2019.05.03_Genetic-Reports-Analysis-Code.R

grecc

Tue May 28 20:51:35 2019

```
library(dplyr)

## Warning: package 'dplyr' was built under R version 3.5.3

##
## Attaching package: 'dplyr'

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

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

library(MASS)

## Warning: package 'MASS' was built under R version 3.5.3

##
## Attaching package: 'MASS'

## The following object is masked from 'package:dplyr':
##
##     select

library(agricolae)

## Warning: package 'agricolae' was built under R version 3.5.3

library(effsize)

## Warning: package 'effsize' was built under R version 3.5.3

library(rcompanion)

## Warning: package 'rcompanion' was built under R version 3.5.3

library(car)

## Warning: package 'car' was built under R version 3.5.3

## Loading required package: carData

##
## Attaching package: 'car'
```

```
## The following object is masked from 'package:dplyr':
##
##     recode

library(plyr)

## Warning: package 'plyr' was built under R version 3.5.3

## ------------------------------------------------------------------------

## You have loaded plyr after dplyr - this is likely to cause problems.
## If you need functions from both plyr and dplyr, please load plyr first,
then dplyr:
## library(plyr); library(dplyr)

## ------------------------------------------------------------------------

##
## Attaching package: 'plyr'

## The following objects are masked from 'package:dplyr':
##
##     arrange, count, desc, failwith, id, mutate, rename, summarise,
##     summarize

library(ggplot2)

## Warning: package 'ggplot2' was built under R version 3.5.3

d <- read.delim("Results_TidyClean.tsv.txt")

alpha <- .01

# Density plots

density.by.splitvar <- function(d, varname, title, omit.nas, splitvar,
splitvar.value1, splitvar.value2, splitvar.name1, splitvar.name2,
                                splitvar.col1 = "black", splitvar.col2 =
"blue",
                                splitvar.lty1 = 3, splitvar.lty2 = 1,
splitvar.lwd1 = 2, splitvar.lwd2 = 2,
                                legend.position="topleft", sub=NULL, xlab="",
ylab="Density", xlim=NULL, ylim=NULL, bw="nrd0") {

  split1 = filter(d, d[splitvar] == splitvar.value1)
  split2 = filter(d, d[splitvar] == splitvar.value2)
  split1nrows = nrow(split1)
  split2nrows = nrow(split2)

  if (omit.nas) {
    split1 <- split1[!is.na(split1[varname]),]
    split2 <- split2[!is.na(split2[varname]),]
```

```
  }
  if (nrow(split1) != split1nrows || nrow(split2) != split2nrows) {
    cat("(Removed NAs)\n")
  }

  plot(density(split1[[varname]], bw=bw), main = title, col=splitvar.col1,
lwd=splitvar.lwd1, lty=splitvar.lty1, sub=sub, xlab=xlab, ylab=ylab,
xlim=xlim, ylim=ylim)
  lines(density(split2[[varname]], bw=bw), col=splitvar.col2,
lwd=splitvar.lwd2, lty=splitvar.lty2, sub=sub, xlab=xlab, ylab=ylab,
xlim=xlim, ylim=ylim)
  legend(legend.position, legend=c(splitvar.name1, splitvar.name2),
col=c(splitvar.col1, splitvar.col2), lty=c(splitvar.lty1, splitvar.lty2),
lwd=c(splitvar.lwd1, splitvar.lwd2))
}

density.by.design <- function(d, varname, title, legend.position="topleft",
sub=NULL, xlab="", ylab="Density", xlim=NULL, ylim=NULL, bw="nrd0",
omit.nas=TRUE) {

  density.by.splitvar(d, varname, title, omit.nas, "Design", "Control",
"UCD", "Control reports", "User-centred reports",
                      legend.position=legend.position, sub=sub, xlab=xlab,
ylab=ylab, xlim=xlim, ylim=ylim, bw=bw, splitvar.lwd1=3)
}

density.by.testresult <- function(d, varname, title,
legend.position="topleft", sub=NULL, xlab="", ylab="Density", xlim=NULL,
ylim=NULL, bw="nrd0", omit.nas=TRUE) {

  density.by.splitvar(d, varname, title, omit.nas, "TestResult", "Positive",
"Negative", "Positive", "Negative",
                      "red", "black", 1, 1,
                      legend.position=legend.position, sub=sub, xlab=xlab,
ylab=ylab, xlim=xlim, ylim=ylim, bw=bw)

}

density.by.both <- function(d, varname, title, legend.position="topleft",
sub=NULL, xlab="", ylab="Density", xlim=NULL, ylim=NULL, bw="nrd0") {
  plot(density(filter(d, d$TestResult=="Positive" &
d$Design=="Control")[[varname]], bw=bw), main = title, col="red", lwd=2,
lty=3, sub=sub, xlab=xlab, ylab=ylab, xlim=xlim, ylim=ylim)
  lines(density(filter(d, d$TestResult=="Negative" &
d$Design=="Control")[[varname]], bw=bw), col="black", lwd=2, lty=3, sub=sub,
xlab=xlab, ylab=ylab, xlim=xlim, ylim=ylim)
  lines(density(filter(d, d$TestResult=="Positive" &
d$Design=="UCD")[[varname]], bw=bw), col="red", lwd=2, sub=sub, xlab=xlab,
ylab=ylab, xlim=xlim, ylim=ylim)
```

```
  lines(density(filter(d, d$TestResult=="Negative" &
d$Design=="UCD")[[varname]], bw=bw), col="black", lwd=2, sub=sub, xlab=xlab,
ylab=ylab, xlim=xlim, ylim=ylim)
  legend(legend.position, legend=c("Positive, control", "Negative, control",
"Positive, user-centred", "Negative, user-centred"), col=c("red", "black",
"red", "black"), lwd=2, lty=c(3,3,1,1))
}

mann.whitney.by.design <- function(d, varname) {
  # Two-sample Mann-Whitney U test
  wtest = wilcox.test(d[[varname]] ~ d$Design)
  pvalue = wtest$p.value

  control <- filter(d, d$Design=="Control")[[varname]]
  ucd <- filter(d, d$Design=="UCD")[[varname]]

  control_mean <- formatC(round(mean(control, na.rm=TRUE), 2), format='f',
digits=2)
  control_sd <- formatC(round(sd(control, na.rm=TRUE), 2), format='f',
digits=2)
  ucd_mean <- formatC(round(mean(ucd, na.rm=TRUE), 2), format='f', digits=2)
  ucd_sd <- formatC(round(sd(ucd, na.rm=TRUE), 2), format='f', digits=2)

  cat(paste0("Mann-Whitney U test ",
           ifelse(pvalue < alpha, "reported", "did not report"),
           " a significant difference (alpha = ", alpha, ") between user-
centered report (M_uc=",
           ucd_mean,
           ", SD_uc=",
           ucd_sd,
           ") and standard report (M_standard=",
           control_mean,
           ", SD_standard=",
           control_sd,
           "), U=",
           formatC(round(wtest$statistic, 3), format='f', digits=3),
           ", p = ",
           formatC(round(pvalue, 3), format='f', digits=3),
           ", Cohen's d = ",
           formatC(-round(cohen.d(as.numeric(d[[varname]]),
as.factor(d$Design), pooled=TRUE, na.rm=TRUE)$estimate, 2), format='f',
digits=2)))

  cat("\n")
}

mann.whitney.by.testresult <- function(d, varname) {
  # Two-sample Mann-Whitney U test
  pvalue = wilcox.test(d[[varname]] ~ d$TestResult)$p.value
```

```
  positive <- filter(d, d$TestResult=="Positive")[[varname]]
  negative <- filter(d, d$TestResult=="Negative")[[varname]]

  cat(paste0("Mann-Whitney U test ",
             ifelse(pvalue < .01, "reported", "did not report"),
             " a significant difference (alpha = ", alpha, ") between
positive reports (M=",
             formatC(round(mean(positive, na.rm=TRUE), 2), format='f',
digits=2),
             ", SD=",
             formatC(round(sd(positive, na.rm=TRUE), 2), format='f',
digits=2),
             ") and negative reports (M=",
             formatC(round(mean(negative, na.rm=TRUE), 2), format='f',
digits=2),
             ", SD=",
             formatC(round(sd(negative, na.rm=TRUE), 2), format='f',
digits=2),
             "), p = ",
             formatC(round(pvalue, 3), format='f', digits=3),
             ", Cohen's d = ",
             formatC(-round(cohen.d(as.numeric(d[[varname]]),
as.factor(d$TestResult), pooled=TRUE, na.rm=TRUE)$estimate, 2), format='f',
digits=2)))
  cat("\n")
}

mann.whitney.by.subjective.numeracy <- function(d, varname) {
  # Two-sample Mann-Whitney U test
  d$binary.subjective.numeracy <- as.numeric(d$subjective.numeracy > 4.34)
  pvalue = wilcox.test(d[[varname]] ~ d$binary.subjective.numeracy)$p.value

  high <- filter(d, d$binary.subjective.numeracy==1)[[varname]]
  low <- filter(d, d$binary.subjective.numeracy==0)[[varname]]

  cat(paste0("Mann-Whitney U test ",
             ifelse(pvalue < .01, "reported", "did not report"),
             " a significant difference (alpha = ", alpha, ") between high
numeracy participants (M=",
             formatC(round(mean(high, na.rm=TRUE), 2), format='f', digits=2),
             ", SD=",
             formatC(round(sd(high, na.rm=TRUE), 2), format='f', digits=2),
             ") and low numeracy participants (M=",
             formatC(round(mean(low, na.rm=TRUE), 2), format='f', digits=2),
             ", SD=",
             formatC(round(sd(low, na.rm=TRUE), 2), format='f', digits=2),
             "), p = ",
             formatC(round(pvalue, 3), format='f', digits=3),
```

```
             ", Cohen's d = ",
             formatC(round(-cohen.d(as.numeric(d[[varname]]),
as.factor(d$binary.subjective.numeracy), pooled=TRUE, na.rm=TRUE)$estimate,
2), format='f', digits=2)))
  cat("\n")
}

mann.whitney.by.education <- function(d, varname) {



  d$Education2 <- mapvalues(d$Education, from=c(2,3,4,5,7),
to=c(2,NA,NA,6,6))


  # Two-sample Mann-Whitney U test
  pvalue = wilcox.test(d[[varname]] ~ d$Education2)$p.value

  low_education = filter(d, d$Education2 == 2)[[varname]]
  high_education = filter(d, d$Education2 == 6)[[varname]]
  cat(paste0("low education count: ", length(low_education), "\n"));
  cat(paste0("high education count: ", length(high_education), "\n"));

  cat(paste0("Mann-Whitney U test ",
             ifelse(pvalue < .01, "reported", "did not report"),
             " a significant difference (alpha = ", alpha, ") between low
education participants (M=",
             formatC(round(mean(low_education, na.rm=TRUE), 2), format='f',
digits=2),
             ", SD=",
             formatC(round(sd(low_education, na.rm=TRUE), 2), format='f',
digits=2),
             ") and high education participants (M=",
             formatC(round(mean(high_education, na.rm=TRUE), 2), format='f',
digits=2),
             ", SD=",
             formatC(round(sd(high_education, na.rm=TRUE), 2), format='f',
digits=2),
             "), p = ",
             formatC(round(pvalue, 3), format='f', digits=3),
             ", Cohen's d = ",
             formatC(round(-cohen.d(as.numeric(d[[varname]]),
as.factor(d$Education2), pooled=TRUE, na.rm=TRUE)$estimate, 2), format='f',
digits=2)))
  cat("\n")
}

mann.whitney.ucd.by.testresult <- function(d, varname) {
  # Two-sample Mann-Whitney U test
```

```
  pvalue = wilcox.test(d[[varname]] ~ d$TestResult)$p.value

  positive <- filter(d, d$TestResult=="Positive" &
d$Design=="UCD")[[varname]]
  negative <- filter(d, d$TestResult=="Negative" &
d$Design=="UCD")[[varname]]

  cat(paste0("Mann-Whitney U test ",
             ifelse(pvalue < .01, "reported", "did not report"),
             " a significant difference (alpha = ", alpha, ") between UCD
positive reports (M=",
             formatC(round(mean(positive), 2), format='f', digits=2),
             ", SD=",
             formatC(round(sd(positive), 2), format='f', digits=2),
             ") and UCD negative reports (M=",
             formatC(round(mean(negative), 2), format='f', digits=2),
             ", SD=",
             formatC(round(sd(negative), 2), format='f', digits=2),
             "), p = ",
             formatC(round(pvalue, 3), format='f', digits=3),
             ", Cohen's d = ",
             formatC(-round(cohen.d(as.numeric(d[[varname]]),
as.factor(d$TestResult), pooled=TRUE)$estimate, 2), format='f', digits=2)))
  cat("\n")
}


test.log.normality <- function(d, varname) {

  x <- log(d[[varname]])
  print(shapiro.test(x))
}

test.sqrt.normality <- function(d, varname) {
  x <- sqrt(d[[varname]])
  print(shapiro.test(x))
}


# Bringing it all together
analyse.by.design <- function(d, varname, title, legend.position="topleft",
sub=NULL, xlab="", ylab="Density", xlim=NULL, ylim=NULL, bw="nrd0",
omit.nas=TRUE, suppress.plot=FALSE)
{
  cat("*****************************************\n")
  cat(title, "\n")
  cat("*****************************************\n")
  if (!suppress.plot) {
    density.by.design(d, varname, title, legend.position=legend.position,
```

```r
sub=sub, xlab=xlab, ylab=ylab, xlim=xlim, ylim=ylim, bw=bw,
omit.nas=omit.nas)
  }

  mann.whitney.by.design(d, varname)
  cat("\n")
}

analyse.by.testresult <- function(d, varname, title,
legend.position="topleft", sub=NULL, xlab="", ylab="Density", xlim=NULL,
ylim=NULL, bw="nrd0", omit.nas=TRUE)
{
  cat("*****************************************\n")
  cat(title, "\n")
  cat("*****************************************\n")
  density.by.testresult(d, varname, title, legend.position=legend.position,
sub=sub, xlab=xlab, ylab=ylab, xlim=xlim, ylim=ylim, bw=bw,
omit.nas=omit.nas)
  mann.whitney.by.testresult(d, varname)
  cat("\n")
}



#################################################
# Key analyses of variables of interest:
# key hypothesis tests that study was powered for
#################################################

print("Tests for normality")

## [1] "Tests for normality"

print(shapiro.test(d$subj.understanding))

##
##  Shapiro-Wilk normality test
##
## data:  d$subj.understanding
## W = 0.90569, p-value = 9.783e-10

print(shapiro.test(d$subj.clarity))

##
##  Shapiro-Wilk normality test
##
## data:  d$subj.clarity
## W = 0.9096, p-value = 1.773e-09

print(shapiro.test(d$oc.score))
```

```
##
##  Shapiro-Wilk normality test
##
## data:  d$oc.score
## W = 0.81912, p-value = 3.263e-14
```

```
print("Running U-tests as variables of interest are not normally
distributed.")
```

