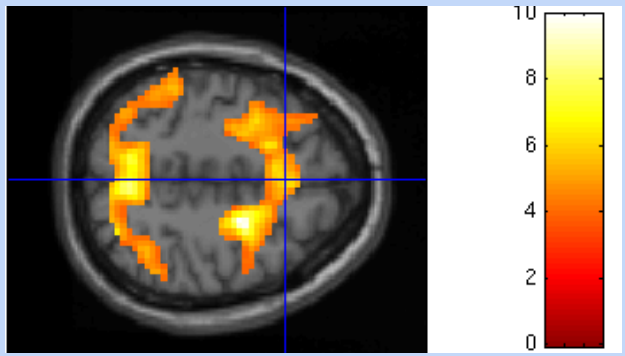
Universitätsklinikum Hamburg-Eppendorf

Julia Jablonowski
Institut für Systemische Neurowissenschaften

Inferences

Part 2: Group level analysis (2nd Level) Random effects analysis



t-oder F-Werte!

Übersicht

- 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

Übersicht

1. Level (Einzelperson)

Person 1: Modell (regression coefficients)

Person 1: t- oder F-Kontraste

Person 2 …..Person n

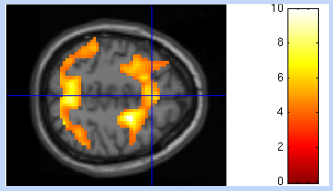
Ergebnisse

2. Level (Gruppe)

Modell für Gruppe (Regressoren)

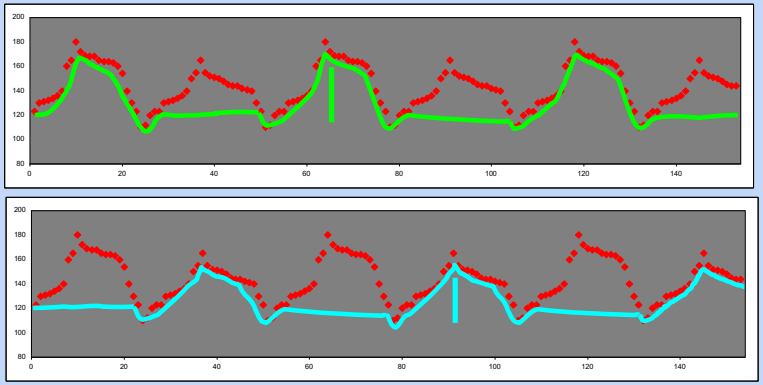
Gruppe: t- oder F-Kontraste

Finale statistische Karte



Daten für Gruppenstatistik

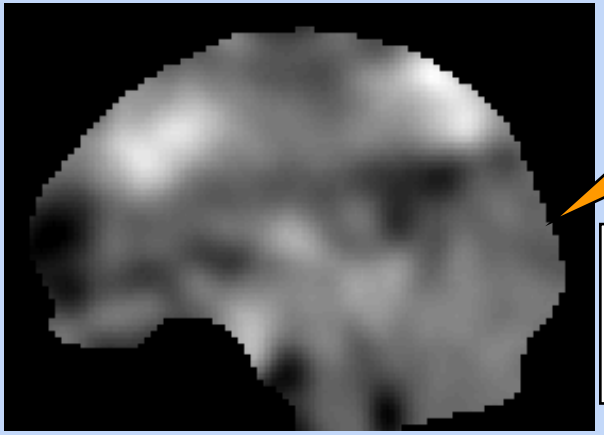
Model estimation Einzelperson → Statistischer Vergleich 1. level



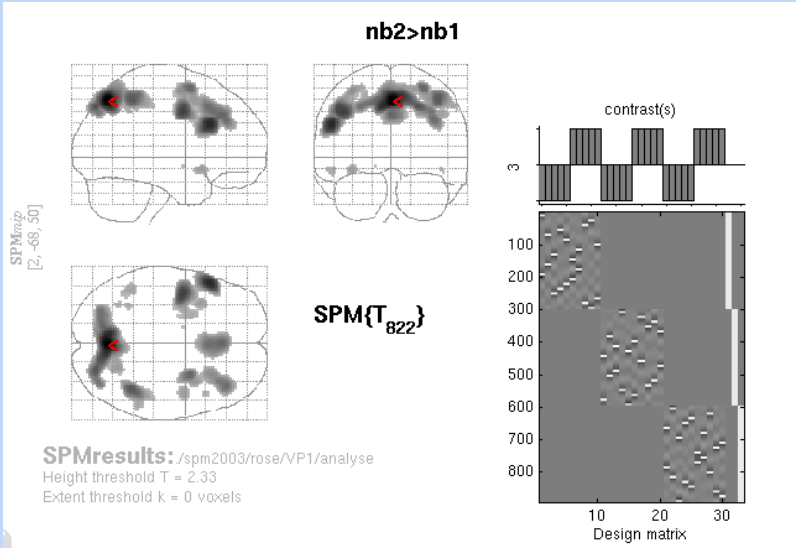
$\hat{\beta}_{nb2}$

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

$$t = \frac{\hat{\beta}_{nb2} - \hat{\beta}_{nb1}}{\sqrt{\hat{\sigma}^2_{(\hat{\beta}_{nb2} - \hat{\beta}_{nb1})}}}$$



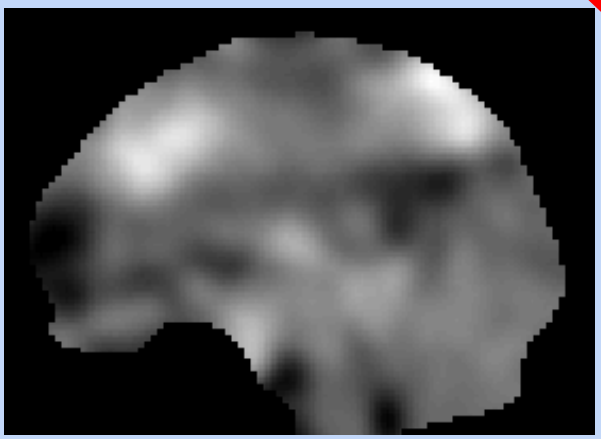
$$D = \sum_i c_i * \hat{\beta}_i$$



Contrast image für jede Person

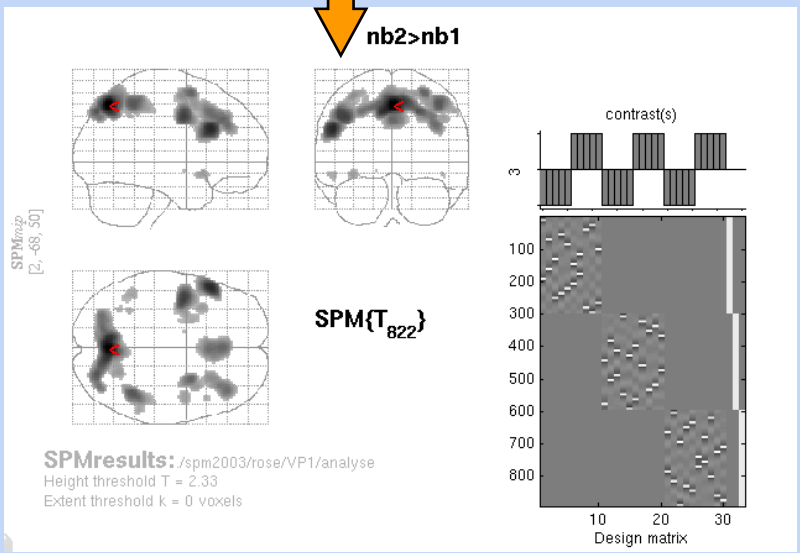
Daten für Gruppenstatistik

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



Con_xxxx.img
„Effect size“

$$t = \frac{\hat{\beta}_{nb2} - \hat{\beta}_{nb1}}{\sqrt{\hat{\sigma}^2_{(\hat{\beta}_{nb2} - \hat{\beta}nb1)}}}$$

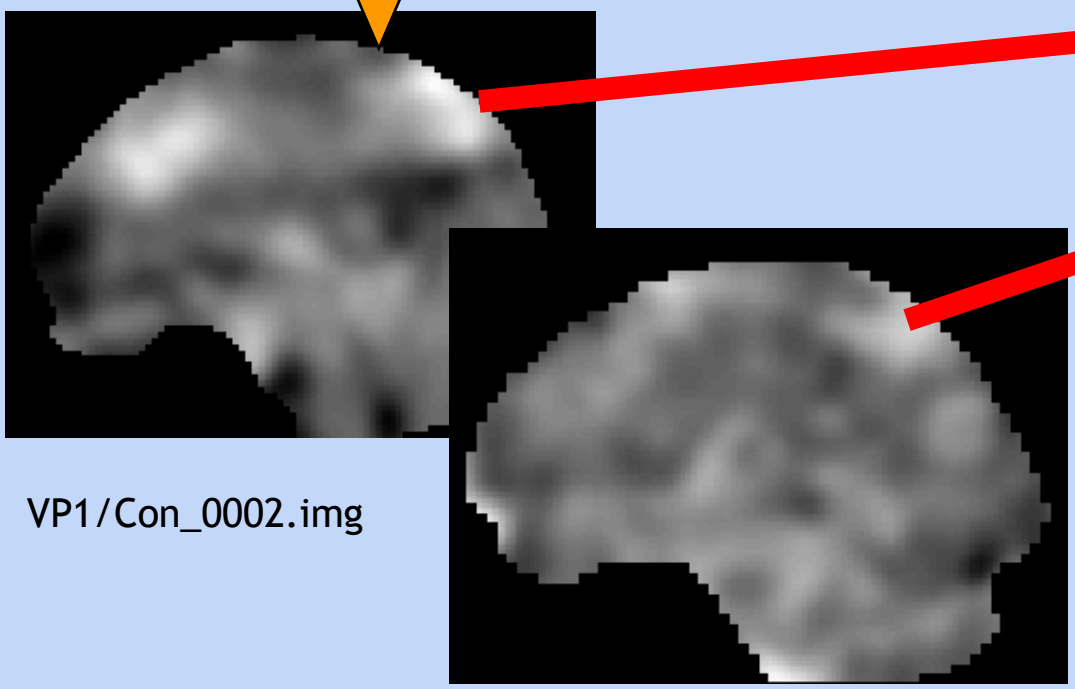


spmT_xxxx.img

Daten für Gruppenstatistik

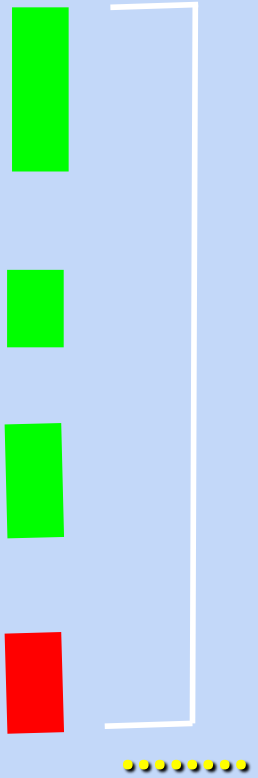
$$D = 1 * \hat{\beta}_{nb2} + (-1) * \hat{\beta}_{nb1}$$

