```r
knitr::opts_chunk$set(echo = TRUE)
nsims <- 100000 #set number of simulations
require(mvtnorm, quietly = TRUE)
require(MASS, quietly = TRUE)
require(afex, quietly = TRUE)
require(emmeans, quietly = TRUE)
require(ggplot2, quietly = TRUE)
require(gridExtra, quietly = TRUE)
require(reshape2, quietly = TRUE)
require(pwr, quietly = TRUE)
```

Validation of Power in Mixed ANOVA

We install the functions:

```r
# Install the two functions from GitHub by running the code below:

source("https://raw.githubusercontent.com/Lakens/ANOVA_power_simulation/master/ANOVA_design.R")
source("https://raw.githubusercontent.com/Lakens/ANOVA_power_simulation/master/ANOVA_power.R")
```

Two by two ANOVA, within-between design

We can simulate a Two-Way ANOVA with a specific alpha, sample size and effect size, to achieve a specified statistical power. We wil try to reproduce the power analysis by g*power for an F-test, ANOVA: Repeated measures, within-between interaction.

For the 2-way interaction, the result should be a power of 91.25% is we have a total samplesize of 46. Since we have 2 groups in the between factor that means the sample size per group is 2 (and both these groups collect 2 repeated measures).

```r
mu <- c(-0.25, 0.25, 0.25, -0.25)
n <- 23
sd <- 1
r <- 0.5
string = "2w*2b"
alpha_level <- 0.05
labelnames = c("age", "old", "young", "color", "blue", "red")
design_result <- ANOVA_design(string = string,
                              n = n,
                              mu = mu,
                              sd = sd,
                              r = r,
                              labelnames = labelnames)
```

