Statistische Tests in SPM

Teil 2: Gruppen- Statistik

2nd level

Random effects analysis

Michael Rose, SPM Kurs 2011

Gruppenanalyse

- Einzel- oder Gruppenuntersuchung = Designfrage
- Gründe für Einzelprobandenstudie
  - Gemeinsame Aktivierungen nicht zu erwarten: z.B. Patienten mit seltenen, ähnlichen, aber nicht identischen Erkrankungen (Läsionen)
- Gründe für Gruppenstudie
  - Aussage über die untersuchten Personen, z.B. über eine bestimmte Gruppe von Patienten mit gleichem Krankheitsbild
  - Aussage über Population, d.h. alle Personen der Grundgesamtheit zeigen diesen Effekt (random effect)
- Gründe für Einzelauswertung und Gruppenstatistik
  - Herausarbeiten der Gemeinsamkeiten und der Unterschiede zwischen Probanden

Daten für Gruppenstatistik

1. Level (Einzelpersonen)

Person 1: Modell (Regressoren)

Person 1: t- oder F-Kontraste

Person 2 …..Person n

Ergebnisse

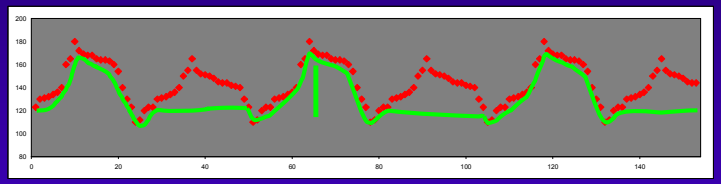
2. Level (Gruppe)

Modell für Gruppe (Regressoren)

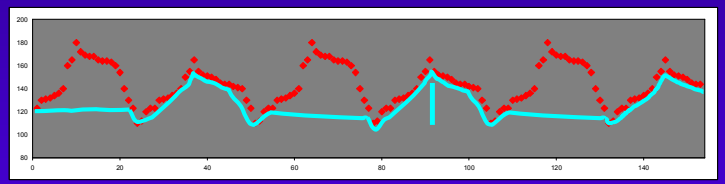
Gruppe: t- oder F-Kontraste

Daten für Gruppenstatistik

Für jedes Single subject



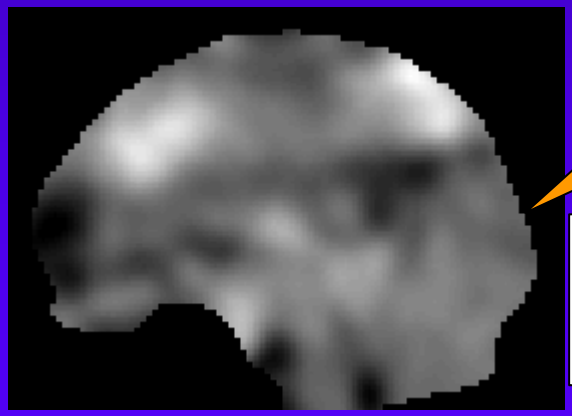
$\hat{\beta}_{nb2}$



$\hat{\beta}_{nb1}$

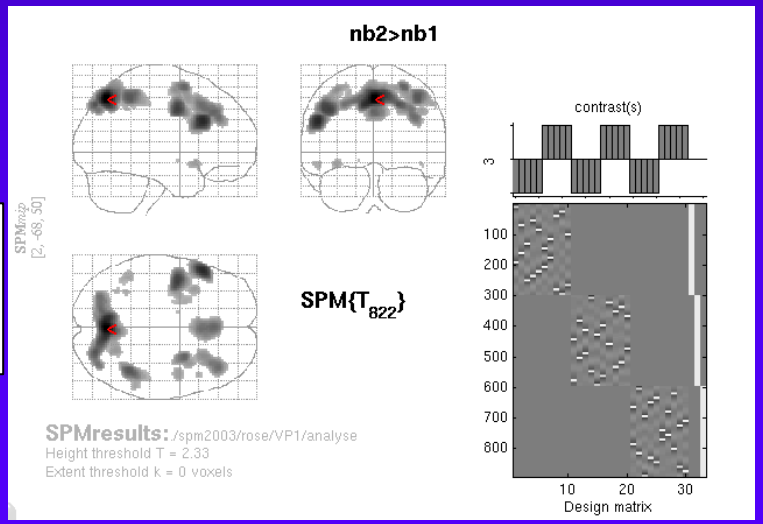
Statistischer Vergleich

$$t = \frac{\hat{\beta}_{nb\,2} - \hat{\beta}_{nb\,1}}{\sqrt{\hat{\sigma}^{2}_{(\hat{\beta}_{nb\,2} - \hat{\beta}nb\,1)}}}$$



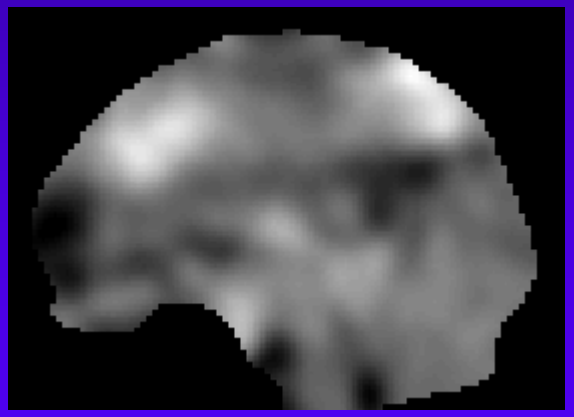
Con_xxxx.img

$$D = \sum_{i} c_i * \hat{\beta}_i$$



Daten für Gruppenstatistik

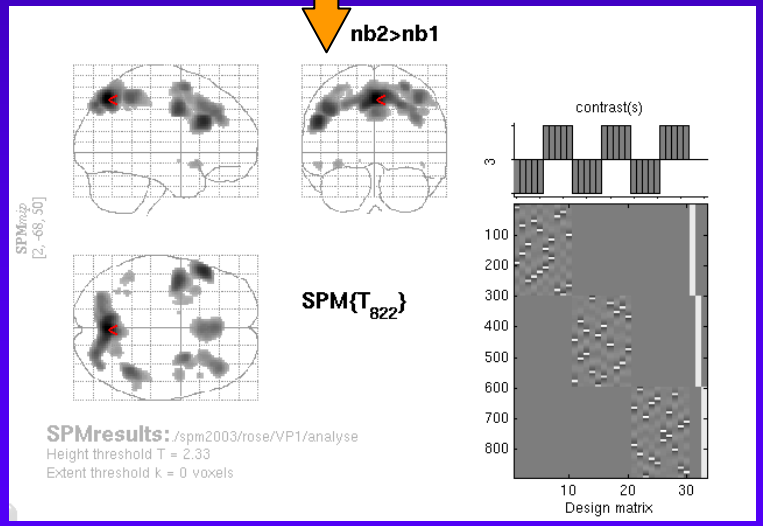
$$D = 1 * \hat{\beta}_{nb2} + (-1) * \hat{\beta}_{nb1}$$



Con_xxxx.img

Effektgröße

$$t = \frac{\hat{\beta}_{nb\,2} - \hat{\beta}_{nb\,1}}{\sqrt{\hat{\sigma}^{2}_{(\hat{\beta}_{nb\,2} - \hat{\beta}nb\,1)}}}$$

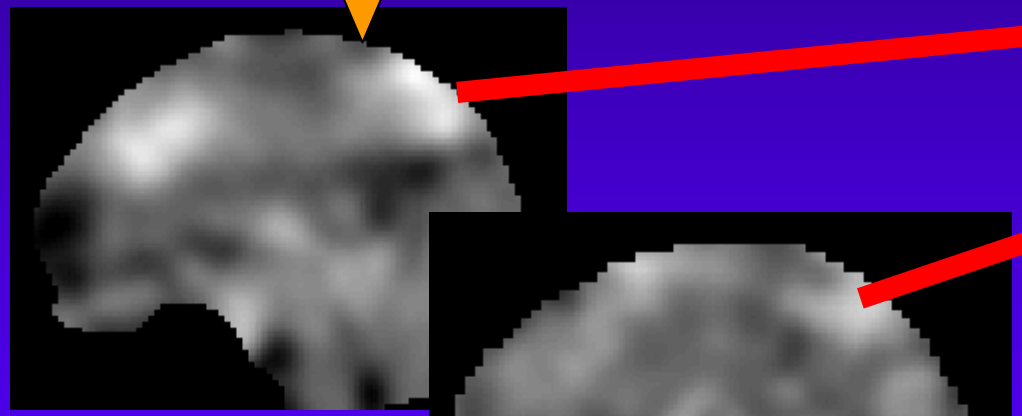


spmT_xxxx.img

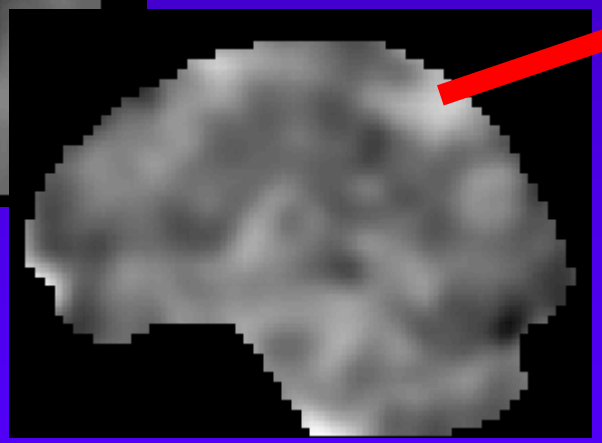
Parameter der Gruppenstatistik

$$D = 1 * \hat{\beta}_{nb2} + (-1) * \hat{\beta}_{nb1}$$

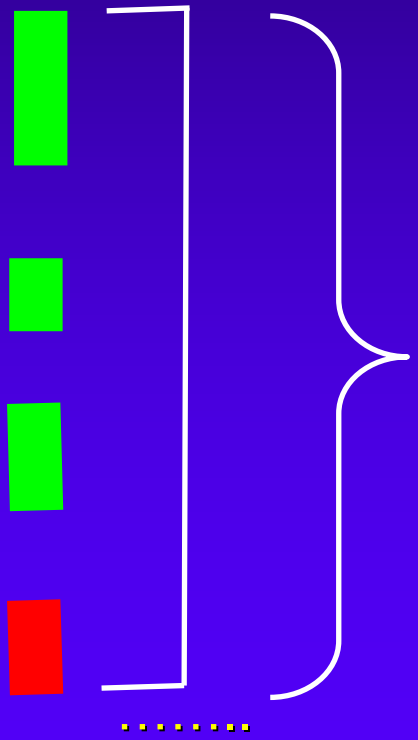
Linearkombination der Parameter – Schätzer pro Voxel