Linearkombination der Parameter – Schätzer pro Voxel



VP1/Con_0002.img

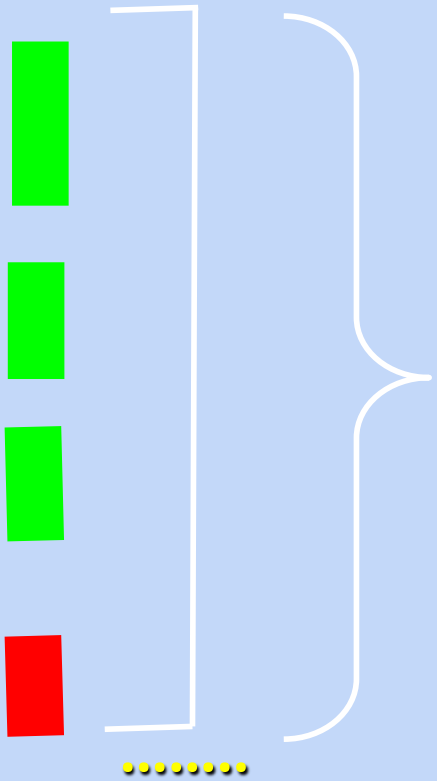
VP2/Con_0002.img



$$\hat{\beta}_e$$

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

Neues Modell und Statistik



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

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

t- oder F- Kontraste über Gruppe

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

Wichtige Unterschiede 1. und 2. Level

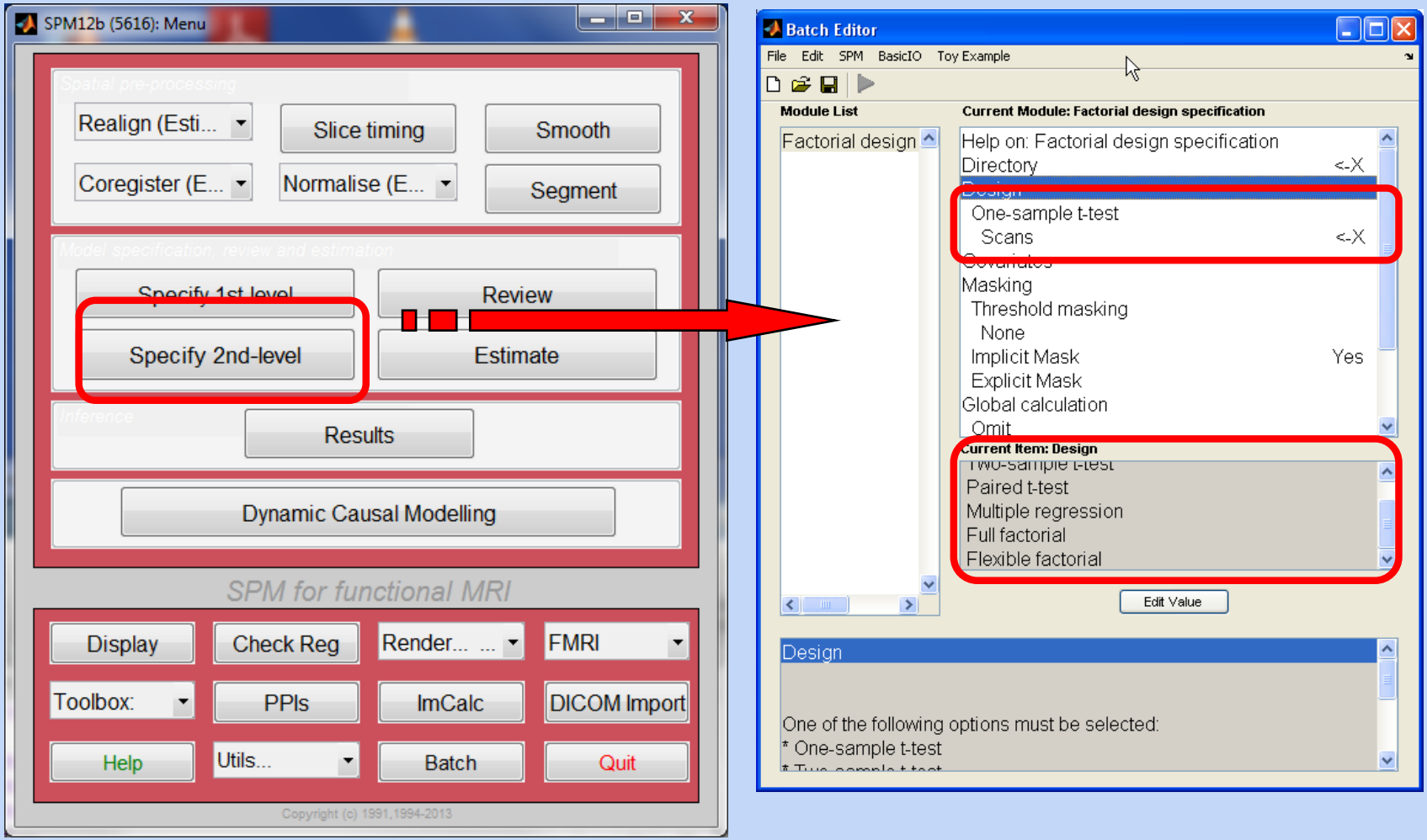
Single subject: Fehlerterm entsteht durch residuelle Varianz eines Modells des Experiments innerhalb einer Person; viele Freiheitsgrade (durch Messungen)

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

Gruppengröße >20 für ausreichende Reliabilität

(Thirion et al, Neuroimage 2007)

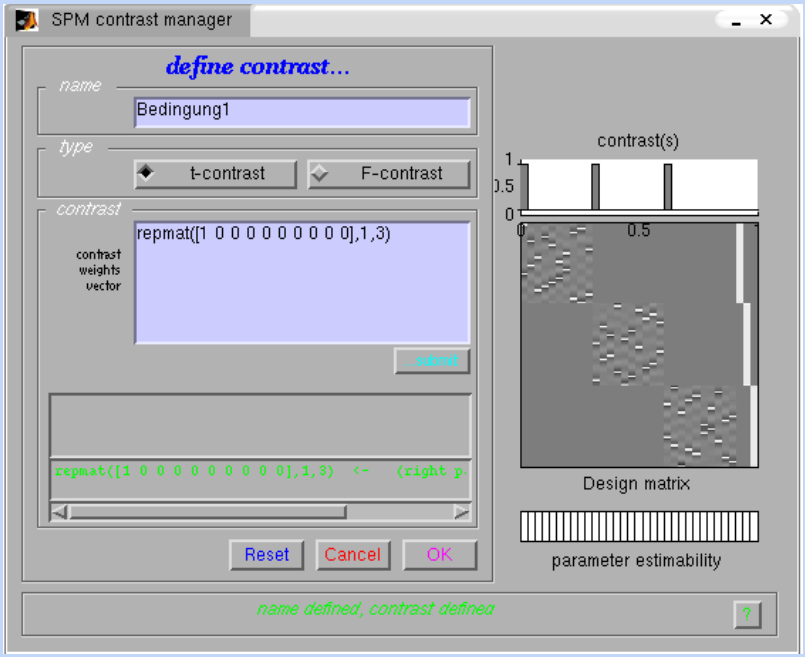
Praktische Beispiele

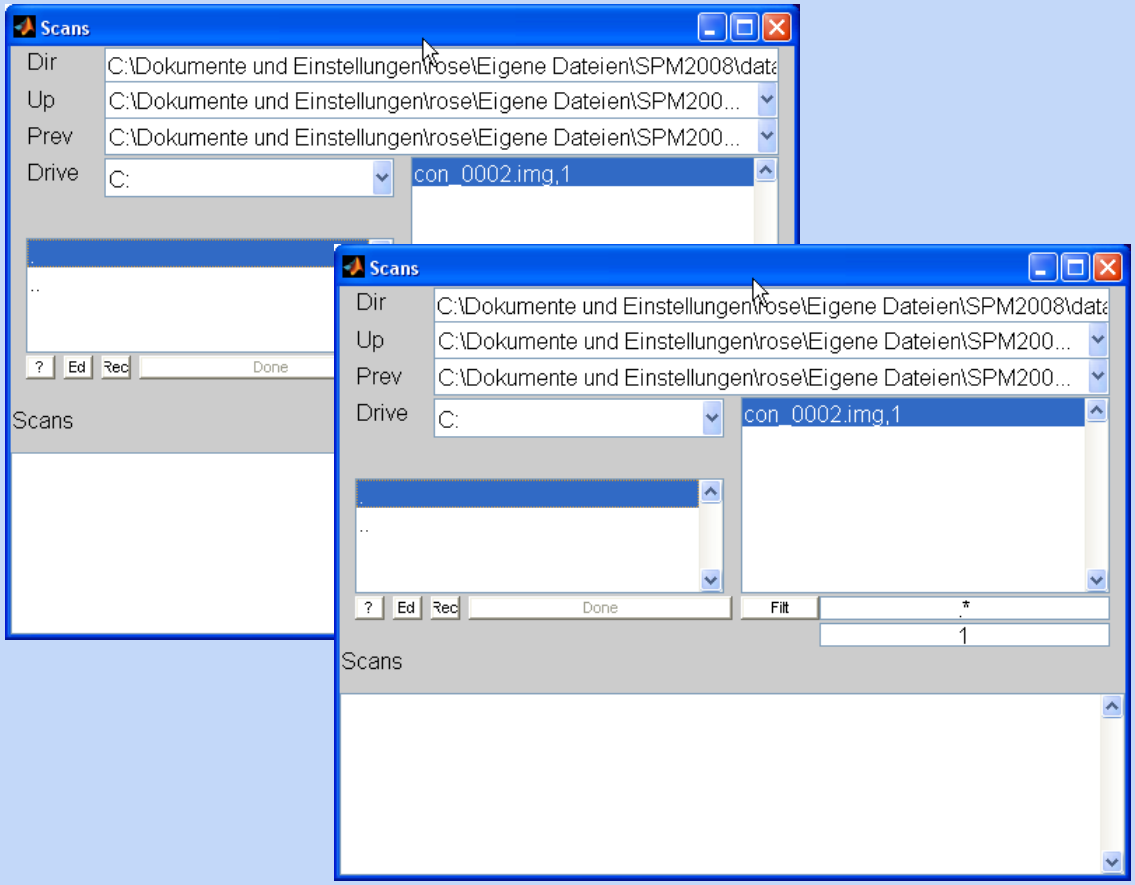


Wichtig: hier wird nur das Modell gewählt, noch keine Statistik berechnet!

One sample t-test: Haupteffekt Bed. 1

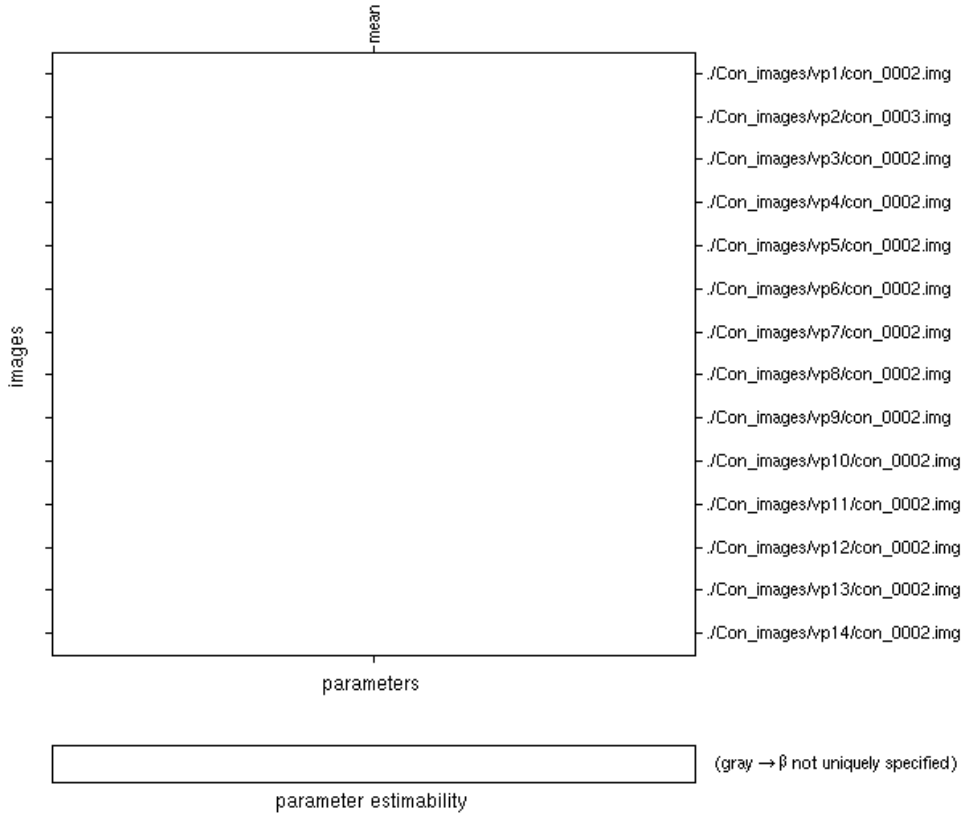
$$t = \frac{\bar{\beta}_{b1}}{\sqrt{\hat{\sigma}^2_{\hat{\beta}_1}}}$$





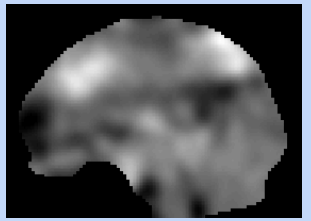
. . . . . .

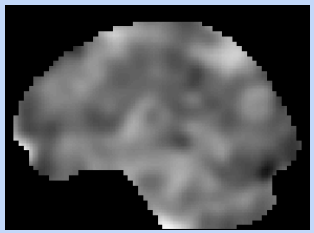
One sample t-test (Neues Model)



