PRELIMINARY ANALYSES:

- How are times distributed in control group and schizophrenic subjects? We obviously notice a significative difference, confirmed by a test on the means.
- Test
- Boxplots and barplots

Let's try to investigate the causes of these differences.

SMOKING:

We started analysing the smoking behaviour of our subjects to find if there is a difference w.r.t. the grouping variable smoking (which can be: never smoker, ex-smoker, currently smoker) in the response time

- Division of the subject in ex-smokers / never smokers / currently smokers
- Profiling

Then we proceeded to perform an ANOVA to verify if the groups are different and, if so, which ones are different:

- Results of ANOVA
- Results of Bonferroni

=> we identified as significant grouping the current / non-current smokers => this will be our categorical variable.

HEALTH RELATED INDEXES, AGE-BMI:

We try to find a difference in the performance (RT) of the 2 groups explained by age and BMI (used as a health index)

If we fit a Linear Regression Model: *Reaction.Time ~ Age + Diagnosis + Age:Diagnosis* and visualise the results we don't see any particular difference in the pattern.

Indeed the interaction terms (AGE:DIAGNOSIS and BMI:DIAGNOSIS) are not significant.

- REGRESSION LINES
- Summary of the model to show the non-significance of the coefficients.

Age seems kind of significant for our analyses since schizophrenic subjects are on average older than neurotypical ones.

- Immagine della distribuzione dell'età fra i due gruppi

=> we'll use the regressors in the big linear model

Reaction Time ~ Age + Diagnosis

PSYCHOLOGICAL TRAITS, BARRATT IMPULSIVENESS SCORES

Since we're doing an experiment involving non neurotypical individuals, it is natural to consider the scores of a behavioural test, specifically thought out for patients affected by schizophrenia.

First, we observe the distribution of the general Barratt score throughout our subjects and (of course) notice higher values in the schizophrenic subjects.

- Boxplots

A test confirms a significant difference in the values of the Barratt scores.

- Test on the means

So, we do a linear model to try to understand any relation between Barratt score:

- Results del LM => We see that the total BIS is not influencing, inutile

Then we try to observe the sub scores and their relation to the Reaction times
=> useless

ANALYSIS OF THE DIFFERENT CONDITIONS OF THE TRIALS, COSTS

SWITCHCOST:

- We try to compute and compare the switchcosts of neurotypical and schizophrenic subjects.
- Boxplots

CORRECTCOST:

- Boxplots

We deduce that, even though the 2 groups have different accuracy rates and different mean Reaction Time, the differential effort is the same => same mechanism

The same deductions can be made for the CSI and the Congruency variables.

ANOVA

We started trying to do an ANOVA on the mean times of each individual according to the different conditions of the experiment.

