ResultsSect

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Descriptives

Participants

Thirty CW (mean age = 25.80 years, SD = 3.84), 30 CM (mean age = 26.03 years, SD = 5.26), 40 TM (mean age = 24.38 years, SD = 5.35), and 41 TW (mean age = 24.88 years, SD = 6.20) participated in the study. One TW participant was excluded because no results could be extracted from FreeSurfer. Demographics can be observed in Table 1. The sample did not differ significantly in age [F(3, 136) = 0.74, p = 0.528].

Table with demographic information

Table 1: Demographics

Group	CW	CM	TM	TW
Age	25.8 ± 3.84	26.03 ± 5.26	24.38 ± 5.35	24.88 ± 6.2
SES	2.3 ± 0.47	2.23 ± 0.57	2 ± 0.6	1.98 ± 0.7
Education	3.57 ± 0.9	3.43 ± 0.82	3.15 ± 0.74	2.95 ± 0.81
Handedness	1.13 ± 0.35	1.07 ± 0.25	1.07 ± 0.27	1.05 ± 0.22

Code for demographics

The code can be found in markdown version of this file, it is not printed in the PDF

```
# Difference between groups for ICV
fit <- lm(formula = c(data.all[,108], data.all[,182]) ~ as.factor(c(data.all[,2],data.all[,2])))
anova(fit)
```

```
## Analysis of Variance Table
##
## Response: c(data.all[, 108], data.all[, 182])
##                                            Df     Sum Sq    Mean Sq
## as.factor(c(data.all[, 2], data.all[, 2]))   3 1.5165e+12 5.0550e+11
## Residuals                                  276 3.5282e+12 1.2783e+10
##                                            F value    Pr(>F)
## as.factor(c(data.all[, 2], data.all[, 2]))  39.544 < 2.2e-16 ***
## Residuals
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
# Average (sd) of ICV for every group
  print(paste("ICV in transgender women is ", mean(c(data.all[data.all[,2]==1,108], data.all[data.all
```

```
## [1] "ICV in transgender women is 1518358.56348333 (90970.2244213793), "
```

```
  print(paste("ICV in transgender women is ", mean(c(data.all[data.all[,2]==2,108], data.all[data.all
```

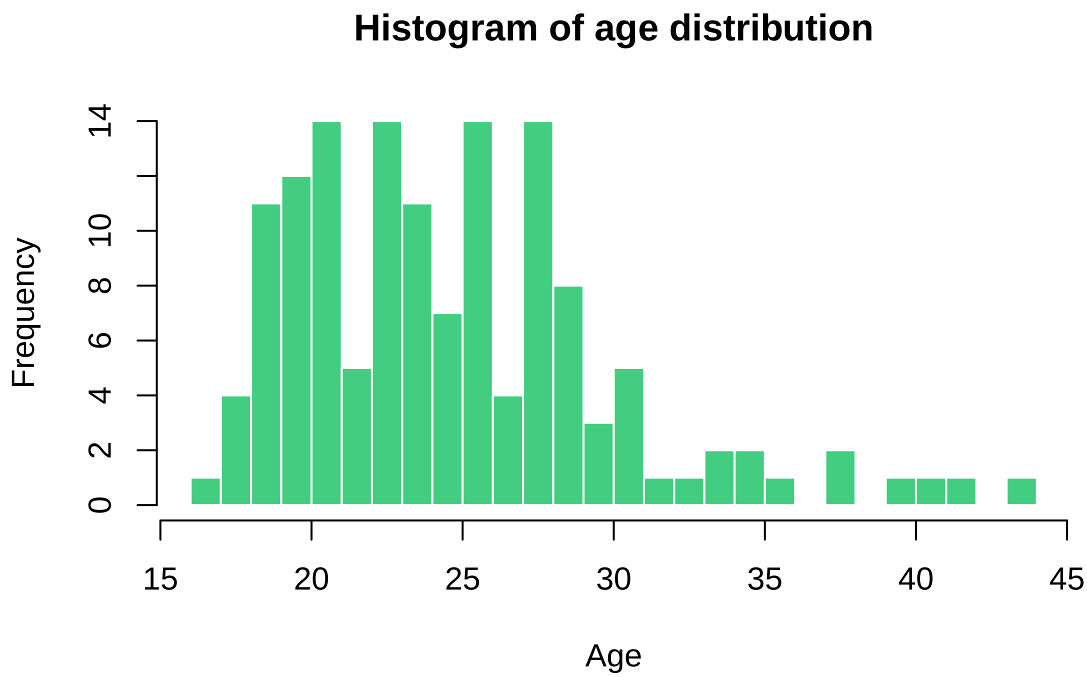
```
## [1] "ICV in transgender women is 1648274.8288 (125281.566112056), "
```

```
print(paste("ICV in transgender women is ", mean(c(data.all[data.all[,2]==3,108], data.all[data.all
```

```
## [1] "ICV in transgender women is 1472419.387075 (114092.749698607), "
```

```
print(paste("ICV in transgender women is ", mean(c(data.all[data.all[,2]==4,108], data.all[data.all
```

```
## [1] "ICV in transgender women is 1624673.961825 (117220.821129745), "
```



Results

Repeated measures

Questions: do we want (to account for) a correlation between regions of the same participant?

