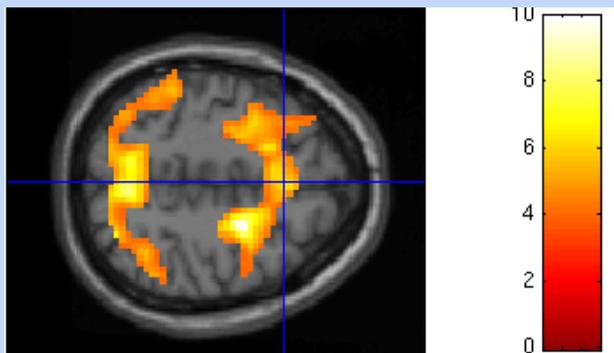


Inferences

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

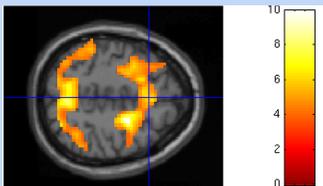
Ergebnisse

2. Level (Gruppe)

Modell für Gruppe (Regressoren)

Gruppe: t- oder F-Kontraste

Finale statistische Karte

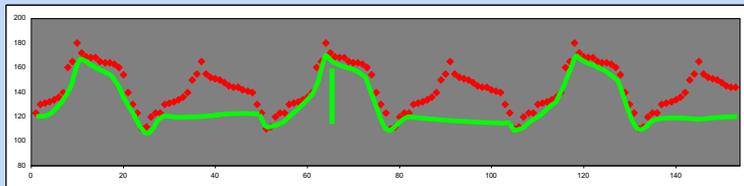


Daten für Gruppenstatistik

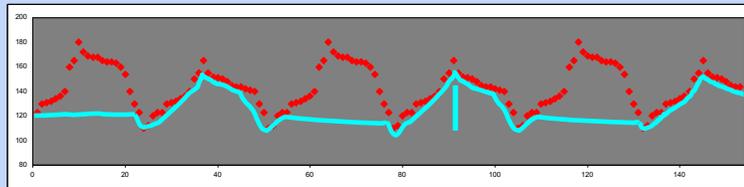
Model estimation Einzelperson



Statistischer Vergleich 1. level

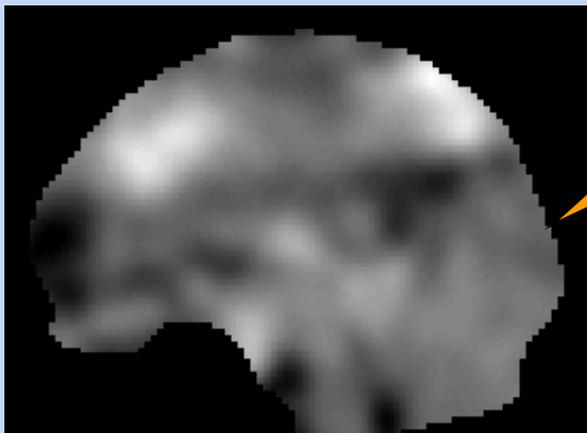


$$\hat{\beta}_{nb2}$$



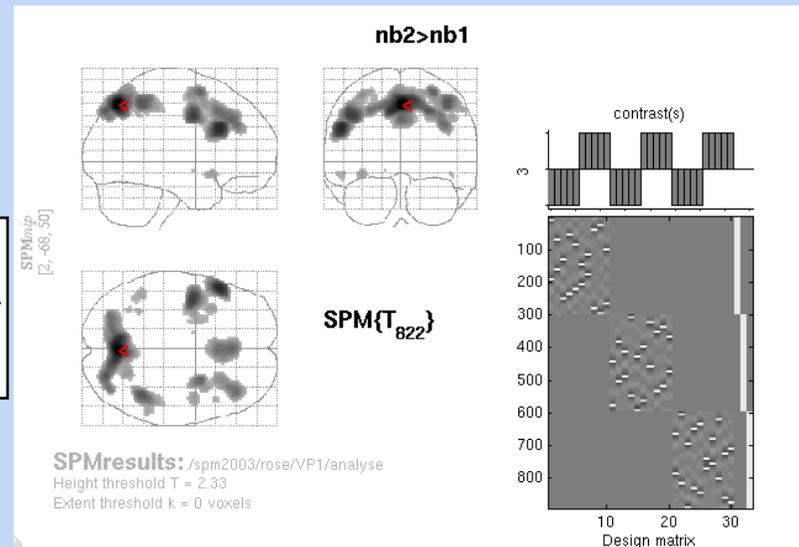
$$\hat{\beta}_{nb1}$$

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