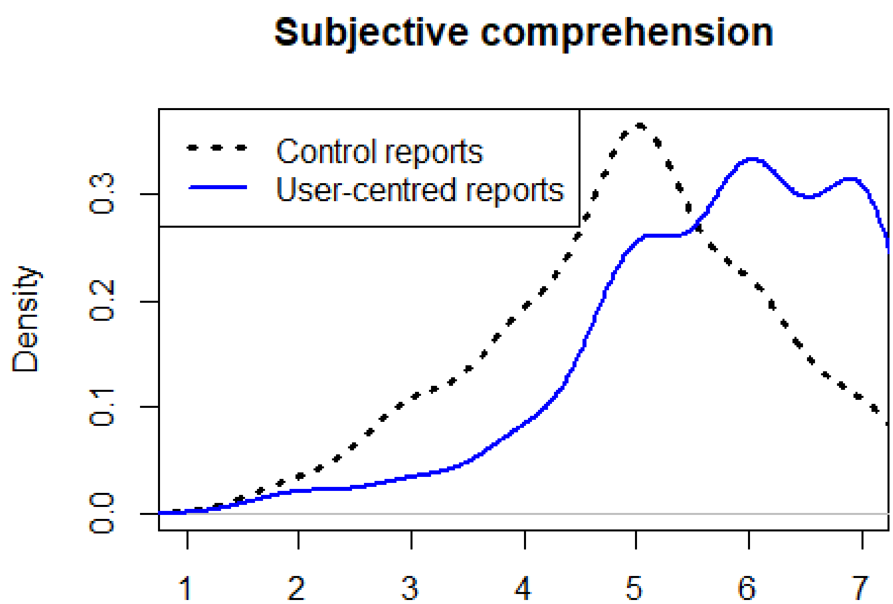
```
## [1] "Running U-tests as variables of interest are not normally
distributed."
```

```
print("Key hypothesis tests that study was powered for")
```

```
## [1] "Key hypothesis tests that study was powered for"
```

```
analyse.by.design(d, "subj.understanding", "Subjective comprehension",
xlim=c(1, 7))
```

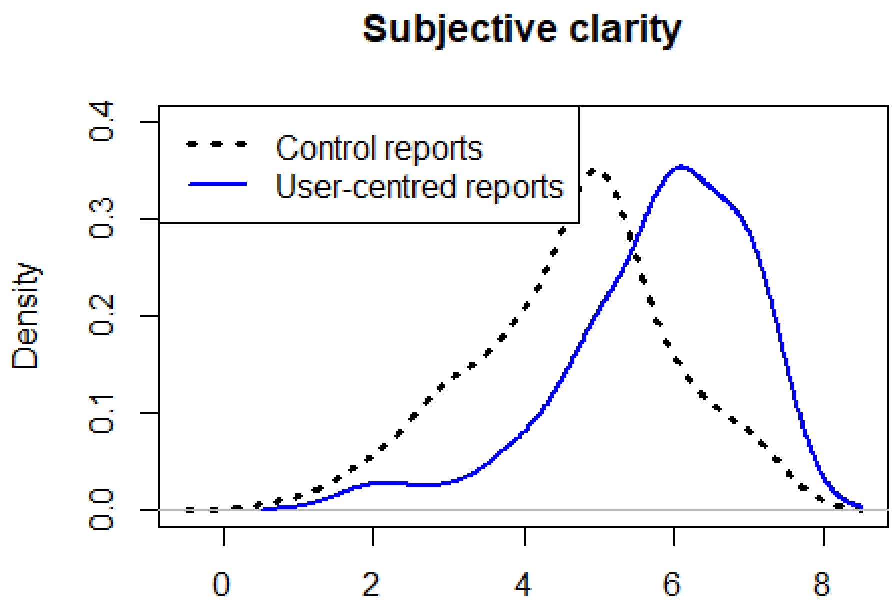
```
## ****************************************
## Subjective comprehension
## ****************************************
```




```
## Mann-Whitney U test reported a significant difference (alpha = 0.01)
between user-centered report (M_uc=5.74, SD_uc=1.18) and standard report
(M_standard=4.94, SD_standard=1.23), U=2896.500, p = 0.000, Cohen's d = 0.67
```

```r
analyse.by.design(d, "subj.clarity", "Subjective clarity", bw=.5,
ylim=c(0,.4))
```

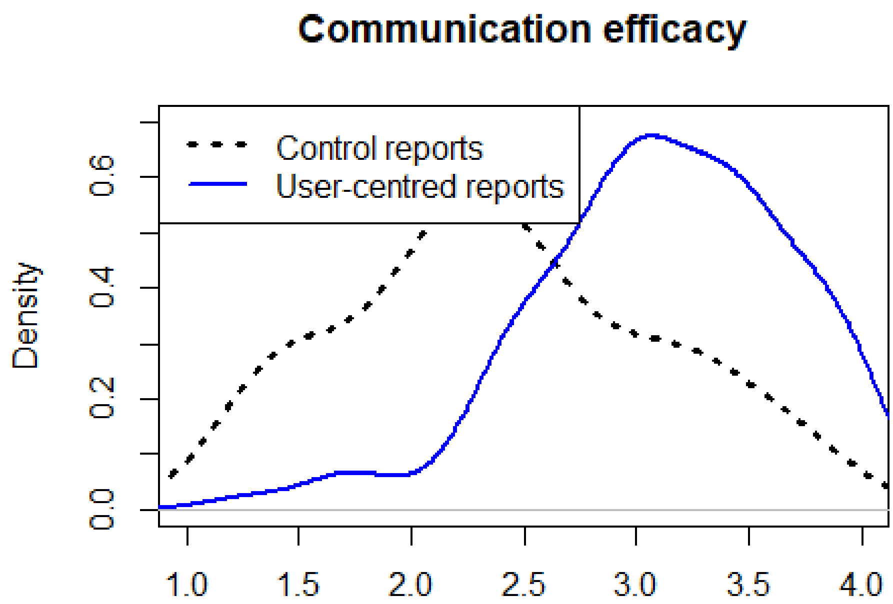
```
## ****************************************
## Subjective clarity
## ****************************************
```




```
## Mann-Whitney U test reported a significant difference (alpha = 0.01)
between user-centered report (M_uc=5.78, SD_uc=1.20) and standard report
(M_standard=4.65, SD_standard=1.31), U=2322.500, p = 0.000, Cohen's d = 0.90
```

```r
analyse.by.design(d, "communication.efficacy", "Communication efficacy",
xlim=c(1, 4), ylim=c(0,.7))
```

