 <- npar.t.test(op80 ~ cns_med , info=F, data=flash7)
f8.op80 <- npar.t.test(op80 ~ cns_med , info=F, data=flash8)
f9.op80 <- npar.t.test(op80 ~ cns_med , info=F, data=flash9)
f10.op80 <- npar.t.test(op80 ~ cns_med , info=F, data=flash10)
```

flash -0.367

```
summary(f1.op80)
```

```
##
## #-----Nonparametric Test Procedures and Confidence Intervals for relative effects-----#
##
## - Alternative Hypothesis: True relative effect p is less or equal than 1/2
## - Confidence level: 95 %
## - Method = Logit - Transformation
## #-----Interpretation-----#
## p(a,b) > 1/2 : b tends to be larger than a
## #-----#
## #---Data Info-----#
##          Sample Size
## not taken not taken 255
## taken      taken    18
##
## #---Analysis-----#
##          Effect Estimator Lower Upper      T p.Value
## 1 p(not taken,taken)      0.404 0.284 0.536 -1.432 0.152
```

flash -0.119

```
summary(f2.op80)
```

```
##
## #-----Nonparametric Test Procedures and Confidence Intervals for relative effects-----#
##
## - Alternative Hypothesis: True relative effect p is less or equal than 1/2
## - Confidence level: 95 %
## - Method = Logit - Transformation
## #-----Interpretation-----#
## p(a,b) > 1/2 : b tends to be larger than a
## #-----#
##
```



```
## #----Data Info-----#
##           Sample Size
## not taken not taken 270
## taken      taken    17
##
## #----Analysis-----#
##           Effect Estimator Lower Upper      T p.Value
## 1 p(not taken,taken)    0.445 0.328 0.568 -0.874  0.382
```

flash 0.114

```
summary(f3.op80)
```

```
##
## #-----Nonparametric Test Procedures and Confidence Intervals for relative effects-----#
##
## - Alternative Hypothesis: True relative effect p is less or equal than 1/2
## - Confidence level: 95 %
## - Method = Logit - Transformation
## #-----Interpretation-----#
## p(a,b) > 1/2 : b tends to be larger than a
## #-----#
##
## #----Data Info-----#
##           Sample Size
## not taken not taken 263
## taken      taken    18
##
## #----Analysis-----#
##           Effect Estimator Lower Upper      T p.Value
## 1 p(not taken,taken)    0.381 0.258 0.522 -1.66  0.097
```

flash 0.398

```
summary(f4.op80)
```

```
##
## #-----Nonparametric Test Procedures and Confidence Intervals for relative effects-----#
##
## - Alternative Hypothesis: True relative effect p is less or equal than 1/2
## - Confidence level: 95 %
## - Method = Logit - Transformation
## #-----Interpretation-----#
## p(a,b) > 1/2 : b tends to be larger than a
## #-----#
##
## #----Data Info-----#
##           Sample Size
## not taken not taken 275
## taken      taken    18
##
## #----Analysis-----#
```

```
##           Effect Estimator Lower Upper      T p.Value
## 1 p(not taken,taken)      0.371 0.262 0.494 -2.059    0.04
```

flash 0.477

```
summary(f5.op80)
```

```
##
## #-----Nonparametric Test Procedures and Confidence Intervals for relative effects-----#
##
## - Alternative Hypothesis: True relative effect p is less or equal than 1/2
## - Confidence level: 95 %
## - Method = Logit - Transformation
## #-----Interpretation-----#
## p(a,b) > 1/2 : b tends to be larger than a
## #-----#
##
## #----Data Info-----#
##           Sample Size
## not taken not taken 257
## taken         taken  15
##
## #----Analysis-----#
##           Effect Estimator Lower Upper      T p.Value
## 1 p(not taken,taken)      0.38 0.259 0.518 -1.704    0.088
```

flash 0.602

```
summary(f6.op80)
```

```
##
## #-----Nonparametric Test Procedures and Confidence Intervals for relative effects-----#
##
## - Alternative Hypothesis: True relative effect p is less or equal than 1/2
## - Confidence level: 95 %
## - Method = Logit - Transformation
## #-----Interpretation-----#
## p(a,b) > 1/2 : b tends to be larger than a
## #-----#
##
## #----Data Info-----#
##           Sample Size
## not taken not taken 276
## taken         taken  18
##
## #----Analysis-----#
##           Effect Estimator Lower Upper      T p.Value
## 1 p(not taken,taken)      0.335 0.237 0.449 -2.797    0.005
```

flash 0.799