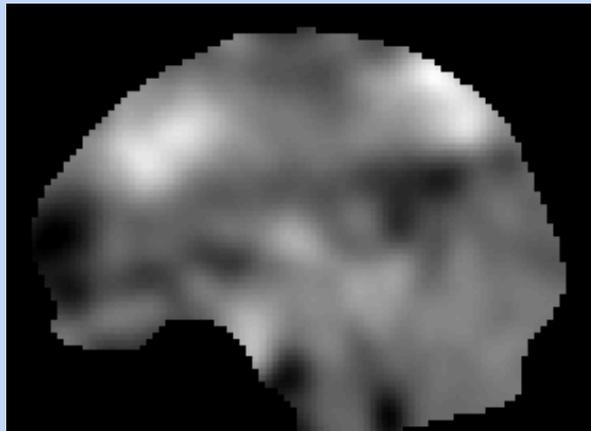
Contrast image für jede Person

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



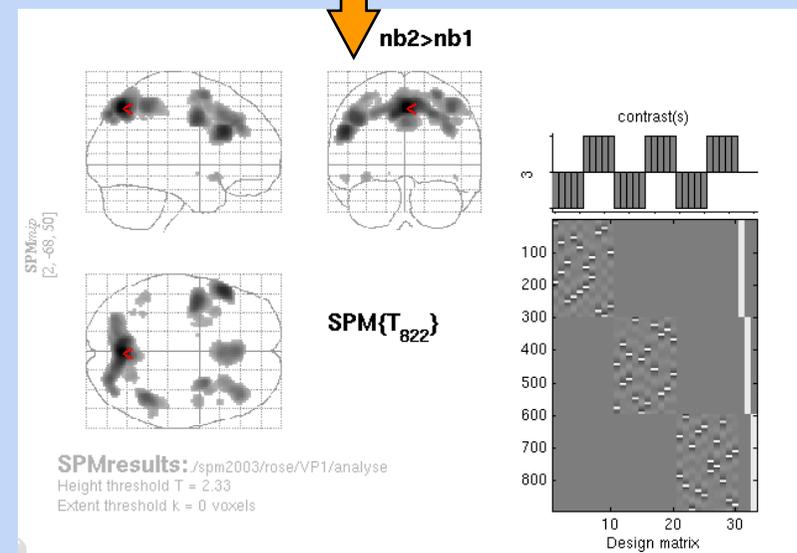
Daten für Gruppenstatistik

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



Con_xxxx.img
„Effect size“

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

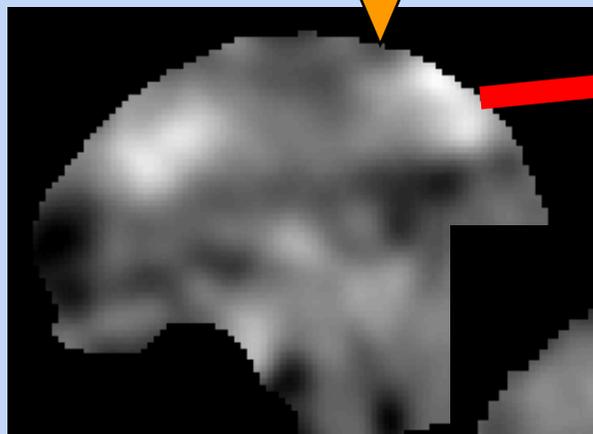


spmT_xxxx.img

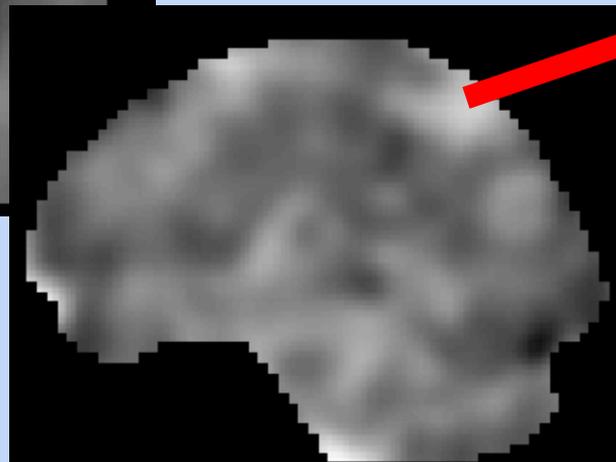
Daten für Gruppenstatistik

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

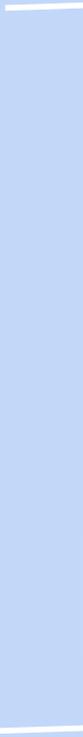
Linearkombination der
Parameter – Schätzer pro
Voxel