First we look at the results for volume. Alle code used to compute this can be found in the markdown version of this document, but is not printed in the pdf.
We fitted two mixed models. In both models a random intercept for every subject was added, in the second model age and total intracranial volume are added as covariates. An ANOVA is conducted on the results of the mixed models and an FDR-correction is applied over regions. For the regions where a statistically significant difference was found between the groups post-hoc paired comparisons were conducted that are bonferroni-corrected. The results for both models are very similar. A summary of the results is displayed in the tables below. All code used to obtain these results can be found in the RmD file.
If no statistically significant difference is found for a regions "NA" is printed for that region.

Table 2: ANOVA for volume with FDR correction for model with and without covariates

region	No cov	With cov
L_fusiform_volume	0	0
L_inferiorparietal_volume	0	0
L_postcentral_volume	0.001	0
L_precentral_volume	0.012	0.008
L_frontalpole_volume	0.008	0.007

R__fusiform__volume	0	0
R__inferiorparietal__volume	0	0
R__postcentral__volume	0.01	0.007
R__precentral__volume	0.001	0.001
R__frontalpole__volume	0.002	0.002
LeftCerebellumWhiteMatter	0.001	0.001
LeftCerebellumCortex	0	0
RightCerebellumWhiteMatter	0.001	0.001
RightCerebellumCortex	0	0
LeftThalamusProper	0	0
LeftCaudate	0.003	0.002
LeftPutamen	0.006	0.004
LeftAccumbensarea	0.542	0.547
RightThalamusProper	0	0
RightCaudate	0.002	0.001
RightPutamen	0	0
RightAccumbensarea	0.121	0.115

Table 3: Group-wise comparison for volume in model with no covariates

	CW vs CM	CW vs TM	CW vs TW	CM vs TM	CM vs TW	TM vs TW
L__fusiform__volume	0.04	0.061	1	0	0.608	0
L__inferiorparietal__volume	0.108	0.076	1	0	1	0.006
L__postcentral__volume	0.007	1	0.357	0.001	1	0.067
L__precentral__volume	0.263	1	0.963	0.026	1	0.115
L__frontalpole__volume	1	1	0.023	1	0.814	0.005
R__fusiform__volume	0.015	0.02	1	0	0.891	0.004
R__inferiorparietal__volume	0.238	0.289	0.786	0	1	0.001
R__postcentral__volume	0.965	1	0.597	0.042	1	0.013
R__precentral__volume	0.017	1	0.013	0.019	1	0.022
R__frontalpole__volume	0.054	1	1	0.001	0.22	0.433
LeftCerebellumWhiteMatter	0.018	1	1	0.001	0.009	0.754
LeftCerebellumCortex	0.004	0.41	0.006	0	1	0
RightCerebellumWhiteMatter	0.018	1	1	0	0.056	0.258
RightCerebellumCortex	0.002	0.184	0.046	0	1	0
LeftThalamusProper	0.005	0.065	1	0	0.056	0.002
LeftCaudate	0.028	1	0.072	0.025	1	0.065
LeftPutamen	0.071	1	0.211	0.032	1	0.11
LeftAccumbensarea	NA	NA	NA	NA	NA	NA
RightThalamusProper	0.143	0.033	1	0	0.455	0.004
RightCaudate	0.004	1	0.162	0.005	1	0.149
RightPutamen	0	1	0.001	0.001	1	0.015
RightAccumbensarea	NA	NA	NA	NA	NA	NA

Table 4: Group-wise comparison for volume in model with covariates

	CW vs CM	CW vs TM	CW vs TW	CM vs TM	CM vs TW	TM vs TW
L__fusiform__volume	0.883	0.049	1	0	1	0.001
L__inferiorparietal__volume	1	0.054	1	0	1	0.015
L__postcentral__volume	1	1	1	0.01	1	0.233
L__precentral__volume	1	1	1	0.324	1	0.184

L__frontalpole__volume	1	1	0.156	1	0.269	0.019
R__fusiform__volume	0.533	0.02	1	0	0.718	0.008
R__inferiorparietal__volume	1	0.198	1	0.005	1	0.002
R__postcentral__volume	1	1	1	0.322	1	0.046
R__precentral__volume	1	1	0.047	0.221	1	0.024
R__frontalpole__volume	0.381	1	1	0.002	0.286	0.701
LeftCerebellumWhiteMatter	1	1	1	0.006	0.103	1
LeftCerebellumCortex	0.149	0.446	0.012	0	1	0
RightCerebellumWhiteMatter	1	0.879	1	0.006	0.365	0.484
RightCerebellumCortex	0.086	0.203	0.071	0	1	0
LeftThalamusProper	1	0.078	1	0	1	0.004
LeftCaudate	1	1	0.236	0.074	1	0.145
LeftPutamen	1	1	0.588	0.693	1	0.157
LeftAccumbensarea	NA	NA	NA	NA	NA	NA
RightThalamusProper	1	0.032	1	0.008	1	0.012
RightCaudate	0.87	1	0.474	0.029	1	0.277
RightPutamen	0.451	1	0.005	0.065	1	0.02
RightAccumbensarea	NA	NA	NA	NA	NA	NA

Then we do the same computations for thickness. However, for thickness we leave out intracranial volume as a covariate (cf. e-mail Meredith Braskie).