VP1/Con_0002.img



VP2/Con_0002.img

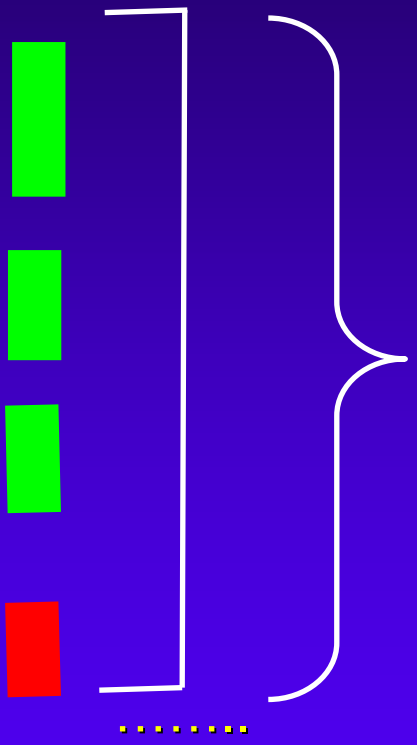


.....

$$\hat{\beta}_e$$

$$\hat{\sigma}_e^2$$

Neues Modell und Statistik



$\hat{\beta}_e$ Regressionskoeffizient über Gruppe

$\hat{\sigma}_e^2$ Fehlervarianz über Gruppe

t- oder F- Kontraste über Gruppe

$$t = \frac{\hat{\beta}_e}{\sqrt{\hat{\sigma}_e^2}}$$

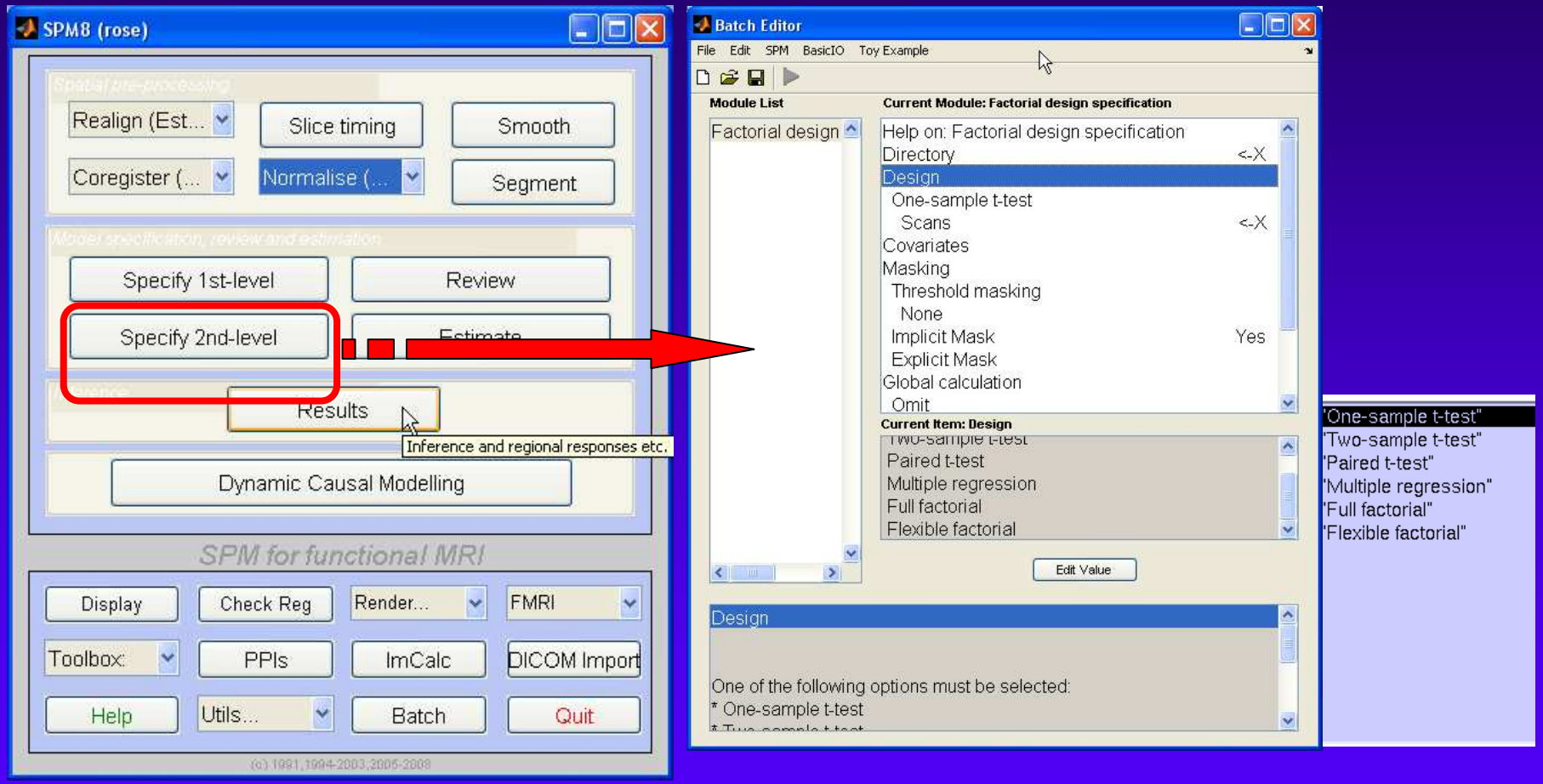
Unterschiede 1. und 2. Level

Single subject: Fehlerterm entsteht durch residuelle Varianz einer Person, viele Freiheitsgrade (durch Messungen)

Gruppenstatistik (RFX): Fehlerterm ist die Varianz über die Personen, wenig Freiheitsgrade (z.B. 1-sample t-test: Anzahl Personen – Anzahl Regressoren)

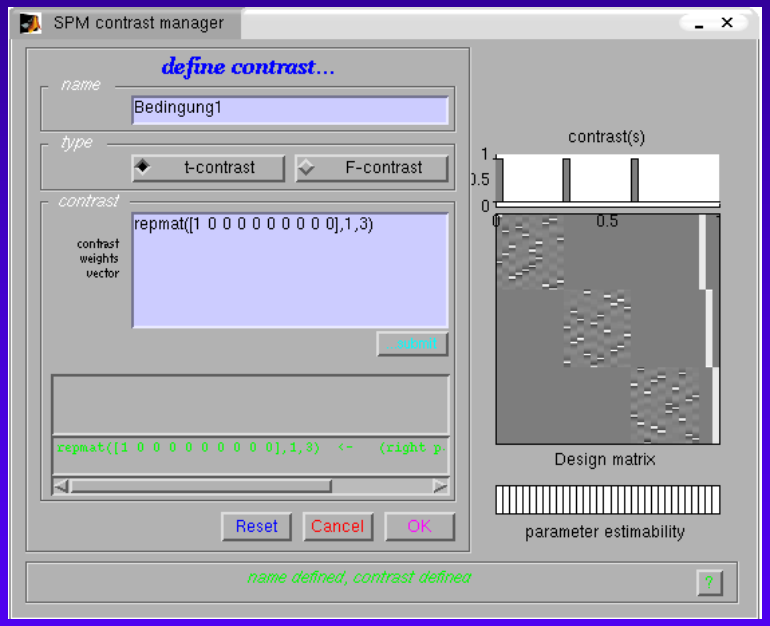
Gruppengröße >20 (Thirion et al, 2007)

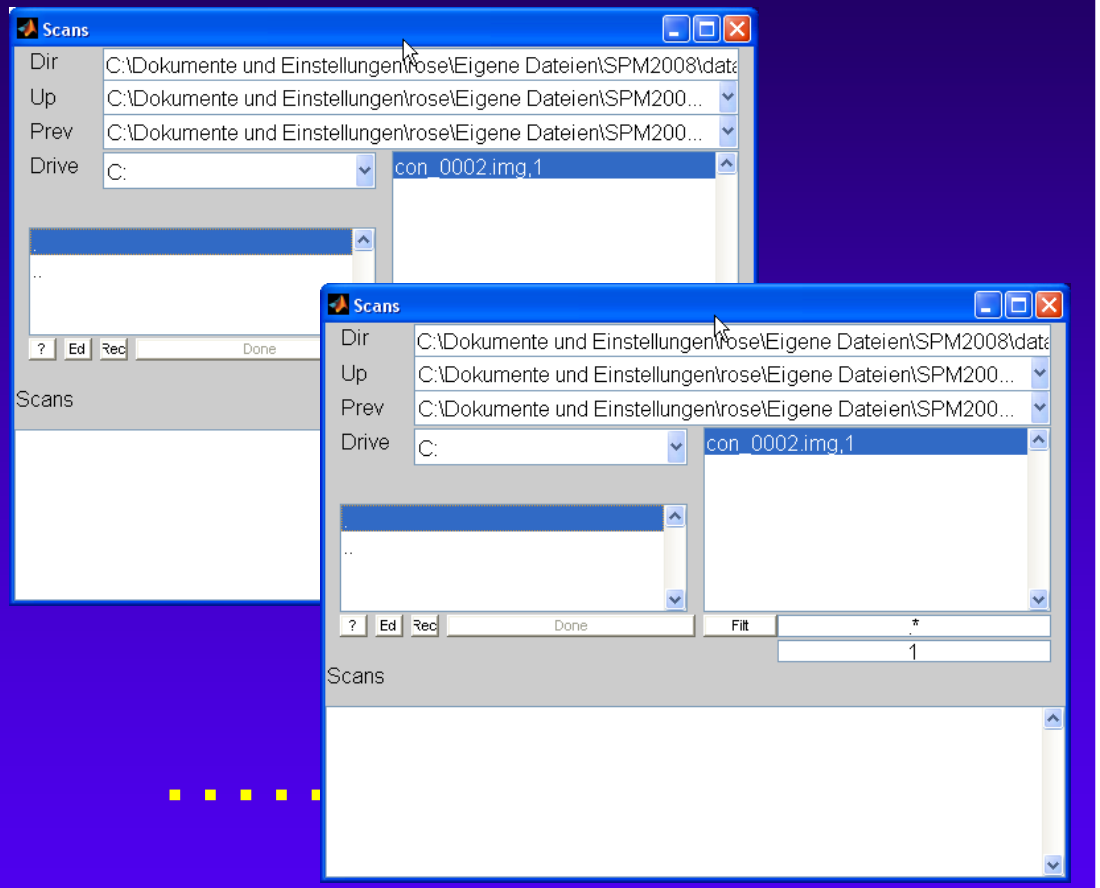
Beispiele


SPM8 (rose)
Realign (Est...
Slice timing
Smooth
Coregister (...
Normalise (...
Segment
Specify 1st-level
Review
Specify 2nd-level
Estimate
Results
Inference and regional responses etc.
Dynamic Causal Modelling
SPM for functional MRI
Display
Check Reg
Render...
FMRI
Toolbox:
PPIs
ImCalc
DICOM Import
Help
Utils...
Batch
Quit
Batch Editor
File Edit SPM BasicIO Toy Example
Module List
Current Module: Factorial design specification
Factorial design
Help on: Factorial design specification
Directory <-X
Design
One-sample t-test
Scans <-X
Covariates
Masking
Threshold masking
None
Implicit Mask Yes
Explicit Mask
Global calculation
Omit
Current Item: Design
Paired t-test
Multiple regression
Full factorial
Flexible factorial
Edit Value
Design
One of the following options must be selected:
* One-sample t-test
'One-sample t-test"
'Two-sample t-test"
'Paired t-test"
'Multiple regression"
'Full factorial"
'Flexible factorial"