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

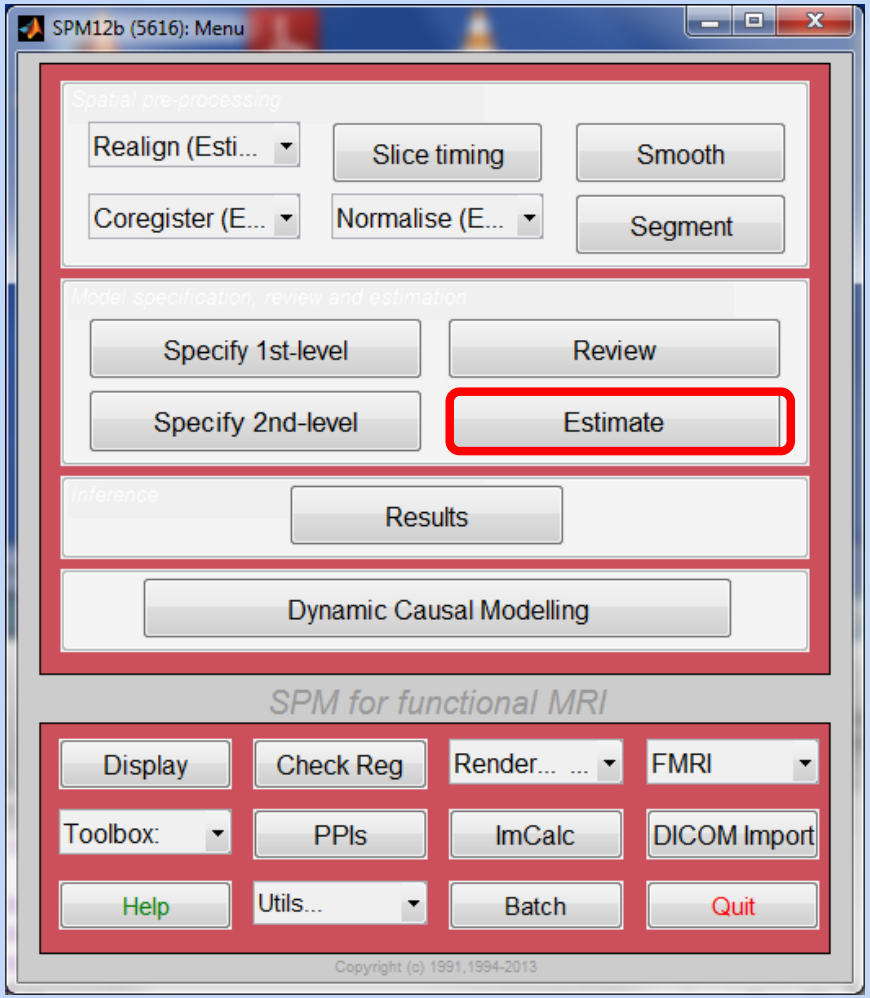


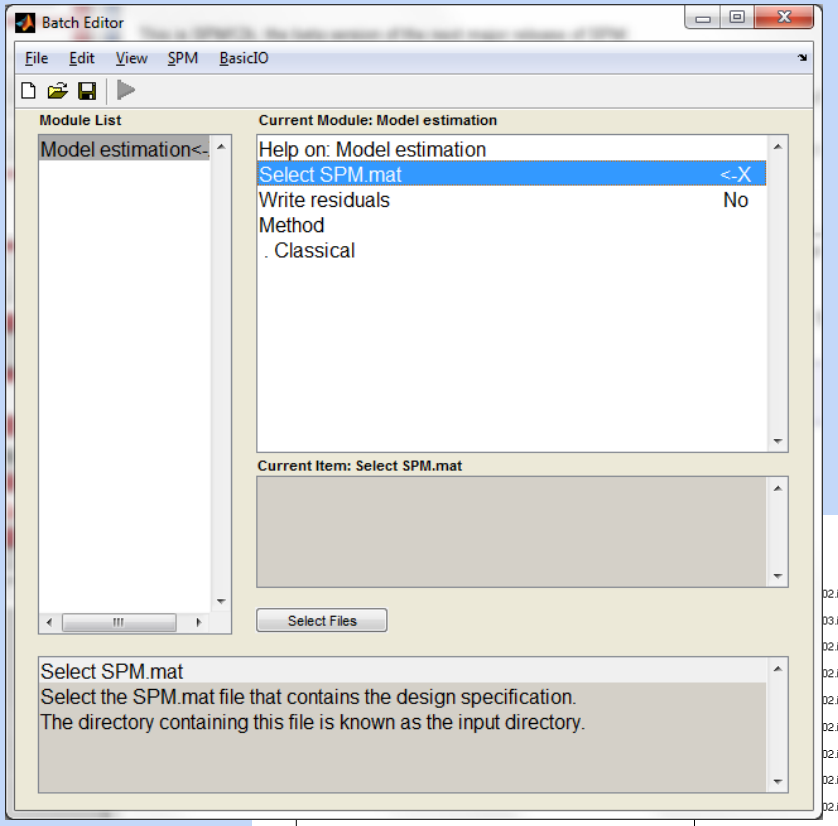


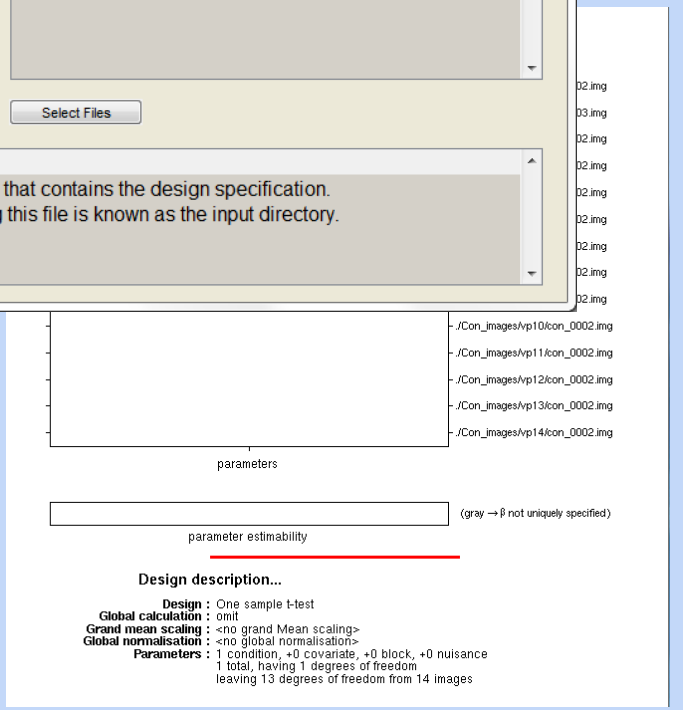
$$\hat{\beta}_e$$

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

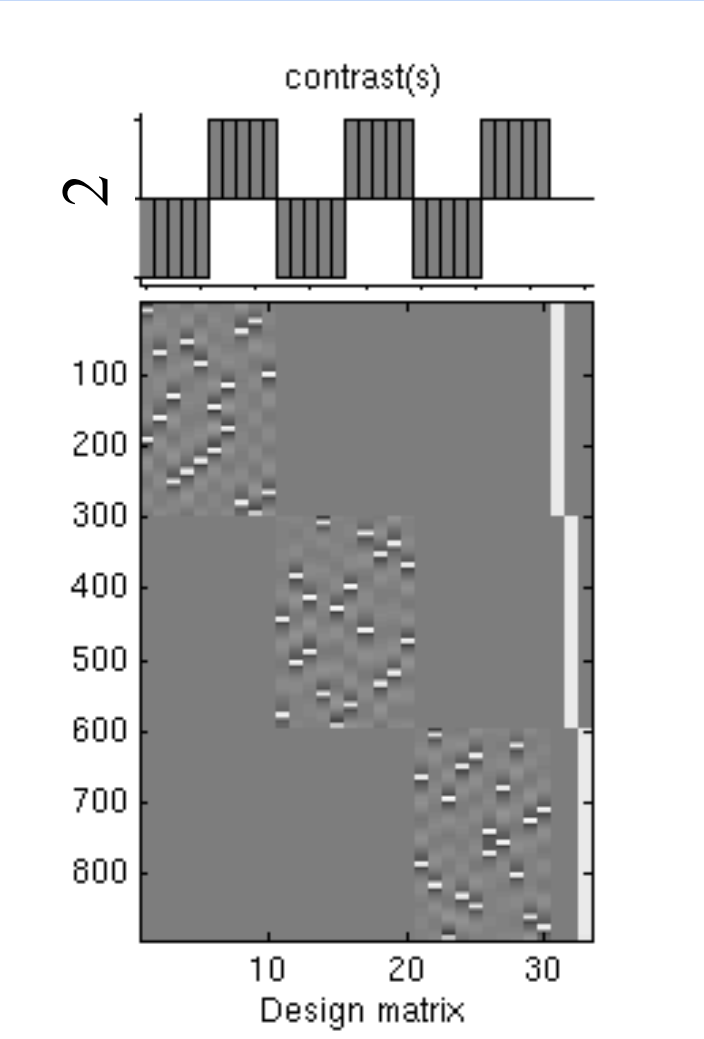
One sample t-test (Neues Model)

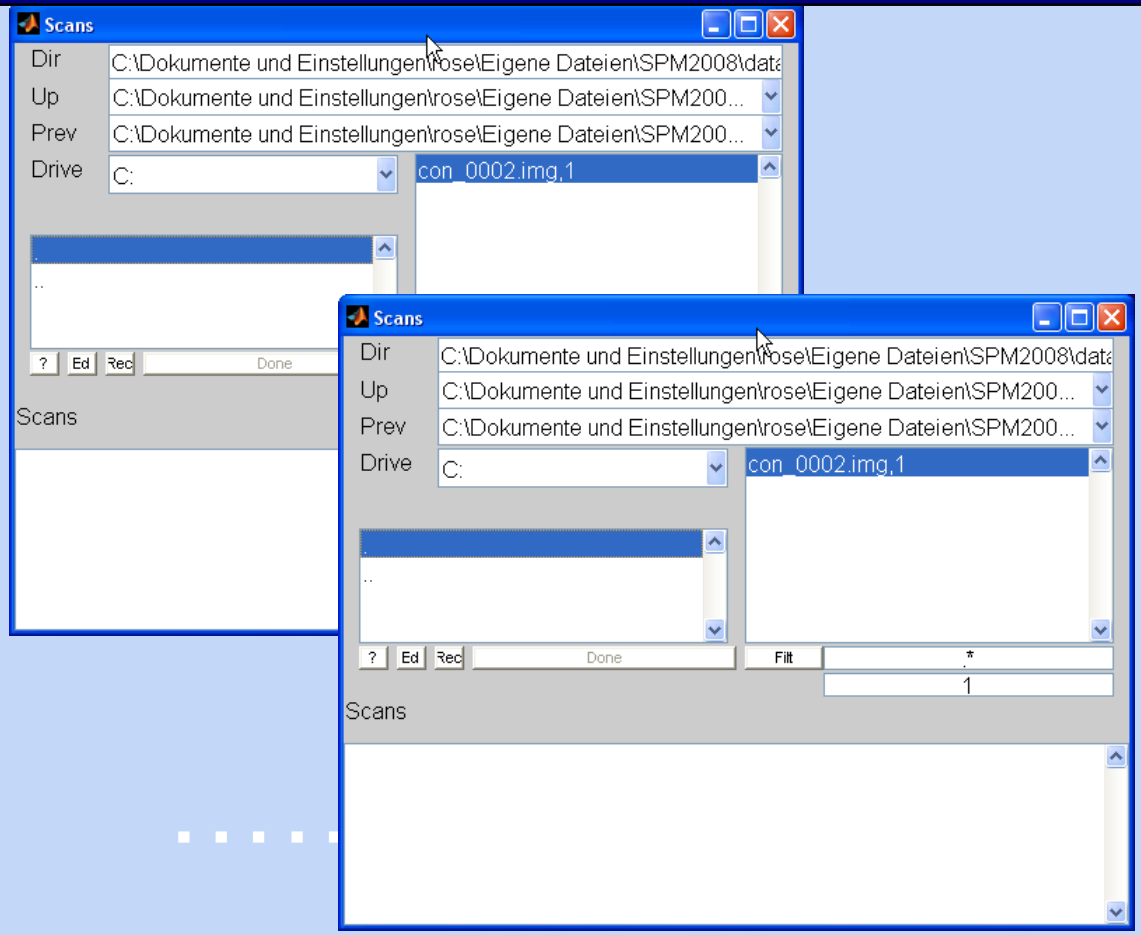




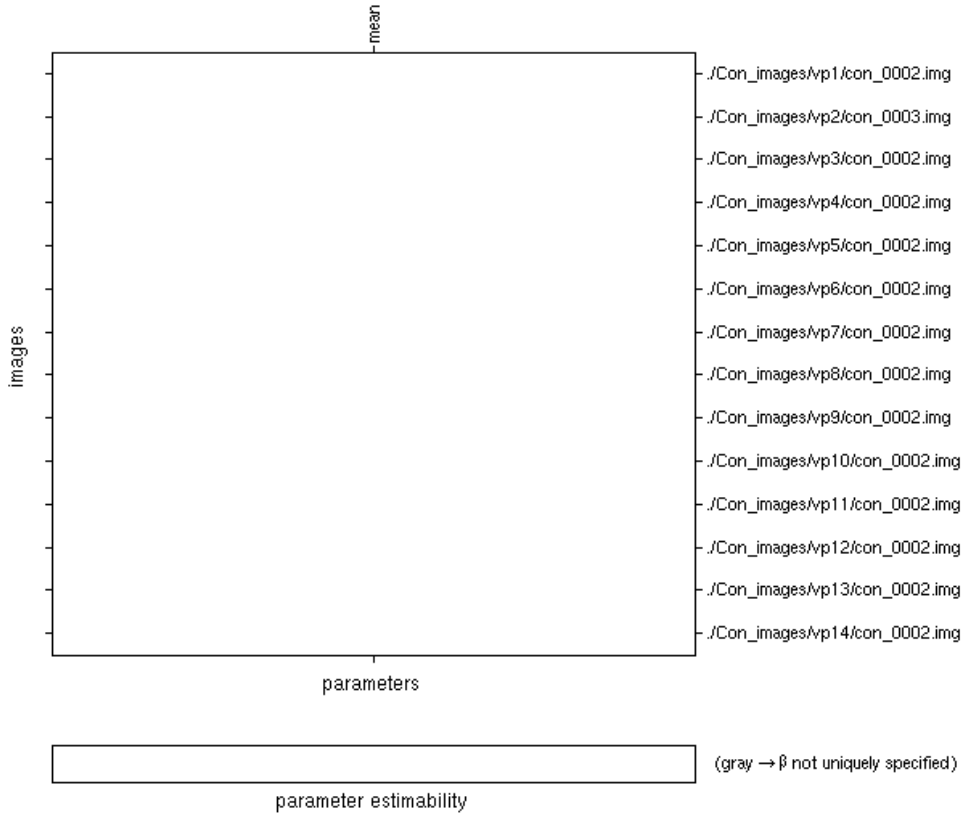


One sample t-test: Differentieller Effekt



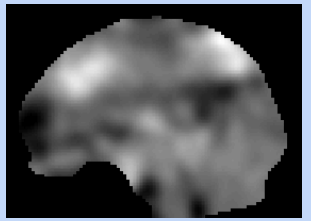


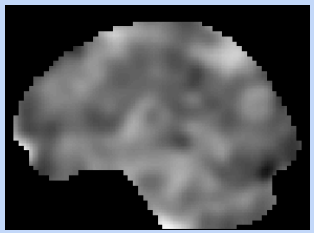
One sample t-test: Differentieller Effekt