Table 5: ANOVA for thickness with FDR correction for model with and without covariates

region	No cov	With cov
L__fusiform__thickavg	0.683	0.68
R__fusiform__thickavg	0.661	0.612
L__inferiorparietal__thickavg	0.661	0.612
R__inferiorparietal__thickavg	0.661	0.612
L__postcentral__thickavg	0.683	0.68
R__postcentral__thickavg	0.753	0.74
L__precentral__thickavg	0.661	0.612
R__precentral__thickavg	0.661	0.612
L__frontalpole__thickavg	0.661	0.612
R__frontalpole__thickavg	0.661	0.612

Table 6: Group-wise comparison for thickness in model with no covariates

	CW vs CM	CW vs TM	CW vs TW	CM vs TM	CM vs TW	TM vs TW
L__fusiform__thickavg	NA	NA	NA	NA	NA	NA
R__fusiform__thickavg	NA	NA	NA	NA	NA	NA
L__inferiorparietal__thickavg	NA	NA	NA	NA	NA	NA
R__inferiorparietal__thickavg	NA	NA	NA	NA	NA	NA
L__postcentral__thickavg	NA	NA	NA	NA	NA	NA
R__postcentral__thickavg	NA	NA	NA	NA	NA	NA
L__precentral__thickavg	NA	NA	NA	NA	NA	NA
R__precentral__thickavg	NA	NA	NA	NA	NA	NA
L__frontalpole__thickavg	NA	NA	NA	NA	NA	NA
R__frontalpole__thickavg	NA	NA	NA	NA	NA	NA

Table 7: Group-wise comparison for thickness in model with covariates

	CW vs CM	CW vs TM	CW vs TW	CM vs TM	CM vs TW	TM vs TW
L__fusiform__thickavg	NA	NA	NA	NA	NA	NA
R__fusiform__thickavg	NA	NA	NA	NA	NA	NA
L__inferiorparietal__thickavg	NA	NA	NA	NA	NA	NA
R__inferiorparietal__thickavg	NA	NA	NA	NA	NA	NA
L__postcentral__thickavg	NA	NA	NA	NA	NA	NA
R__postcentral__thickavg	NA	NA	NA	NA	NA	NA
L__precentral__thickavg	NA	NA	NA	NA	NA	NA
R__precentral__thickavg	NA	NA	NA	NA	NA	NA
L__frontalpole__thickavg	NA	NA	NA	NA	NA	NA
R__frontalpole__thickavg	NA	NA	NA	NA	NA	NA

And surface area:

Table 8: ANOVA for surface area with FDR correction for model with and without covariates

region	No cov	With cov
L__fusiform__surfavg	0.004	0
R__fusiform__surfavg	0.014	0.001
L__inferiorparietal__surfavg	0.001	0
R__inferiorparietal__surfavg	0.003	0
L__postcentral__surfavg	0.019	0.001
R__postcentral__surfavg	0.082	0.012
L__precentral__surfavg	0.012	0.001
R__precentral__surfavg	0.002	0
L__frontalpole__surfavg	0.612	0.539
R__frontalpole__surfavg	0.001	0

Table 9: Group-wise comparison for surface area in model with no covariates

	CW vs CM	CW vs TM	CW vs TW	CM vs TM	CM vs TW	TM vs TW
L__fusiform__surfavg	0.034	1	1	0.001	0.08	1
R__fusiform__surfavg	0.065	1	1	0.003	0.543	0.896
L__inferiorparietal__surfavg	0.009	1	1	0	0.174	0.175
R__inferiorparietal__surfavg	0.009	1	1	0.001	0.227	0.545
L__postcentral__surfavg	0.004	1	1	0.203	0.159	1
R__postcentral__surfavg	NA	NA	NA	NA	NA	NA
L__precentral__surfavg	0.016	1	0.365	0.02	1	0.444
R__precentral__surfavg	0	0.418	0.128	0.05	0.314	1
L__frontalpole__surfavg	NA	NA	NA	NA	NA	NA
R__frontalpole__surfavg	0.004	1	1	0.001	0.003	1

Table 10: Group-wise comparison for surface area in model with covariates

	CW vs CM	CW vs TM	CW vs TW	CM vs TM	CM vs TW	TM vs TW

L__fusiform__surfavg	1	0.68	1	0.154	0.876	1
R__fusiform__surfavg	1	0.205	1	0.254	1	1
L__inferiorparietal__surfavg	1	0.513	1	0.016	1	0.218
R__inferiorparietal__surfavg	1	1	1	0.044	1	0.842
L__postcentral__surfavg	1	1	1	1	1	1
R__postcentral__surfavg	1	1	1	1	1	1
L__precentral__surfavg	1	1	1	0.666	1	0.87
R__precentral__surfavg	0.541	0.447	0.466	1	1	1
L__frontalpole__surfavg	NA	NA	NA	NA	NA	NA
R__frontalpole__surfavg	0.417	1	1	0.051	0.037	1

Compare to results from 1 timepoint

In this section we explore what the results would have been if we would have been limited to one scan for the analysis. Tables 11, 14 and 17 show the p-values resulting from the anova's conducted on T1, T2 and both respectively. You can observe the (slight) increase in power here.