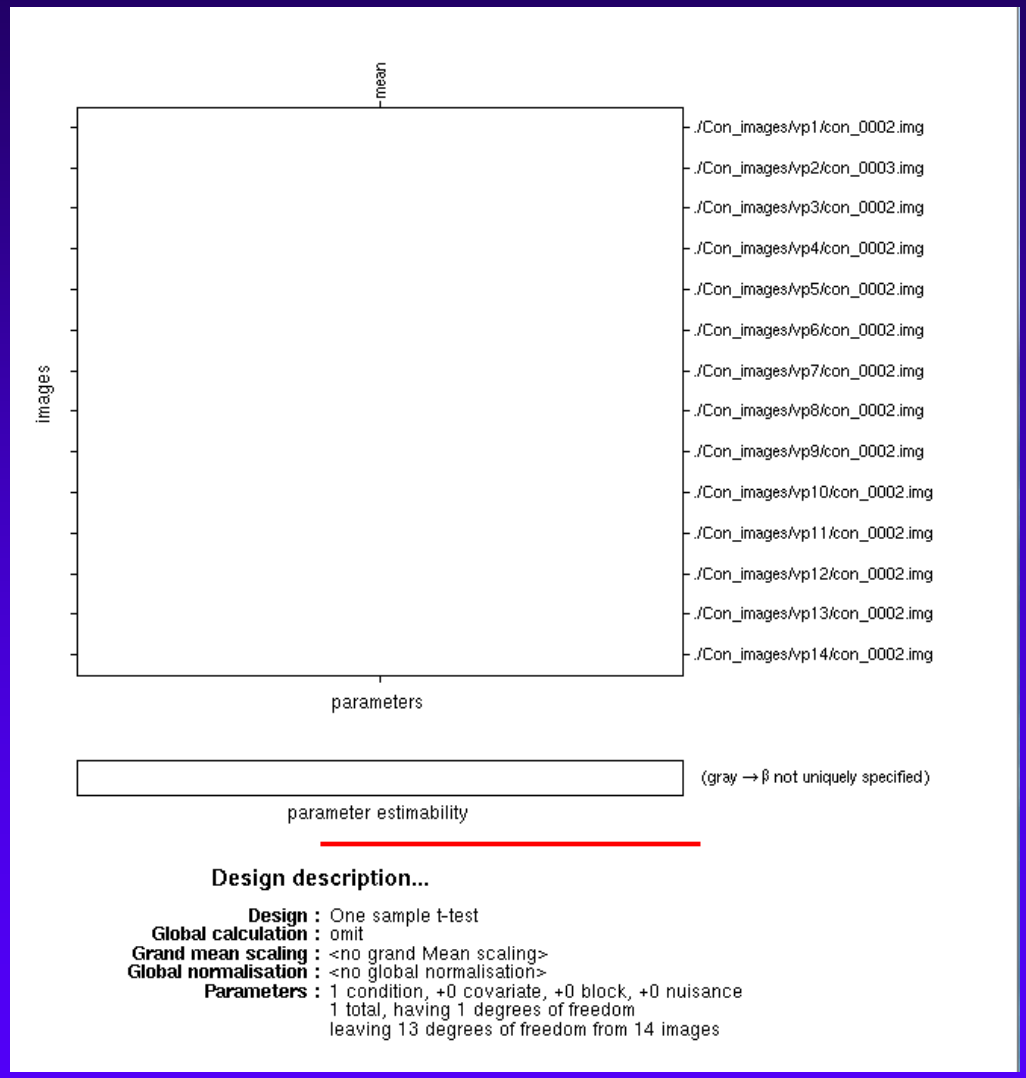
One- Sample t- Test (Bedingung 1)

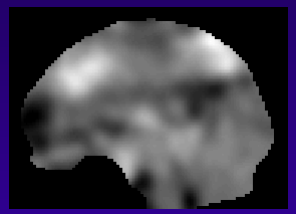
$$t = \frac{\overline{\beta}_{b1}}{\sqrt{\hat{\sigma}^2_{\hat{\beta}_1}}}$$