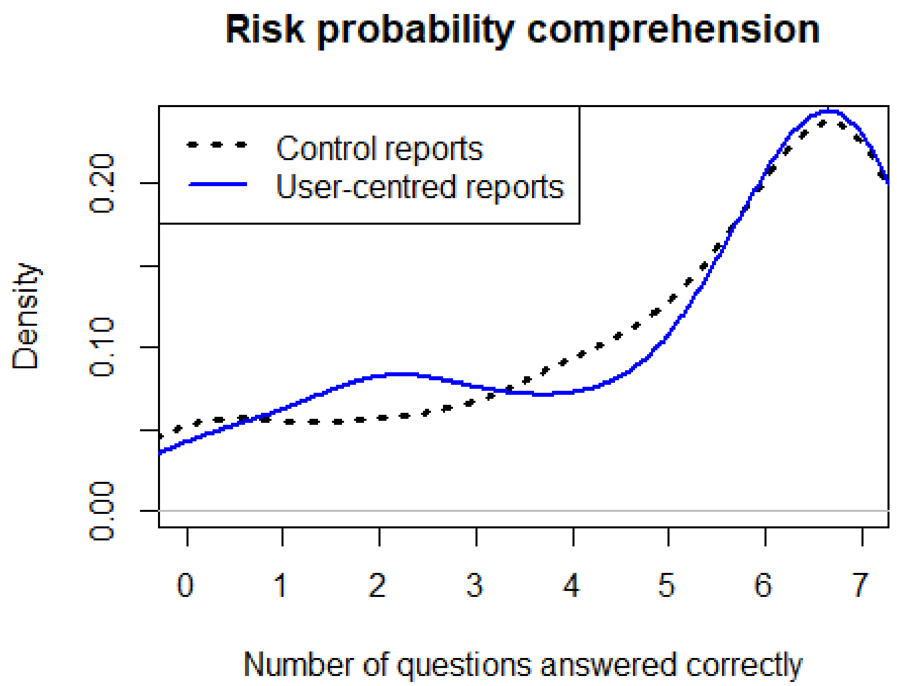
```
## ****************************************
## Communication efficacy
## ****************************************
```




```
## Mann-Whitney U test reported a significant difference (alpha = 0.01)
between user-centered report (M_uc=3.11, SD_uc=0.56) and standard report
(M_standard=2.41, SD_standard=0.70), U=2045.500, p = 0.000, Cohen's d = 1.10
```

```
analyse.by.design(d, "oc.score", "Risk probability comprehension", xlim=c(0,
7), xlab="Number of questions answered correctly")
```

```
## ****************************************
## Risk probability comprehension
## ****************************************
```




```
## Mann-Whitney U test did not report a significant difference (alpha = 0.01)
between user-centered report (M_uc=4.95, SD_uc=2.30) and standard report
(M_standard=4.94, SD_standard=2.31), U=4618.000, p = 0.921, Cohen's d = 0.00

print("Planned 2x2 ANOVAs crossing design with test result,")

## [1] "Planned 2x2 ANOVAs crossing design with test result,"

print("and Scheirer-Ray-Hare extension of the Kruskal Wallis test, to rule
out interactions")

## [1] "and Scheirer-Ray-Hare extension of the Kruskal Wallis test, to rule
out interactions"

print(summary(aov(subj.understanding ~ TestResult * Design, data = d)))

##                      Df Sum Sq Mean Sq F value  Pr(>F)
## TestResult            1   1.27   1.270   0.876   0.351
## Design                1  31.18  31.184  21.495 6.6e-06 ***
## TestResult:Design     1   2.78   2.784   1.919   0.168
## Residuals           189 274.19   1.451
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

print(summary(aov(subj.clarity ~ TestResult * Design, data = d)))

##                      Df Sum Sq Mean Sq F value  Pr(>F)
## TestResult            1   0.20    0.20   0.126   0.723
```

```
## Design              1  62.49   62.49  39.388 2.32e-09 ***
## TestResult:Design   1   2.34    2.34   1.475    0.226
## Residuals         189 299.83    1.59
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
print(summary(aov(communication.efficacy ~ TestResult * Design, data = d)))
```

```
##                    Df Sum Sq Mean Sq F value   Pr(>F)
## TestResult          1   0.05   0.046   0.114    0.736
## Design              1  23.59  23.591  58.093 1.18e-12 ***
## TestResult:Design   1   0.04   0.036   0.090    0.765
## Residuals         189  76.75   0.406
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
print(summary(aov(oc.score ~ TestResult * Design, data = d)))
```

```
##                    Df Sum Sq Mean Sq F value Pr(>F)
## TestResult          1    1.5   1.508   0.285 0.5938
## Design              1    0.0   0.005   0.001 0.9758
## TestResult:Design   1   14.5  14.536   2.752 0.0988 .
## Residuals         189  998.3   5.282
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
print(scheirerRayHare(subj.understanding ~ TestResult * Design, data = d))
```

```
##
## DV:  subj.understanding
## Observations:  193
## D:  0.9403795
## MS total:  3120.167
##
##                    Df Sum Sq       H p.value
## TestResult          1   2149  0.7324 0.39211
## Design              1  64045 21.8275 0.00000
## TestResult:Design   1   5096  1.7367 0.18756
## Residuals         189 492066
```

```
print(scheirerRayHare(subj.clarity ~ TestResult * Design, data = d))
```

```
##
## DV:  subj.clarity
## Observations:  193
## D:  0.947553
## MS total:  3120.167
##
##                    Df Sum Sq      H p.value
## TestResult          1    744  0.252 0.61585
## Design              1 112955 38.205 0.00000
```

```
## TestResult:Design   1   4235  1.432 0.23138
## Residuals         189 449719
```

```r
print(scheirerRayHare(communication.efficacy ~ TestResult * Design, data =
d))
```

```
##
## DV:  communication.efficacy
## Observations:  193
## D:  0.9991278
## MS total:  3120.167
##
##                     Df Sum Sq      H p.value
## TestResult           1    867  0.278 0.59799
## Design               1 141359 45.345 0.00000
## TestResult:Design    1    494  0.158 0.69066
## Residuals          189 455830
```

```r
print(scheirerRayHare(oc.score ~ TestResult * Design, data = d))
```

```
##
## DV:  oc.score
## Observations:  193
## D:  0.9394138
## MS total:  3120.167
##
##                     Df Sum Sq       H p.value
## TestResult           1   6805 2.32161 0.12759
## Design               1     25 0.00869 0.92575
## TestResult:Design    1   8593 2.93153 0.08687
## Residuals          189 547353
```

```r
#################################################
# EXPLORATORY ANALYSES START HERE
#################################################
#
cat("\n\n")
```

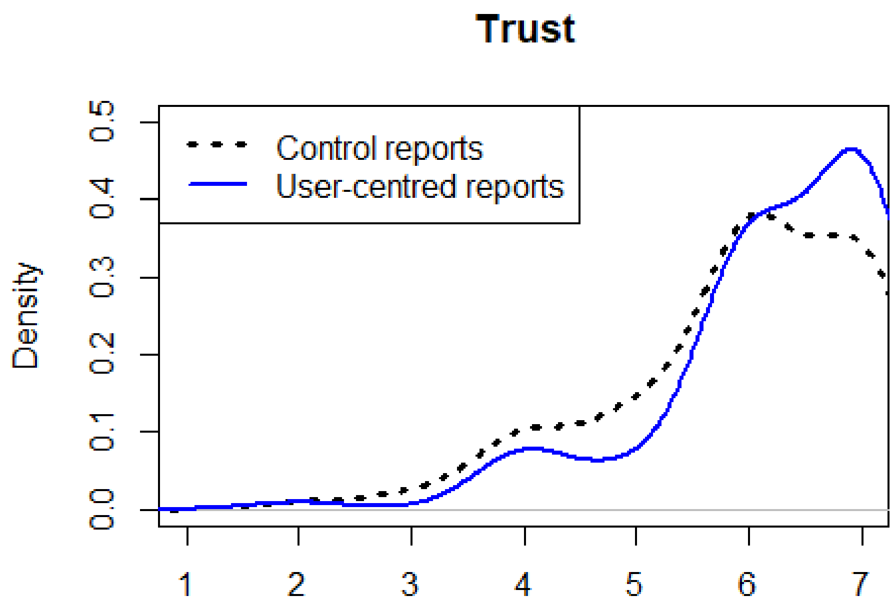
```r
cat("Exploratory analyses", fill=TRUE)
```

```
## Exploratory analyses
```

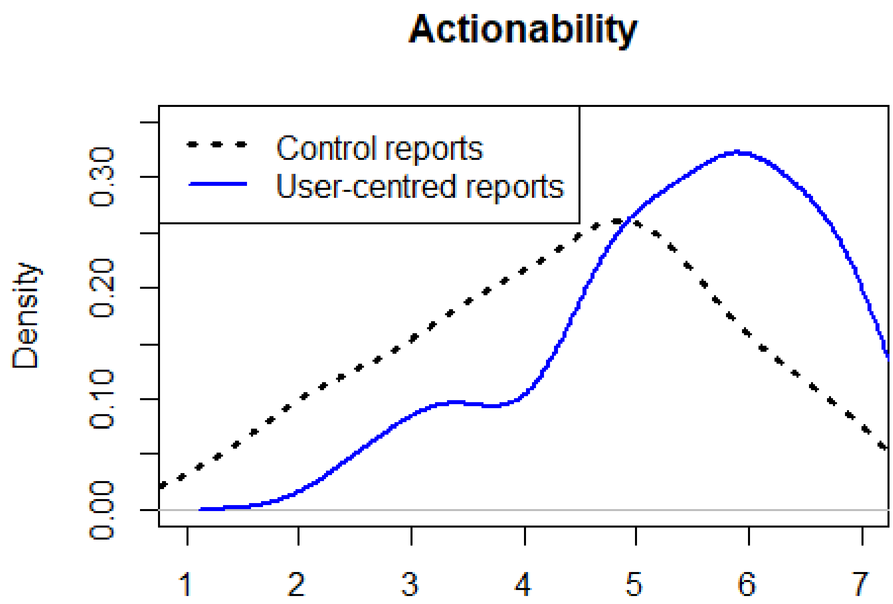
```r
cat("\n\n")
```

```r
analyse.by.design(d, "subj.trusted", "Trust", xlim=c(1, 7), bw=.45,
ylim=c(0,.5))
```

```
## ****************************************
## Trust
## ****************************************
```



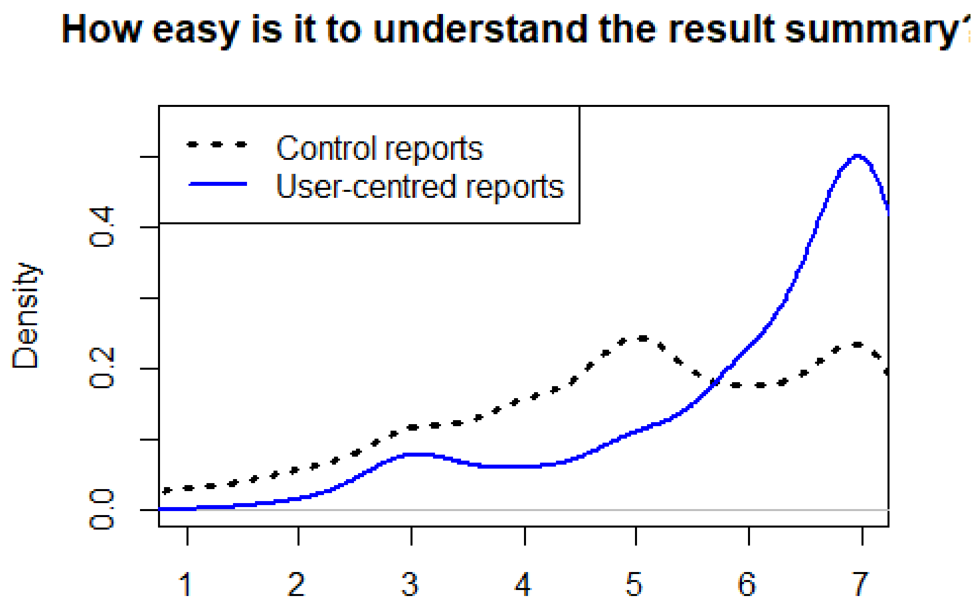

```
## Mann-Whitney U test did not report a significant difference (alpha = 0.01)
between user-centered report (M_uc=6.23, SD_uc=0.99) and standard report
(M_standard=5.92, SD_standard=1.12), U=3873.500, p = 0.031, Cohen's d = 0.29

analyse.by.design(d, "Next.Steps.Average", "Actionability", xlim=c(1, 7),
ylim=c(0,.35))

## ****************************************
## Actionability
## ****************************************
```




```
## Mann-Whitney U test reported a significant difference (alpha = 0.01)
between user-centered report (M_uc=5.41, SD_uc=1.20) and standard report
(M_standard=4.37, SD_standard=1.47), U=2733.000, p = 0.000, Cohen's d = 0.77
```