```
summary(f7.op80)
```

```
##
## #-----Nonparametric Test Procedures and Confidence Intervals for relative effects-----#
##
## - Alternative Hypothesis: True relative effect p is less or equal than 1/2
## - Confidence level: 95 %
## - Method = Logit - Transformation
## #-----Interpretation-----#
## p(a,b) > 1/2 : b tends to be larger than a
## #-----#
## #----Data Info-----#
##           Sample Size
## not taken not taken 282
## taken      taken    16
##
## #----Analysis-----#
##           Effect Estimator Lower Upper      T p.Value
## 1 p(not taken,taken)    0.291 0.18 0.433 -2.815 0.005
```

flash 0.949

```
summary(f8.op80)
```

```
##
## #-----Nonparametric Test Procedures and Confidence Intervals for relative effects-----#
##
## - Alternative Hypothesis: True relative effect p is less or equal than 1/2
## - Confidence level: 95 %
## - Method = Logit - Transformation
## #-----Interpretation-----#
## p(a,b) > 1/2 : b tends to be larger than a
## #-----#
## #----Data Info-----#
##           Sample Size
## not taken not taken 281
## taken      taken    18
##
## #----Analysis-----#
##           Effect Estimator Lower Upper      T p.Value
## 1 p(not taken,taken)    0.293 0.179 0.441 -2.681 0.007
```

flash 1.114

```
summary(f9.op80)
```

```
##
## #-----Nonparametric Test Procedures and Confidence Intervals for relative effects-----#
```

```

##
## - Alternative Hypothesis: True relative effect p is less or equal than 1/2
## - Confidence level: 95 %
## - Method = Logit - Transformation
## #-----Interpretation-----#
## p(a,b) > 1/2 : b tends to be larger than a
## #-----#
##
## #----Data Info-----#
##           Sample Size
## not taken not taken 283
## taken         taken  18
##
## #----Analysis-----#
##           Effect Estimator Lower Upper      T p.Value
## 1 p(not taken,taken)      0.305 0.181 0.466 -2.35  0.019

```

flash 1.204

```
summary(f10.op80)
```

```

##
## #-----Nonparametric Test Procedures and Confidence Intervals for relative effects-----#
##
## - Alternative Hypothesis: True relative effect p is less or equal than 1/2
## - Confidence level: 95 %
## - Method = Logit - Transformation
## #-----Interpretation-----#
## p(a,b) > 1/2 : b tends to be larger than a
## #-----#
##
## #----Data Info-----#
##           Sample Size
## not taken not taken 283
## taken         taken  18
##
## #----Analysis-----#
##           Effect Estimator Lower Upper      T p.Value
## 1 p(not taken,taken)      0.3 0.176 0.462 -2.392  0.017

```

op160

```

# the tests...
f1.op160 <- npar.t.test(op160 ~ cns_med , info=F, data=flash1)
f2.op160 <- npar.t.test(op160 ~ cns_med , info=F, data=flash2)
f3.op160 <- npar.t.test(op160 ~ cns_med , info=F, data=flash3)
f4.op160 <- npar.t.test(op160 ~ cns_med , info=F, data=flash4)
f5.op160 <- npar.t.test(op160 ~ cns_med , info=F, data=flash5)
f6.op160 <- npar.t.test(op160 ~ cns_med , info=F, data=flash6)
f7.op160 <- npar.t.test(op160 ~ cns_med , info=F, data=flash7)
f8.op160 <- npar.t.test(op160 ~ cns_med , info=F, data=flash8)

```

```
f9.op160 <- npar.t.test(op160 ~ cns_med , info=F, data=flash9)
f10.op160 <- npar.t.test(op160 ~ cns_med ,info=F, data=flash10)
```

flash -0.367

```
summary(f1.op160)
```

```
##
## #-----Nonparametric Test Procedures and Confidence Intervals for relative effects-----#
##
## - Alternative Hypothesis: True relative effect p is less or equal than 1/2
## - Confidence level: 95 %
## - Method = Logit - Transformation
## #-----Interpretation-----#
## p(a,b) > 1/2 : b tends to be larger than a
## #-----#
## #----Data Info-----#
##           Sample Size
## not taken not taken 255
## taken         taken  18
##
## #----Analysis-----#
##           Effect Estimator Lower Upper      T p.Value
## 1 p(not taken,taken)    0.296 0.213 0.396 -3.819      0
```

flash -0.119