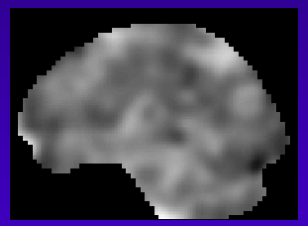




2. Level Model (Bedingung 1)



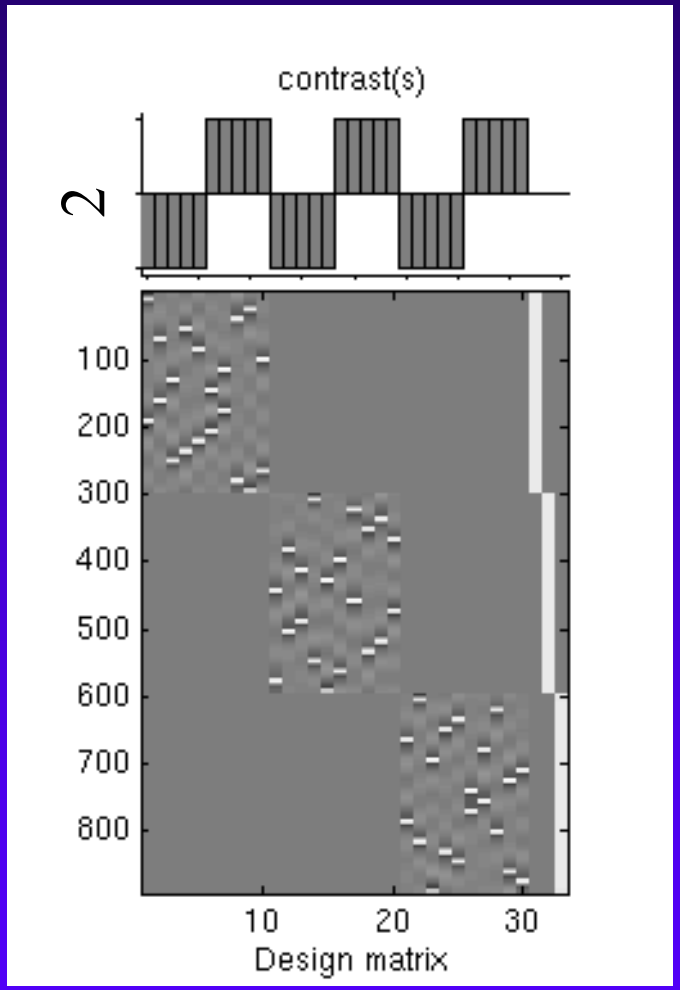


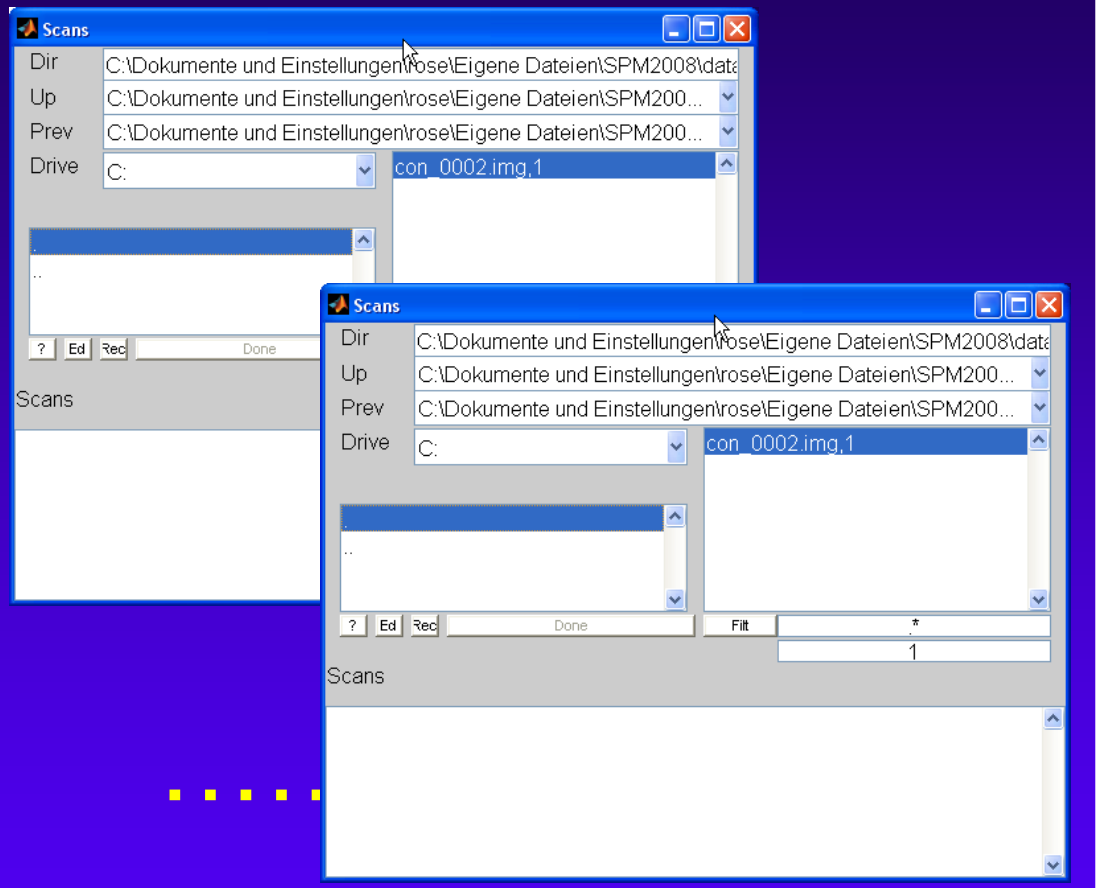


$\hat{\beta}_e$

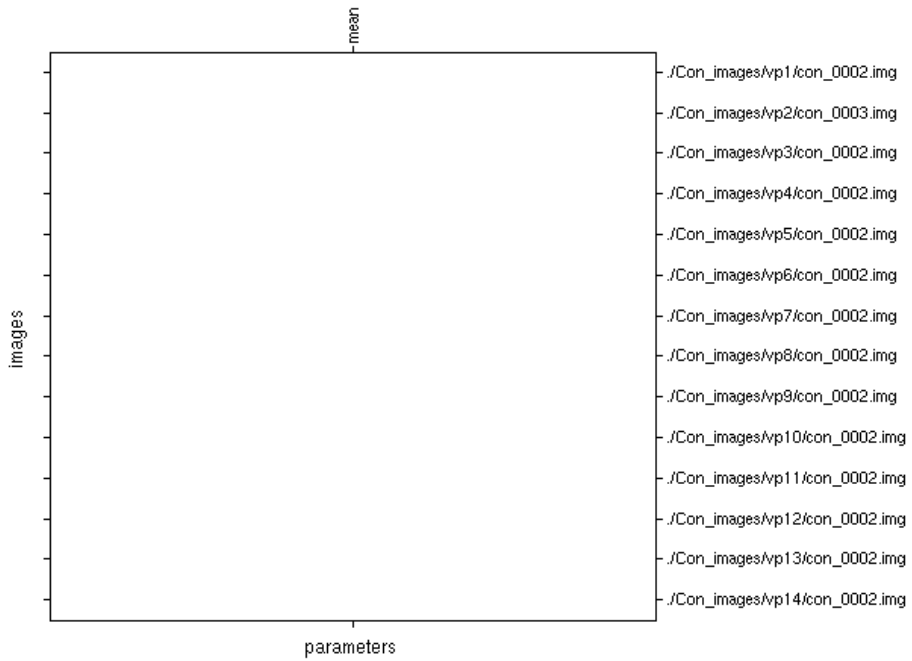
$\hat{\sigma}_e^2$

One- Sample t- Test (nb2 > nb1)



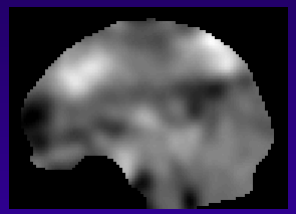


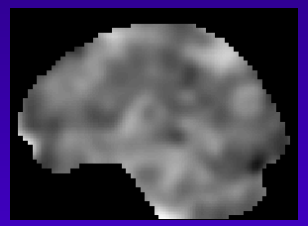
One Sample t-Test (nb2 > nb1)



Design description...

Design : One sample t-test
Global calculation : omit
Grand mean scaling : <no grand Mean scaling>
Global normalisation : <no global normalisation>
Parameters : 1 condition, +0 covariate, +0 block, +0 nuisance
1 total, having 1 degrees of freedom
leaving 13 degrees of freedom from 14 images