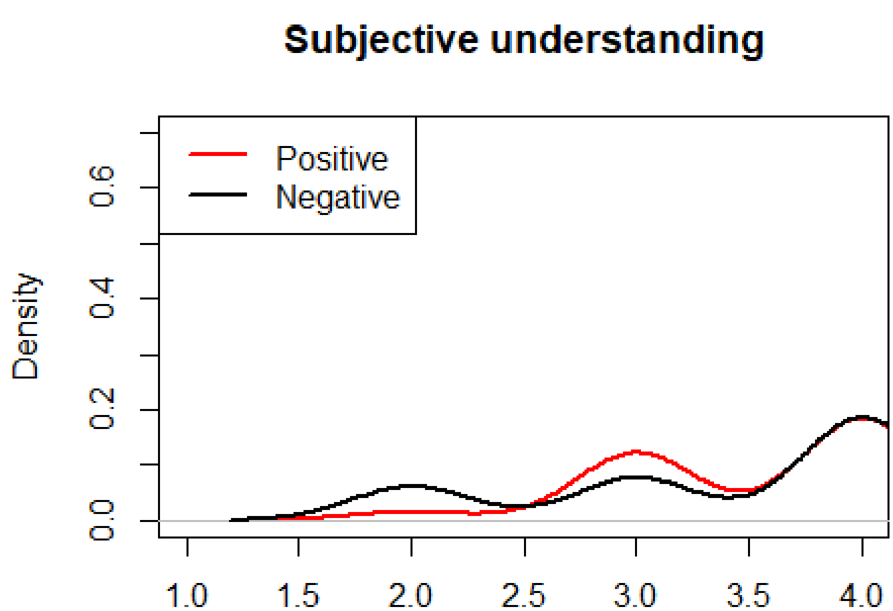
```
analyse.by.design(d, "Result.Understood.Value", "How easy is it to understand
the result summary?", xlim=c(1, 7), bw=.45, ylim=c(0,.55))
```

```
## ****************************************
## How easy is it to understand the result summary?
## ****************************************
```




```
## Mann-Whitney U test reported a significant difference (alpha = 0.01)
between user-centered report (M_uc=6.05, SD_uc=1.33) and standard report
(M_standard=5.00, SD_standard=1.66), U=2876.500, p = 0.000, Cohen's d = 0.70

cat("\n\n")

cat("Correlations with subjective numeracy:", fill=TRUE)

## Correlations with subjective numeracy:

cat("Subj. understanding ", cor(d$subjective.numeracy, d$subj.understanding),
fill=TRUE)

## Subj. understanding  0.275779

cat("Subj. clarity ", cor(d$subjective.numeracy, d$subj.clarity), fill=TRUE)

## Subj. clarity  0.189341

cat("Communication efficacy ", cor(d$subjective.numeracy,
d$communication.efficacy), fill=TRUE)

## Communication efficacy  0.1413112

cat("Risk probability comprehension ", cor(d$subjective.numeracy,
d$oc.score), fill=TRUE)

## Risk probability comprehension  0.4168061
```

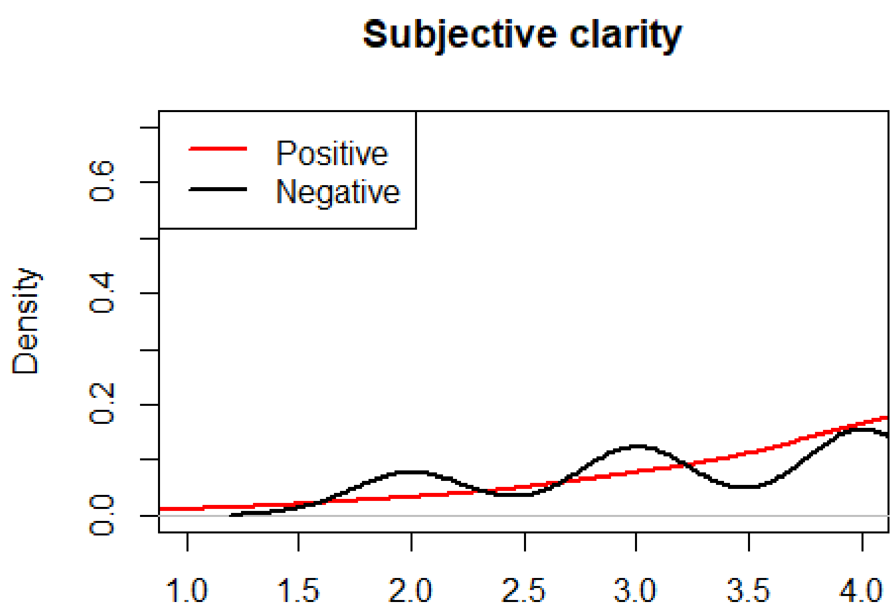
```
cat("Trust ", cor(d$subjective.numeracy, d$subj.trusted), fill=TRUE)

## Trust  0.2008329

cat("Actionability ", cor(d$subjective.numeracy, d$Next.Steps.Average),
fill=TRUE)

## Actionability  0.1550265

cat("Easy of understanding result summary ", cor(d$subjective.numeracy,
d$Result.Understood.Value), fill=TRUE)

## Easy of understanding result summary  0.1794436

cat("\n\n")

print("Analogous U-tests comparing positive vs negative reports on key
variables of interest")

## [1] "Analogous U-tests comparing positive vs negative reports on key
variables of interest"

analyse.by.testresult(d, "subj.understanding", "Subjective understanding",
xlim=c(1, 4), ylim=c(0,.7))

## ****************************************
## Subjective understanding
## ****************************************
```



```
## Mann-Whitney U test did not report a significant difference (alpha = 0.01)
between positive reports (M=5.42, SD=1.27) and negative reports (M=5.26,
SD=1.27), p = 0.393, Cohen's d = 0.13
```

```r
analyse.by.testresult(d, "subj.clarity", "Subjective clarity", xlim=c(1, 4),
ylim=c(0,.7))
```

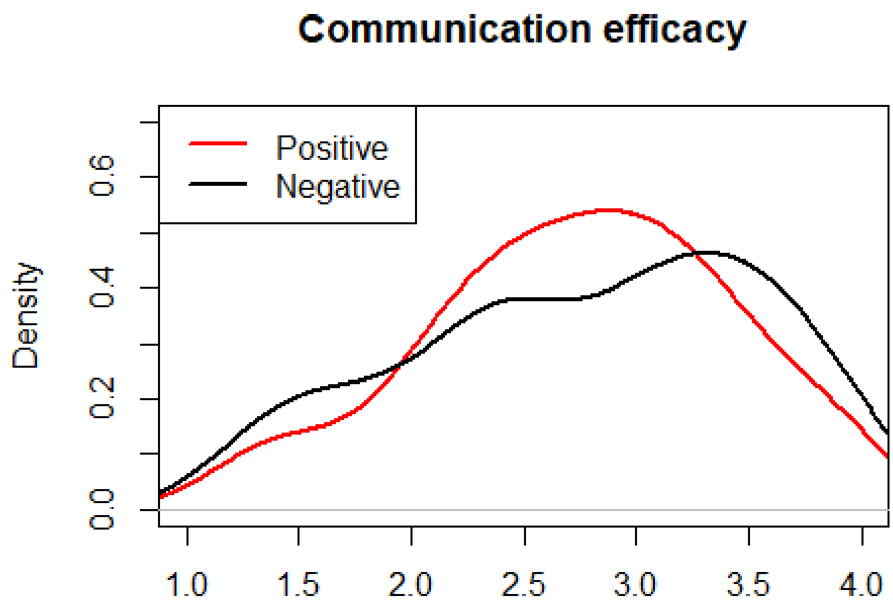
```
## ****************************************
## Subjective clarity
## ****************************************
```