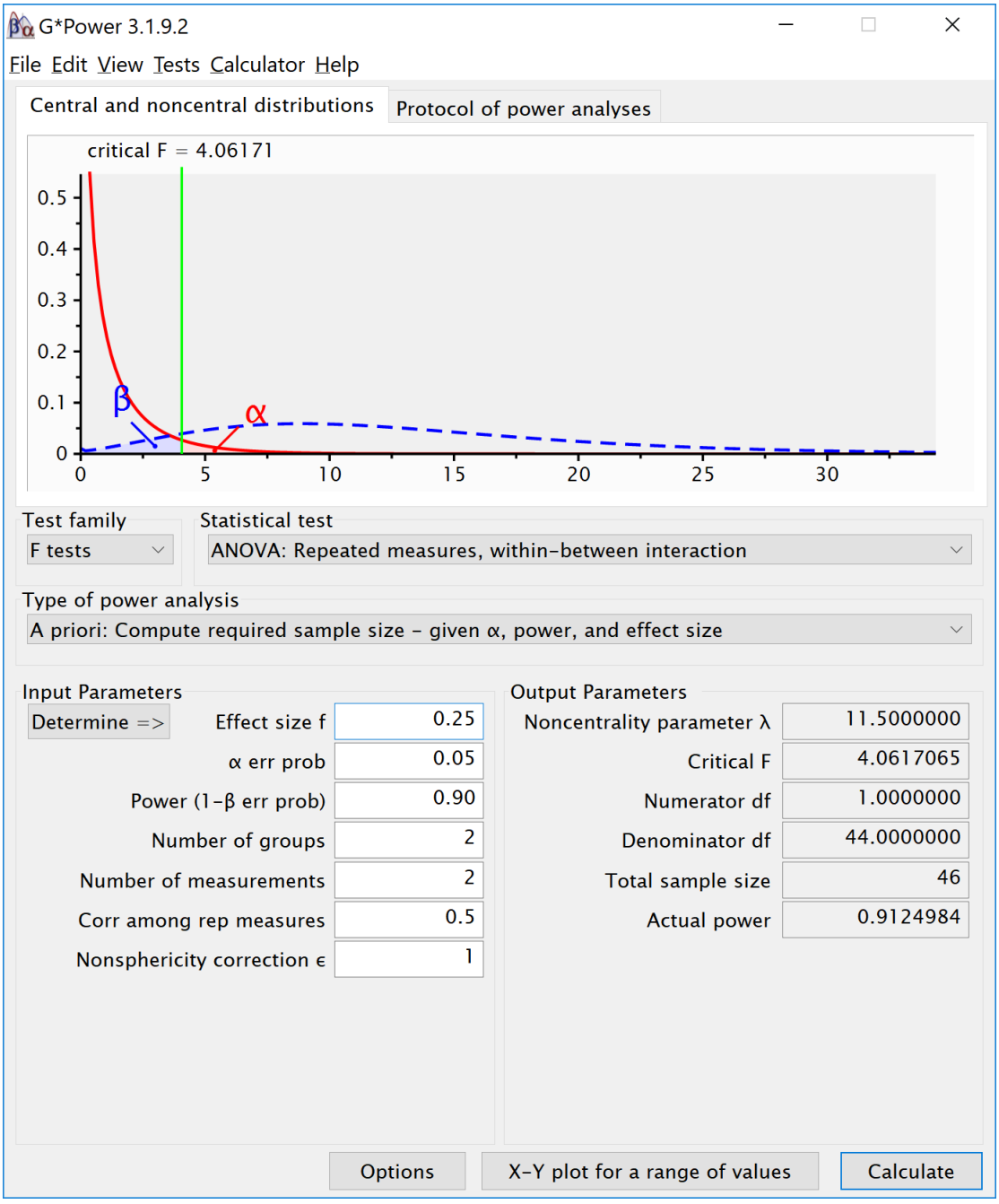
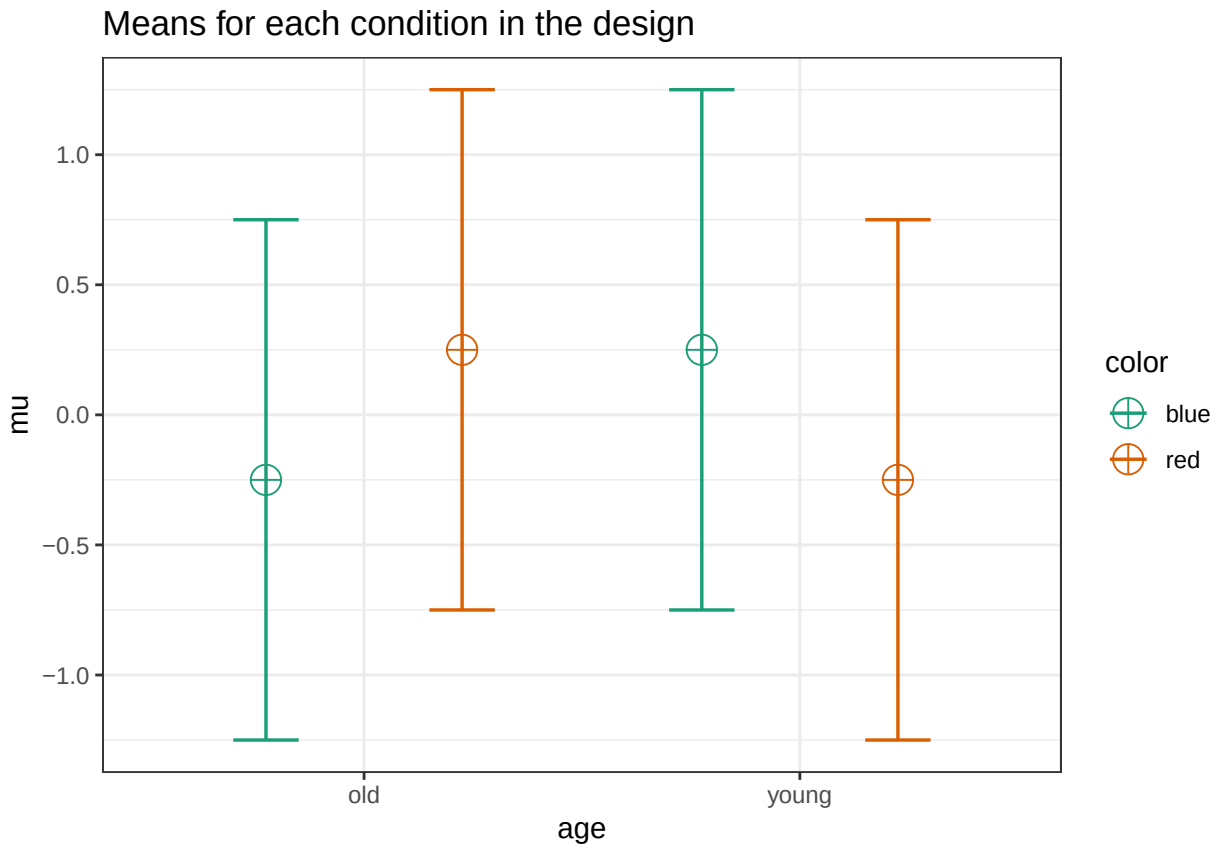