```
summary(f2.op160)
```

```
##
## #-----Nonparametric Test Procedures and Confidence Intervals for relative effects-----#
##
## - Alternative Hypothesis: True relative effect p is less or equal than 1/2
## - Confidence level: 95 %
## - Method = Logit - Transformation
## #-----Interpretation-----#
## p(a,b) > 1/2 : b tends to be larger than a
## #-----#
## #----Data Info-----#
##           Sample Size
## not taken not taken 270
## taken         taken  17
##
## #----Analysis-----#
##           Effect Estimator Lower Upper      T p.Value
## 1 p(not taken,taken)    0.408 0.289 0.538 -1.39    0.165
```

flash 0.114

```
summary(f3.op160)
```

```
##
## #-----Nonparametric Test Procedures and Confidence Intervals for relative effects-----#
##
## - Alternative Hypothesis: True relative effect p is less or equal than 1/2
## - Confidence level: 95 %
## - Method = Logit - Transformation
## #-----Interpretation-----#
## p(a,b) > 1/2 : b tends to be larger than a
## #-----#
## #----Data Info-----#
##           Sample Size
## not taken not taken 263
## taken      taken    18
##
## #----Analysis-----#
##           Effect Estimator Lower Upper      T p.Value
## 1 p(not taken,taken)    0.369 0.246 0.511 -1.806  0.071
```

flash 0.398

```
summary(f4.op160)
```

```
##
## #-----Nonparametric Test Procedures and Confidence Intervals for relative effects-----#
##
## - Alternative Hypothesis: True relative effect p is less or equal than 1/2
## - Confidence level: 95 %
## - Method = Logit - Transformation
## #-----Interpretation-----#
## p(a,b) > 1/2 : b tends to be larger than a
## #-----#
## #----Data Info-----#
##           Sample Size
## not taken not taken 275
## taken      taken    18
##
## #----Analysis-----#
##           Effect Estimator Lower Upper      T p.Value
## 1 p(not taken,taken)    0.344 0.247 0.456 -2.687  0.007
```

flash 0.477

```
summary(f5.op160)
```

```
##
## #-----Nonparametric Test Procedures and Confidence Intervals for relative effects-----#
```

```

##
## - Alternative Hypothesis: True relative effect p is less or equal than 1/2
## - Confidence level: 95 %
## - Method = Logit - Transformation
## #-----Interpretation-----#
## p(a,b) > 1/2 : b tends to be larger than a
## #-----#
##
## #----Data Info-----#
##           Sample Size
## not taken not taken 257
## taken      taken    15
##
## #----Analysis-----#
##           Effect Estimator Lower Upper      T p.Value
## 1 p(not taken,taken)    0.374 0.251 0.515 -1.751    0.08

```

flash 0.602

```
summary(f6.op160)
```

```

##
## #-----Nonparametric Test Procedures and Confidence Intervals for relative effects-----#
##
## - Alternative Hypothesis: True relative effect p is less or equal than 1/2
## - Confidence level: 95 %
## - Method = Logit - Transformation
## #-----Interpretation-----#
## p(a,b) > 1/2 : b tends to be larger than a
## #-----#
##
## #----Data Info-----#
##           Sample Size
## not taken not taken 276
## taken      taken    18
##
## #----Analysis-----#
##           Effect Estimator Lower Upper      T p.Value
## 1 p(not taken,taken)    0.319 0.226 0.428 -3.182    0.001

```

flash 0.799

```
summary(f7.op160)
```

```

##
## #-----Nonparametric Test Procedures and Confidence Intervals for relative effects-----#
##
## - Alternative Hypothesis: True relative effect p is less or equal than 1/2
## - Confidence level: 95 %
## - Method = Logit - Transformation
## #-----Interpretation-----#
## p(a,b) > 1/2 : b tends to be larger than a

```

```
## #-----#
##
## #---Data Info-----#
##           Sample Size
## not taken not taken  282
## taken           taken   16
##
## #---Analysis-----#
##           Effect Estimator Lower Upper      T p.Value
## 1 p(not taken,taken)    0.325 0.208  0.47 -2.346  0.019
```

flash 0.949