Volume

Table 11: Comparison volume

Region	T1	T2	Rep Meas
L__fusiform__volume	0	0	0
L__inferiorparietal__volume	0.001	0	0
L__postcentral__volume	0.002	0.001	0.001
L__precentral__volume	0.032	0.007	0.012
L__frontalpole__volume	0.006	0.045	0.008
R__fusiform__volume	0	0	0
R__inferiorparietal__volume	0.001	0	0
R__postcentral__volume	0.014	0.011	0.01
R__precentral__volume	0.002	0.001	0.001
R__frontalpole__volume	0.001	0.009	0.002
LeftCerebellumWhiteMatter	0.001	0.001	0.001
LeftCerebellumCortex	0	0	0
RightCerebellumWhiteMatter	0.001	0	0.001
RightCerebellumCortex	0	0	0
LeftThalamusProper	0	0	0
LeftCaudate	0.002	0.005	0.003
LeftPutamen	0.006	0.013	0.006
LeftAccumbensarea	0.453	0.249	0.542
RightThalamusProper	0	0	0
RightCaudate	0.002	0.002	0.002
RightPutamen	0	0	0
RightAccumbensarea	0.119	0.169	0.121

Table 12: Volume: T1

	CW vs CM	CW vs TM	CW vs TW	CM vs TM	CM vs TW	TM vs TW
L__fusiform__volume	0.014	0.047	1	0	0.202	0.001
L__inferiorparietal__volume	0.137	0.158	1	0	0.949	0.025
L__postcentral__volume	0.01	1	0.233	0.002	1	0.06
L__precentral__volume	0.284	1	0.807	0.087	1	0.243
L__frontalpole__volume	0.929	1	0.015	0.998	1	0.009
R__fusiform__volume	0.013	0.02	1	0	0.78	0.006
R__inferiorparietal__volume	0.162	0.568	1	0.001	1	0.006
R__postcentral__volume	0.87	1	0.534	0.067	1	0.018
R__precentral__volume	0.014	1	0.026	0.034	1	0.087
R__frontalpole__volume	0.004	1	0.624	0.005	0.177	0.724
LeftCerebellumWhiteMatter	0.036	0.775	1	0	0.01	0.677
LeftCerebellumCortex	0.005	0.587	0.009	0	1	0
RightCerebellumWhiteMatter	0.04	1	1	0.001	0.133	0.221
RightCerebellumCortex	0.003	0.227	0.058	0	1	0
LeftThalamusProper	0.004	0.196	0.61	0	0.174	0.002

LeftCaudate	0.021	1	0.072	0.02	1	0.066
LeftPutamen	0.14	1	0.417	0.032	1	0.069
LeftAccumbensarea	NA	NA	NA	NA	NA	NA
RightThalamusProper	0.127	0.047	1	0	0.775	0.004
RightCaudate	0.003	1	0.124	0.007	1	0.203
RightPutamen	0	1	0.002	0.001	1	0.03
RightAccumbensarea	NA	NA	NA	NA	NA	NA

Table 13: Volume: T2

	CW vs CM	CW vs TM	CW vs TW	CM vs TM	CM vs TW	TM vs TW
L__fusiform__volume	0.136	0.146	0.831	0	1	0
L__inferiorparietal__volume	0.119	0.075	1	0	1	0.003
L__postcentral__volume	0.007	1	0.393	0.001	0.981	0.088
L__precentral__volume	0.28	1	0.95	0.029	1	0.058
L__frontalpole__volume	1	1	0.169	1	1	0.027
R__fusiform__volume	0.03	0.009	1	0	0.87	0.004
R__inferiorparietal__volume	0.388	0.179	0.632	0.001	1	0
R__postcentral__volume	1	1	0.786	0.051	1	0.012
R__precentral__volume	0.03	1	0.009	0.023	1	0.007
R__frontalpole__volume	1	0.173	1	0.004	0.576	0.439
LeftCerebellumWhiteMatter	0.016	1	1	0	0.009	0.877
LeftCerebellumCortex	0.004	0.456	0.013	0	1	0
RightCerebellumWhiteMatter	0.01	1	1	0	0.024	0.337
RightCerebellumCortex	0.002	0.251	0.061	0	1	0
LeftThalamusProper	0.015	0.022	1	0	0.047	0.004
LeftCaudate	0.043	1	0.055	0.056	1	0.071
LeftPutamen	0.075	1	0.147	0.137	1	0.318
LeftAccumbensarea	NA	NA	NA	NA	NA	NA
RightThalamusProper	0.208	0.018	1	0	0.425	0.007
RightCaudate	0.007	1	0.142	0.005	1	0.118
RightPutamen	0	1	0	0.004	1	0.013
RightAccumbensarea	NA	NA	NA	NA	NA	NA

Thickness

Table 14: Comparison thickness

Region	T1	T2	Rep Meas
L__fusiform__thickavg	0.66	0.86	0.683
R__fusiform__thickavg	0.66	0.746	0.661
L__inferiorparietal__thickavg	0.66	0.746	0.661
R__inferiorparietal__thickavg	0.66	0.746	0.661
L__postcentral__thickavg	0.894	0.746	0.683
R__postcentral__thickavg	0.66	0.86	0.753
L__precentral__thickavg	0.66	0.746	0.661
R__precentral__thickavg	0.66	0.746	0.661
L__frontalpole__thickavg	0.66	0.86	0.661
R__frontalpole__thickavg	0.66	0.746	0.661