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

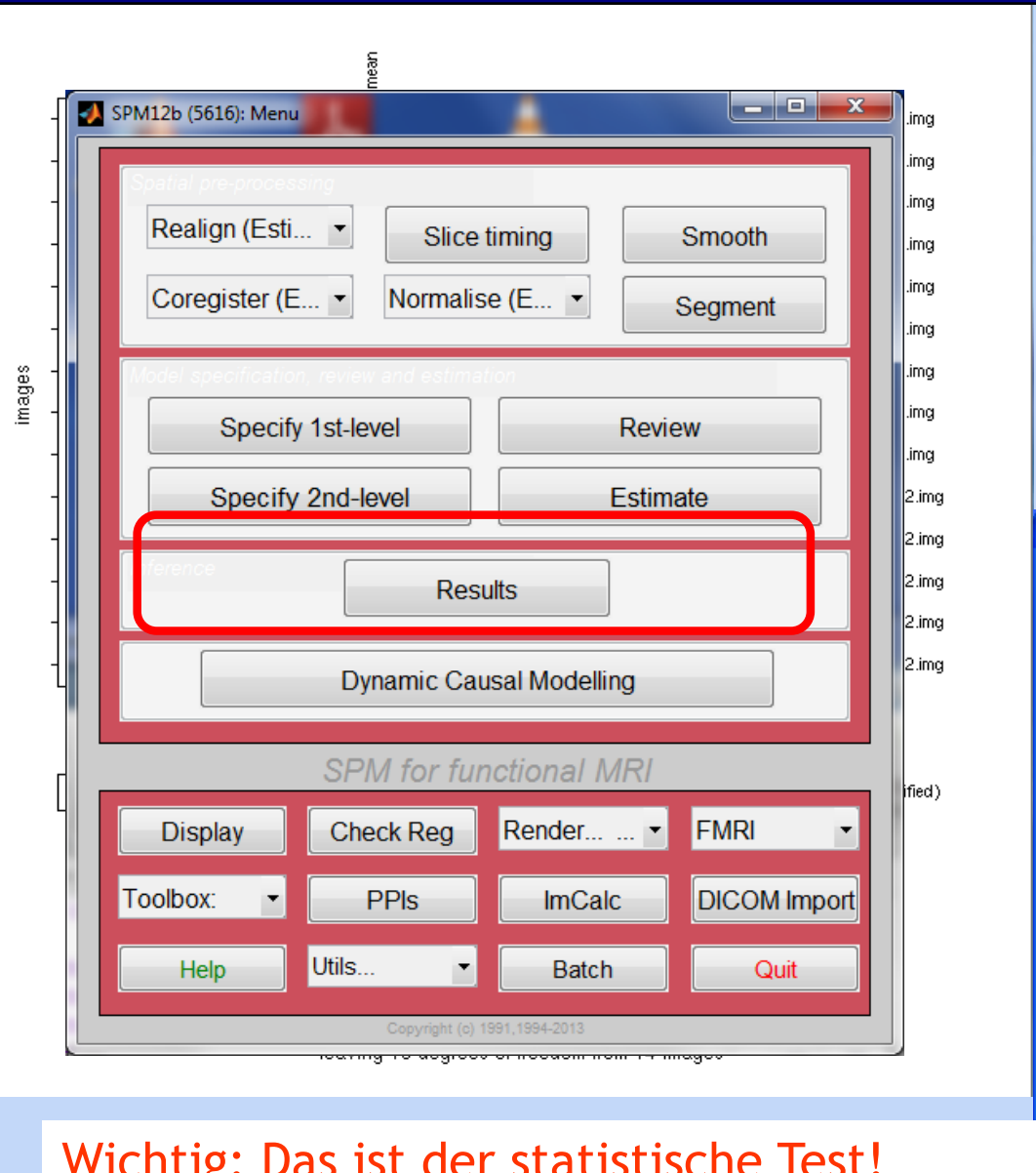


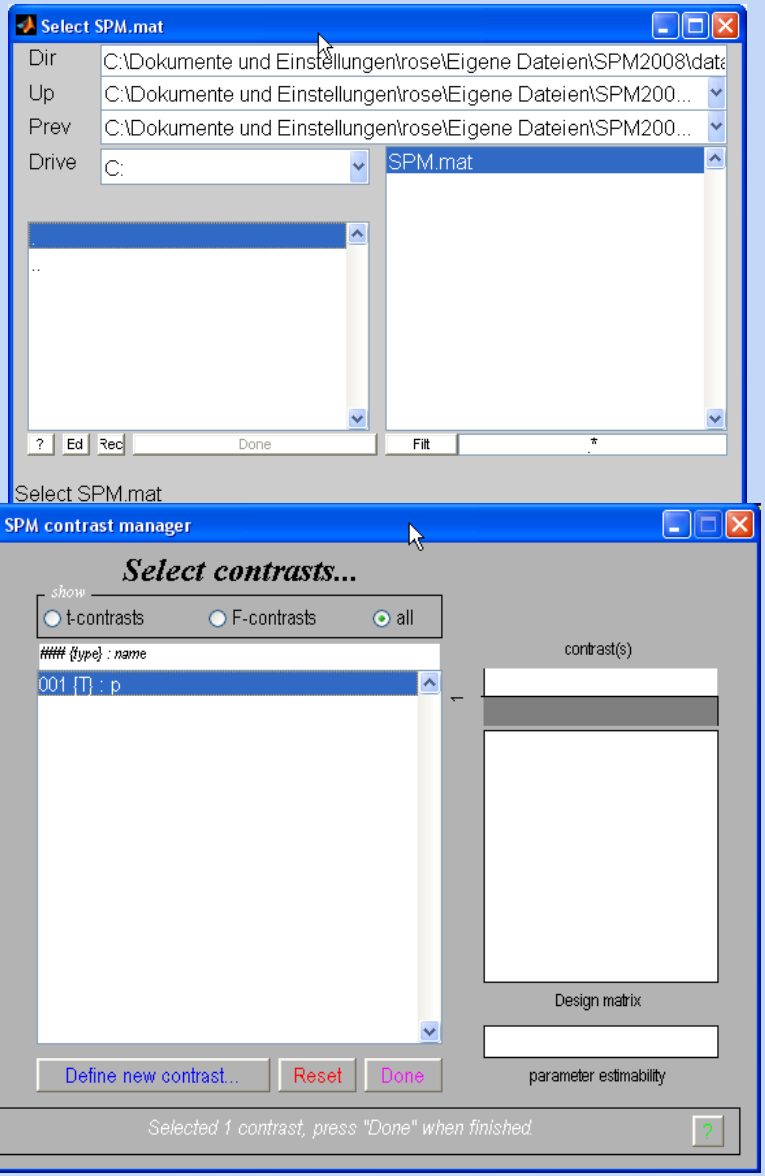


$$\hat{\beta}_e$$

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

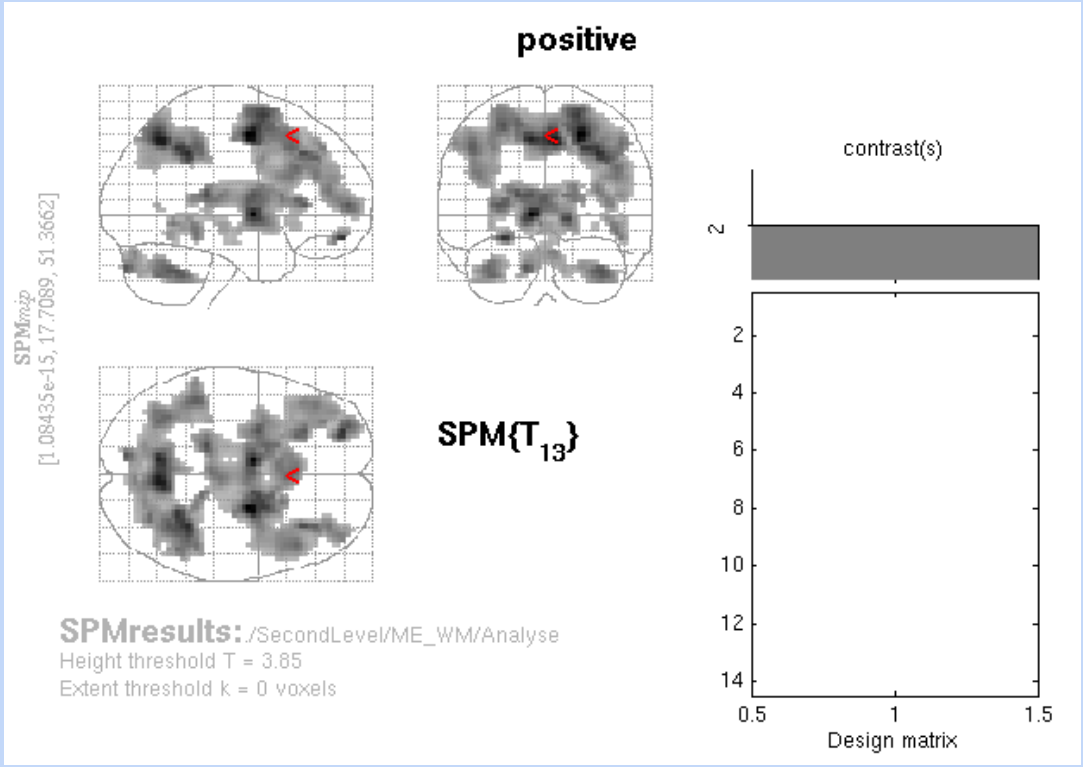
One sample t-test: Differentieller Effekt





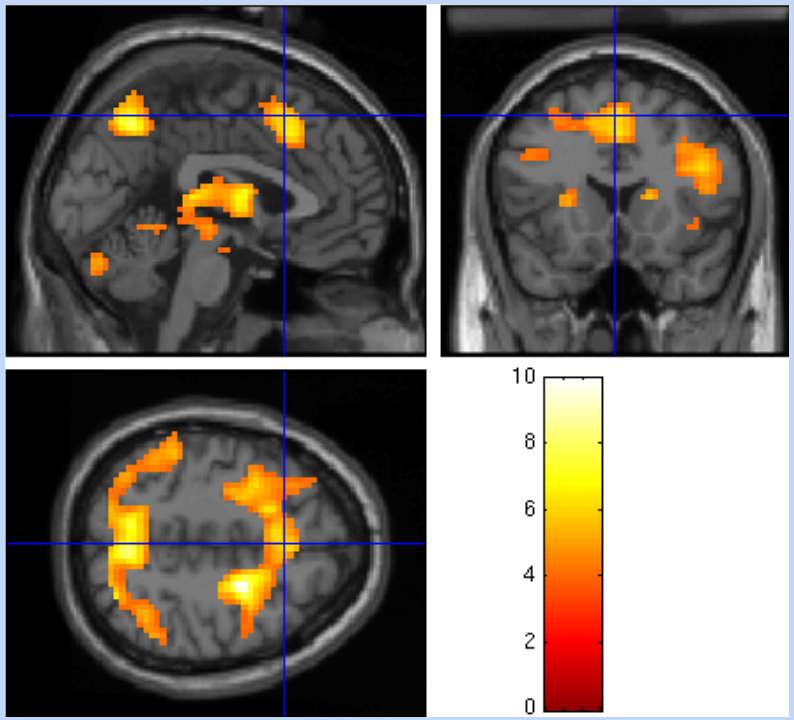
Wichtig: Das ist der statistische Test!