```
summary(f8.op160)
```

```
##
## #-----Nonparametric Test Procedures and Confidence Intervals for relative effects-----#
##
## - Alternative Hypothesis: True relative effect p is less or equal than 1/2
## - Confidence level: 95 %
## - Method = Logit - Transformation
## #-----Interpretation-----#
## p(a,b) > 1/2 : b tends to be larger than a
## #-----#
##
## #---Data Info-----#
##           Sample Size
## not taken not taken  281
## taken           taken   18
##
## #---Analysis-----#
##           Effect Estimator Lower Upper      T p.Value
## 1 p(not taken,taken)    0.255 0.155 0.389 -3.39  0.001
```

flash 1.114

```
summary(f9.op160)
```

```
##
## #-----Nonparametric Test Procedures and Confidence Intervals for relative effects-----#
##
## - Alternative Hypothesis: True relative effect p is less or equal than 1/2
## - Confidence level: 95 %
## - Method = Logit - Transformation
## #-----Interpretation-----#
## p(a,b) > 1/2 : b tends to be larger than a
## #-----#
##
## #---Data Info-----#
##           Sample Size
## not taken not taken  283
## taken           taken   18
```



```
##
## #----Analysis-----#
##           Effect Estimator Lower Upper      T p.Value
## 1 p(not taken,taken)      0.289  0.17 0.446 -2.575    0.01
```

flash 1.204

```
summary(f10.op160)
```

```
##
## #-----Nonparametric Test Procedures and Confidence Intervals for relative effects-----#
##
## - Alternative Hypothesis: True relative effect p is less or equal than 1/2
## - Confidence level: 95 %
## - Method = Logit - Transformation
## #-----Interpretation-----#
## p(a,b) > 1/2 : b tends to be larger than a
## #-----#
##
## #----Data Info-----#
##           Sample Size
## not taken not taken  283
## taken         taken   18
##
## #----Analysis-----#
##           Effect Estimator Lower Upper      T p.Value
## 1 p(not taken,taken)      0.276  0.173 0.409 -3.162    0.002
```

b20

```
# the tests...
f1.b20 <- npar.t.test(b20 ~ cns_med , info=F, data=flash1)
f2.b20 <- npar.t.test(b20 ~ cns_med , info=F, data=flash2)
f3.b20 <- npar.t.test(b20 ~ cns_med , info=F, data=flash3)
f4.b20 <- npar.t.test(b20 ~ cns_med , info=F, data=flash4)
f5.b20 <- npar.t.test(b20 ~ cns_med , info=F, data=flash5)
f6.b20 <- npar.t.test(b20 ~ cns_med , info=F, data=flash6)
f7.b20 <- npar.t.test(b20 ~ cns_med , info=F, data=flash7)
f8.b20 <- npar.t.test(b20 ~ cns_med , info=F, data=flash8)
f9.b20 <- npar.t.test(b20 ~ cns_med , info=F, data=flash9)
f10.b20 <- npar.t.test(b20 ~ cns_med ,info=F, data=flash10)
```

flash -0.367

```
summary(f1.b20)
```

```
##
## #-----Nonparametric Test Procedures and Confidence Intervals for relative effects-----#
##
## - Alternative Hypothesis: True relative effect p is less or equal than 1/2
```

```

## - Confidence level: 95 %
## - Method = Logit - Transformation
## #-----Interpretation-----#
## p(a,b) > 1/2 : b tends to be larger than a
## #-----#
##
## #----Data Info-----#
##           Sample Size
## not taken not taken 255
## taken      taken    18
##
## #----Analysis-----#
##           Effect Estimator Lower Upper      T p.Value
## 1 p(not taken,taken)    0.382 0.25 0.534 -1.524 0.127

```

flash -0.119

```
summary(f2.b20)
```

```

##
## #-----Nonparametric Test Procedures and Confidence Intervals for relative effects-----#
##
## - Alternative Hypothesis: True relative effect p is less or equal than 1/2
## - Confidence level: 95 %
## - Method = Logit - Transformation
## #-----Interpretation-----#
## p(a,b) > 1/2 : b tends to be larger than a
## #-----#
##
## #----Data Info-----#
##           Sample Size
## not taken not taken 270
## taken      taken    17
##
## #----Analysis-----#
##           Effect Estimator Lower Upper      T p.Value
## 1 p(not taken,taken)    0.379 0.253 0.524 -1.64 0.101

```

flash 0.114