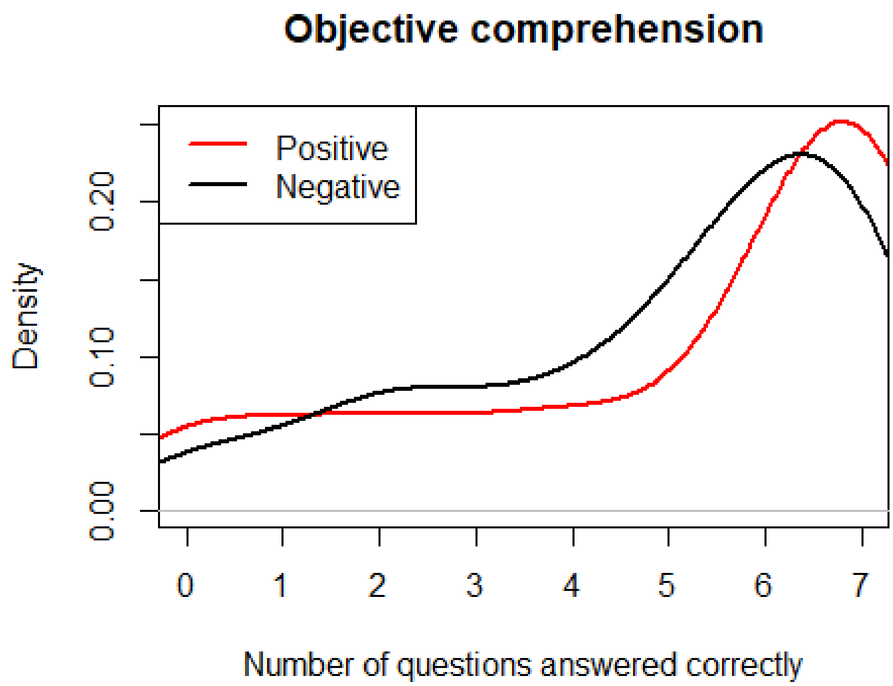

```
## Mann-Whitney U test did not report a significant difference (alpha = 0.01)
between positive reports (M=5.19, SD=1.38) and negative reports (M=5.25,
SD=1.38), p = 0.617, Cohen's d = -0.05
```

```r
analyse.by.testresult(d, "communication.efficacy", "Communication efficacy",
xlim=c(1, 4), ylim=c(0,.7))
```

```
## ****************************************
## Communication efficacy
## ****************************************
```




```
## Mann-Whitney U test did not report a significant difference (alpha = 0.01)
between positive reports (M=2.75, SD=0.68) and negative reports (M=2.78,
SD=0.77), p = 0.599, Cohen's d = -0.04

analyse.by.testresult(d, "oc.score", "Objective comprehension", xlim=c(0, 7),
xlab="Number of questions answered correctly")

## ***************************************
## Objective comprehension
## ***************************************
```




```
## Mann-Whitney U test did not report a significant difference (alpha = 0.01)
between positive reports (M=5.03, SD=2.46) and negative reports (M=4.85,
SD=2.13), p = 0.128, Cohen's d = 0.08

print("Item-wise analyses")

## [1] "Item-wise analyses"

d$q1 <- as.numeric(d$status.is.nearly.correct == "y")
d$q2 <- as.numeric(d$status.slider.is.nearly.correct == "y")
d$q3 <- as.numeric(d$child.is.nearly.correct == "y")
d$q4 <- as.numeric(d$child.slider.is.nearly.correct == "y")
d$q5 <- as.numeric(d$hard1000.is.nearly.correct == "y")
d$q6 <- as.numeric(d$hard800.is.nearly.correct == "y")
d$q7 <- as.numeric(d$oc.compare.is.correct == "y")

print("Item-wise chi-squared tests: comprehension questions, by design")

## [1] "Item-wise chi-squared tests: comprehension questions, by design"

print("Q1")

## [1] "Q1"

print(chisq.test(table(d$q1, d$Design)))

##
##  Pearson's Chi-squared test with Yates' continuity correction
```

```
##
## data:  table(d$q1, d$Design)
## X-squared = 2.3142, df = 1, p-value = 0.1282
```

```r
print("Q2")
```

```
## [1] "Q2"
```

```r
print(chisq.test(table(d$q2, d$Design)))
```

```
##
##  Pearson's Chi-squared test with Yates' continuity correction
##
## data:  table(d$q2, d$Design)
## X-squared = 0.98672, df = 1, p-value = 0.3205
```

```r
print("Q3")
```

```
## [1] "Q3"
```

```r
print(chisq.test(table(d$q3, d$Design)))
```

```
##
##  Pearson's Chi-squared test with Yates' continuity correction
##
## data:  table(d$q3, d$Design)
## X-squared = 1.2266, df = 1, p-value = 0.2681
```

```r
print("Q4")
```

```
## [1] "Q4"
```

```r
print(chisq.test(table(d$q4, d$Design)))
```

```
##
##  Pearson's Chi-squared test with Yates' continuity correction
##
## data:  table(d$q4, d$Design)
## X-squared = 0.31803, df = 1, p-value = 0.5728
```

```r
print("Q5")
```

```
## [1] "Q5"
```

```r
print(chisq.test(table(d$q5, d$Design)))
```

```
##
##  Pearson's Chi-squared test with Yates' continuity correction
##
## data:  table(d$q5, d$Design)
## X-squared = 0.96376, df = 1, p-value = 0.3262
```

```r
print("Q6")
```

```
## [1] "Q6"

print(chisq.test(table(d$q6, d$Design)))

##
##  Pearson's Chi-squared test with Yates' continuity correction
##
## data:  table(d$q6, d$Design)
## X-squared = 0.22622, df = 1, p-value = 0.6343

print("Q7")

## [1] "Q7"

print(chisq.test(table(d$q7, d$Design)))

##
##  Pearson's Chi-squared test with Yates' continuity correction
##
## data:  table(d$q7, d$Design)
## X-squared = 0.62178, df = 1, p-value = 0.4304

print("Item-wise U-tests: communication efficacy questions, by design")

## [1] "Item-wise U-tests: communication efficacy questions, by design"

analyse.by.design(d, "Scheuner.1", "Scheuner 1", suppress.plot=T)

## ****************************************
## Scheuner 1
## ****************************************
## Mann-Whitney U test reported a significant difference (alpha = 0.01)
between user-centered report (M_uc=3.31, SD_uc=0.71) and standard report
(M_standard=2.62, SD_standard=0.90), U=2670.000, p = 0.000, Cohen's d = 0.85

analyse.by.design(d, "Scheuner.2", "Scheuner 2", suppress.plot=T)

## ****************************************
## Scheuner 2
## ****************************************
## Mann-Whitney U test reported a significant difference (alpha = 0.01)
between user-centered report (M_uc=3.38, SD_uc=0.73) and standard report
(M_standard=2.83, SD_standard=0.83), U=2934.000, p = 0.000, Cohen's d = 0.70

analyse.by.design(d, "Scheuner.3", "Scheuner 3", suppress.plot=T)

## ****************************************
## Scheuner 3
## ****************************************
## Mann-Whitney U test reported a significant difference (alpha = 0.01)
between user-centered report (M_uc=3.29, SD_uc=0.71) and standard report
(M_standard=2.68, SD_standard=0.88), U=2851.000, p = 0.000, Cohen's d = 0.77
```

```r
analyse.by.design(d, "Scheuner.4", "Scheuner 4", suppress.plot=T)
```

```
## ****************************************
## Scheuner 4
## ****************************************
## Mann-Whitney U test reported a significant difference (alpha = 0.01)
between user-centered report (M_uc=3.35, SD_uc=0.78) and standard report
(M_standard=2.67, SD_standard=0.95), U=2761.500, p = 0.000, Cohen's d = 0.79
```

```r
analyse.by.design(d, "Scheuner.5", "Scheuner 5", suppress.plot=T)
```

```
## ****************************************
## Scheuner 5
## ****************************************
## Mann-Whitney U test reported a significant difference (alpha = 0.01)
between user-centered report (M_uc=3.10, SD_uc=0.78) and standard report
(M_standard=2.42, SD_standard=0.90), U=2749.000, p = 0.000, Cohen's d = 0.81
```

```r
analyse.by.design(d, "Scheuner.6", "Scheuner 6", suppress.plot=T)
```

```
## ****************************************
## Scheuner 6
## ****************************************
## Mann-Whitney U test reported a significant difference (alpha = 0.01)
between user-centered report (M_uc=3.25, SD_uc=0.78) and standard report
(M_standard=2.35, SD_standard=0.88), U=2227.500, p = 0.000, Cohen's d = 1.07
```

```r
analyse.by.design(d, "Scheuner.7", "Scheuner 7", suppress.plot=T)
```

```
## ****************************************
## Scheuner 7
## ****************************************
## Mann-Whitney U test reported a significant difference (alpha = 0.01)
between user-centered report (M_uc=3.34, SD_uc=0.76) and standard report
(M_standard=2.53, SD_standard=0.89), U=2380.000, p = 0.000, Cohen's d = 0.97
```

```r
analyse.by.design(d, "Scheuner.8", "Scheuner 8", suppress.plot=T)
```

```
## ****************************************
## Scheuner 8
## ****************************************
## Mann-Whitney U test reported a significant difference (alpha = 0.01)
between user-centered report (M_uc=3.13, SD_uc=0.80) and standard report
(M_standard=2.56, SD_standard=0.90), U=3021.000, p = 0.000, Cohen's d = 0.67
```

```r
analyse.by.design(d, "Scheuner.9", "Scheuner 9", suppress.plot=T)
```

```
## ****************************************
## Scheuner 9
## ****************************************
## Mann-Whitney U test reported a significant difference (alpha = 0.01)
```

```
between user-centered report (M_uc=3.38, SD_uc=0.73) and standard report
(M_standard=2.67, SD_standard=0.88), U=2563.500, p = 0.000, Cohen's d = 0.89
```

```r
analyse.by.design(d, "Scheuner.10", "Scheuner 10", suppress.plot=T)
```

```
## ****************************************
## Scheuner 10
## ****************************************
## Mann-Whitney U test reported a significant difference (alpha = 0.01)
between user-centered report (M_uc=3.23, SD_uc=0.67) and standard report
(M_standard=2.47, SD_standard=0.98), U=2594.500, p = 0.000, Cohen's d = 0.90
```

```r
analyse.by.design(d, "Scheuner.11", "Scheuner 11", suppress.plot=T)
```

```
## ****************************************
## Scheuner 11
## ****************************************
## Mann-Whitney U test reported a significant difference (alpha = 0.01)
between user-centered report (M_uc=2.94, SD_uc=0.79) and standard report
(M_standard=2.16, SD_standard=1.00), U=2639.000, p = 0.000, Cohen's d = 0.87
```

```r
analyse.by.design(d, "Scheuner.12", "Scheuner 12", suppress.plot=T)
```

```
## ****************************************
## Scheuner 12
## ****************************************
## Mann-Whitney U test reported a significant difference (alpha = 0.01)
between user-centered report (M_uc=2.95, SD_uc=0.86) and standard report
(M_standard=1.98, SD_standard=0.96), U=2206.000, p = 0.000, Cohen's d = 1.06
```

```r
analyse.by.design(d, "Scheuner.13", "Scheuner 13", suppress.plot=T)
```

```
## ****************************************
## Scheuner 13
## ****************************************
## Mann-Whitney U test reported a significant difference (alpha = 0.01)
between user-centered report (M_uc=2.87, SD_uc=0.82) and standard report
(M_standard=2.10, SD_standard=0.92), U=2568.500, p = 0.000, Cohen's d = 0.87
```

```r
# NOTE: The variables Scheuner.14 through Scheuner.18 have scores of 2
through 5
# rather than 1 through 4 due to a issue with the Qualtrics mapping from
choices
# to output numbers. The corrected values appear in the variables
Scheuner.14.Value
# onwards, and are used below.

analyse.by.design(d, "Scheuner.14.Value", "Scheuner 14", suppress.plot=T)
```

```
## ****************************************
## Scheuner 14
## ****************************************
```

```
## Mann-Whitney U test reported a significant difference (alpha = 0.01)
between user-centered report (M_uc=3.01, SD_uc=0.74) and standard report
(M_standard=2.46, SD_standard=0.99), U=3140.500, p = 0.000, Cohen's d = 0.63

analyse.by.design(d, "Scheuner.15.Value", "Scheuner 15", suppress.plot=T)

## *****************************************
## Scheuner 15
## *****************************************
## Mann-Whitney U test reported a significant difference (alpha = 0.01)
between user-centered report (M_uc=3.00, SD_uc=0.88) and standard report
(M_standard=2.42, SD_standard=0.93), U=3088.000, p = 0.000, Cohen's d = 0.65

analyse.by.design(d, "Scheuner.16.Value", "Scheuner 16", suppress.plot=T)

## *****************************************
## Scheuner 16
## *****************************************
## Mann-Whitney U test reported a significant difference (alpha = 0.01)
between user-centered report (M_uc=2.81, SD_uc=0.89) and standard report
(M_standard=2.27, SD_standard=0.90), U=3183.500, p = 0.000, Cohen's d = 0.61

analyse.by.design(d, "Scheuner.17.Value", "Scheuner 17", suppress.plot=T)

## *****************************************
## Scheuner 17
## *****************************************
## Mann-Whitney U test reported a significant difference (alpha = 0.01)
between user-centered report (M_uc=2.97, SD_uc=0.85) and standard report
(M_standard=2.40, SD_standard=0.93), U=3106.000, p = 0.000, Cohen's d = 0.64

analyse.by.design(d, "Scheuner.18.Value", "Scheuner 18", suppress.plot=T)

## *****************************************
## Scheuner 18
## *****************************************
## Mann-Whitney U test reported a significant difference (alpha = 0.01)
between user-centered report (M_uc=2.69, SD_uc=0.96) and standard report
(M_standard=1.83, SD_standard=0.83), U=2466.500, p = 0.000, Cohen's d = 0.95

print("Item-wise U-tests: actionability questions, by design")

## [1] "Item-wise U-tests: actionability questions, by design"

analyse.by.design(d, "subj.next.1", "'Next steps' question 1",
suppress.plot=T)

## *****************************************
## 'Next steps' question 1
## *****************************************
## Mann-Whitney U test reported a significant difference (alpha = 0.01)
```

```
between user-centered report (M_uc=5.53, SD_uc=1.35) and standard report
(M_standard=4.40, SD_standard=1.60), U=2756.500, p = 0.000, Cohen's d = 0.76

analyse.by.design(d, "subj.next.2", "'Next steps' question 2",
suppress.plot=T)

## ****************************************
## 'Next steps' question 2
## ****************************************
## Mann-Whitney U test reported a significant difference (alpha = 0.01)
between user-centered report (M_uc=5.21, SD_uc=1.52) and standard report
(M_standard=4.26, SD_standard=1.71), U=3153.000, p = 0.000, Cohen's d = 0.58

analyse.by.design(d, "subj.next.3", "'Next steps' question 3",
suppress.plot=T)

## ****************************************
## 'Next steps' question 3
## ****************************************
## Mann-Whitney U test reported a significant difference (alpha = 0.01)
between user-centered report (M_uc=5.62, SD_uc=1.32) and standard report
(M_standard=4.49, SD_standard=1.75), U=2890.000, p = 0.000, Cohen's d = 0.73

analyse.by.design(d, "subj.next.4", "'Next steps' question 4",
suppress.plot=T)

## ****************************************
## 'Next steps' question 4
## ****************************************
## Mann-Whitney U test reported a significant difference (alpha = 0.01)
between user-centered report (M_uc=5.47, SD_uc=1.30) and standard report
(M_standard=4.45, SD_standard=1.53), U=2902.500, p = 0.000, Cohen's d = 0.72

analyse.by.design(d, "subj.next.5", "'Next steps' question 5",
suppress.plot=T)

## ****************************************
## 'Next steps' question 5
## ****************************************
## Mann-Whitney U test reported a significant difference (alpha = 0.01)
between user-centered report (M_uc=5.21, SD_uc=1.38) and standard report
(M_standard=4.27, SD_standard=1.72), U=3259.000, p = 0.000, Cohen's d = 0.60

#################################################
# Differences in the degree to which people saw the box
#################################################

table(d$Result.Noticed.Binary, d$Design)

##
##     Control UCD
```

```
##   0       8  26
##   1      88  71
```

```r
control <- filter(d, d$Design=="Control")$Result.Noticed.Binary
ucd <- filter(d, d$Design=="UCD")$Result.Noticed.Binary

control_mean <- formatC(100 * round(mean(control, na.rm=TRUE), 2),
format='f', digits=0)
ucd_mean <- formatC(100 * round(mean(ucd, na.rm=TRUE), 2), format='f',
digits=0)
print(paste0("Control: ", control_mean, "% saw results summary"))
```

```
## [1] "Control: 92% saw results summary"
```

```r
print(paste0("UCD: ", ucd_mean, "% saw results summary"))
```

```
## [1] "UCD: 73% saw results summary"
```

```r
print(chisq.test(table(d$Result.Noticed.Binary, d$Design)))
```

```
##
##  Pearson's Chi-squared test with Yates' continuity correction
##
## data:  table(d$Result.Noticed.Binary, d$Design)
## X-squared = 10.105, df = 1, p-value = 0.001479
```

```r
######################################################################
# Are there differences in the probabilities of CF estimated by participants
# between the UCD & control conditions, when we restrict ourselves to the
subset of
# reports that are positive, or the subset of reports that are negative?
######################################################################

d$oc.child.slider.100 <- d$oc.child.slider_1 / 100.0
d$oc.status.slider.100 <- d$oc.status.slider_1 / 100.0

positives = filter(d, d$TestResult == "Positive")
negatives = filter(d, d$TestResult == "Negative")


print("Child slider results")
```