One sample t-test: Differentieller Effekt

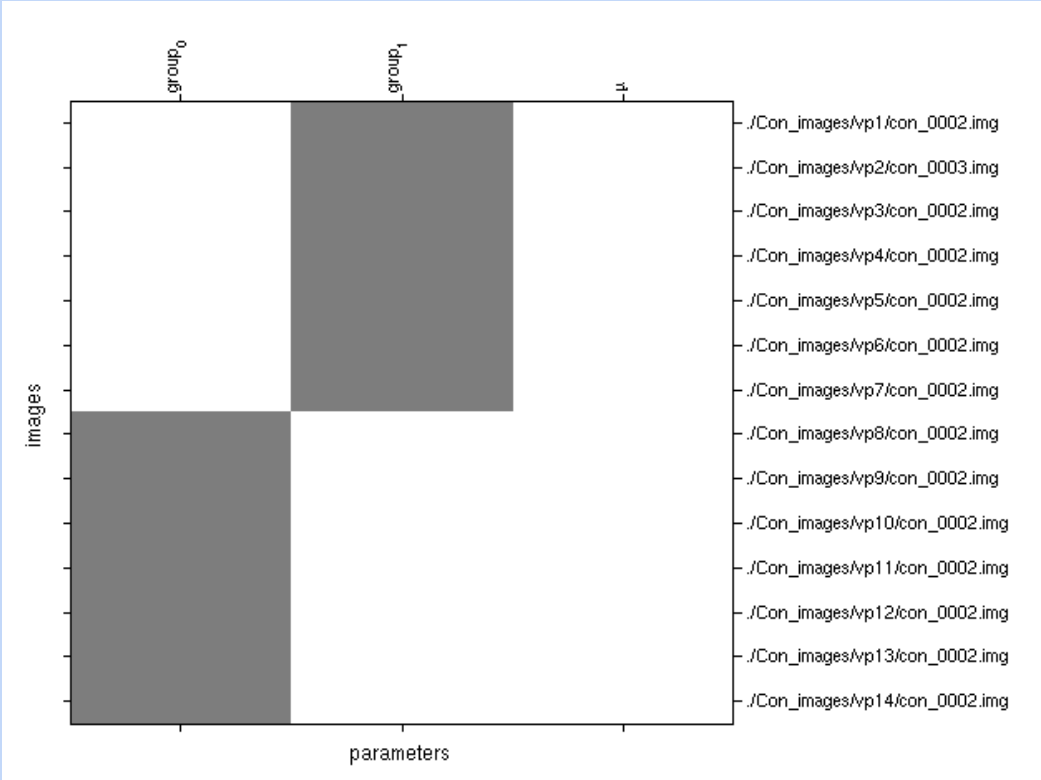


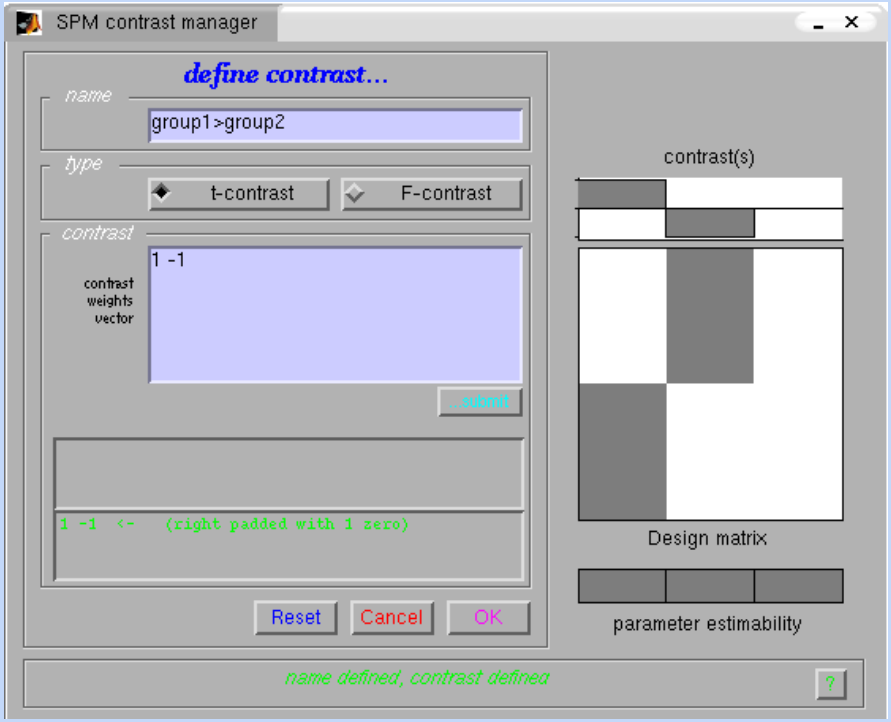
c=1

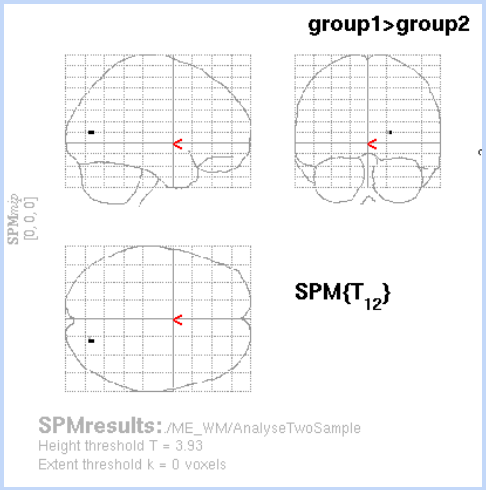
$$t = \frac{\hat{\beta}_e}{\sqrt{\hat{\sigma}_e^2}}$$