```
summary(f3.b20)
```

```

##
## #-----Nonparametric Test Procedures and Confidence Intervals for relative effects-----#
##
## - Alternative Hypothesis: True relative effect p is less or equal than 1/2
## - Confidence level: 95 %
## - Method = Logit - Transformation
## #-----Interpretation-----#
## p(a,b) > 1/2 : b tends to be larger than a
## #-----#
##

```

```
## #----Data Info-----#
##           Sample Size
## not taken not taken 263
## taken      taken    18
##
## #----Analysis-----#
##           Effect Estimator Lower Upper      T p.Value
## 1 p(not taken,taken)      0.41 0.276 0.559 -1.19  0.234
```

flash 0.398

```
summary(f4.b20)
```

```
##
## #-----Nonparametric Test Procedures and Confidence Intervals for relative effects-----#
##
## - Alternative Hypothesis: True relative effect p is less or equal than 1/2
## - Confidence level: 95 %
## - Method = Logit - Transformation
## #-----Interpretation-----#
## p(a,b) > 1/2 : b tends to be larger than a
## #-----#
##
## #----Data Info-----#
##           Sample Size
## not taken not taken 275
## taken      taken    18
##
## #----Analysis-----#
##           Effect Estimator Lower Upper      T p.Value
## 1 p(not taken,taken)      0.415 0.278 0.567 -1.102  0.27
```

flash 0.477

```
summary(f5.b20)
```

```
##
## #-----Nonparametric Test Procedures and Confidence Intervals for relative effects-----#
##
## - Alternative Hypothesis: True relative effect p is less or equal than 1/2
## - Confidence level: 95 %
## - Method = Logit - Transformation
## #-----Interpretation-----#
## p(a,b) > 1/2 : b tends to be larger than a
## #-----#
##
## #----Data Info-----#
##           Sample Size
## not taken not taken 257
## taken      taken    15
##
## #----Analysis-----#
```

```
##           Effect Estimator Lower Upper      T p.Value
## 1 p(not taken,taken)      0.429 0.271 0.603 -0.794  0.427
```

flash 0.602

```
summary(f6.b20)
```

```
##
## #-----Nonparametric Test Procedures and Confidence Intervals for relative effects-----#
##
## - Alternative Hypothesis: True relative effect p is less or equal than 1/2
## - Confidence level: 95 %
## - Method = Logit - Transformation
## #-----Interpretation-----#
## p(a,b) > 1/2 : b tends to be larger than a
## #-----#
##
## #----Data Info-----#
##           Sample Size
## not taken not taken  276
## taken      taken     18
##
## #----Analysis-----#
##           Effect Estimator Lower Upper      T p.Value
## 1 p(not taken,taken)      0.382 0.245 0.541 -1.466  0.143
```

flash 0.799

```
summary(f7.b20)
```

```
##
## #-----Nonparametric Test Procedures and Confidence Intervals for relative effects-----#
##
## - Alternative Hypothesis: True relative effect p is less or equal than 1/2
## - Confidence level: 95 %
## - Method = Logit - Transformation
## #-----Interpretation-----#
## p(a,b) > 1/2 : b tends to be larger than a
## #-----#
##
## #----Data Info-----#
##           Sample Size
## not taken not taken  282
## taken      taken     16
##
## #----Analysis-----#
##           Effect Estimator Lower Upper      T p.Value
## 1 p(not taken,taken)      0.379 0.248 0.531 -1.568  0.117
```

flash 0.949

```
summary(f8.b20)
```

```
##
## #-----Nonparametric Test Procedures and Confidence Intervals for relative effects-----#
##
## - Alternative Hypothesis: True relative effect p is less or equal than 1/2
## - Confidence level: 95 %
## - Method = Logit - Transformation
## #-----Interpretation-----#
## p(a,b) > 1/2 : b tends to be larger than a
## #-----#
## #----Data Info-----#
##           Sample Size
## not taken not taken 281
## taken      taken    18
##
## #----Analysis-----#
##           Effect Estimator Lower Upper      T p.Value
## 1 p(not taken,taken)    0.374 0.239 0.533 -1.563  0.118
```

flash 1.114

```
summary(f9.b20)
```

```
##
## #-----Nonparametric Test Procedures and Confidence Intervals for relative effects-----#
##
## - Alternative Hypothesis: True relative effect p is less or equal than 1/2
## - Confidence level: 95 %
## - Method = Logit - Transformation
## #-----Interpretation-----#
## p(a,b) > 1/2 : b tends to be larger than a
## #-----#
## #----Data Info-----#
##           Sample Size
## not taken not taken 283
## taken      taken    18
##
## #----Analysis-----#
##           Effect Estimator Lower Upper      T p.Value
## 1 p(not taken,taken)    0.37 0.228 0.54 -1.506  0.132
```

flash 1.204