VP1/Con_0002.img



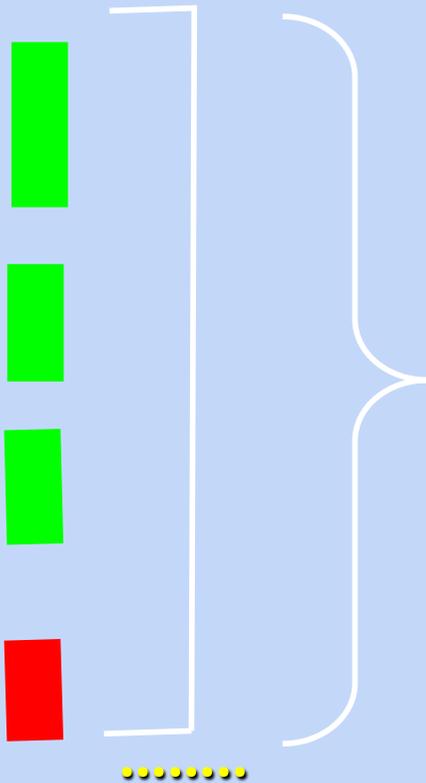
VP2/Con_0002.img



$$\hat{\beta}_e$$

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

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

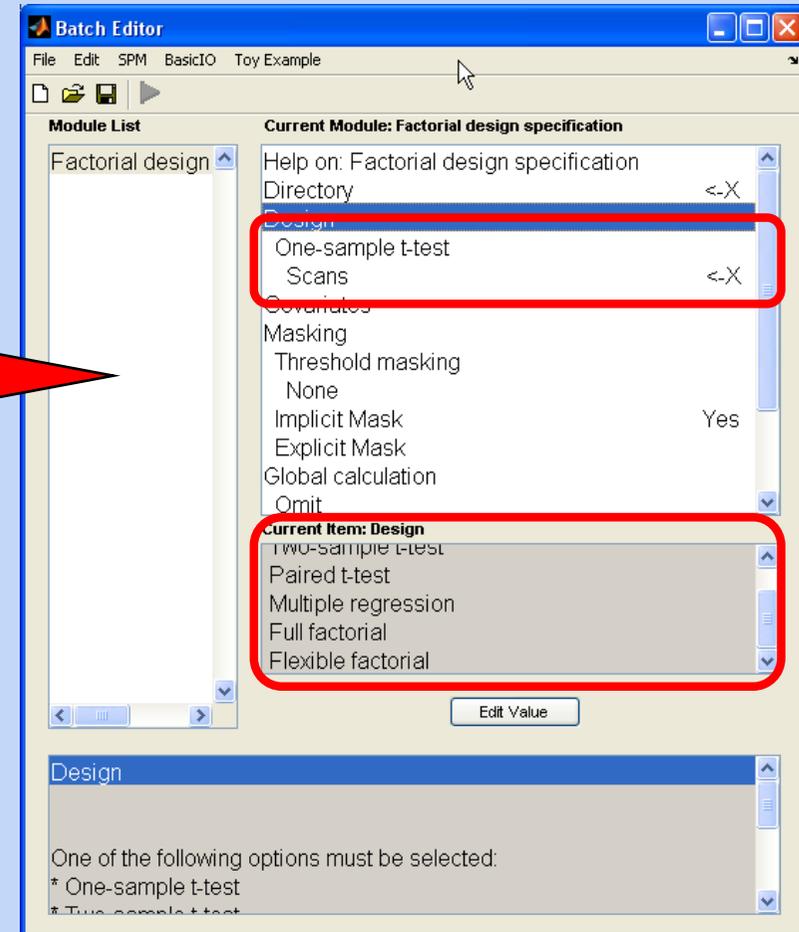
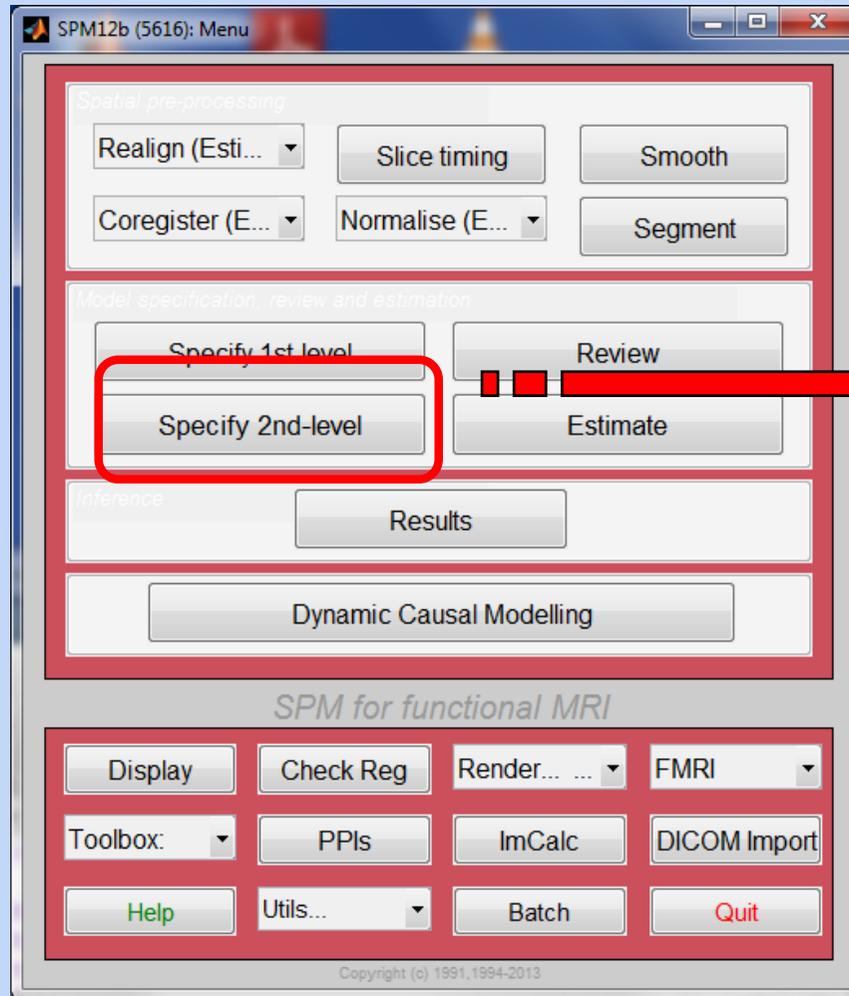
Single subject: Fehlerterm entsteht durch residuelle Varianz eines Modells des Experiments innerhalb einer Person; viele Freiheitsgrade (durch Messungen)

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)