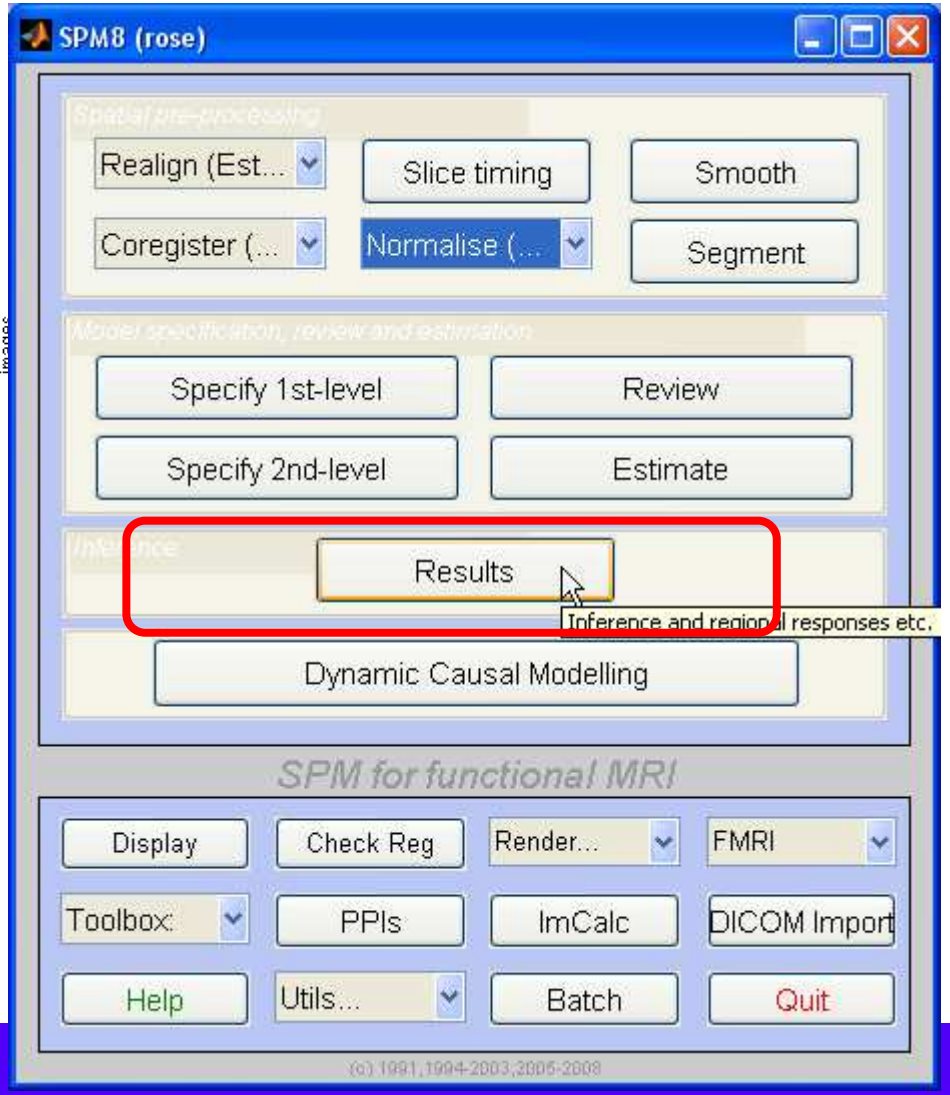


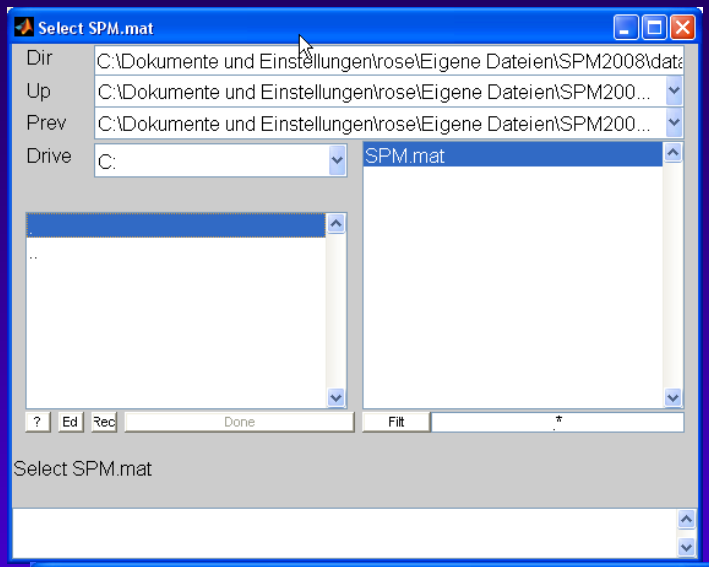


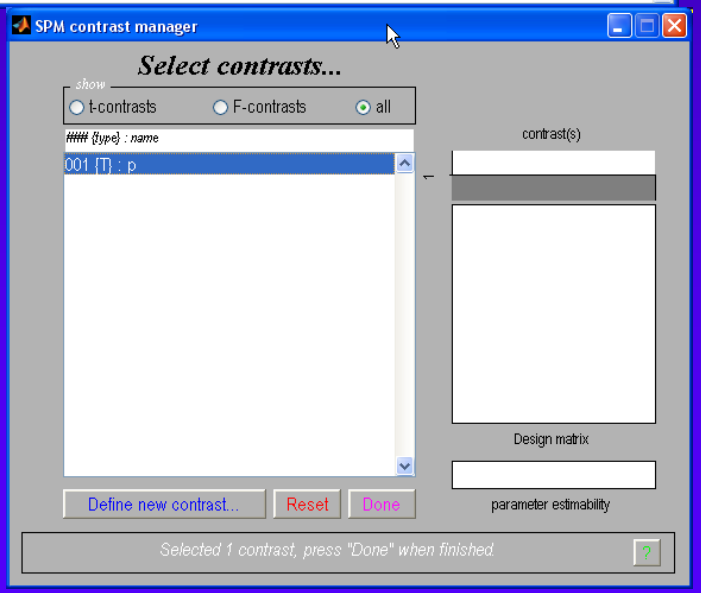
$\hat{\beta}_e$

$\hat{\sigma}_e^2$

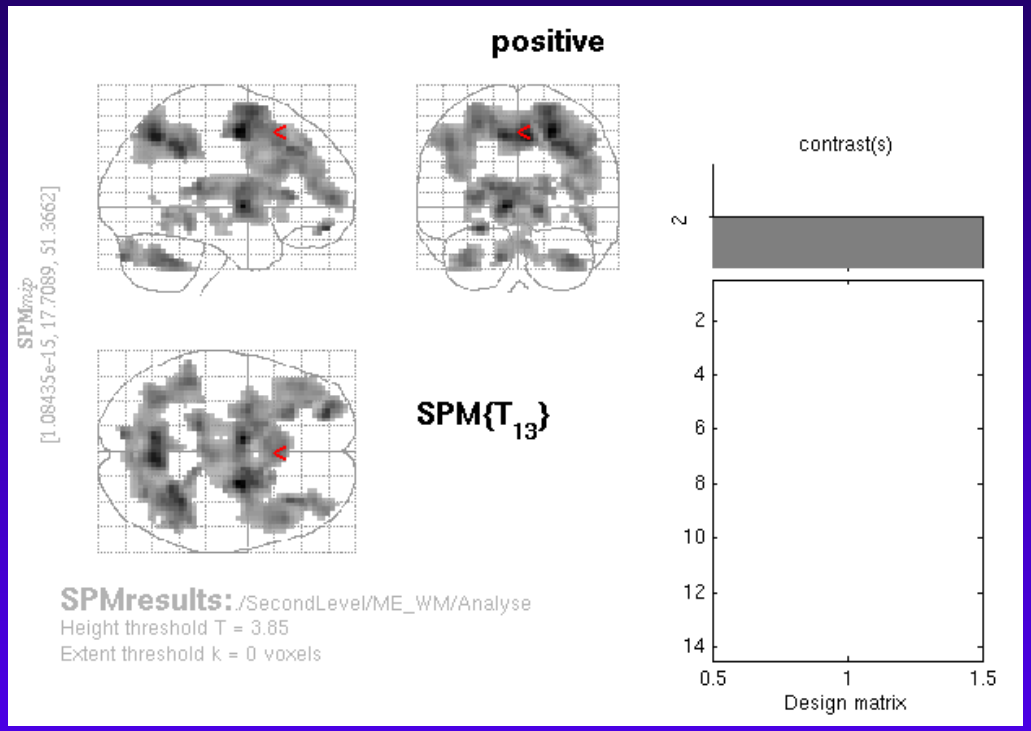
One Sample t-Test (nb2 > nb1)





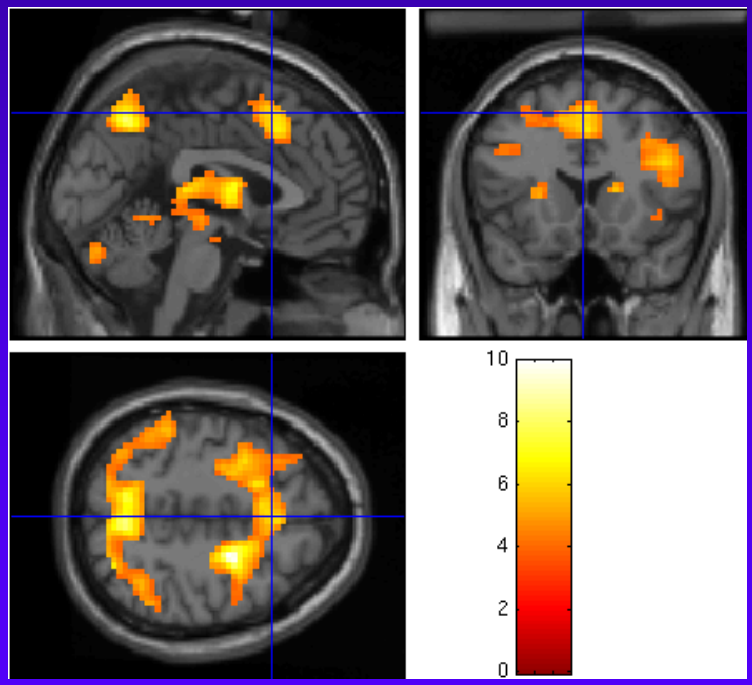


One Sample t-Test (nb2 > nb1)

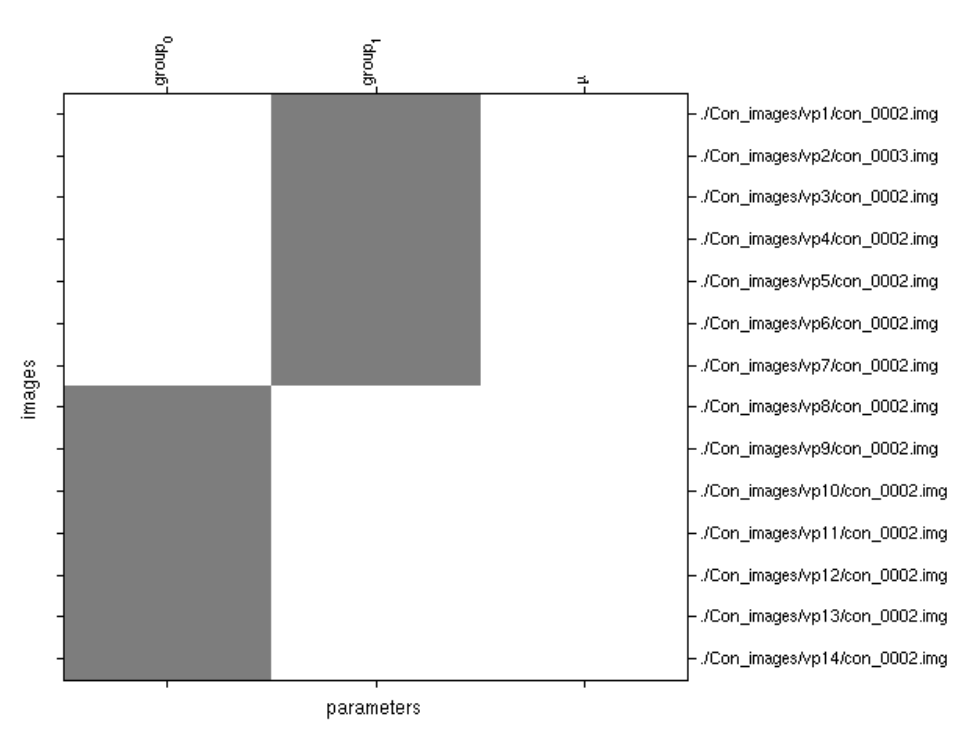


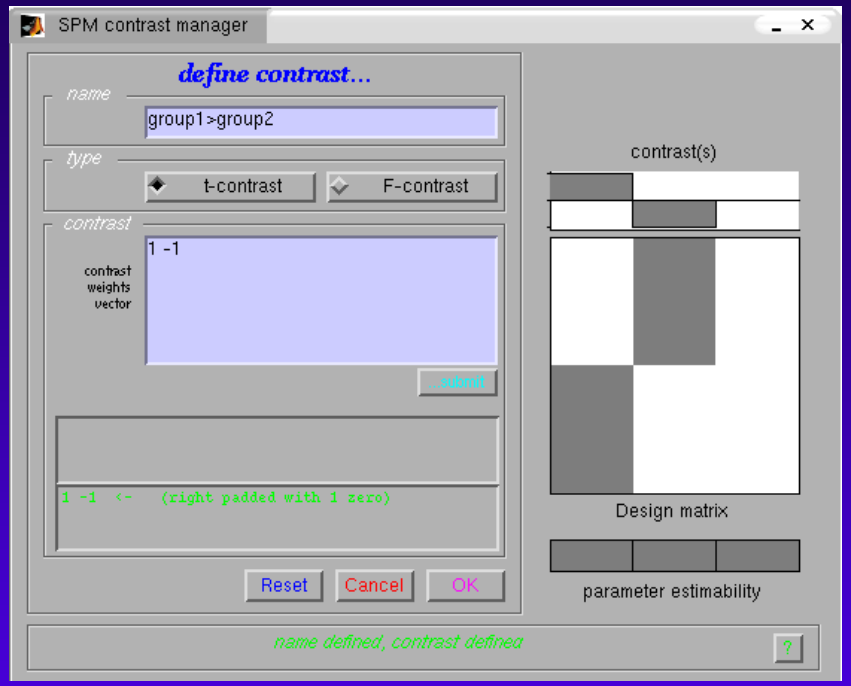
c=1

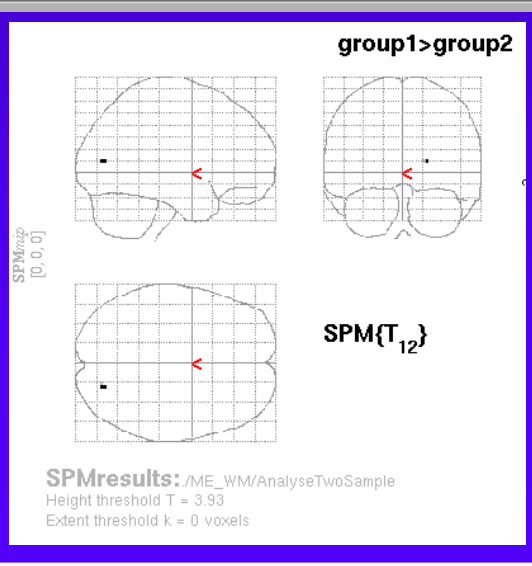
$$t = \frac{\hat{\beta}_e}{\sqrt{\hat{\sigma}_e^2}}$$