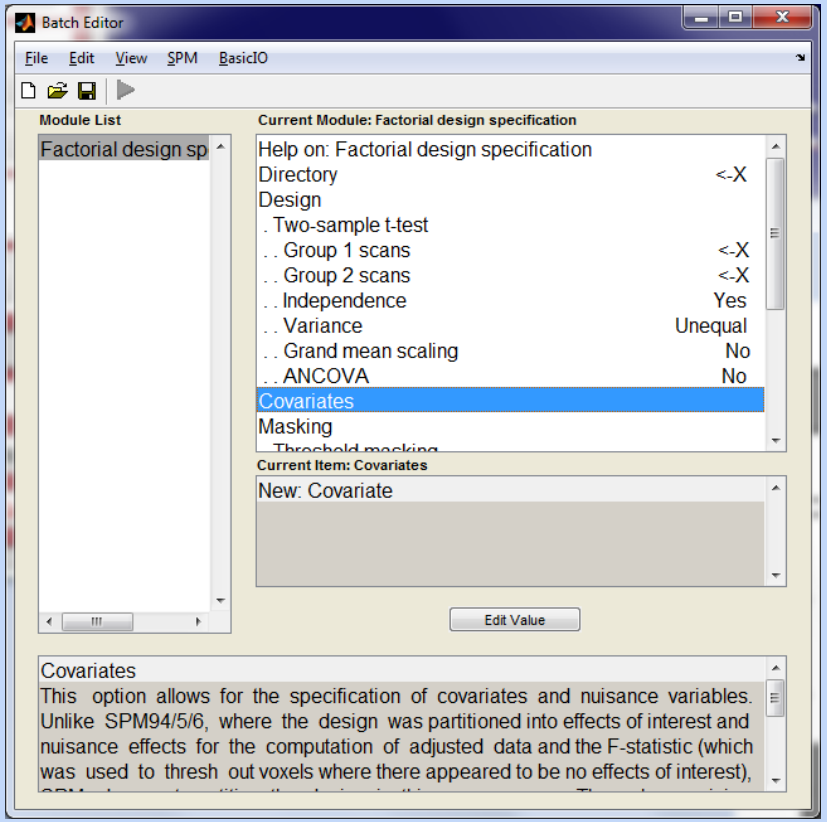
Two sample t-test

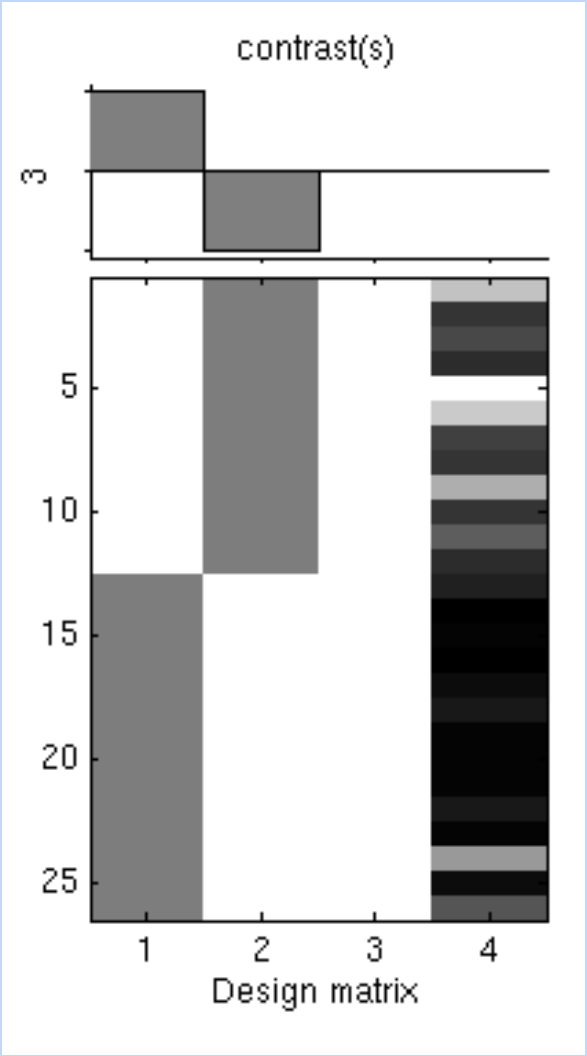




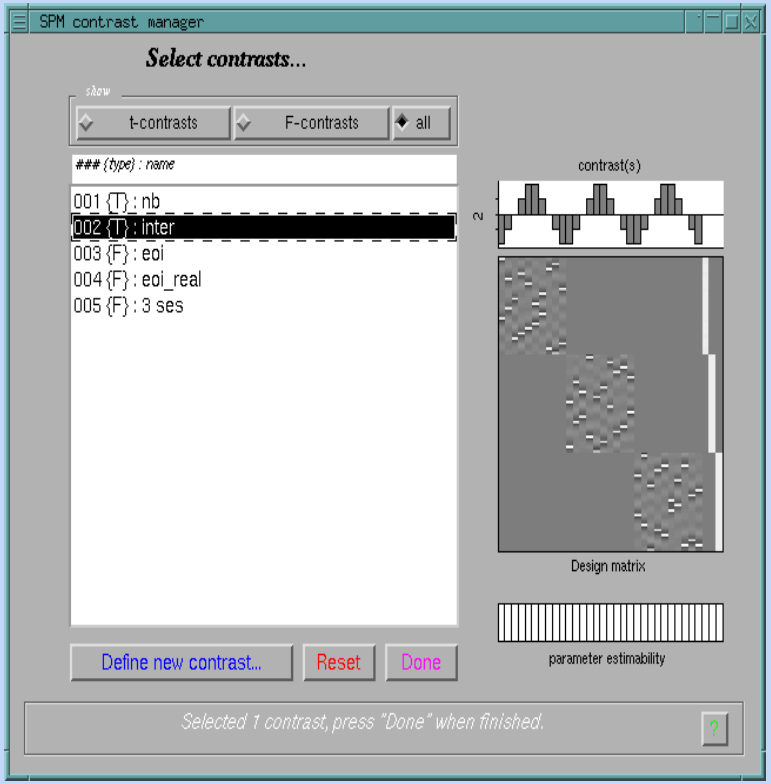


Two sample t-test mit Kovariaten

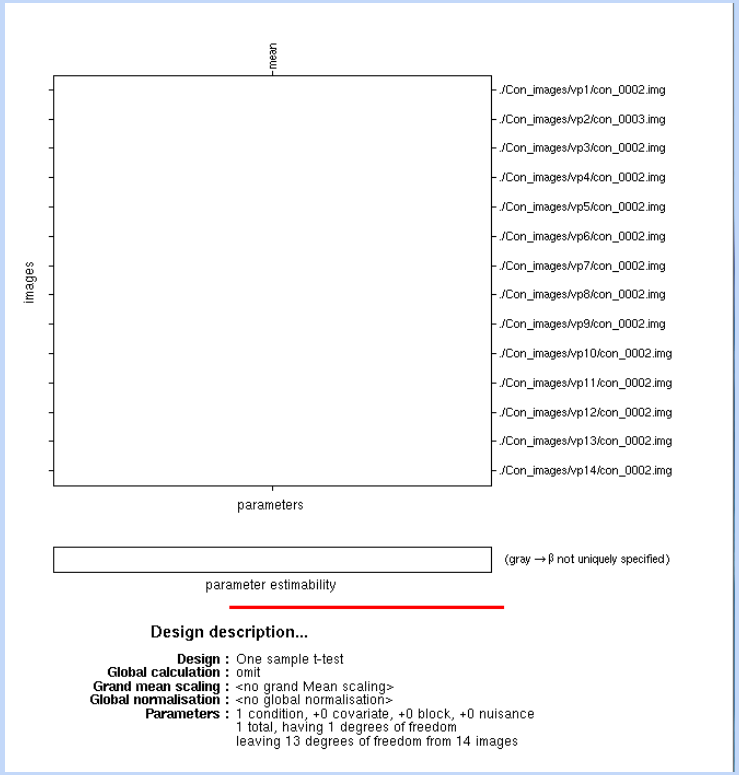




Komplexe Kontraste als t-test

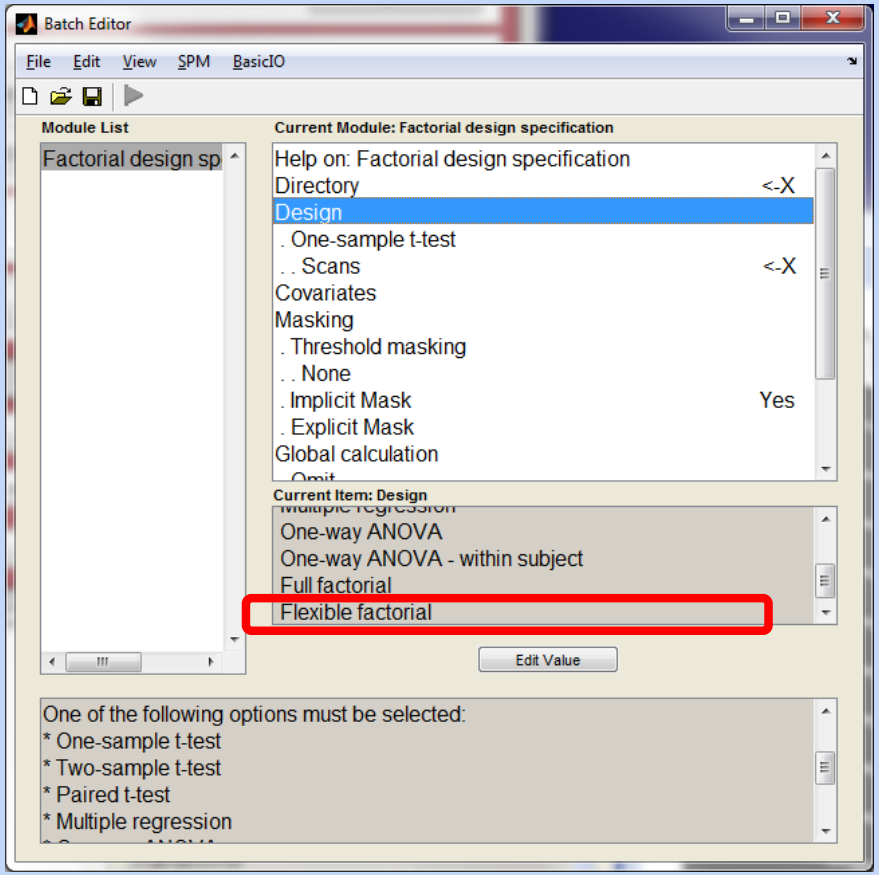


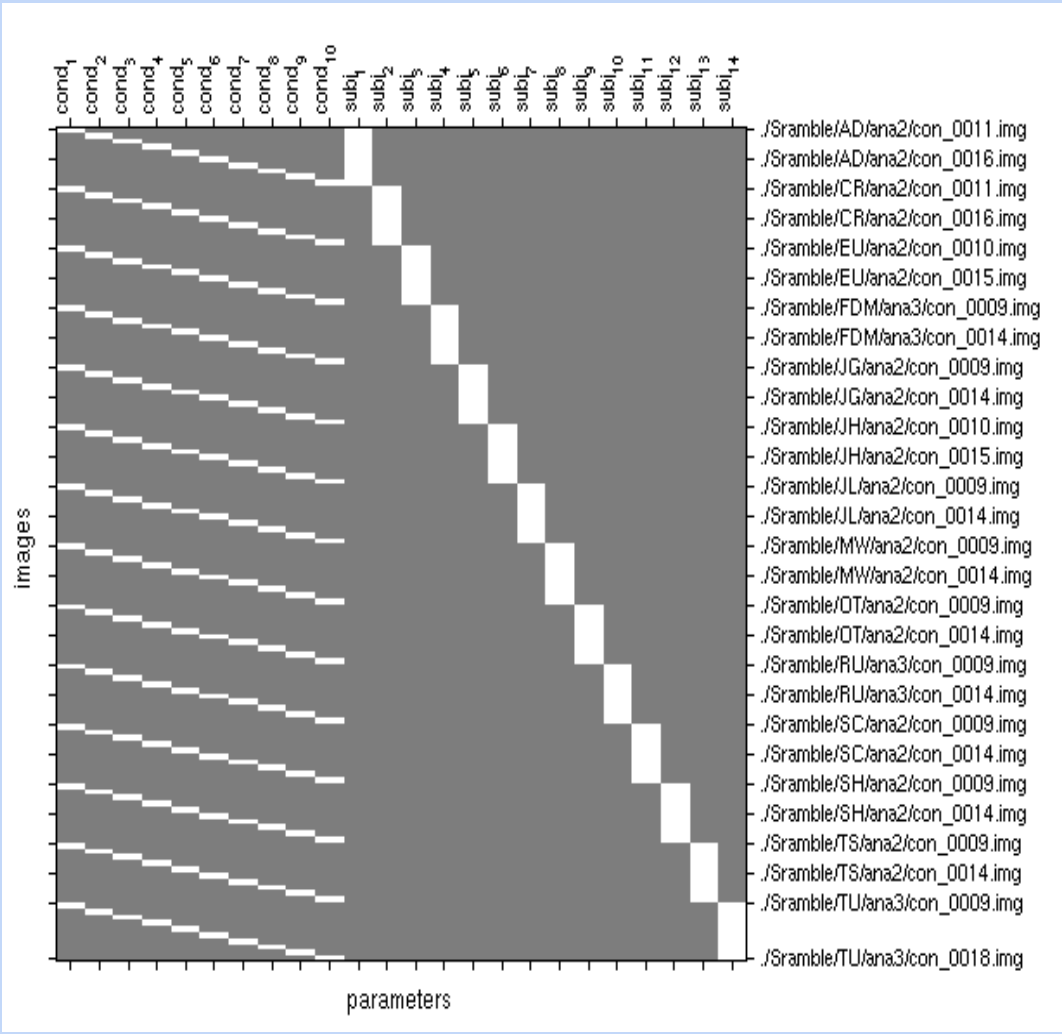
First Level



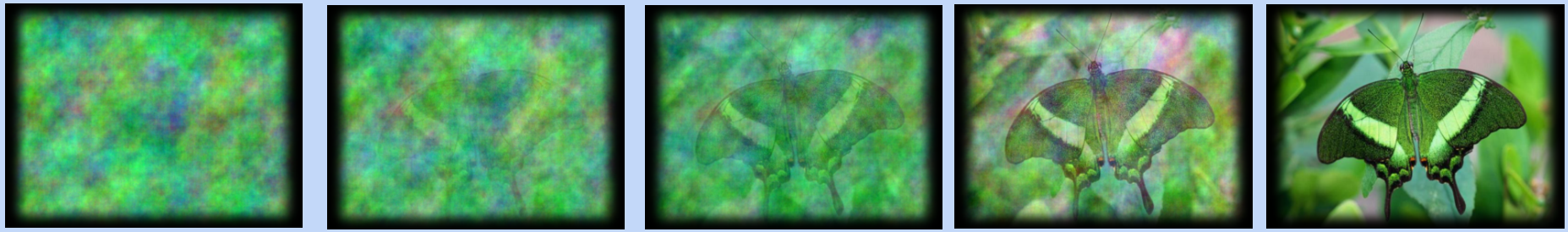
Second Level

Factorial designs

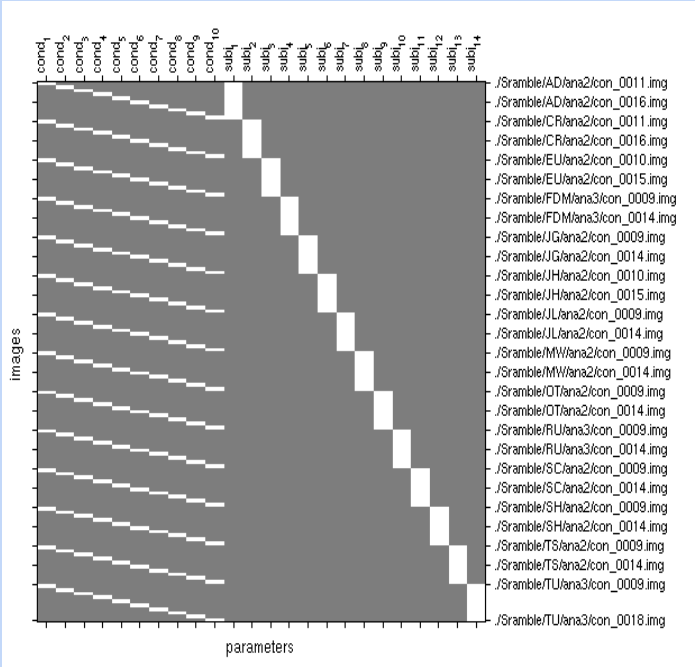




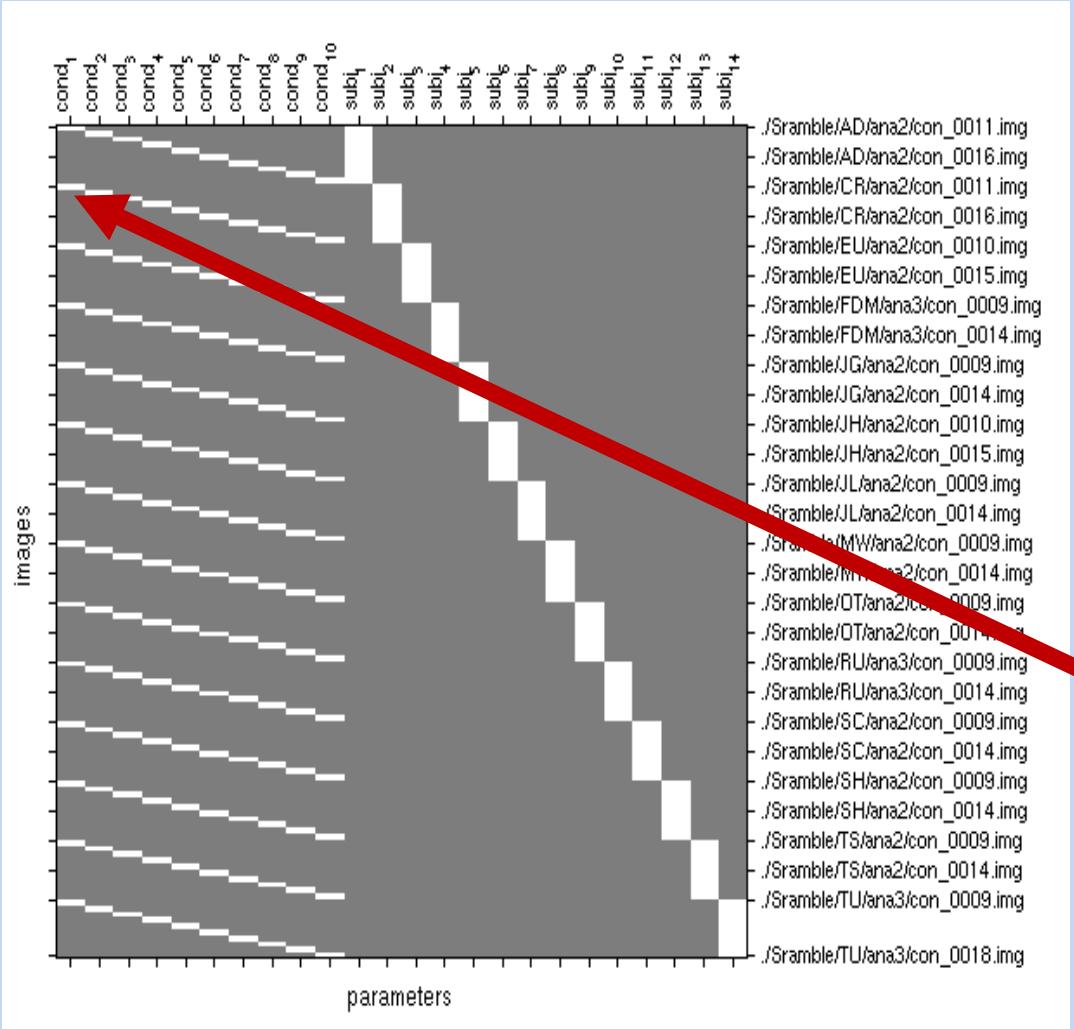
Factorial designs



N-back 1 (1:5) or 2 (6:10)