```
summary(f10.b20)
```

```
##
## #-----Nonparametric Test Procedures and Confidence Intervals for relative effects-----#
```

```

##
## - Alternative Hypothesis: True relative effect p is less or equal than 1/2
## - Confidence level: 95 %
## - Method = Logit - Transformation
## #-----Interpretation-----#
## p(a,b) > 1/2 : b tends to be larger than a
## #-----#
##
## #----Data Info-----#
##           Sample Size
## not taken not taken 283
## taken           taken  18
##
## #----Analysis-----#
##           Effect Estimator Lower Upper      T p.Value
## 1 p(not taken,taken)      0.357 0.224 0.518 -1.75   0.08

```

b40

```

# the tests...
f1.b40 <- npar.t.test(b40 ~ cns_med , info=F, data=flash1)
f2.b40 <- npar.t.test(b40 ~ cns_med , info=F, data=flash2)
f3.b40 <- npar.t.test(b40 ~ cns_med , info=F, data=flash3)
f4.b40 <- npar.t.test(b40 ~ cns_med , info=F, data=flash4)
f5.b40 <- npar.t.test(b40 ~ cns_med , info=F, data=flash5)
f6.b40 <- npar.t.test(b40 ~ cns_med , info=F, data=flash6)
f7.b40 <- npar.t.test(b40 ~ cns_med , info=F, data=flash7)
f8.b40 <- npar.t.test(b40 ~ cns_med , info=F, data=flash8)
f9.b40 <- npar.t.test(b40 ~ cns_med , info=F, data=flash9)
f10.b40 <- npar.t.test(b40 ~ cns_med , info=F, data=flash10)

```

flash -0.367

```
summary(f1.b40)
```

```

##
## #-----Nonparametric Test Procedures and Confidence Intervals for relative effects-----#
##
## - Alternative Hypothesis: True relative effect p is less or equal than 1/2
## - Confidence level: 95 %
## - Method = Logit - Transformation
## #-----Interpretation-----#
## p(a,b) > 1/2 : b tends to be larger than a
## #-----#
##
## #----Data Info-----#
##           Sample Size
## not taken not taken 255
## taken           taken  18
##
## #----Analysis-----#

```

```
##           Effect Estimator Lower Upper      T p.Value
## 1 p(not taken,taken)      0.395 0.272 0.532 -1.514    0.13
```

flash -0.119

```
summary(f2.b40)
```

```
##
## #-----Nonparametric Test Procedures and Confidence Intervals for relative effects-----#
##
## - Alternative Hypothesis: True relative effect p is less or equal than 1/2
## - Confidence level: 95 %
## - Method = Logit - Transformation
## #-----Interpretation-----#
## p(a,b) > 1/2 : b tends to be larger than a
## #-----#
##
## #----Data Info-----#
##           Sample Size
## not taken not taken  270
## taken         taken   17
##
## #----Analysis-----#
##           Effect Estimator Lower Upper      T p.Value
## 1 p(not taken,taken)      0.445 0.311 0.587 -0.758    0.448
```

flash 0.114

```
summary(f3.b40)
```

```
##
## #-----Nonparametric Test Procedures and Confidence Intervals for relative effects-----#
##
## - Alternative Hypothesis: True relative effect p is less or equal than 1/2
## - Confidence level: 95 %
## - Method = Logit - Transformation
## #-----Interpretation-----#
## p(a,b) > 1/2 : b tends to be larger than a
## #-----#
##
## #----Data Info-----#
##           Sample Size
## not taken not taken  263
## taken         taken   18
##
## #----Analysis-----#
##           Effect Estimator Lower Upper      T p.Value
## 1 p(not taken,taken)      0.388 0.264 0.527 -1.579    0.114
```

flash 0.398

```
summary(f4.b40)
```

```
##
## #-----Nonparametric Test Procedures and Confidence Intervals for relative effects-----#
##
## - Alternative Hypothesis: True relative effect p is less or equal than 1/2
## - Confidence level: 95 %
## - Method = Logit - Transformation
## #-----Interpretation-----#
## p(a,b) > 1/2 : b tends to be larger than a
## #-----#
## #----Data Info-----#
##           Sample Size
## not taken not taken 275
## taken      taken    18
##
## #----Analysis-----#
##           Effect Estimator Lower Upper      T p.Value
## 1 p(not taken,taken)    0.398 0.27 0.542 -1.396 0.163
```

flash 0.477