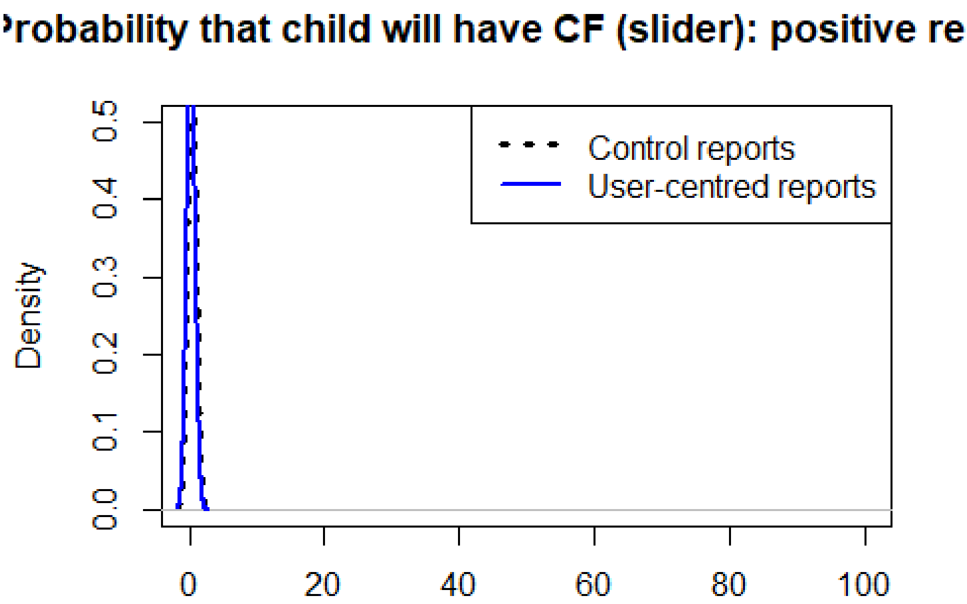
```
## [1] "Child slider results"
```

```r
print(paste0("median ucd positive: ", median(filter(d, d$TestResult ==
"Positive" & d$Design == "UCD")$oc.child.slider_1, na.rm=TRUE)))
```

```
## [1] "median ucd positive: 25"
```

```r
print(paste0("median control positive: ", median(filter(d, d$TestResult ==
"Positive" & d$Design == "Control")$oc.child.slider_1, na.rm=TRUE)))
```

```
## [1] "median control positive: 25"

print(paste0("median ucd negative: ", median(filter(d, d$TestResult ==
"Negative" & d$Design == "UCD")$oc.child.slider_1, na.rm=TRUE)))

## [1] "median ucd negative: 1"

print(paste0("median control negative: ", median(filter(d, d$TestResult ==
"Negative" & d$Design == "Control")$oc.child.slider_1, na.rm=TRUE)))

## [1] "median control negative: 1"

print("***")

## [1] "***"

print("Status slider results")

## [1] "Status slider results"

print(paste0("median ucd positive: ", median(filter(d, d$TestResult ==
"Positive" & d$Design == "UCD")$oc.status.slider_1, na.rm=TRUE)))

## [1] "median ucd positive: 100"

print(paste0("median control positive: ", median(filter(d, d$TestResult ==
"Positive" & d$Design == "Control")$oc.status.slider_1, na.rm=TRUE)))

## [1] "median control positive: 100"

print(paste0("median ucd negative: ", median(filter(d, d$TestResult ==
"Negative" & d$Design == "UCD")$oc.status.slider_1, na.rm=TRUE)))

## [1] "median ucd negative: 1"

print(paste0("median control negative: ", median(filter(d, d$TestResult ==
"Negative" & d$Design == "Control")$oc.status.slider_1, na.rm=TRUE)))

## [1] "median control negative: 1"

print("***")

## [1] "***"

analyse.by.design(positives, "oc.child.slider.100", "Probability that child
will have CF (slider): positive reports", xlim=c(0,100), ylim=c(0,.5),
legend.position="topright", omit.nas=TRUE, bw=.6)

## *****************************************
## Probability that child will have CF (slider): positive reports
## *****************************************

## Warning in wilcox.test.default(x = c(0.25, 0.25, 0.51, 0.25, 0.6, 0.25, :
## cannot compute exact p-value with ties
```

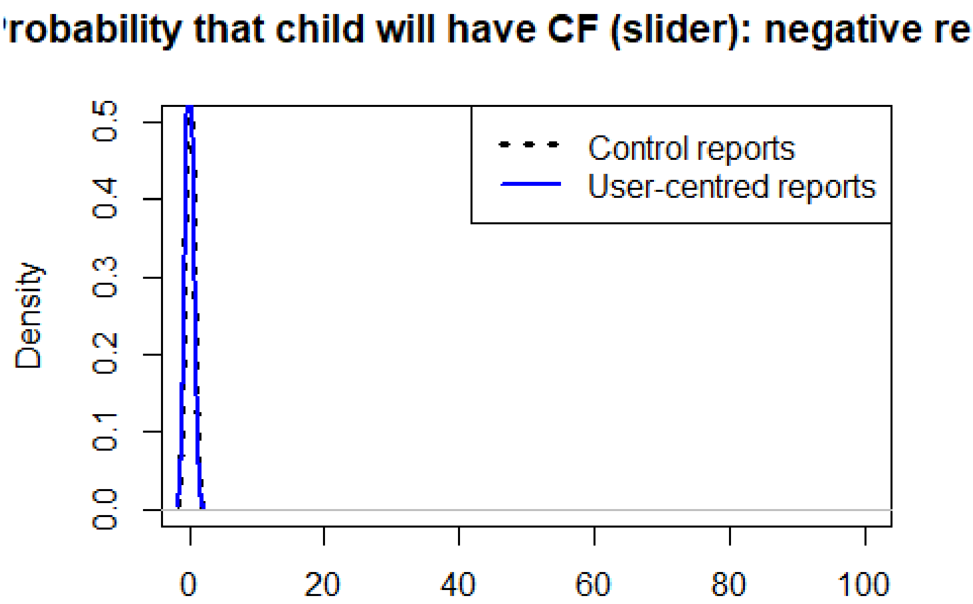



```
## Mann-Whitney U test did not report a significant difference (alpha = 0.01)
between user-centered report (M_uc=0.31, SD_uc=0.16) and standard report
(M_standard=0.33, SD_standard=0.19), U=1328.500, p = 0.165, Cohen's d = -0.16
```

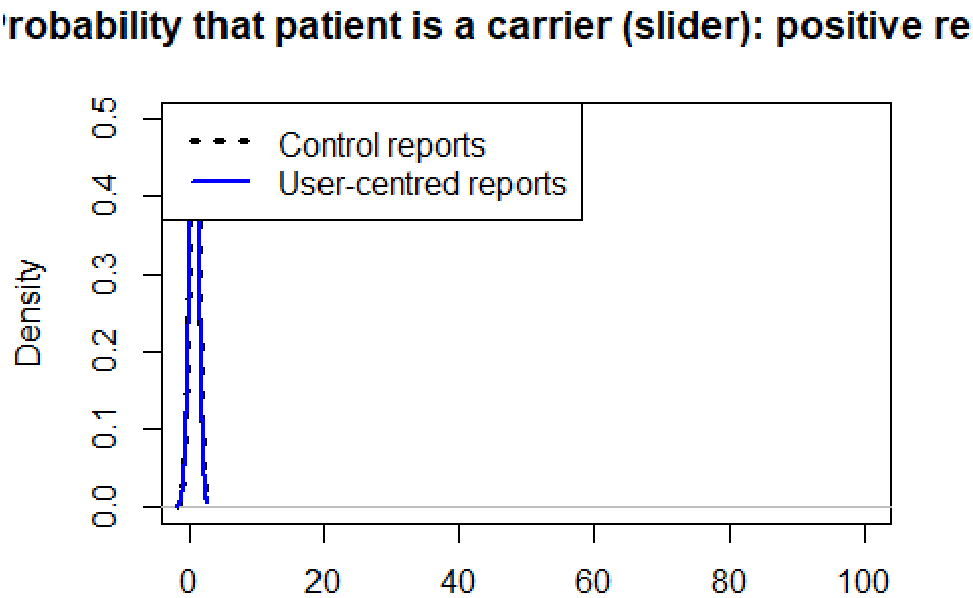
```
analyse.by.design(negatives, "oc.child.slider.100", "Probability that child
will have CF (slider): negative reports", xlim=c(0,100), ylim=c(0,.5),
legend.position="topright", omit.nas=TRUE, bw=.6)
```

```
## *****************************************
## Probability that child will have CF (slider): negative reports
## *****************************************
## (Removed NAs)
```

```
## Warning in wilcox.test.default(x = c(0.01, 0, 0, 0.01, 0.01, 0.35, 0.15, :
## cannot compute exact p-value with ties
```