Table 15: Thickness: T1

	CW vs CM	CW vs TM	CW vs TW	CM vs TM	CM vs TW	TM vs TW
L_fusiform_thickavg	NA	NA	NA	NA	NA	NA
R_fusiform_thickavg	NA	NA	NA	NA	NA	NA
L_inferiorparietal_thickavg	NA	NA	NA	NA	NA	NA
R_inferiorparietal_thickavg	NA	NA	NA	NA	NA	NA
L_postcentral_thickavg	NA	NA	NA	NA	NA	NA
R_postcentral_thickavg	NA	NA	NA	NA	NA	NA
L_precentral_thickavg	NA	NA	NA	NA	NA	NA
R_precentral_thickavg	NA	NA	NA	NA	NA	NA
L_frontalpole_thickavg	NA	NA	NA	NA	NA	NA
R_frontalpole_thickavg	NA	NA	NA	NA	NA	NA

Table 16: Thickness: T2

	CW vs CM	CW vs TM	CW vs TW	CM vs TM	CM vs TW	TM vs TW
L_fusiform_thickavg	NA	NA	NA	NA	NA	NA
R_fusiform_thickavg	NA	NA	NA	NA	NA	NA
L_inferiorparietal_thickavg	NA	NA	NA	NA	NA	NA
R_inferiorparietal_thickavg	NA	NA	NA	NA	NA	NA
L_postcentral_thickavg	NA	NA	NA	NA	NA	NA
R_postcentral_thickavg	NA	NA	NA	NA	NA	NA
L_precentral_thickavg	NA	NA	NA	NA	NA	NA
R_precentral_thickavg	NA	NA	NA	NA	NA	NA
L_frontalpole_thickavg	NA	NA	NA	NA	NA	NA
R_frontalpole_thickavg	NA	NA	NA	NA	NA	NA

Surface Area

Table 17: Comparison surface area

Region	T1	T2	Rep Meas
L_fusiform_surfavg	0.002	0.01	0.004
R_fusiform_surfavg	0.016	0.014	0.014
L_inferiorparietal_surfavg	0.002	0.001	0.001
R_inferiorparietal_surfavg	0.002	0.004	0.003
L_postcentral_surfavg	0.021	0.019	0.019
R_postcentral_surfavg	0.044	0.167	0.082
L_precentral_surfavg	0.014	0.01	0.012
R_precentral_surfavg	0.002	0.004	0.002
L_frontalpole_surfavg	0.323	0.909	0.612
R_frontalpole_surfavg	0	0.004	0.001

Table 18: Surface area: T1

	CW vs CM	CW vs TM	CW vs TW	CM vs TM	CM vs TW	TM vs TW
L_fusiform_surfavg	0.017	1	1	0.001	0.02	1
R_fusiform_surfavg	0.06	1	1	0.004	0.451	1
L_inferiorparietal_surfavg	0.016	1	1	0	0.179	0.255
R_inferiorparietal_surfavg	0.006	1	1	0.001	0.118	0.798

L_postcentral_surfavg	0.006	1	1	0.156	0.139	1
R_postcentral_surfavg	0.107	1	1	0.095	0.822	1
L_precentral_surfavg	0.015	1	0.223	0.046	1	0.55
R_precentral_surfavg	0	0.696	0.182	0.023	0.234	1
L_frontalpole_surfavg	NA	NA	NA	NA	NA	NA
R_frontalpole_surfavg	0.001	1	0.983	0	0.023	0.886

Table 19: Surface area: T2

	CW vs CM	CW vs TM	CW vs TW	CM vs TM	CM vs TW	TM vs TW
L_fusiform_surfavg	0.079	1	1	0.001	0.261	0.589
R_fusiform_surfavg	0.092	0.746	1	0.002	0.484	0.787
L_inferiorparietal_surfavg	0.006	1	1	0	0.185	0.141
R_inferiorparietal_surfavg	0.013	1	1	0.001	0.357	0.383
L_postcentral_surfavg	0.003	0.894	1	0.224	0.161	1
R_postcentral_surfavg	NA	NA	NA	NA	NA	NA
L_precentral_surfavg	0.021	1	0.355	0.021	1	0.374
R_precentral_surfavg	0	0.234	0.049	0.173	0.464	1
L_frontalpole_surfavg	NA	NA	NA	NA	NA	NA
R_frontalpole_surfavg	0.137	1	0.971	0.012	0.003	1

Simulations

First we need to define the parameters of our simulations.

```
# variance/sd epsilon
seps <- 1

# Number of simulations
asim <- 5000

# Effect size
delta <- 0.8

# Number of participants
n <- 30
n.1 <- n/2      # in the first group
n.2 <- n/2      # in the second group

# Level of statistical significance
alpha <- 0.05

# Correlation between first and second measurement
rho <- seq(0.01,0.99,0.01)
```