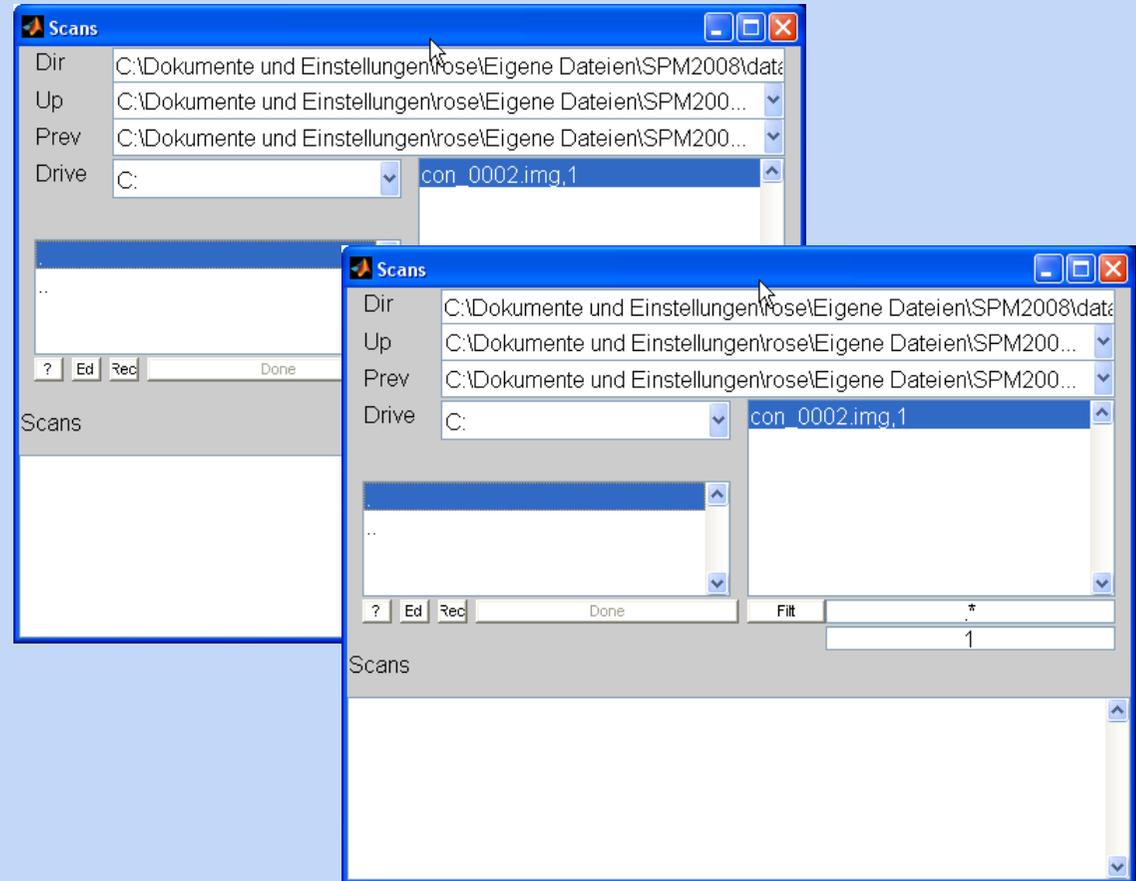
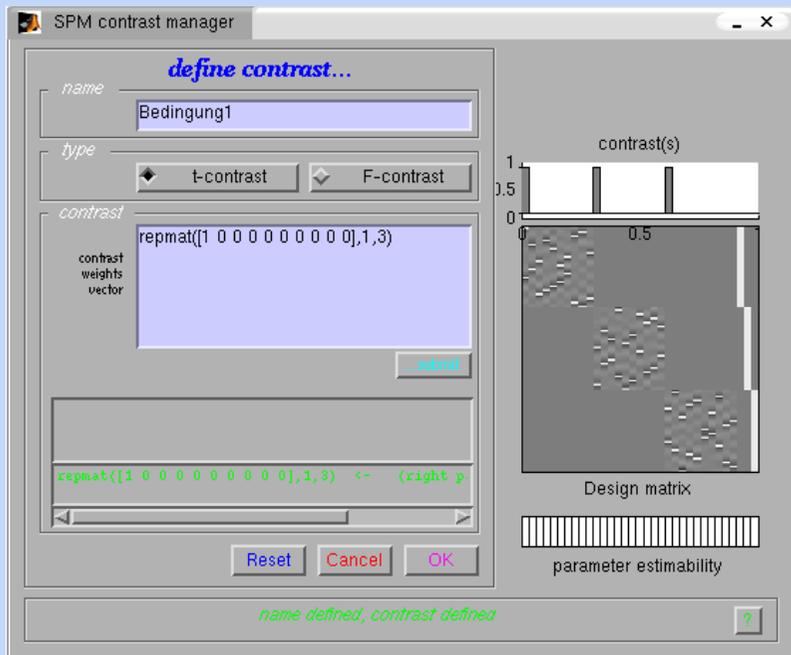
Praktische Beispiele