G*Power 3.1.9.2
File Edit View Tests Calculator Help
Central and noncentral distributions
Protocol of power analyses
critical F = 4.06171
0.5
0.4
0.3
0.2
0.1
0
β
α
0
5
10
15
20
25
30
Test family
F tests
Statistical test
ANOVA: Repeated measures, within-between interaction
Type of power analysis
A priori: Compute required sample size – given α, power, and effect size
Input Parameters
Determine =>
Effect size f
0.25
α err prob
0.05
Power (1-β err prob)
0.90
Number of groups
2
Number of measurements
2
Corr among rep measures
0.5
Nonsphericity correction ε
1
Output Parameters
Noncentrality parameter λ
11.5000000
Critical F
4.0617065
Numerator df
1.0000000
Denominator df
44.0000000
Total sample size
46
Actual power
0.9124984
Options
X-Y plot for a range of values
Calculate

Figure 1:




```
simulation_result <- ANOVA_power(design_result, alpha = 0.05, nsims = nsims)
```

```
## Power and Effect sizes for ANOVA tests
##                  power effect size
## anova_color      5.087      0.0103
## anova_age        5.105      0.0105
## anova_color:age 91.190      0.2086
##
## Power and Effect sizes for contrasts
##                                              power effect size
## p_age_old_color_blue_age_old_color_red      38.039      0.5083
## p_age_old_color_blue_age_young_color_blue   62.954      0.5174
## p_age_old_color_blue_age_young_color_red     4.998     -0.0004
## p_age_old_color_red_age_young_color_blue     5.025     -0.0003
## p_age_old_color_red_age_young_color_red     63.078     -0.5178
## p_age_young_color_blue_age_young_color_red 38.033     -0.5085
```

Two by two ANOVA, within-between design Variation 1

We can simulate the same Two-Way ANOVA increasing the correlation to 0.7.

```
mu <- c(-0.25, 0.25, 0.25, -0.25)
n <- 23
sd <- 1
```