Two Sample t-Test



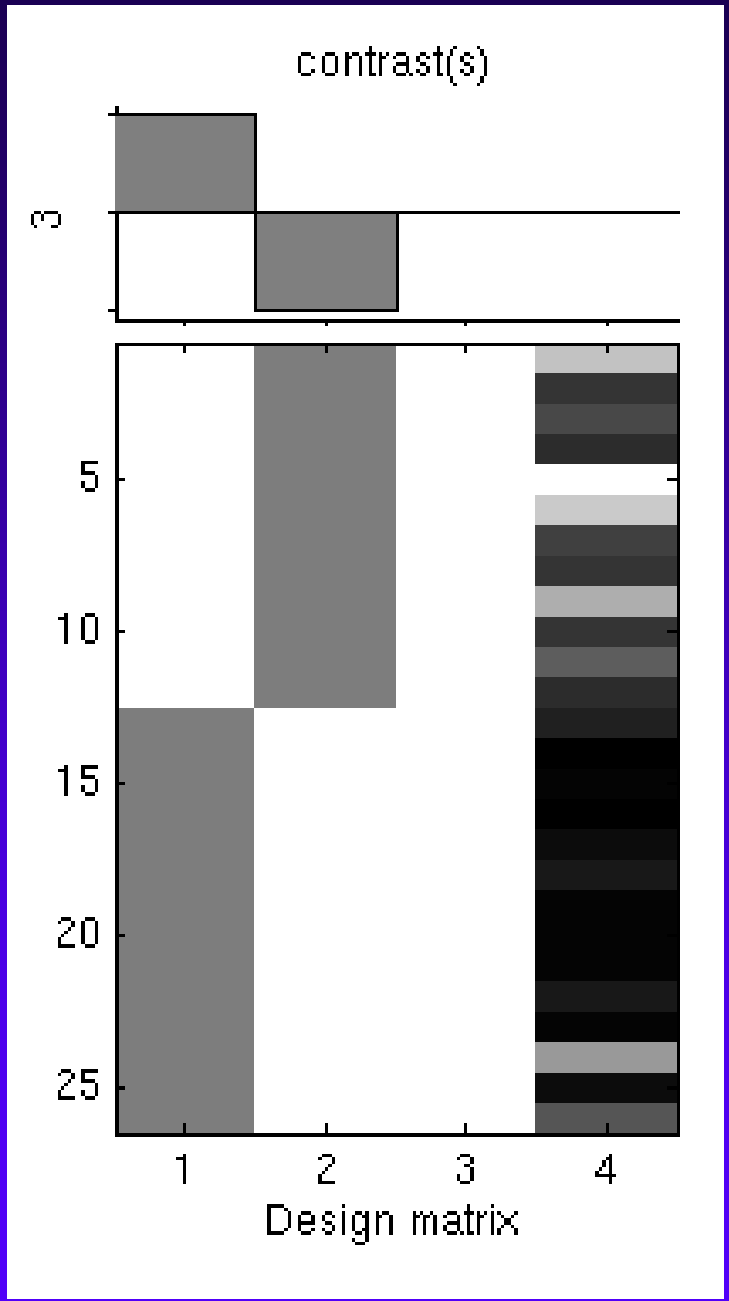




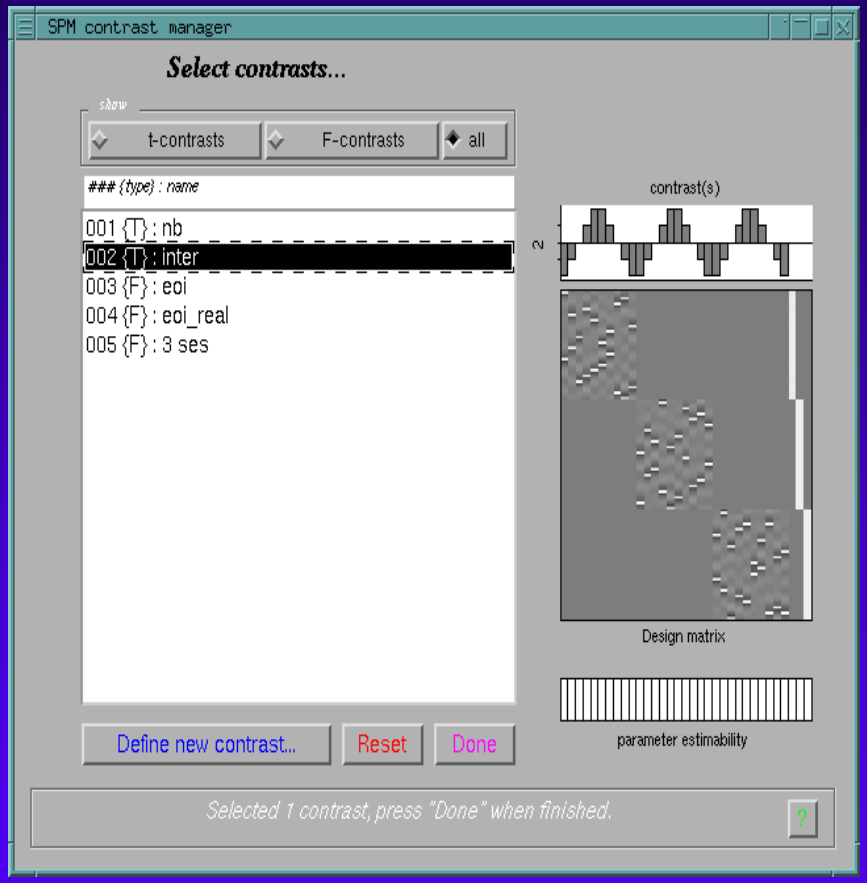
Kovariaten

Gruppenvergleich

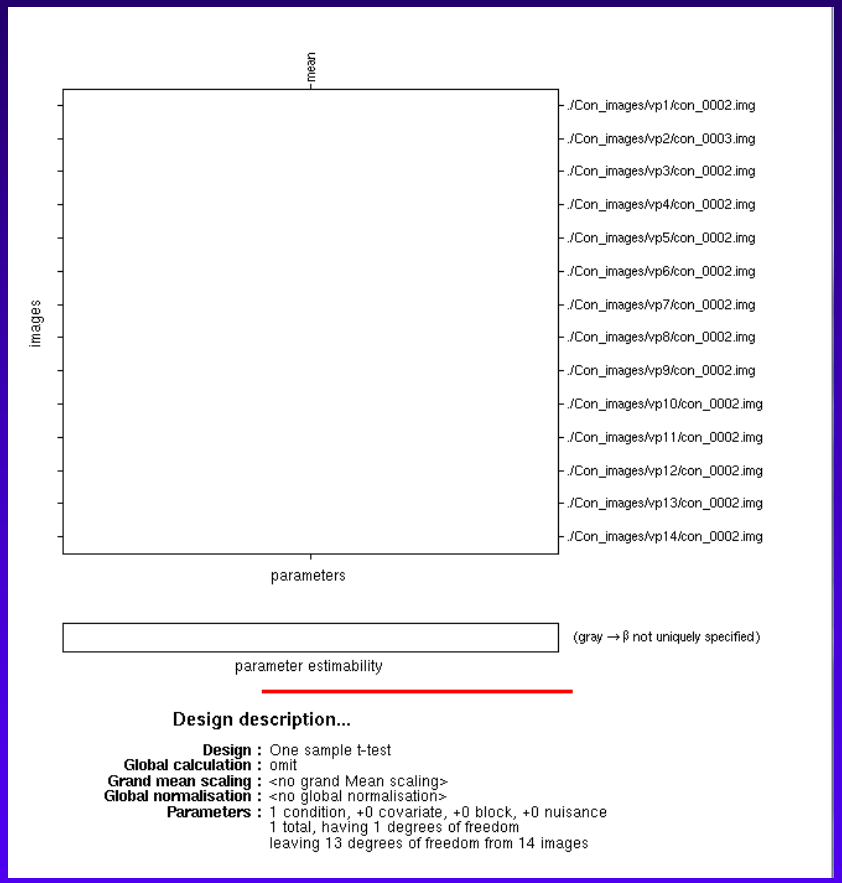
Nicht- interessierende Variable wird berücksichtig