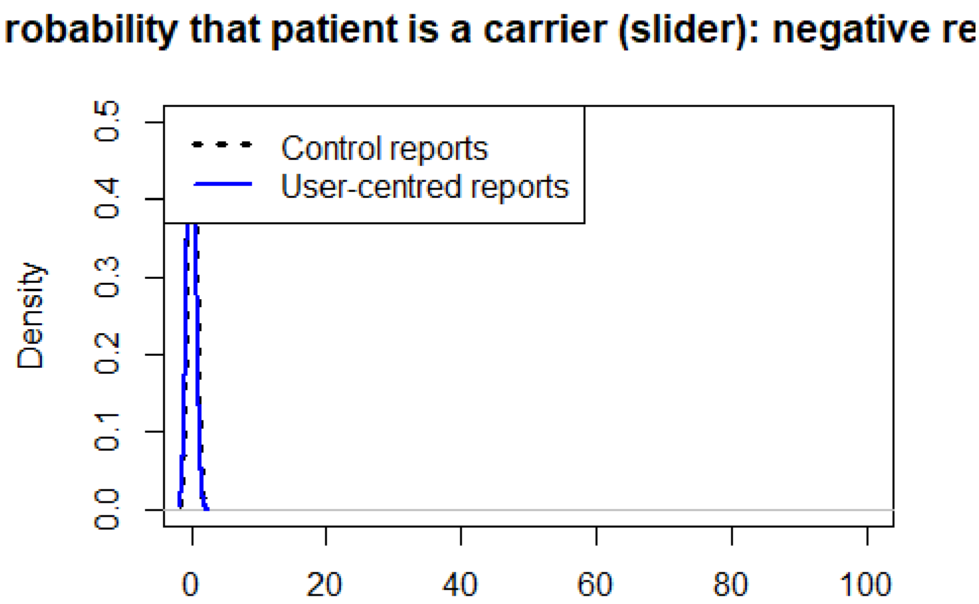

```
## Mann-Whitney U test did not report a significant difference (alpha = 0.01)
between user-centered report (M_uc=0.10, SD_uc=0.17) and standard report
(M_standard=0.06, SD_standard=0.11), U=1099.500, p = 0.829, Cohen's d = 0.27

analyse.by.design(positives, "oc.status.slider.100", "Probability that
patient is a carrier (slider): positive reports", xlim=c(0,100),
ylim=c(0,.5), legend.position="topleft", omit.nas=TRUE, bw=.6)

## *****************************************
## Probability that patient is a carrier (slider): positive reports
## *****************************************

## Warning in wilcox.test.default(x = c(1, 1, 0.69, 0.8, 1, 0.01, 1, 0.06, :
## cannot compute exact p-value with ties
```




```
## Mann-Whitney U test did not report a significant difference (alpha = 0.01)
between user-centered report (M_uc=0.86, SD_uc=0.29) and standard report
(M_standard=0.80, SD_standard=0.32), U=1170.500, p = 0.968, Cohen's d = 0.19
```

```
analyse.by.design(negatives, "oc.status.slider.100", "Probability that
patient is a carrier (slider): negative reports", xlim=c(0,100),
ylim=c(0,.5), legend.position="topleft", omit.nas=TRUE, bw=.6)
```

```
## *****************************************
## Probability that patient is a carrier (slider): negative reports
## *****************************************

## Warning in wilcox.test.default(x = c(0, 0.3, 0, 0.01, 0.02, 0.3, 0.01,
## 0.01, : cannot compute exact p-value with ties
```




```
## Mann-Whitney U test did not report a significant difference (alpha = 0.01)
between user-centered report (M_uc=0.07, SD_uc=0.16) and standard report
(M_standard=0.07, SD_standard=0.16), U=1161.000, p = 0.947, Cohen's d = -0.02

##################################################
# Differences in risk probability *interpretation*
##################################################

print("Differences in risk probability *interpretation*")

## [1] "Differences in risk probability *interpretation*"

positives = filter(d, d$TestResult == "Positive")
fulltable = table(positives$oc.child.verbal, positives$Design)
print(fulltable)

##
##      Control UCD
##   1       1   0
##   2       8  22
##   3      36  25
##   4       0   1
##   5       3   1

print(chisq.test(fulltable))

## Warning in chisq.test(fulltable): Chi-squared approximation may be
## incorrect
```

```
##
##  Pearson's Chi-squared test
##
## data:  fulltable
## X-squared = 11.508, df = 4, p-value = 0.02141
```

```
print(paste0("Those who saw the user-centred positive report are more apt to
say that a child of two",
" carriers was 'unlikely' to have cystic fibrosis than those who saw the",
" standard positive report:"))
```

```
## [1] "Those who saw the user-centred positive report are more apt to say
that a child of two carriers was 'unlikely' to have cystic fibrosis than
those who saw the standard positive report:"
```

```
positives$unlikely_or_not <- as.numeric(positives$oc.child.verbal == 2)  # 2
== "unlikely"
smalltable = table(positives$unlikely_or_not, positives$Design)
print(smalltable)
```

```
##
##     Control UCD
##   0      40  27
##   1       8  22
```

```
print(chisq.test(smalltable))
```

```
##
##  Pearson's Chi-squared test with Yates' continuity correction
##
## data:  smalltable
## X-squared = 7.7731, df = 1, p-value = 0.005303
```

```
print("Analyses described in Figure 1 caption")
```

```
## [1] "Analyses described in Figure 1 caption"
```

```
std_unlikely = filter(d, d$TestResult == "Positive" & d$Design == "Control" &
d$oc.child.verbal == 2)
std_likely = filter(d, d$TestResult == "Positive" & d$Design == "Control" &
d$oc.child.verbal == 3)
ucd_unlikely = filter(d, d$TestResult == "Positive" & d$Design == "UCD" &
d$oc.child.verbal == 2)
ucd_likely = filter(d, d$TestResult == "Positive" & d$Design == "UCD" &
d$oc.child.verbal == 3)

unlikely = filter(d, d$TestResult == "Positive" & d$oc.child.verbal == 2)
likely = filter(d, d$TestResult == "Positive" & d$oc.child.verbal == 3)

cat(paste0("std_unlikely ", mean(std_unlikely$oc.child.slider_1)), " (",
sd(std_unlikely$oc.child.slider_1), ")\n")
```

```
## std_unlikely 25.125  ( 0.3535534 )

cat(paste0("std_likely ", mean(std_likely$oc.child.slider_1)), " (",
sd(std_likely$oc.child.slider_1), ")\n")

## std_likely 34.4444444444444  ( 21.03663 )

cat(paste0("ucd_unlikely ", mean(ucd_unlikely$oc.child.slider_1)), " (",
sd(ucd_unlikely$oc.child.slider_1), ")\n")

## ucd_unlikely 27.4090909090909  ( 13.97842 )

cat(paste0("ucd_likely ", mean(ucd_likely$oc.child.slider_1)), " (",
sd(ucd_likely$oc.child.slider_1), ")\n")

## ucd_likely 30.72  ( 11.59928 )

wilcox.test(likely$oc.child.slider_1 ~ likely$Design)

## Warning in wilcox.test.default(x = c(25L, 25L, 51L, 60L, 25L, 25L, 70L, :
## cannot compute exact p-value with ties

##
##  Wilcoxon rank sum test with continuity correction
##
## data:  likely$oc.child.slider_1 by likely$Design
## W = 473, p-value = 0.6763
## alternative hypothesis: true location shift is not equal to 0

wilcox.test(unlikely$oc.child.slider_1 ~ unlikely$Design)

## Warning in wilcox.test.default(x = c(25L, 26L, 25L, 25L, 25L, 25L, 25L, :
## cannot compute exact p-value with ties

##
##  Wilcoxon rank sum test with continuity correction
##
## data:  unlikely$oc.child.slider_1 by unlikely$Design
## W = 100.5, p-value = 0.4206
## alternative hypothesis: true location shift is not equal to 0

#################################################
# Exploring possible covariates and demographic variables
#################################################

print(Anova(lm(oc.score ~ Gender.Value * Design, data = d), type=2))

## Anova Table (Type II tests)
##
## Response: oc.score
##                      Sum Sq  Df F value Pr(>F)
## Gender.Value           0.05   2  0.0047 0.9953
## Design                 0.01   1  0.0010 0.9742
```

```
## Gender.Value:Design  22.52   2  2.1226 0.1226
## Residuals           991.80 187
```

```r
print(Anova(lm(subj.understanding ~ Gender.Value * Design, data = d),
type=2))
```

```
## Anova Table (Type II tests)
##
## Response: subj.understanding
##                      Sum Sq  Df F value    Pr(>F)
## Gender.Value          2.601   2  0.9149    0.4023
## Design               31.336   1 22.0443 5.142e-06 ***
## Gender.Value:Design   9.764   2  3.4343    0.0343 *
## Residuals           265.817 187
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```r
print(Anova(lm(communication.efficacy ~ Gender.Value * Design, data = d),
type=2))
```

```
## Anova Table (Type II tests)
##
## Response: communication.efficacy
##                     Sum Sq  Df F value    Pr(>F)
## Gender.Value         1.900   2  2.4035   0.09319 .
## Design              23.579   1 59.6419 6.694e-13 ***
## Gender.Value:Design  1.013   2  1.2811   0.28016
## Residuals           73.930 187
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```r
print(Anova(lm(subj.clarity ~ Gender.Value * Design, data = d), type=2))
```

```
## Anova Table (Type II tests)
##
## Response: subj.clarity
##                      Sum Sq  Df F value   Pr(>F)
## Gender.Value          1.000   2  0.3166   0.7290
## Design               62.555   1 39.6215 2.14e-09 ***
## Gender.Value:Design   6.173   2  1.9550   0.1445
## Residuals           295.239 187
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```r
print(Anova(lm(oc.score ~ Age * Design, data = d), type=2))
```

```
## Anova Table (Type II tests)
##
## Response: oc.score
##             Sum Sq  Df F value Pr(>F)
## Age           3.41   1  0.6370 0.4258
## Design        0.08   1  0.0142 0.9053
```

```
## Age:Design  10.68   1  1.9978 0.1592
## Residuals  989.38 185
```

```r
print(Anova(lm(subj.understanding ~ Age * Design, data = d), type=2))
```

```
## Anova Table (Type II tests)
##
## Response: subj.understanding
##              Sum Sq  Df F value    Pr(>F)
## Age           2.818   1  1.9297    0.1665
## Design       29.851   1 20.4441 1.094e-05 ***
## Age:Design    0.050   1  0.0339    0.8541
## Residuals   270.126 185
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```r
print(Anova(lm(communication.efficacy ~ Age * Design, data = d), type=2))
```

```
## Anova Table (Type II tests)
##
## Response: communication.efficacy
##             Sum Sq  Df F value    Pr(>F)
## Age          0.000   1  0.0000    0.9965
## Design      24.732   1 62.5928 2.251e-13 ***
## Age:Design   0.069   1  0.1749    0.6762
## Residuals   73.099 185
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```r
print(Anova(lm(subj.clarity ~ Age * Design, data = d), type=2))
```

```
## Anova Table (Type II tests)
##
## Response: subj.clarity
##              Sum Sq  Df F value    Pr(>F)
## Age           1.453   1  0.9181    0.3392
## Design       61.056   1 38.5798 3.386e-09 ***
## Age:Design    2.759   1  1.7435    0.1883
## Residuals   292.779 185
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```r
print(Anova(lm(oc.score ~ income.lower.bound * Design, data = d), type=2))
```

```
## Anova Table (Type II tests)
##
## Response: oc.score
##                           Sum Sq  Df F value Pr(>F)
## income.lower.bound         34.25   1  6.4728 0.0118 *
## Design                      0.05   1  0.0085 0.9266
## income.lower.bound:Design   0.62   1  0.1164 0.7334
## Residuals                 947.17 179
```