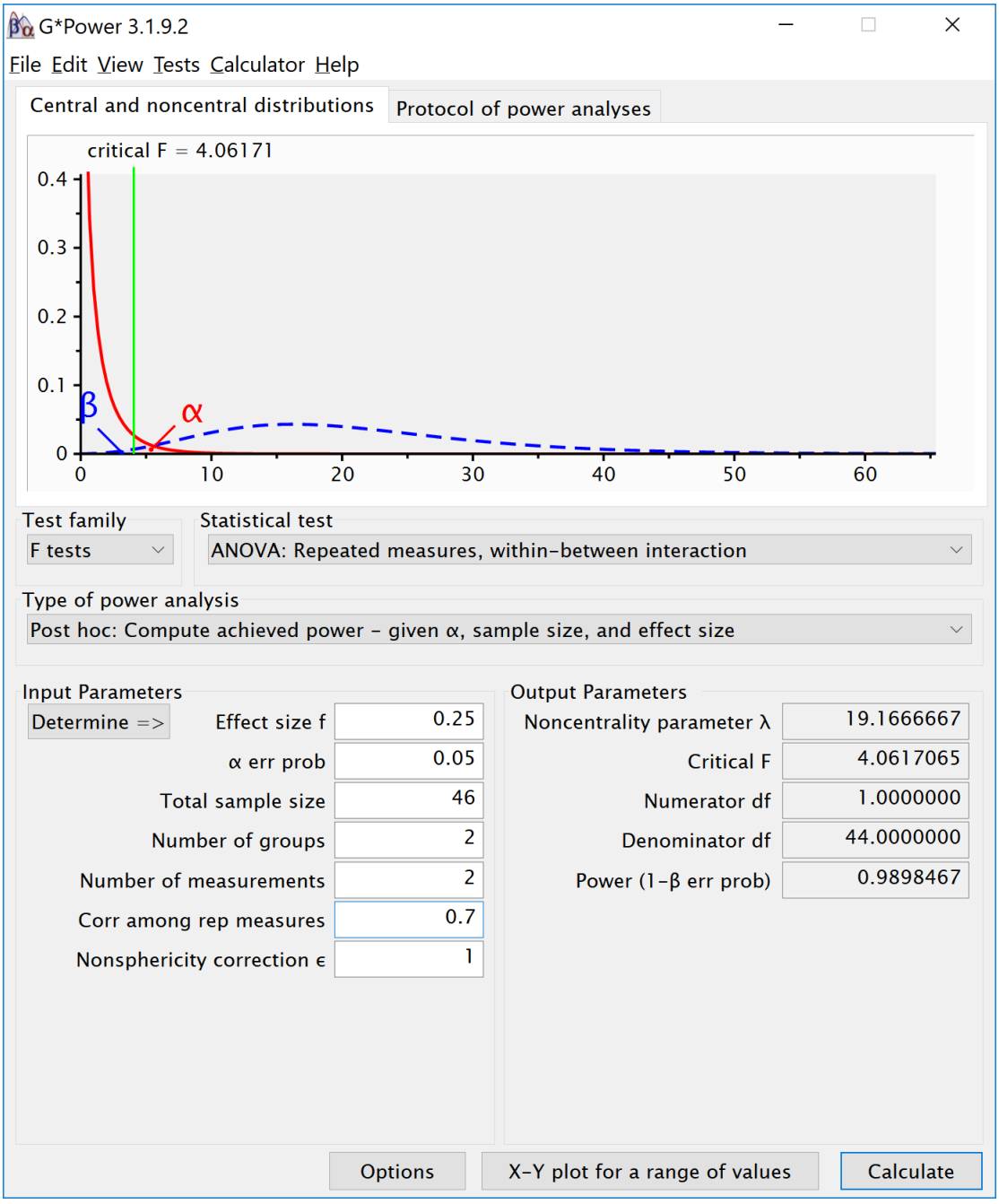
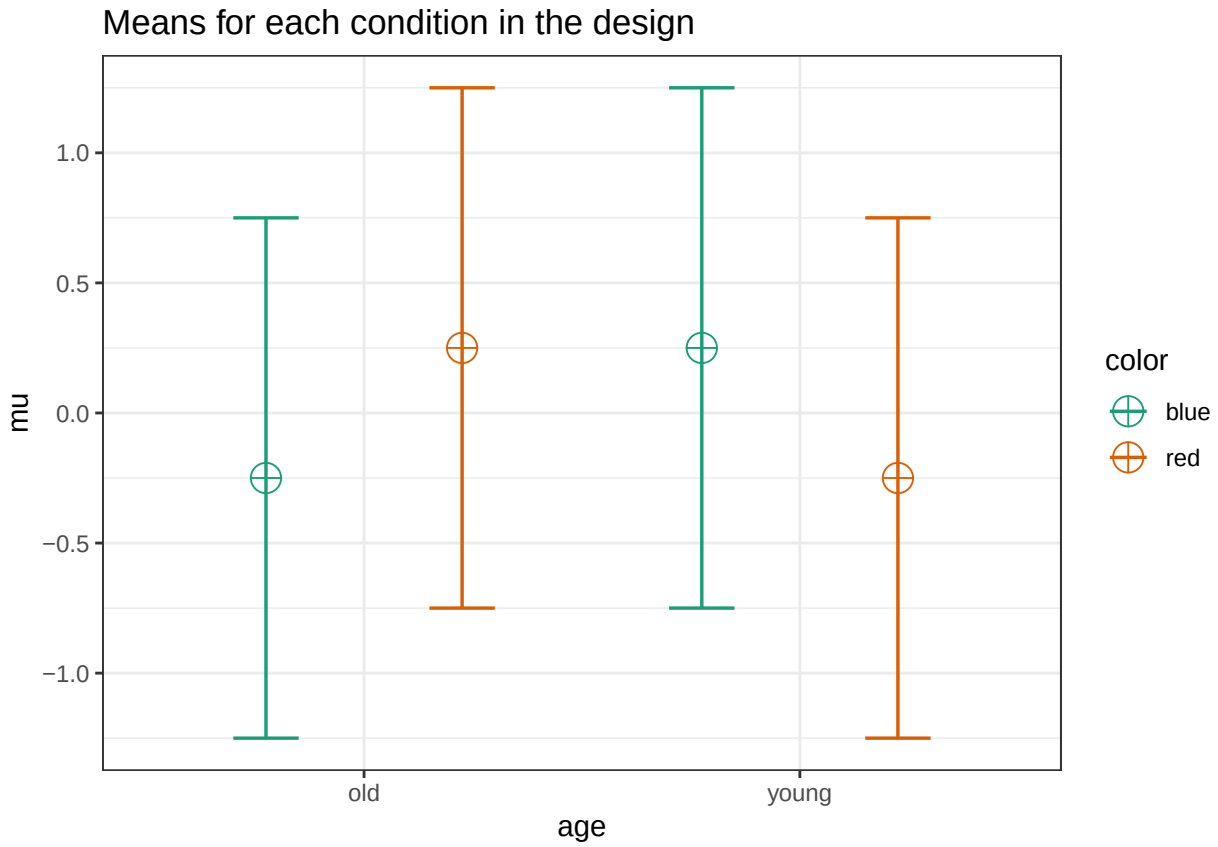