Then we prepare objects to store our results

```
# Number of simulations
pow.mean1<-vector("numeric",length(rho))
pow.mean2<-vector("numeric",length(rho))
pow.mean3<-vector("numeric",length(rho))
```

```
# Loop over preset correlations between measure 1 and measure 2
for(i in 1:length(rho)){
  # Create objects to store power in for every simulations
  pow.1<-vector("numeric",asim)
  pow.2<-vector("numeric",asim)
  pow.3<-vector("numeric",asim)

  for(k in 1:asim){
    # Scenario 1: lower bound of power curve
    # two groups with equal amount of subjects, groups differ with an effect size delta
    # Construct a vector that determines in which group each subject falls
    x<-c(rep(1,n.1),rep(0,n.2))

    # Vector with observations in the set of participants
    y<-rnorm(n,0,seps)
    # Add an effect size to the first group
    y[1:n.1]<-y[1:n.1]+delta

    # Boolean of whether an effect is detected, this is later used to compute the power
    pow.1[k]<-summary(lm(y~x))$coef[2,4]<alpha

    # Scenario 2: upper bound of power curve
    # two groups with equal amount of subjects, twice as many as scenario 1, groups differ with an effe
    # Construct a vector that determines in which group each subject falls
    x2<-c(rep(1,(n.1*2)),rep(0,(n.2*2)))

    # Vector with observations in the set of participants
    y2<-rnorm(n*2,0,seps)
    # Add an effect size to the first group
    y2[1:(n.1*2)]<-y2[1:(n.1*2)]+delta

    # Boolean of whether an effect is detected, this is later used to compute the power
    pow.2[k]<-summary(lm(y2~x2))$coef[2,4]<alpha

    # Scenario 3: two measurements for every subject, same amount of subjects as in scenario 1
    # two groups with equal amount of subjects, correlation between measurements, groups differ with an
    # Construct a vector that determines in which group each subject falls
    x3<-c(rep(1,n.1),rep(0,n.2),rep(1,n.1),rep(0,n.2))

    # Vector with first observation of every participant
    y3<-rnorm(n,0,seps)
    # Factor to multiply second set of observations with to obtain results in line with predefined corr
    alpac<-sqrt(rho[i]^2/(1-rho[i]^2)*seps)
    # Construct second set of observations that are correlated with first set (y3)
    y3.2u<-alpac*y3+rnorm(n)
    y3.2<-y3.2u/sqrt(var(y3.2u))
    # Add effect size to the first group of participants
    y3[1:n.1]<-y3[1:n.1]+delta
    y3.2[1:n.1]<-y3.2[1:n.1]+delta
    # Combine both observations in 1 vector
    y3o<-c(y3,y3.2)

    # Define subject numbers
```

```r
    subject<-rep(1:n,2)
    # Construct mixed model
    mm<-lmer(y3o ~ x3 + (1 | subject))
    # Boolean of whether an effect is detected, this is later used to compute the power
    pow.3[k]<-summary(mm)$coef[2,5]<alpha
  }
  pow.mean1[i]<-mean(pow.1)
  pow.mean2[i]<-mean(pow.2)
  pow.mean3[i]<-mean(pow.3)
}
```

```
## Warning in optwrap(optimizer, devfun, getStart(start, rho$lower, rho$pp), :
## convergence code 3 from bobyqa: bobyqa -- a trust region step failed to
## reduce q

## Warning in optwrap(optimizer, devfun, getStart(start, rho$lower, rho$pp), :
## convergence code 3 from bobyqa: bobyqa -- a trust region step failed to
## reduce q

## Warning in optwrap(optimizer, devfun, getStart(start, rho$lower, rho$pp), :
## convergence code 3 from bobyqa: bobyqa -- a trust region step failed to
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## convergence code 3 from bobyqa: bobyqa -- a trust region step failed to
## reduce q

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## reduce q

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## convergence code 3 from bobyqa: bobyqa -- a trust region step failed to
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## Warning in optwrap(optimizer, devfun, getStart(start, rho$lower, rho$pp), :
## convergence code 3 from bobyqa: bobyqa -- a trust region step failed to
## reduce q

## Warning in optwrap(optimizer, devfun, getStart(start, rho$lower, rho$pp), :
## convergence code 3 from bobyqa: bobyqa -- a trust region step failed to
## reduce q
```
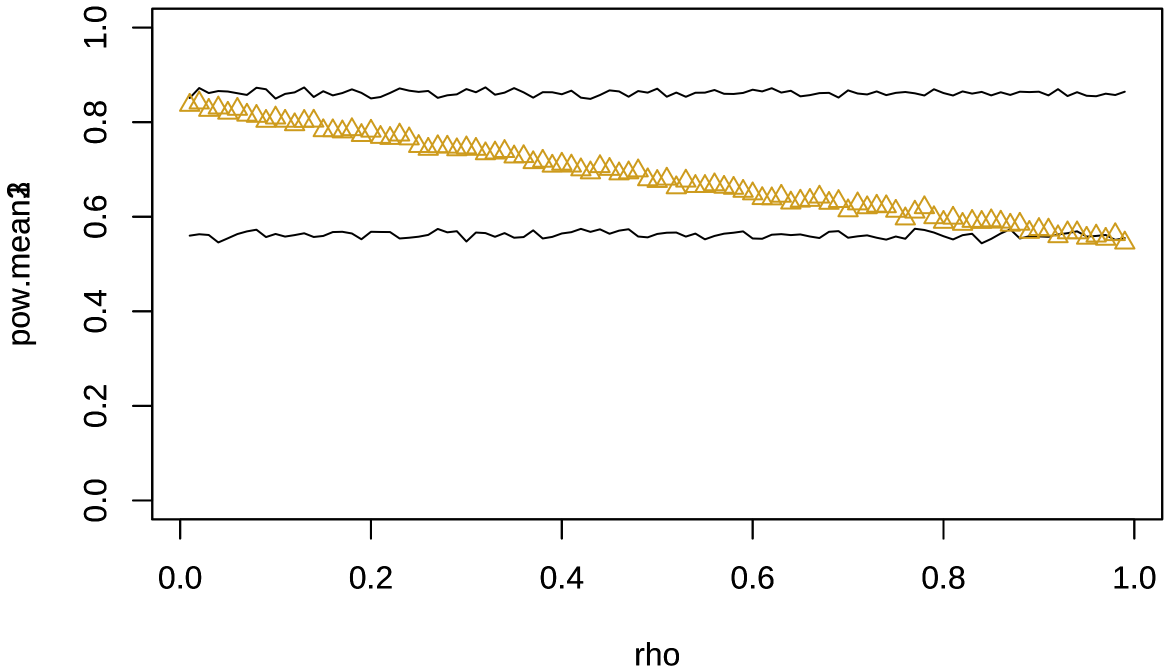