Interaktion als t- Test

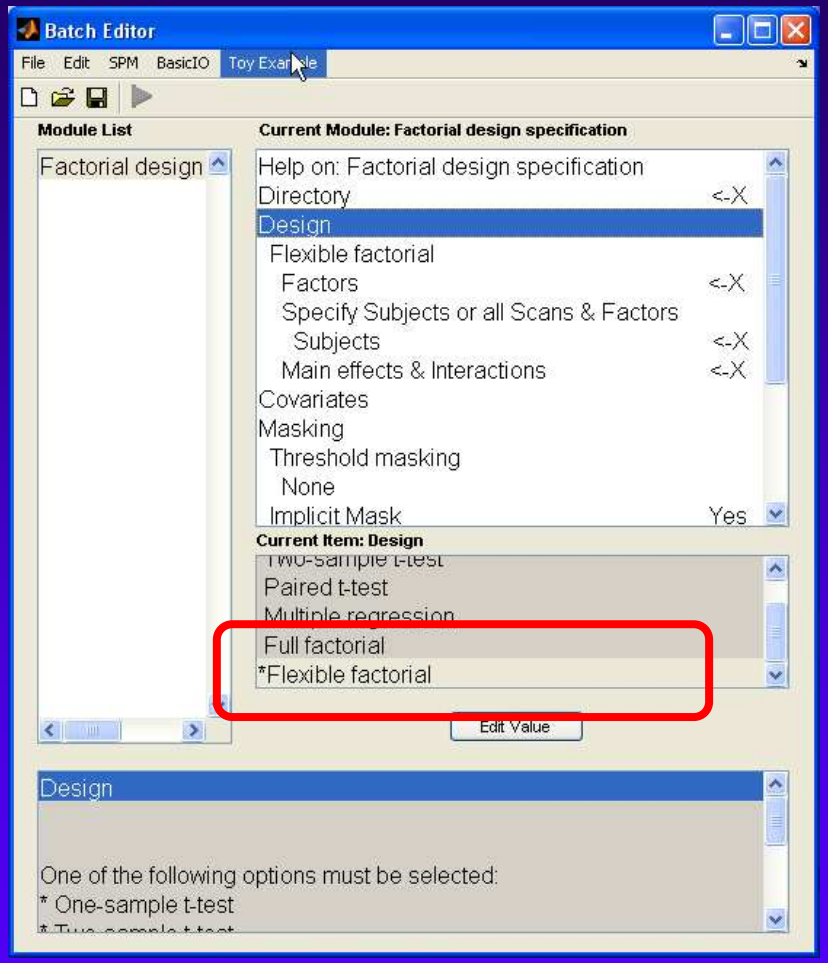


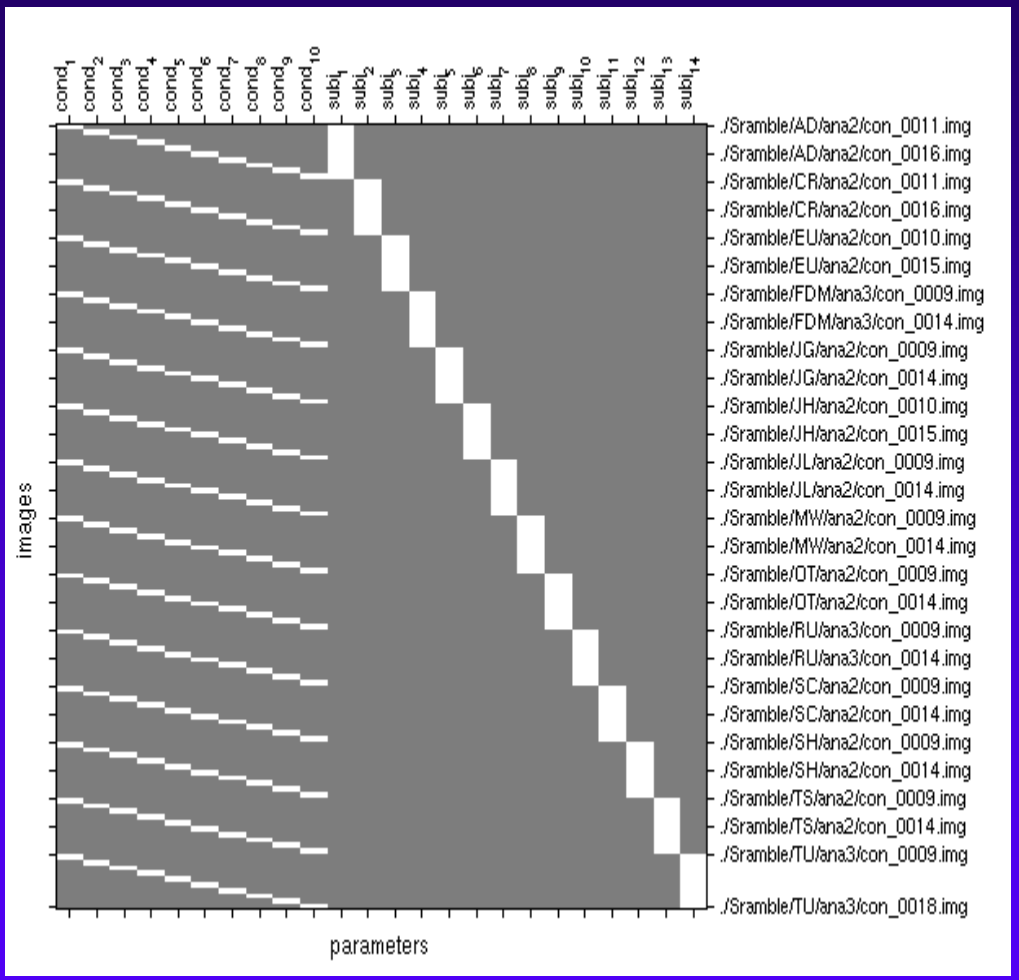
1 con-image für jede Person auf 1. level



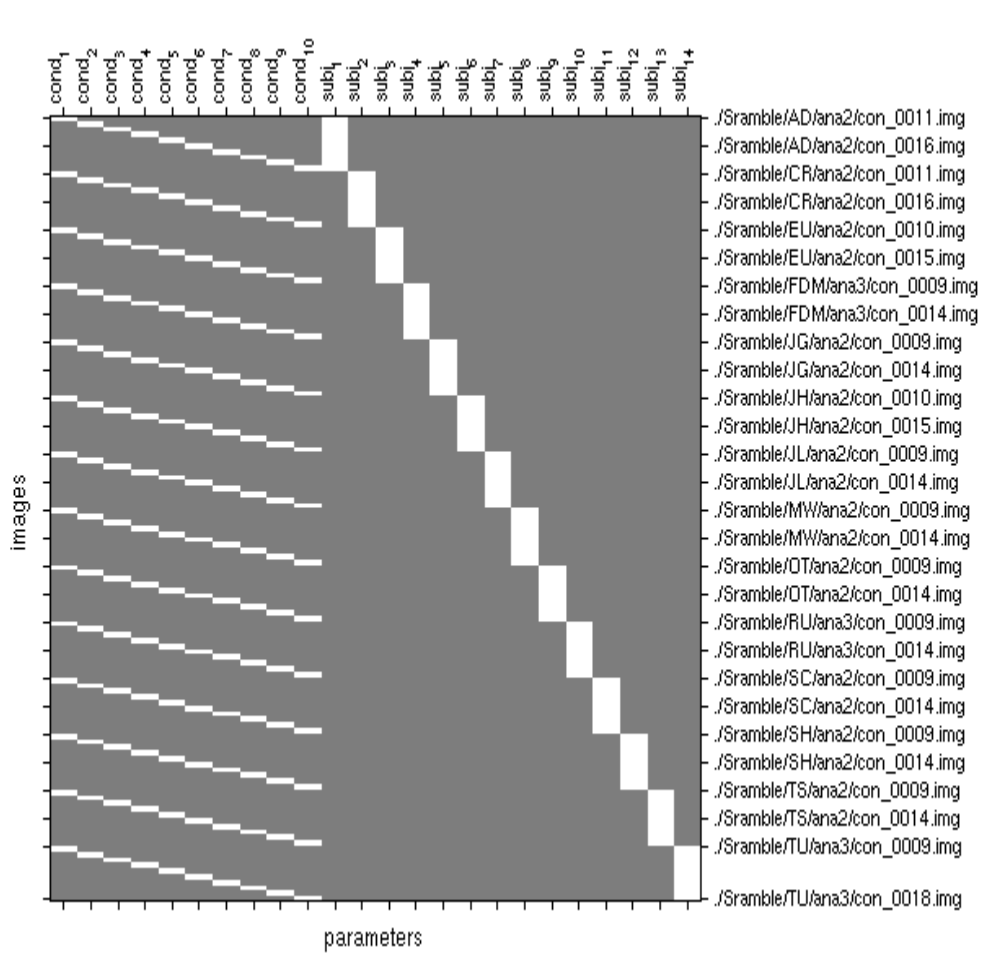
alle con-images im 2. level

Factorial Designs (ANOVA)



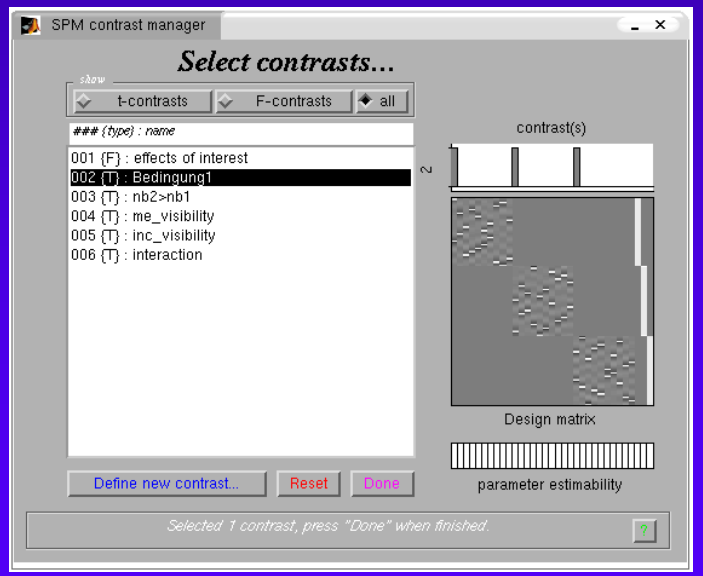


Factorial Designs

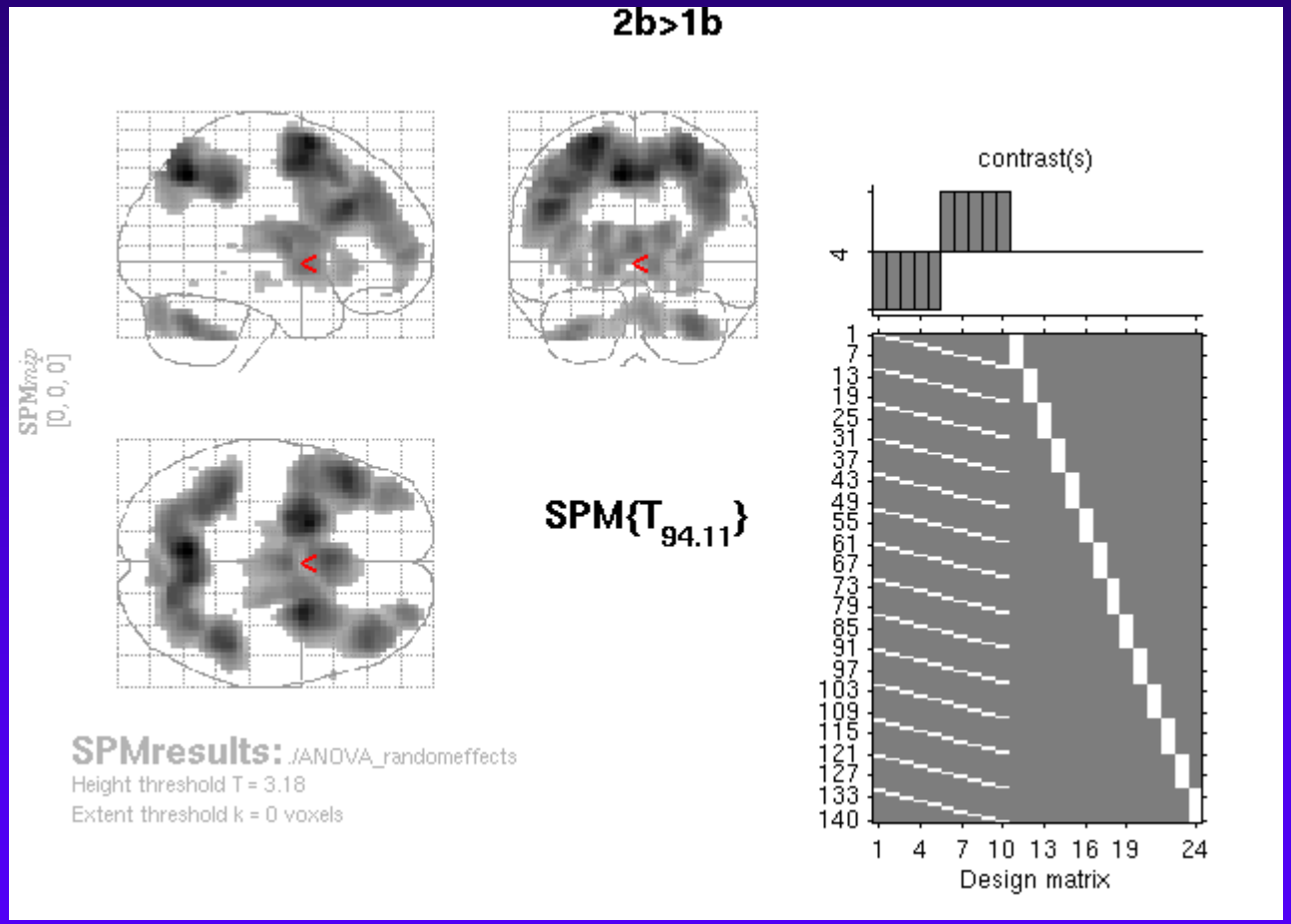


Voraussetzung:

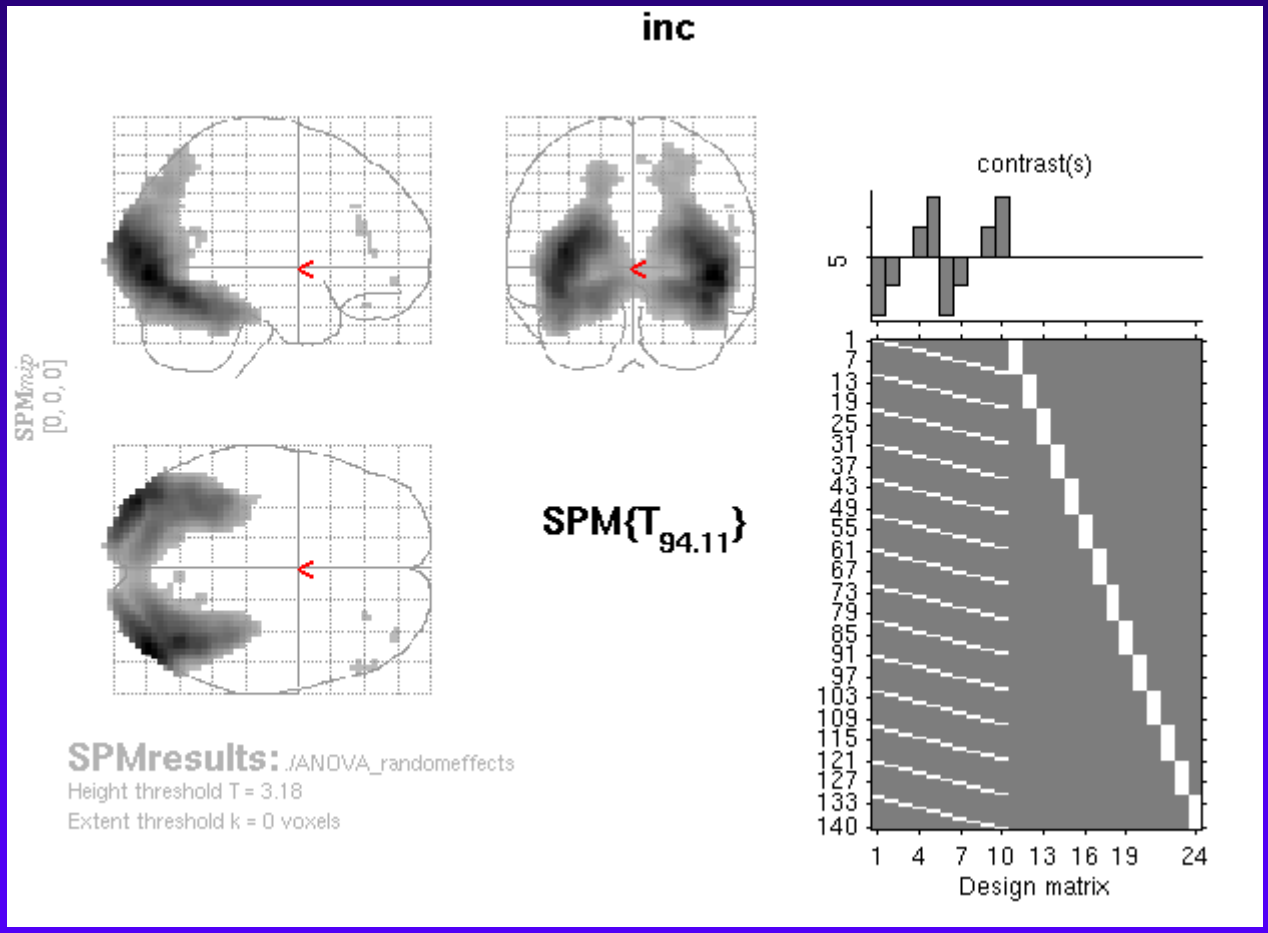
In allen Vp con-images für jede Bedingung einzeln auf 1. level



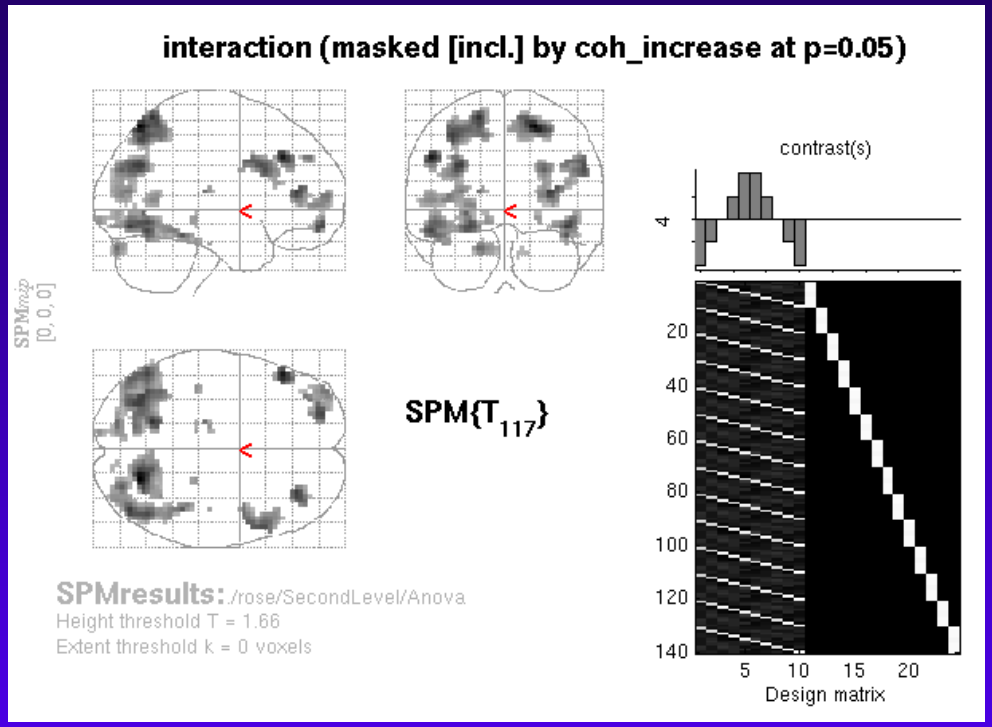
Factorial Designs



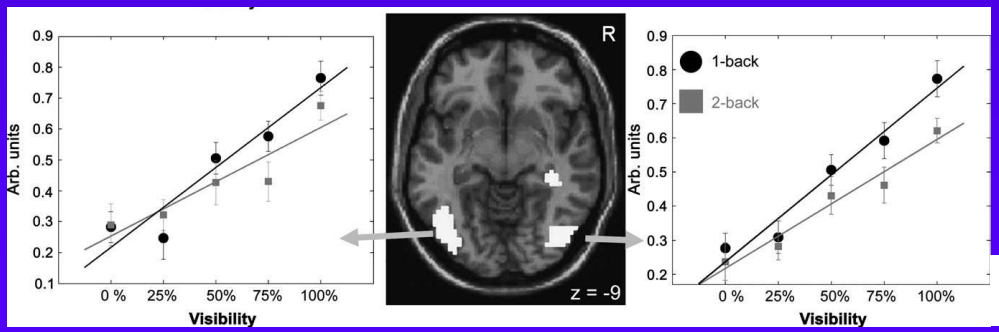
Factorial Designs



Factorial Designs



Wichtig: Bedingungen abhängig, non-spericity correction nötig

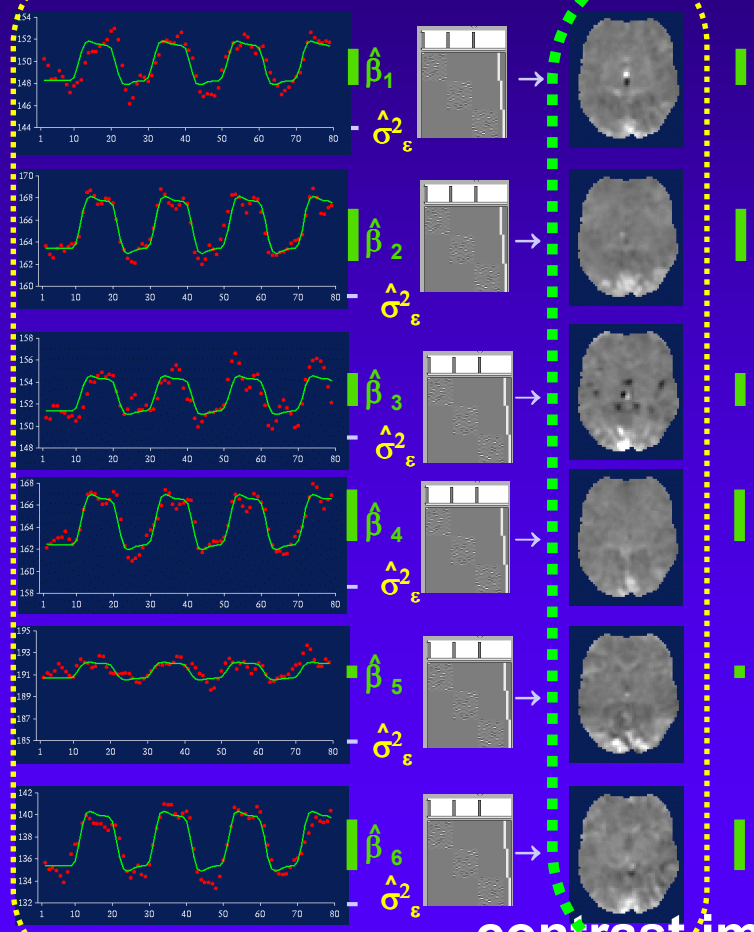


Rose et al (2005), Cerebral Cortex

Random effects

1.level
(within-subject)

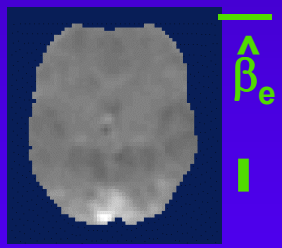
2.level
(between-subject)



timecourses at [03, -78, 00]

contrast images

variance $\hat{\sigma}^2_\varepsilon$



$\hat{\beta}_e$

$$t = \frac{\hat{\beta}_e}{\sqrt{\hat{\sigma}^2_e}}$$