G*Power 3.1.9.2
File Edit View Tests Calculator Help
Central and noncentral distributions
Protocol of power analyses
critical F = 4.06171
0.4
0.3
0.2
0.1
0
β
α
0
10
20
30
40
50
60
Test family
F tests
Statistical test
ANOVA: Repeated measures, within-between interaction
Type of power analysis
Post hoc: Compute achieved power – given α, sample size, and effect size
Input Parameters
Determine =>
Effect size f
0.25
α err prob
0.05
Total sample size
46
Number of groups
2
Number of measurements
2
Corr among rep measures
0.7
Nonsphericity correction ε
1
Output Parameters
Noncentrality parameter λ
19.1666667
Critical F
4.0617065
Numerator df
1.0000000
Denominator df
44.0000000
Power (1-β err prob)
0.9898467
Options
X-Y plot for a range of values
Calculate

Figure 2:

```
r <- 0.7
string = "2w*2b"
alpha_level <- 0.05
labelnames = c("age", "old", "young", "color", "blue", "red")
design_result <- ANOVA_design(string = string,
                              n = n,
                              mu = mu,
                              sd = sd,
                              r = r,
                              labelnames = labelnames)
```




```
simulation_result <- ANOVA_power(design_result, alpha = 0.05, nsims = nsims)
```

```
## Power and Effect sizes for ANOVA tests
##                  power effect size
## anova_color      5.025      0.0104
## anova_age        5.120      0.0105
## anova_color:age 98.936      0.3063
##
## Power and Effect sizes for contrasts
##                                            power effect size
## p_age_old_color_blue_age_old_color_red     38.362      0.5086
## p_age_old_color_blue_age_young_color_blue  83.908      0.6677
## p_age_old_color_blue_age_young_color_red    4.991     -0.0004
## p_age_old_color_red_age_young_color_blue    5.001     -0.0002
```

```
## p_age_old_color_red_age_young_color_red    84.022     -0.6692
## p_age_young_color_blue_age_young_color_red 38.155     -0.5085
```