```
summary(f5.b40)
```

```
##
## #-----Nonparametric Test Procedures and Confidence Intervals for relative effects-----#
##
## - Alternative Hypothesis: True relative effect p is less or equal than 1/2
## - Confidence level: 95 %
## - Method = Logit - Transformation
## #-----Interpretation-----#
## p(a,b) > 1/2 : b tends to be larger than a
## #-----#
## #----Data Info-----#
##           Sample Size
## not taken not taken 257
## taken      taken    15
##
## #----Analysis-----#
##           Effect Estimator Lower Upper      T p.Value
## 1 p(not taken,taken)    0.405 0.267 0.56 -1.201 0.23
```

flash 0.602

```
summary(f6.b40)
```

```
##
## #-----Nonparametric Test Procedures and Confidence Intervals for relative effects-----#
```



```

##
## - Alternative Hypothesis: True relative effect p is less or equal than 1/2
## - Confidence level: 95 %
## - Method = Logit - Transformation
## #-----Interpretation-----#
## p(a,b) > 1/2 : b tends to be larger than a
## #-----#
##
## #----Data Info-----#
##           Sample Size
## not taken not taken 276
## taken      taken    18
##
## #----Analysis-----#
##           Effect Estimator Lower Upper      T p.Value
## 1 p(not taken,taken)    0.355 0.239 0.492 -2.071  0.038

```

flash 0.799

```
summary(f7.b40)
```

```

##
## #-----Nonparametric Test Procedures and Confidence Intervals for relative effects-----#
##
## - Alternative Hypothesis: True relative effect p is less or equal than 1/2
## - Confidence level: 95 %
## - Method = Logit - Transformation
## #-----Interpretation-----#
## p(a,b) > 1/2 : b tends to be larger than a
## #-----#
##
## #----Data Info-----#
##           Sample Size
## not taken not taken 282
## taken      taken    16
##
## #----Analysis-----#
##           Effect Estimator Lower Upper      T p.Value
## 1 p(not taken,taken)    0.34 0.217 0.488 -2.111  0.035

```

flash 0.949

```
summary(f8.b40)
```

```

##
## #-----Nonparametric Test Procedures and Confidence Intervals for relative effects-----#
##
## - Alternative Hypothesis: True relative effect p is less or equal than 1/2
## - Confidence level: 95 %
## - Method = Logit - Transformation
## #-----Interpretation-----#
## p(a,b) > 1/2 : b tends to be larger than a

```

```

## #-----#
##
## #---Data Info-----#
##           Sample Size
## not taken not taken  281
## taken           taken   18
##
## #---Analysis-----#
##           Effect Estimator Lower Upper      T p.Value
## 1 p(not taken,taken)    0.331 0.209 0.481 -2.191  0.028

```

flash 1.114

```
summary(f9.b40)
```

```

##
## #-----Nonparametric Test Procedures and Confidence Intervals for relative effects-----#
##
## - Alternative Hypothesis: True relative effect p is less or equal than 1/2
## - Confidence level: 95 %
## - Method = Logit - Transformation
## #-----Interpretation-----#
## p(a,b) > 1/2 : b tends to be larger than a
## #-----#
##
## #---Data Info-----#
##           Sample Size
## not taken not taken  283
## taken           taken   18
##
## #---Analysis-----#
##           Effect Estimator Lower Upper      T p.Value
## 1 p(not taken,taken)    0.327 0.19 0.502 -1.943  0.052

```

flash 1.204

```
summary(f10.b40)
```

```

##
## #-----Nonparametric Test Procedures and Confidence Intervals for relative effects-----#
##
## - Alternative Hypothesis: True relative effect p is less or equal than 1/2
## - Confidence level: 95 %
## - Method = Logit - Transformation
## #-----Interpretation-----#
## p(a,b) > 1/2 : b tends to be larger than a
## #-----#
##
## #---Data Info-----#
##           Sample Size
## not taken not taken  283
## taken           taken   18

```

```
##
## #---Analysis-----#
##           Effect Estimator Lower Upper      T p.Value
## 1 p(not taken,taken)    0.304 0.171 0.479 -2.176    0.03
```