Results

```r
# power of taking both measures into account
plot(rho,pow.mean1,ylim=c(0,1), type="l")
par(new = TRUE)
plot(rho,pow.mean2,ylim=c(0,1), type="l")
```

```r
par(new = TRUE)
plot(rho,pow.mean3,ylim=c(0,1), type="p", col = "goldenrod3", pch = 2)
```




```r
# Correlation of hypothesized regions
  bg.one <- 3
  nd.one <- 24
  ln <- nd.one-bg.one+1

  # Object to save correlations
  corrhyp <- array(data=NA, dim = ln)

  # Compute ANOVA for every predictor and save p-value
  for(i in bg.one:nd.one){
    corrhyp[i-bg.one+1] <- cor(x = data.hyp[,i], y = data.hyp[,i + ln])
  }

  summary(corrhyp)
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max. 
##  0.7046  0.8897  0.9313  0.8990  0.9492  0.9963
```

```r
  kable(cbind(substring(names(data.hyp[,3:24]), 4), round(corrhyp,3)))
```

L_fusiform_volume	0.922
L_inferiorparietal_volume	0.902
L_postcentral_volume	0.958
L_precentral_volume	0.948
L_frontalpole_volume	0.711
R_fusiform_volume	0.944
R_inferiorparietal_volume	0.934
R_postcentral_volume	0.926
R_precentral_volume	0.93
R_frontalpole_volume	0.708

LeftCerebellumWhiteMatter	0.949
LeftCerebellumCortex	0.996
RightCerebellumWhiteMatter	0.949
RightCerebellumCortex	0.996
LeftThalamusProper	0.886
LeftCaudate	0.975
LeftPutamen	0.814
LeftAccumbensarea	0.705
RightThalamusProper	0.93
RightCaudate	0.973
RightPutamen	0.932
RightAccumbensarea	0.79

```
# Increase in power
```