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

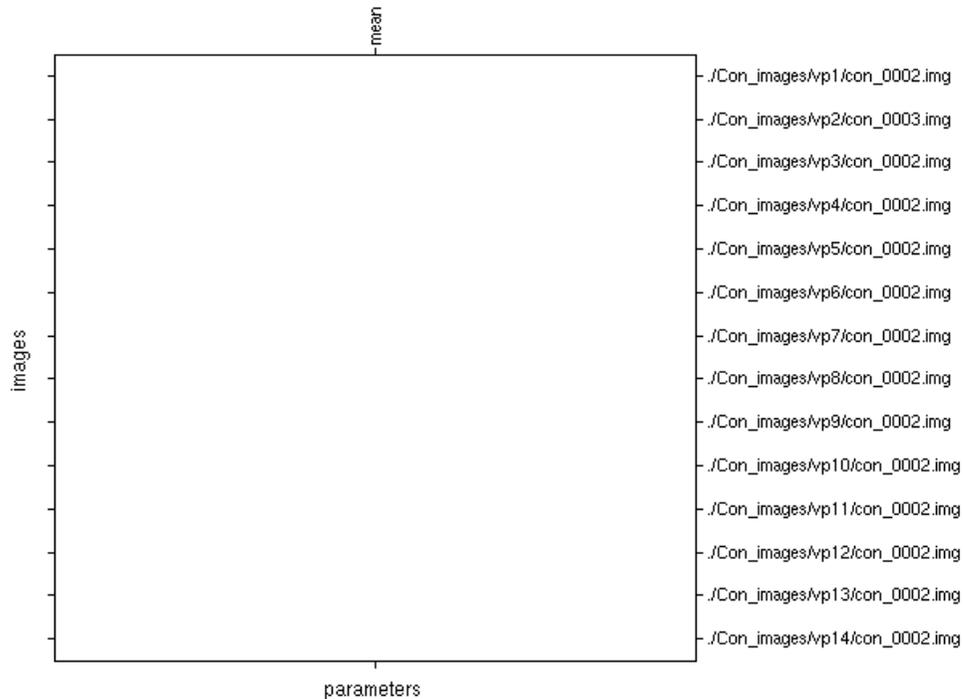
One sample t-test: Haupteffekt Bed. 1

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



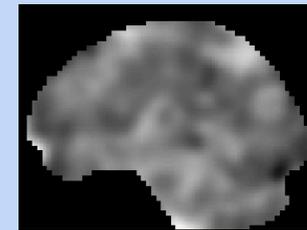
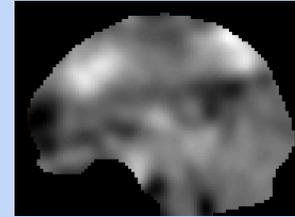
■ ■ ■ ■ ■ ■

One sample t-test (Neues Model)



Design description...