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

```r
print(Anova(lm(subj.understanding ~ income.lower.bound * Design, data = d),
type=2))
```

```
## Anova Table (Type II tests)
##
## Response: subj.understanding
##                            Sum Sq  Df F value    Pr(>F)
## income.lower.bound          1.741   1  1.1913    0.2765
## Design                     29.603   1 20.2532 1.219e-05 ***
## income.lower.bound:Design   1.417   1  0.9697    0.3261
## Residuals                 261.637 179
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```r
print(Anova(lm(communication.efficacy ~ income.lower.bound * Design, data =
d), type=2))
```

```
## Anova Table (Type II tests)
##
## Response: communication.efficacy
##                           Sum Sq  Df F value    Pr(>F)
## income.lower.bound         0.102   1  0.2638    0.6081
## Design                    26.107   1 67.2448 4.504e-14 ***
## income.lower.bound:Design  0.241   1  0.6209    0.4318
## Residuals                 69.496 179
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```r
print(Anova(lm(subj.clarity ~ income.lower.bound * Design, data = d),
type=2))
```

```
## Anova Table (Type II tests)
##
## Response: subj.clarity
##                            Sum Sq  Df F value    Pr(>F)
## income.lower.bound          0.078   1  0.0496   0.82409
## Design                     62.553   1 39.6061 2.324e-09 ***
## income.lower.bound:Design   7.088   1  4.4876   0.03552 *
## Residuals                 282.709 179
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```r
print(Anova(lm(oc.score ~ Adults.in.House.Value * Design, data = d), type=2))
```

```
## Anova Table (Type II tests)
##
## Response: oc.score
##                               Sum Sq  Df F value Pr(>F)
## Adults.in.House.Value           4.36   1  0.8239 0.3652
```

```
## Design                              0.00   1  0.0000 0.9965
## Adults.in.House.Value:Design        9.79   1  1.8498 0.1754
## Residuals                        1000.22 189
```

```
print(Anova(lm(subj.understanding ~ Adults.in.House.Value * Design, data =
d), type=2))
```

```
## Anova Table (Type II tests)
##
## Response: subj.understanding
##                                Sum Sq  Df F value    Pr(>F)
## Adults.in.House.Value           3.489   1  2.4249    0.1211
## Design                         30.562   1 21.2412 7.437e-06 ***
## Adults.in.House.Value:Design    2.755   1  1.9150    0.1680
## Residuals                     271.937 189
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
print(Anova(lm(communication.efficacy ~ Adults.in.House.Value * Design, data
= d), type=2))
```

```
## Anova Table (Type II tests)
##
## Response: communication.efficacy
##                               Sum Sq  Df F value    Pr(>F)
## Adults.in.House.Value          0.277   1  0.6835    0.4094
## Design                        23.395   1 57.7553 1.342e-12 ***
## Adults.in.House.Value:Design   0.008   1  0.0201    0.8875
## Residuals                     76.559 189
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
print(Anova(lm(subj.clarity ~ Adults.in.House.Value * Design, data = d),
type=2))
```

```
## Anova Table (Type II tests)
##
## Response: subj.clarity
##                                Sum Sq  Df F value    Pr(>F)
## Adults.in.House.Value           4.820   1  3.0846   0.08066 .
## Design                         61.297   1 39.2298 2.481e-09 ***
## Adults.in.House.Value:Design    2.278   1  1.4580   0.22875
## Residuals                     295.314 189
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
print(Anova(lm(oc.score ~ Children.in.House.Value * Design, data = d),
type=2))
```

```
## Anova Table (Type II tests)
##
## Response: oc.score
```

```
##                                     Sum Sq  Df F value Pr(>F)
## Children.in.House.Value              4.36   1  0.8239 0.3652
## Design                               0.00   1  0.0000 0.9965
## Children.in.House.Value:Design       9.79   1  1.8498 0.1754
## Residuals                         1000.22 189
```

```
print(Anova(lm(subj.understanding ~ Children.in.House.Value * Design, data =
d), type=2))
```

```
## Anova Table (Type II tests)
##
## Response: subj.understanding
##                                    Sum Sq  Df F value    Pr(>F)
## Children.in.House.Value             3.489   1  2.4249    0.1211
## Design                             30.562   1 21.2412 7.437e-06 ***
## Children.in.House.Value:Design      2.755   1  1.9150    0.1680
## Residuals                         271.937 189
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
print(Anova(lm(communication.efficacy ~ Children.in.House.Value * Design,
data = d), type=2))
```

```
## Anova Table (Type II tests)
##
## Response: communication.efficacy
##                                   Sum Sq  Df F value    Pr(>F)
## Children.in.House.Value            0.277   1  0.6835    0.4094
## Design                            23.395   1 57.7553 1.342e-12 ***
## Children.in.House.Value:Design     0.008   1  0.0201    0.8875
## Residuals                         76.559 189
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
print(Anova(lm(subj.clarity ~ Children.in.House.Value * Design, data = d),
type=2))
```

```
## Anova Table (Type II tests)
##
## Response: subj.clarity
##                                    Sum Sq  Df F value    Pr(>F)
## Children.in.House.Value             4.820   1  3.0846   0.08066 .
## Design                             61.297   1 39.2298 2.481e-09 ***
## Children.in.House.Value:Design      2.278   1  1.4580   0.22875
## Residuals                         295.314 189
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
print(Anova(lm(oc.score ~ subjective.numeracy * Design, data = d), type=2))
```

```
## Anova Table (Type II tests)
##
```

```
## Response: oc.score
##                              Sum Sq  Df F value    Pr(>F)    
## subjective.numeracy          176.27   1 39.7518 1.989e-09 ***
## Design                         0.05   1  0.0122    0.9122    
## subjective.numeracy:Design     0.01   1  0.0014    0.9704    
## Residuals                    838.09 189                      
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
print(Anova(lm(subj.understanding ~ subjective.numeracy * Design, data = d),
type=2))
```

```
## Anova Table (Type II tests)
## 
## Response: subj.understanding
##                               Sum Sq  Df F value    Pr(>F)    
## subjective.numeracy           24.180   1 18.0173 3.428e-05 ***
## Design                        31.895   1 23.7660 2.299e-06 ***
## subjective.numeracy:Design     0.358   1  0.2664    0.6063    
## Residuals                    253.644 189                      
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

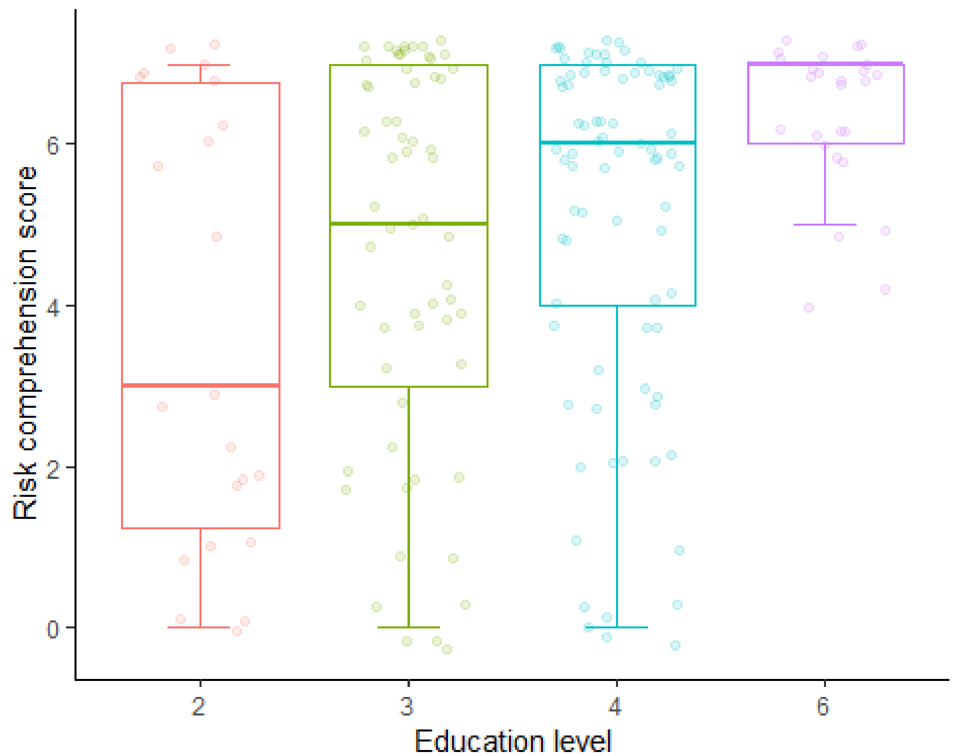
```
print(Anova(lm(communication.efficacy ~ subjective.numeracy * Design, data =
d), type=2))
```

```
## Anova Table (Type II tests)
## 
## Response: communication.efficacy
##                              Sum Sq  Df F value    Pr(>F)    
## subjective.numeracy           2.171   1  5.4957    0.0201 *  
## Design                       23.745   1 60.1122 5.386e-13 ***
## subjective.numeracy:Design    0.016   1  0.0405    0.8407    
## Residuals                    74.657 189                      
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
print(Anova(lm(subj.clarity ~ subjective.numeracy * Design, data = d),
type=2))
```

```
## Anova Table (Type II tests)
## 
## Response: subj.clarity
##                               Sum Sq  Df F value    Pr(>F)    
## subjective.numeracy           13.764   1  9.0193  0.003033 ** 
## Design                        63.132   1 41.3695 1.006e-09 ***
## subjective.numeracy:Design     0.225   1  0.1474  0.701485    
## Residuals                    288.423 189                      
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
# Examine range of educational backgrounds
# 2 = GCSE or equivalent
# 3 = A-level or equivalent
# 4 = Bachelors
# 5 = Masters
# 7 = PhD or greater
#
table(d$Education)

##
##  2  3  4  5  7
## 22 61 81 21  5

# Since so few in PhD category, lump 5 & 7 together into
# 6 = Postgraduate study

d$Education2 <- as.factor(mapvalues(d$Education,
                                     from=c(2,3,4,5,7),
                                     to=c(2,3,4,6,6)))

ggplot(data=subset(d, !is.na(d$Education2)), mapping=aes(x=Education2,
y=oc.score)) + stat_boxplot(aes(col=Education2), geom = "errorbar", width =
0.3) +
  geom_boxplot( aes(col=Education2),outlier.shape=NA,notch=F) + #avoid
plotting outliers twice, notch set to F as data means goes out of hinges
  geom_jitter(aes(col=Education2),position = position_jitter(width = .3,
height=0.3), alpha = 0.15)+ theme_classic()+
  labs(x="Education level",y="Risk comprehension score") +
  theme(legend.position="none")
```




```
d$Education_low_vs_high <- mapvalues(d$Education,
                           from=c(2,3,4,5,7),
                           to=c(2,NA,NA,6,6))

print(summary(aov(oc.score ~ Education_low_vs_high * Design, data = d,
na.action=na.omit)))

##                                Df Sum Sq Mean Sq F value   Pr(>F)
## Education_low_vs_high           1  81.73   81.73  20.371 4.72e-05 ***
## Design                          1   2.45    2.45   0.610    0.439
## Education_low_vs_high:Design    1   1.26    1.26   0.315    0.577
## Residuals                      44 176.54    4.01
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## 145 observations deleted due to missingness

print(summary(aov(subj.understanding ~ Education_low_vs_high * Design, data =
d, na.action=na.omit)))

##                                Df Sum Sq Mean Sq F value  Pr(>F)
## Education_low_vs_high           1  12.42  12.422   8.546 0.00545 **
## Design                          1   4.79   4.795   3.298 0.07616 .
## Education_low_vs_high:Design    1   0.49   0.493   0.339 0.56326
## Residuals                      44  63.96   1.454
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## 145 observations deleted due to missingness
```

```r
print(summary(aov(communication.efficacy ~ Education_low_vs_high * Design,
data = d, na.action=na.omit)))
```

```
##                                Df Sum Sq Mean Sq F value Pr(>F)
## Education_low_vs_high           1  0.724   0.724   1.733  0.195
## Design                          1  5.193   5.193  12.427  0.001 **
## Education_low_vs_high:Design    1  0.118   0.118   0.282  0.598
## Residuals                      44 18.386   0.418
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## 145 observations deleted due to missingness
```

```r
print(summary(aov(subj.clarity ~ Education_low_vs_high * Design, data = d,
na.action=na.omit)))
```

```
##                                Df Sum Sq Mean Sq F value Pr(>F)
## Education_low_vs_high           1   3.92   3.918   2.403 0.1283
## Design                          1   7.93   7.927   4.861 0.0327 *
## Education_low_vs_high:Design    1   0.06   0.064   0.039 0.8442
## Residuals                      44  71.76   1.631
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## 145 observations deleted due to missingness
```