Added later

Here we create table 11 and table 17 with covariates

Table 11 - Volume

```
# Volume
  # Dataset
    T1.vol <- data.hyp[,3:24]

  # FDR
    nr <- 22
    p.T1.vol.cov <- array(data=NA, dim = nr)
    for(r in 1:nr){
      p.T1.vol.cov[r] <- unlist(summary(aov(T1.vol[,r] ~ data.all[,4] + data.all[,108] + as.factor(data
    }
    p.T1.vol.cov.corr <- p.adjust(p.T1.vol.cov, method = "fdr")

  # Bonferroni
    # pt.T1.vol.cov <- array(data = NA, dim = c(nr,dim(allcomb)[2]))
    # pt.T1.vol.cov.corr <- array(data = NA, dim = c(nr,dim(allcomb)[2]))
    # for(r in 1:nr){
    #   # general model
    #   if (p.T1.vol.cov.corr[r] > 0.05) {
    #       pt.T1.vol.cov[r,] <- rep(NA,dim(allcomb)[2])
    #   }else{
    #     for(i in 1:dim(allcomb)[2]){
    #       pt.T1.vol.cov[r,i] <- unlist(t.test(T1.vol[data.hyp[,2]==allcomb[1,i],r], T1.vol[data.hyp[,
    #     }
    #     pt.T1.vol.cov.corr[r,] <- p.adjust(pt.T1.vol.cov[r,], method = "bonferroni")
    #   }
    # }
```

```r
# Surface Area
  # Dataset
    T1.sa <- data.hyp[,67:76]

  # FDR
    nr <- 10
    p.T1.sa.cov <- array(data=NA, dim = nr)
    for(r in 1:nr){
      p.T1.sa.cov[r] <- unlist(summary(aov(T1.sa[,r] ~ data.all[,4] + data.all[,108] + as.factor(data.hy
    }
    p.T1.sa.cov.corr <- p.adjust(p.T1.sa.cov, method = "fdr")

  # Bonferroni
    # pt.T1.sa.cov <- array(data = NA, dim = c(nr,dim(allcomb)[2]))
    # pt.T1.sa.cov.corr <- array(data = NA, dim = c(nr,dim(allcomb)[2]))
    # for(r in 1:nr){
    #   # general model
    #   if (p.T1.sa.cov.corr[r] > 0.05) {
    #       pt.T1.sa.cov[r,] <- rep(NA,dim(allcomb)[2])
    #   }else{
    #     for(i in 1:dim(allcomb)[2]){
    #       pt.T1.sa.cov[r,i] <- unlist(t.test(T1.sa[data.hyp[,2]==allcomb[1,i],r], T1.sa[data.hyp[,2]=
    #     }
    #     pt.T1.sa.cov.corr[r,] <- p.adjust(pt.T1.sa[r,], method = "bonferroni")
    #   }
    # }

# Volume
  # Dataset
    T2.vol <- data.hyp[,25:46]

  # FDR
    nr <- 22
    p.T2.vol.cov <- array(data=NA, dim = nr)
    for(r in 1:nr){
      p.T2.vol.cov[r] <- unlist(summary(aov(T2.vol[,r] ~ data.all[,4] + data.all[,108] + as.factor(data
    }
    p.T2.vol.cov.corr <- p.adjust(p.T2.vol.cov, method = "fdr")

  # Bonferroni
    # pt.T2.vol.cov <- array(data = NA, dim = c(nr,dim(allcomb)[2]))
    # pt.T2.vol.cov.corr <- array(data = NA, dim = c(nr,dim(allcomb)[2]))
    # for(r in 1:nr){
    #   # general model
    #   if (p.T2.vol.cov.corr[r] > 0.05) {
    #       pt.T2.vol.cov[r,] <- rep(NA,dim(allcomb)[2])
    #   }else{
    #     for(i in 1:dim(allcomb)[2]){
    #       pt.T2.vol.cov[r,i] <- unlist(t.test(T2.vol[data.hyp[,2]==allcomb[1,i],r], T2.vol[data.hyp[,
    #     }
    #     pt.T2.vol.cov.corr[r,] <- p.adjust(pt.T2.vol.cov[r,], method = "bonferroni")
    #   }
    # }
```

```
# Surface Area
  # Dataset
    T2.sa <- data.hyp[,77:86]

  # FDR
    nr <- 10
    p.T2.sa.cov <- array(data=NA, dim = nr)
    for(r in 1:nr){
      p.T2.sa.cov[r] <- unlist(summary(aov(T2.sa[,r] ~ data.all[,4] + data.all[,108] + as.factor(data.hy
    }
    p.T2.sa.cov.corr <- p.adjust(p.T2.sa.cov, method = "fdr")

  # Bonferroni
    # pt.T2.sa.cov <- array(data = NA, dim = c(nr,dim(allcomb)[2]))
    # pt.T2.sa.cov.corr <- array(data = NA, dim = c(nr,dim(allcomb)[2]))
    # for(r in 1:nr){
    #   # general model
    #   if (p.T2.sa.cov.corr[r] > 0.05) {
    #       pt.T2.sa.cov[r,] <- rep(NA,dim(allcomb)[2])
    #   }else{
    #     for(i in 1:dim(allcomb)[2]){
    #       pt.T2.sa.cov[r,i] <- unlist(t.test(T2.sa[data.hyp[,2]==allcomb[1,i],r], T2.sa[data.hyp[,2]=
    #     }
    #     pt.T2.sa.cov.corr[r,] <- p.adjust(pt.T2.sa.cov[r,], method = "bonferroni")
    #   }
    # }
```

```
# Volume
  kable(caption = "Comparison volume", rbind(c("Region", "T1", "T2", "Rep Meas"), cbind(substring(names
```

Table 21: Comparison volume

Region	T1	T2	Rep Meas
L__fusiform__volume	0	0.001	0
L__inferiorparietal__volume	0.003	0.001	0
L__postcentral__volume	0.025	0.022	0
L__precentral__volume	0.23	0.106	0.008
L__frontalpole__volume	0.025	0.116	0.007
R__fusiform__volume	0	0	0
R__inferiorparietal__volume	0.004	0.002	0
R__postcentral__volume	0.09	0.076	0.007
R__precentral__volume	0.031	0.013	0.001
R__frontalpole__volume	0.002	0.022	0.002
LeftCerebellumWhiteMatter	0.004	0.008	0.001
LeftCerebellumCortex	0	0	0
RightCerebellumWhiteMatter	0.01	0.003	0.001
RightCerebellumCortex	0	0	0
LeftThalamusProper	0	0	0
LeftCaudate	0.023	0.044	0.002
LeftPutamen	0.07	0.106	0.004
LeftAccumbensarea	0.569	0.244	0.547
RightThalamusProper	0.002	0.001	0
RightCaudate	0.017	0.02	0.001

RightPutamen	0.001	0.001	0
RightAccumbensarea	0.233	0.269	0.115

```
# Surface area
  kable(caption = "Comparison surface area", rbind(c("Region", "T1", "T2", "Rep Meas"), cbind(substring
```

Table 22: Comparison surface area

Region	T1	T2	Rep Meas
L__fusiform__surfavg	0.349	0.359	0
R__fusiform__surfavg	0.514	0.359	0.001
L__inferiorparietal__surfavg	0.267	0.14	0
R__inferiorparietal__surfavg	0.407	0.359	0
L__postcentral__surfavg	0.848	0.632	0.001
R__postcentral__surfavg	0.909	0.941	0.012
L__precentral__surfavg	0.621	0.532	0.001
R__precentral__surfavg	0.407	0.359	0
L__frontalpole__surfavg	0.909	0.814	0.539
R__frontalpole__surfavg	0.038	0.14	0