For each subject we have switch congruent, switch incongruent, noswitch congruent, noswitch incongruent.

```
> fit <- aov(rows_per_anova$time ~ rows_per_anova$diagnosis + rows_per_anova$congruent + rows_per_anova$switch +
 rows_per_anova$diagnosis*rows_per_anova$congruent +
+           rows_per_anova$diagnosis*rows_per_anova$switch + rows_per_anova$congruent*rows_per_anova$switch)
> summary(fit)
                                                Df Sum Sq Mean Sq F value   Pr(>F)
rows_per_anova$diagnosis                         1  7.494   7.494 183.831  < 2e-16 ***
rows_per_anova$congruent                         1  0.175   0.175   4.283   0.0389 *
rows_per_anova$switch                            1  1.872   1.872  45.924 2.63e-11 ***
rows_per_anova$diagnosis:rows_per_anova$congruent   1  0.002   0.002   0.052   0.8202
rows_per_anova$diagnosis:rows_per_anova$switch      1  0.014   0.014   0.345   0.5574
rows_per_anova$congruent:rows_per_anova$switch      1  0.001   0.001   0.026   0.8718
Residuals                                       693 28.250   0.041
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

Results of the ANOVA:

- high significance of diagnosis and switch,
- but no interaction is significant.

=> after a stepwise feature selection, we reduce the model until we end up obtaining the additive model:

Reaction.time ~ diagnosis + switch.

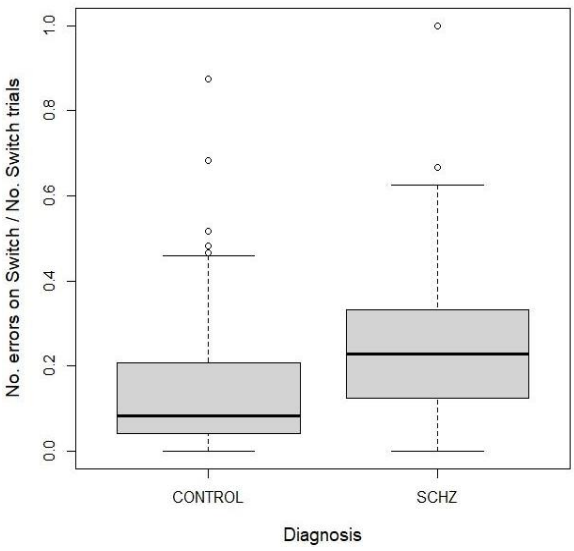
```
> fit2 <- aov(rows_per_anova$time ~ rows_per_anova$diagnosis + rows_per_anova$switch)
> summary(fit2)
                        Df Sum Sq Mean Sq F value   Pr(>F)
rows_per_anova$diagnosis   1  7.494   7.494  183.65  < 2e-16 ***
rows_per_anova$switch      1  1.872   1.872   45.88 2.68e-11 ***
Residuals                697 28.441   0.041
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
>
```

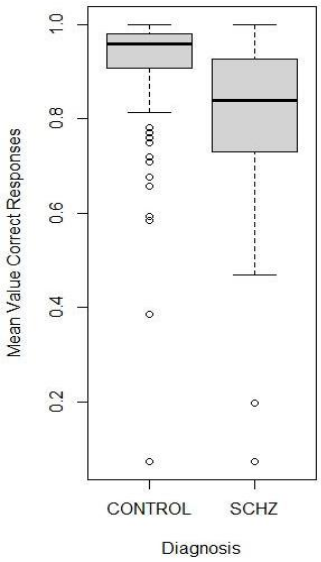
Interpretation: schizophrenics perform worse than control subjects in terms of time, but they're affected by the switch in the same way control subjects are, in the sense that **the switchcost is the same**.

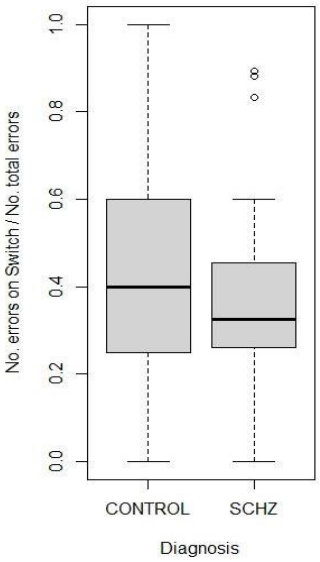
_____

ANALYSIS OF ERROR AND ACCURACY OF THE ANSWERS

Does diagnosis influence the number of correct answers given by the subjects?







count= Number of wrong answers given by each individual

NSwitch = Number of wrong answers given in the case of switch

MediaRisposte = Total percentage of correct answers given during the experiment

NSwitch/$count.

Schizophrenics make more mistakes on the switch than control subjects.

- Schizophrenic subjects have in general less accuracy.
- On switch trials Schizophrenics perform with less accuracy than on nonswitch trials
- But in general neurotypicals' errors are more concentrated on switch than schizophrenic, that is schizophrenic have a general un general impediment, a general low accuracy. The presence of the switch doesn't make the trial much harder.

Conclusions from literature for similar experiments:

> *"Schizophrenics suffer from larger between-task interference. This implies that the schizophrenic subject needs to perform anticipatory reconfiguration for both switch and non-switch trials* (while the control subjects only do it on switch trials). *Schizophrenic patients exhibit more effortful processing* (more brain activity) *on non-switch trials than controls, suggesting that patients found task-repetition as difficult as task-switching."*

and

> *"Task switching difficulties in schizophrenia do not result from a specific switching deficit, but rather from a broader difficulty in active memory for task context. In some experiments, patients needed to be reminded by the experimenter several times what responses indicated."*

In conclusion, having obtained results consistent with the literature, we expect to find consistency with the data reported in the z-maps, particularly in the areas of the brain involved for working memory.

Pur sbagliando in assoluto di più, uno schizofrenico concentra i propri errori sullo switch meno di quanto fa un sano.

gli schizophrenic subjects sono sia più lenti che meno accurati, => “both groups apply similar speed/accuracy tradeoffs”

=> This is coherent with the correct-cost boxplots and tests performed in the preliminary steps.

PCA

First, to avoid the huge noise of the functional connectivity map, we have averaged the values on 83 regions in which the brain is typically considered to be divided into, according to their functions.

- Paraview visualization of the brains of the control group and the schizophrenic subjects group

Afterwards we have performed PCA on these data:

- Paraview visualization of the PCs
- Interpretation of the PCs
- Scores along the PCs

We observe that the 3rd score is the one that discriminates the groups the most. Indeed:

- Test fra le medie delle due popolazioni

LMM

We want to understand how the diagnosis and the switch variable influence the Reaction Times, so we started performing a Linear regression:
Reaction.time ~ diagnosi + switch + congruent.
So, for every subject we have different kinds of trials in 4 conditions (switch-congruent, switch-non congruent, non switch-congruent, non switch-non congruent)

First, we performed an ANOVA to discriminate the 4 groups,

- Result of the ANOVA

but the data related to the same subject are not independent, so we used the subject as a Random Effect:
tempo di risposta ~ diagnosi + switch + congruent + (1 | Subject)

- Result of the LMER model
- PVRE coefficient
- Marginal covariance matrix
- Dotplot

The PVRE is extremely high, this result suggest that we have to assign most of the real variability to the intrinsic difference between the subjects rather than the difference between the two groups (Since we don't notice any specific pattern in the random effects)

- Boxplot of the random effects in the two groups