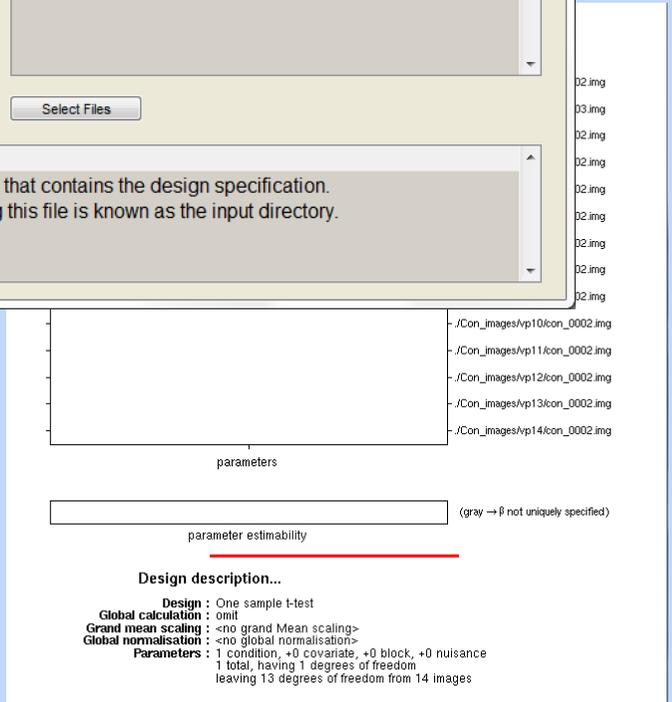
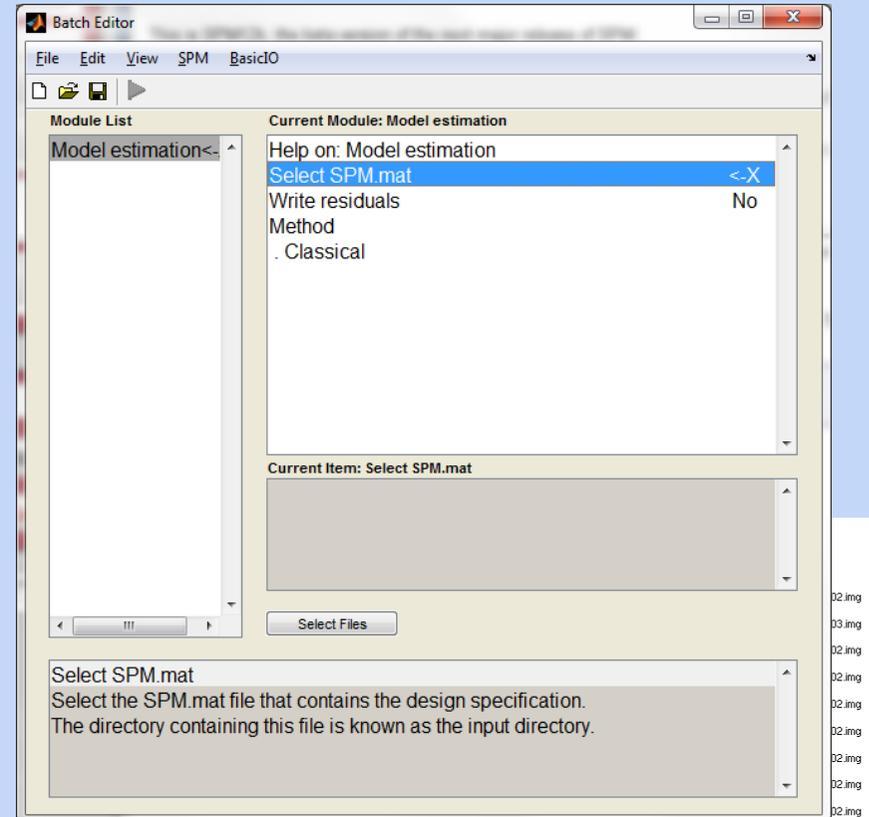
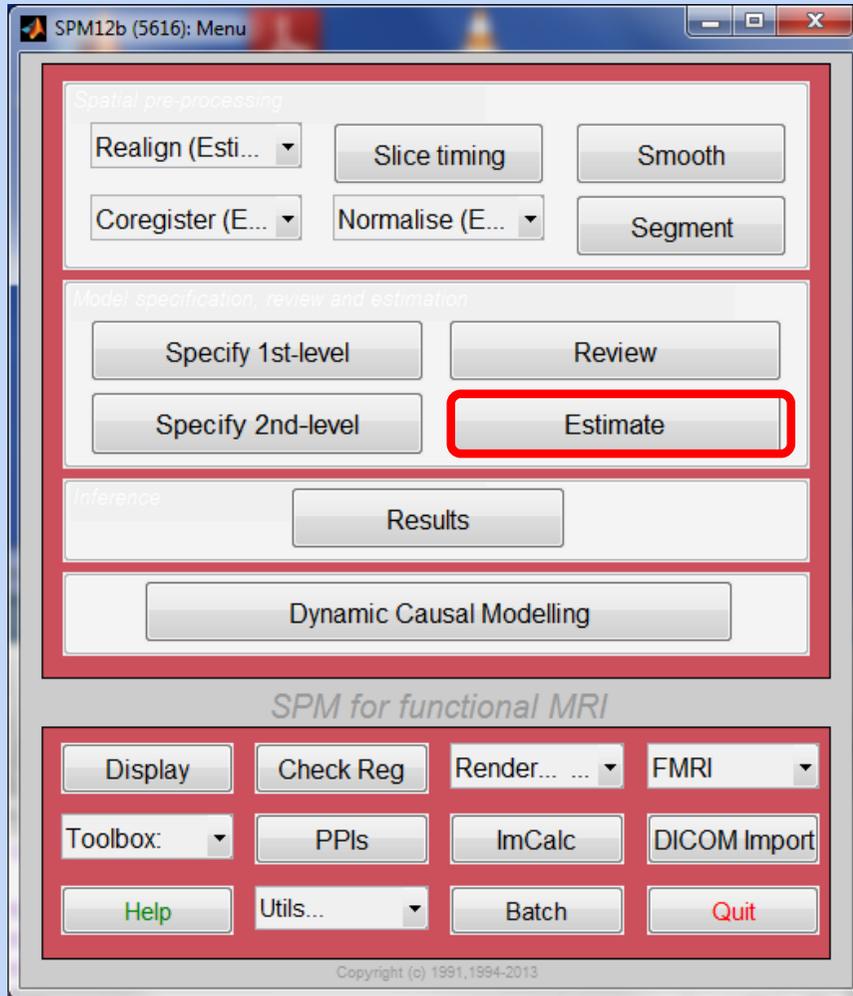
Design : One sample t-test
Global calculation : omit
Grand mean scaling : <no grand Mean scaling>
Global normalisation : <no global normalisation>
Parameters : 1 condition, +0 covariate, +0 block, +0 nuisance
 1 total, having 1 degrees of freedom
 leaving 13 degrees of freedom from 14 images