Factorial designs

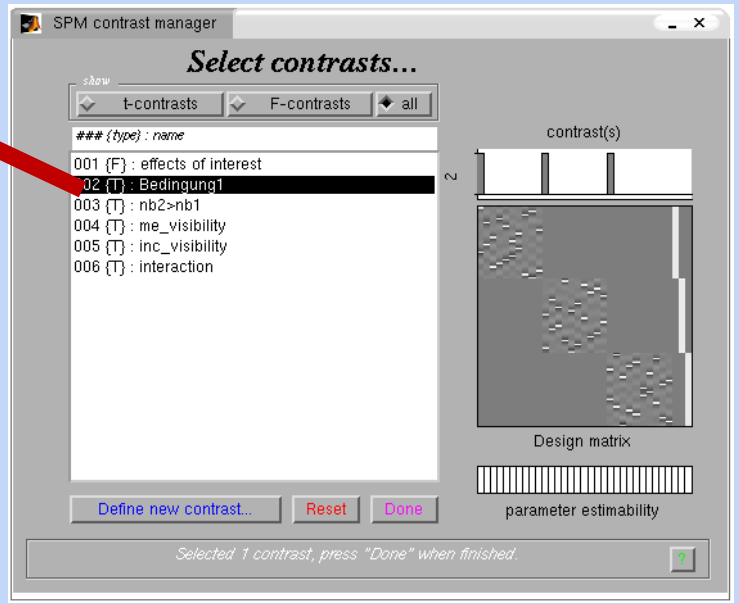


Second Level

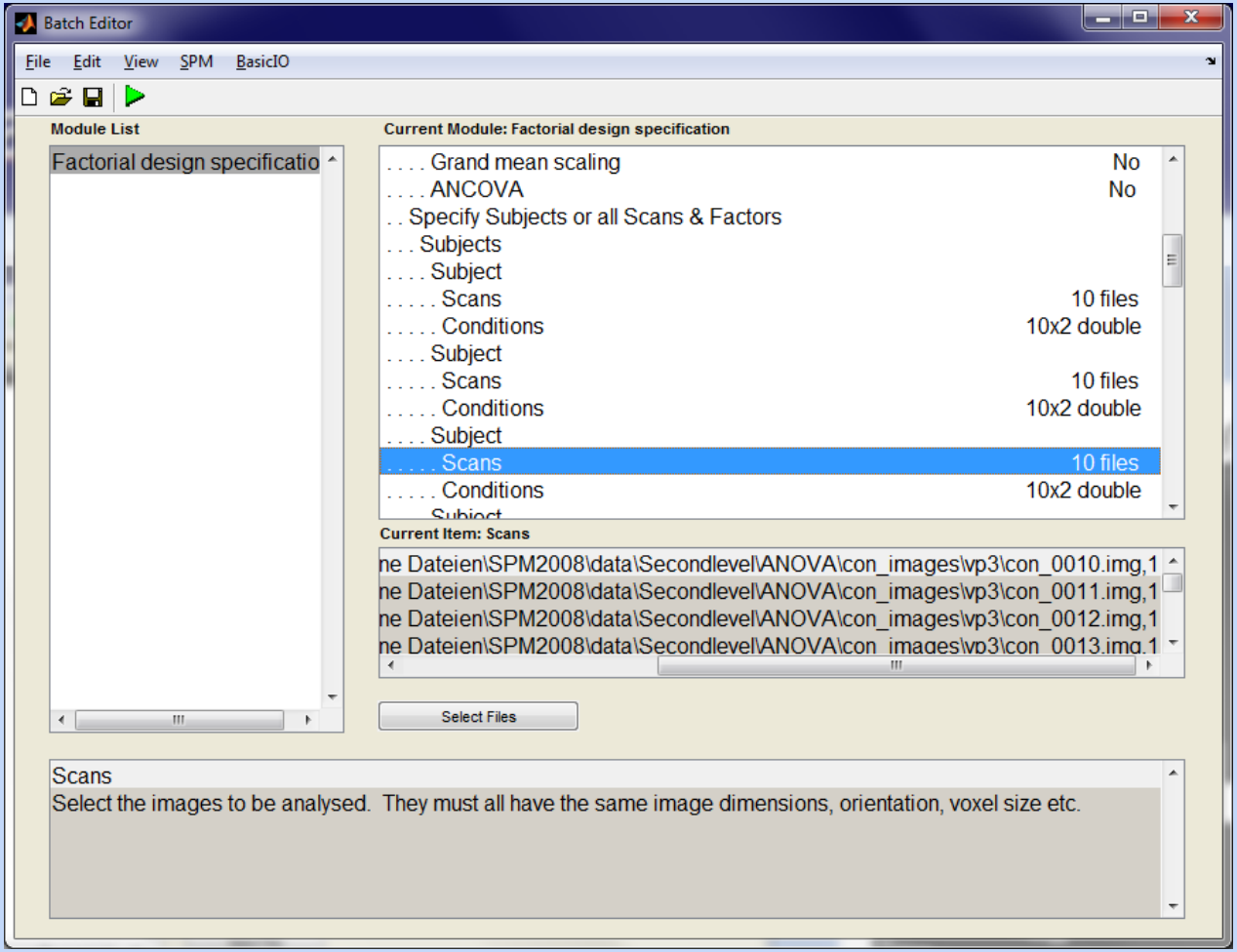
Voraussetzung:

In allen VP‘s con-images für **jede** Bedingung einzeln auf 1. Level

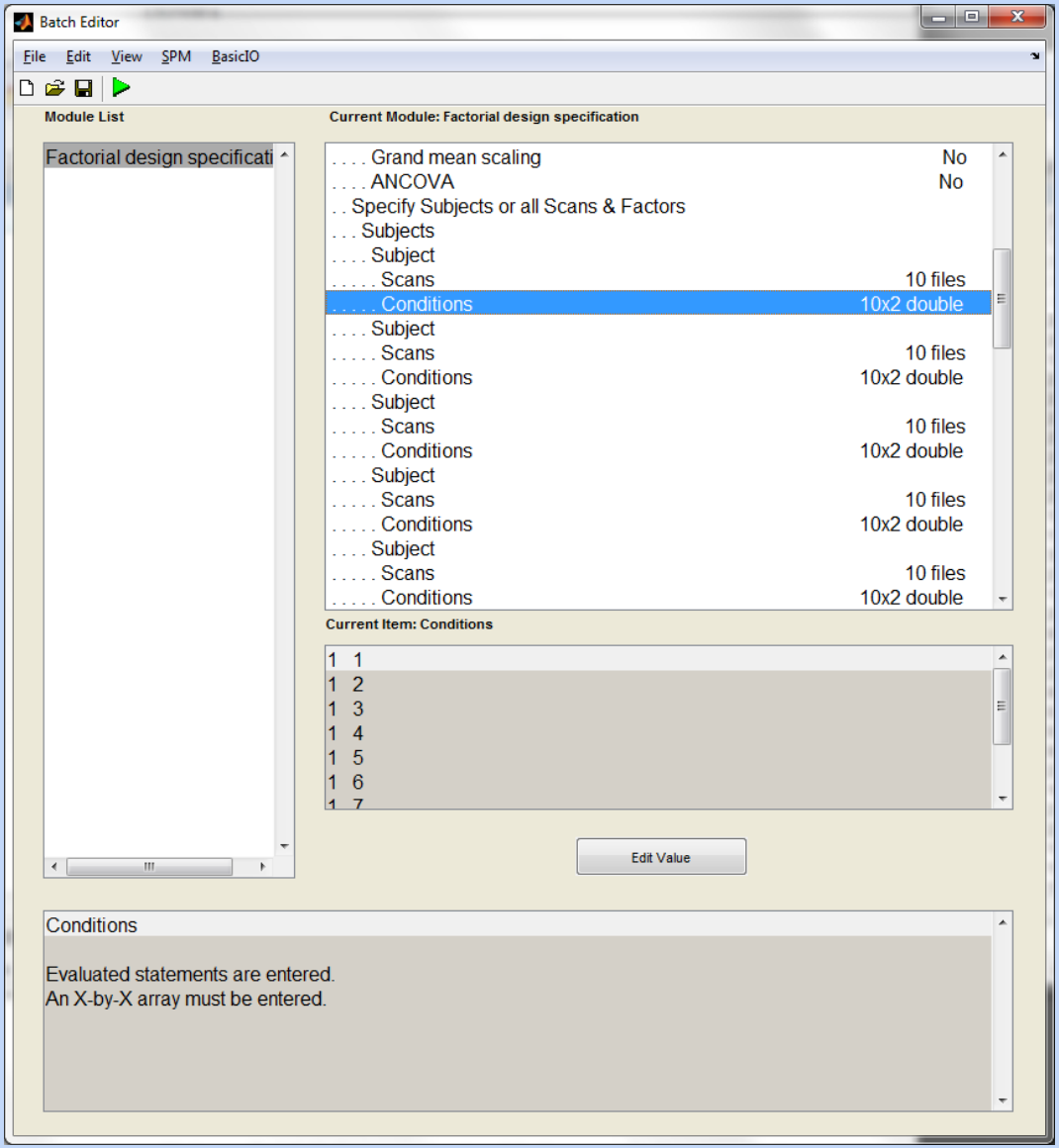
First Level

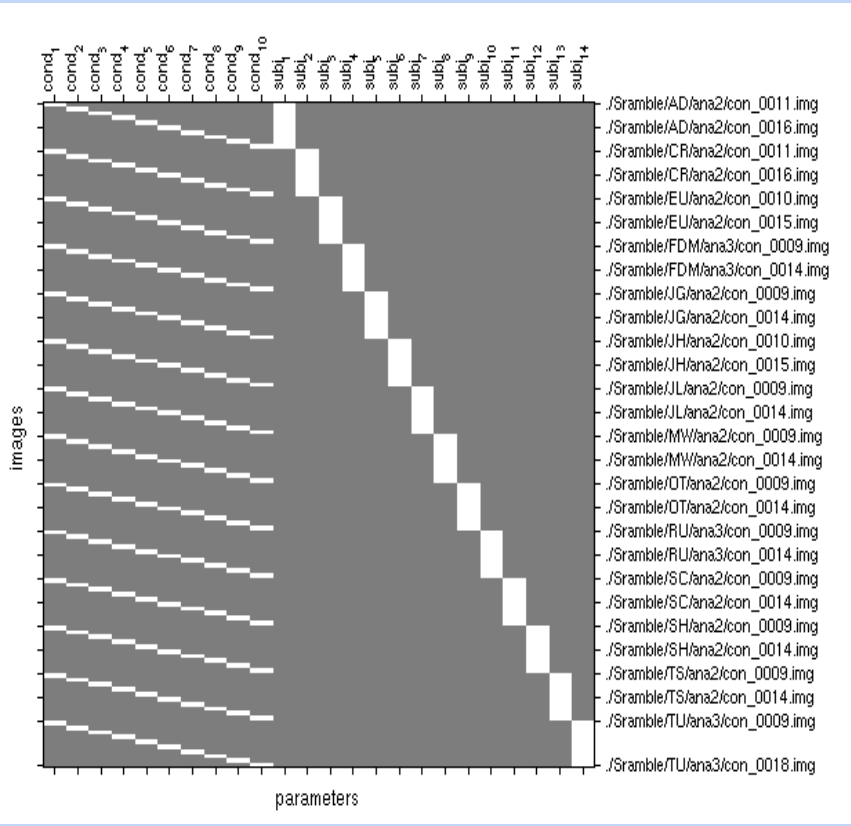


Factorial designs

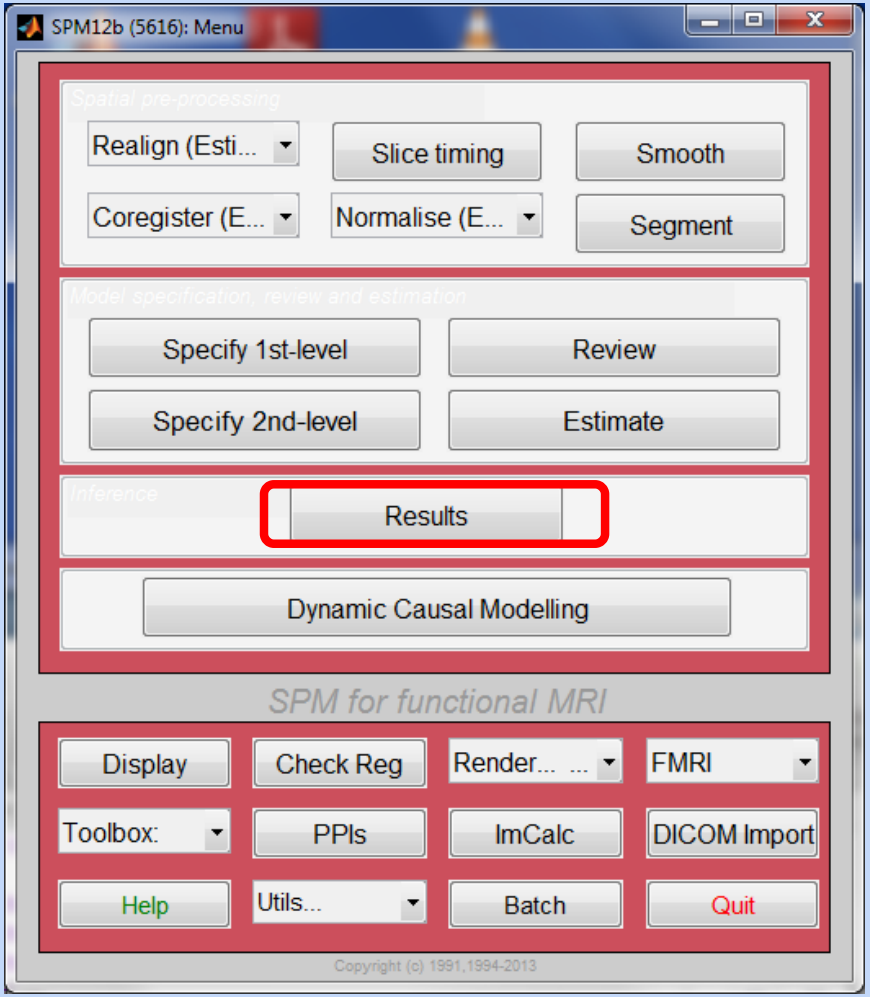


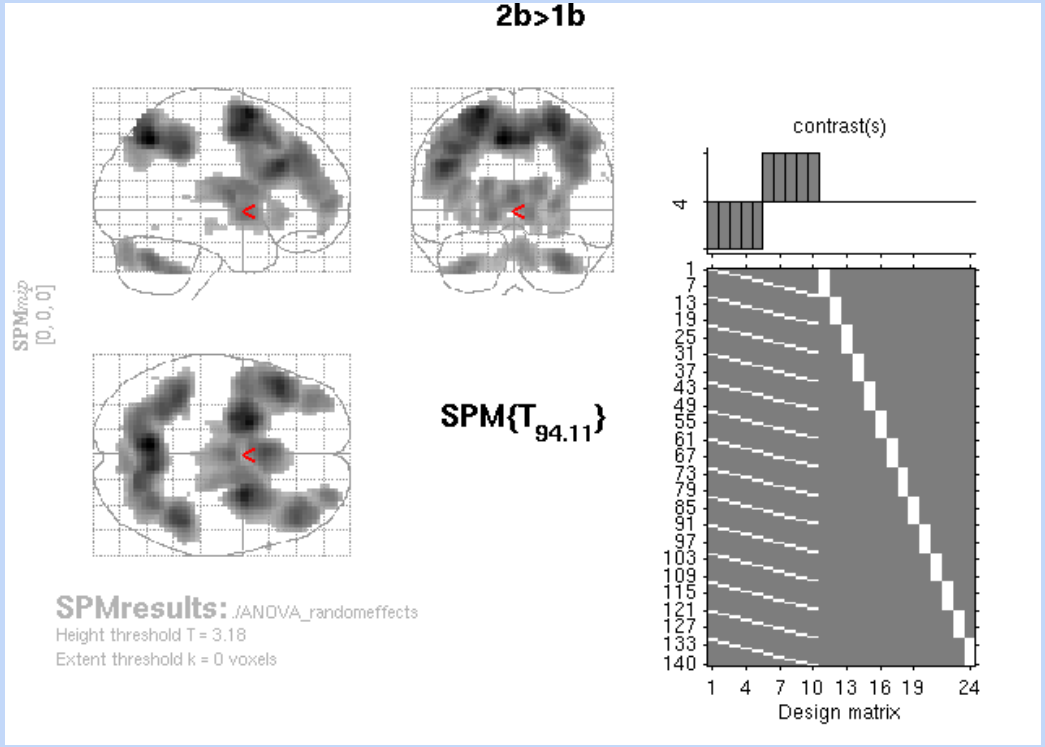
Factorial designs



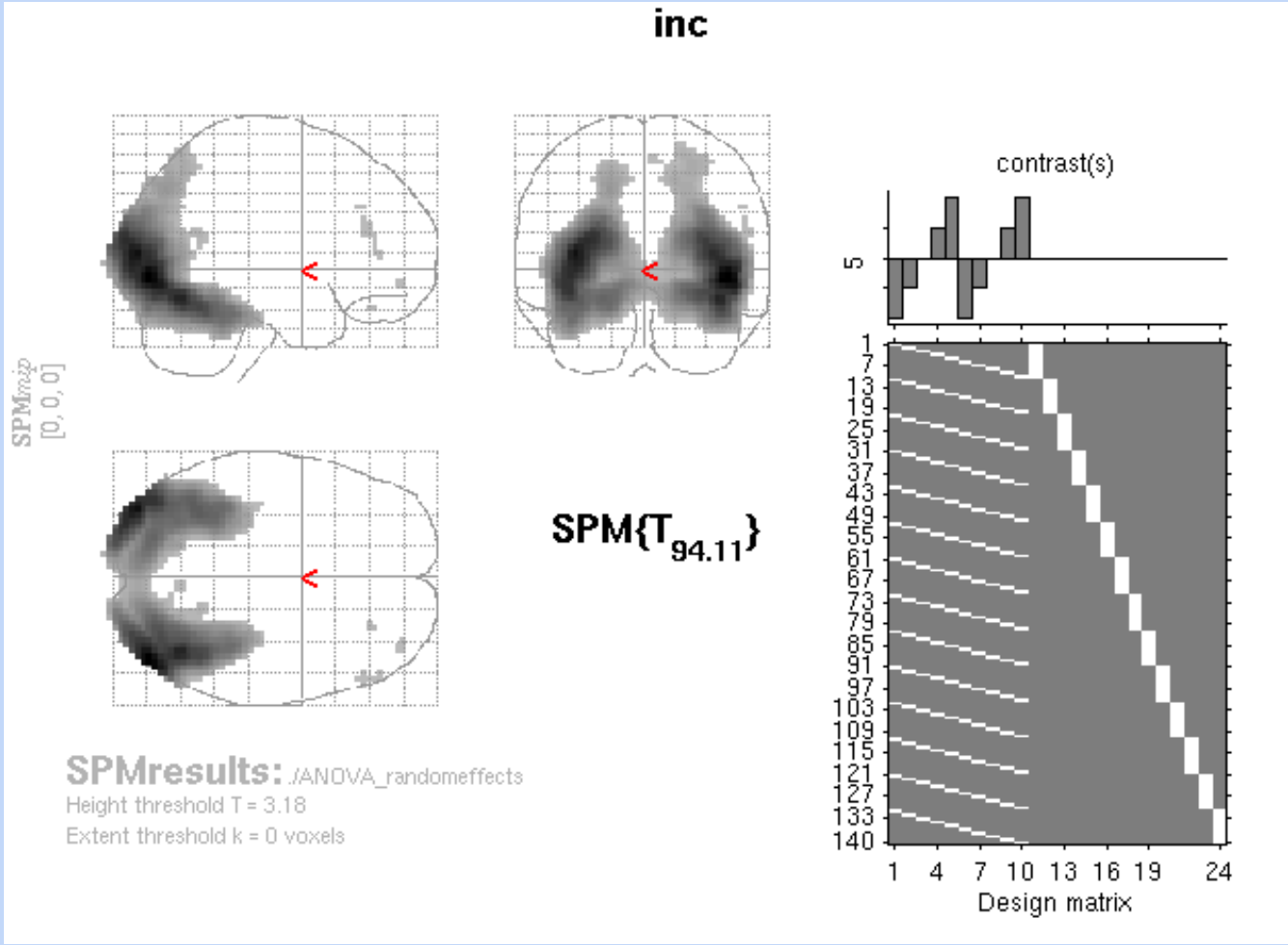


Factorial designs

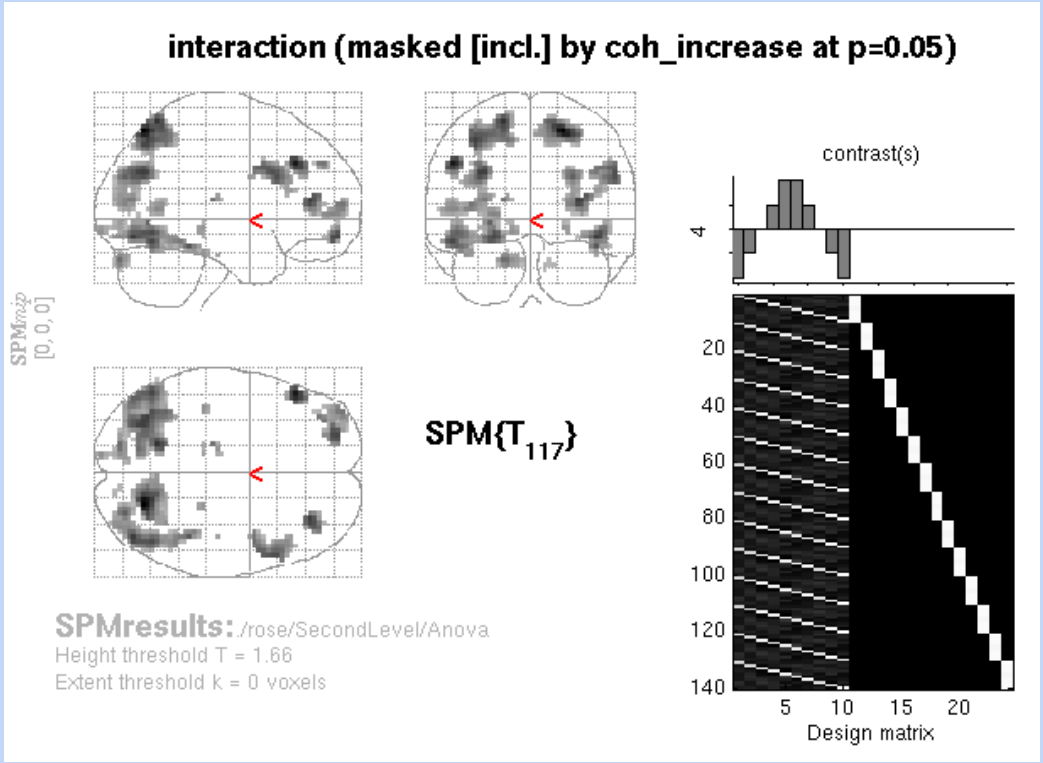




Factorial designs

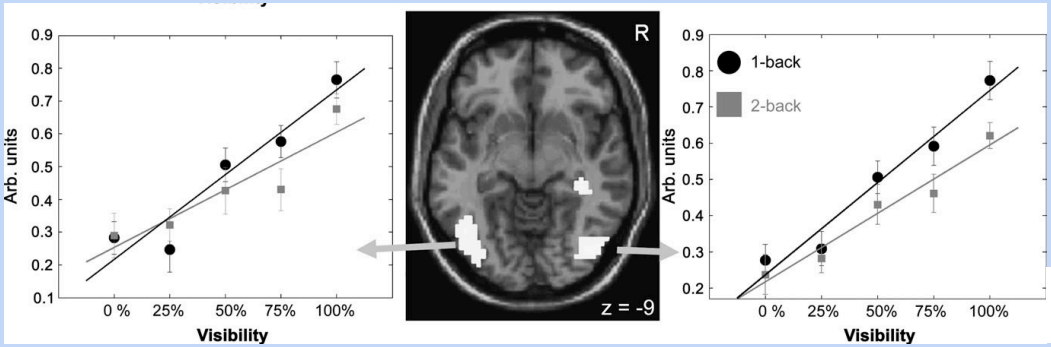


Factorial designs



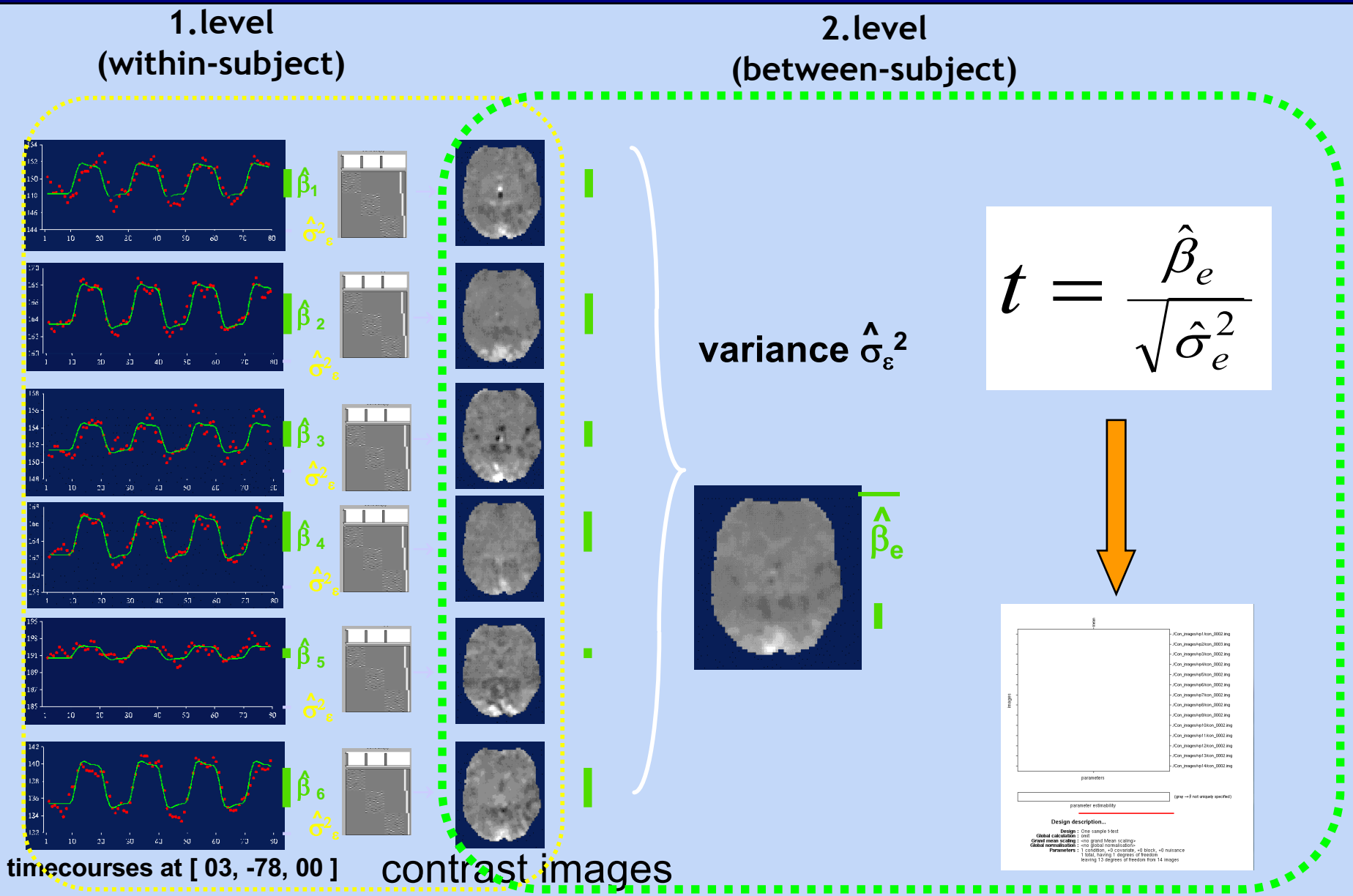
Vorteile von „factorial designs“:

- Sensitivität (mehr df)
- F- Kontraste
- Mehr Parameter Kombinationen
- Maskierungen (Masking)
- Conjunctions



Rose et al (2005)

Summary


1.level
(within-subject)
2.level
(between-subject)
variance $\hat{\sigma}_\varepsilon^2$
$t = \frac{\hat{\beta}_e}{\sqrt{\hat{\sigma}_e^2}}$
timecourses at [03, -78, 00]
contrast images