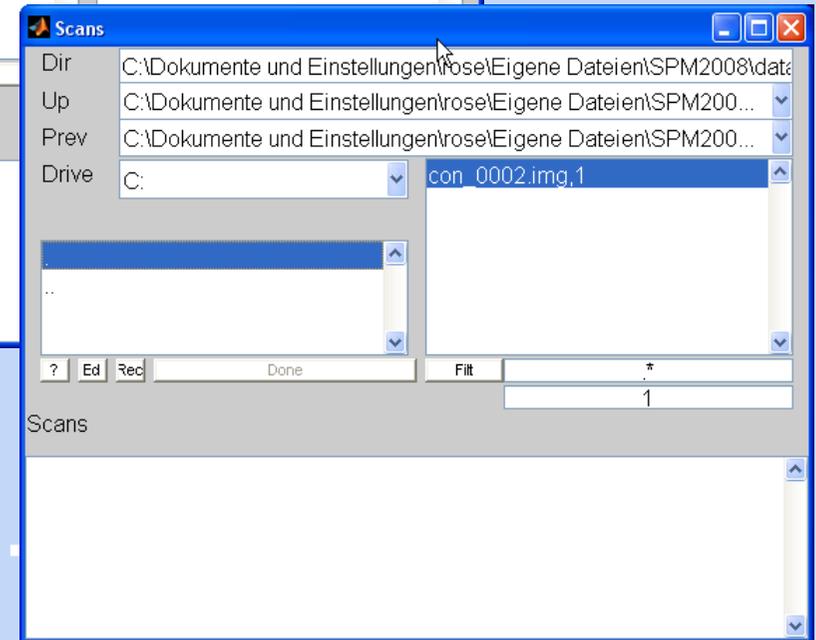
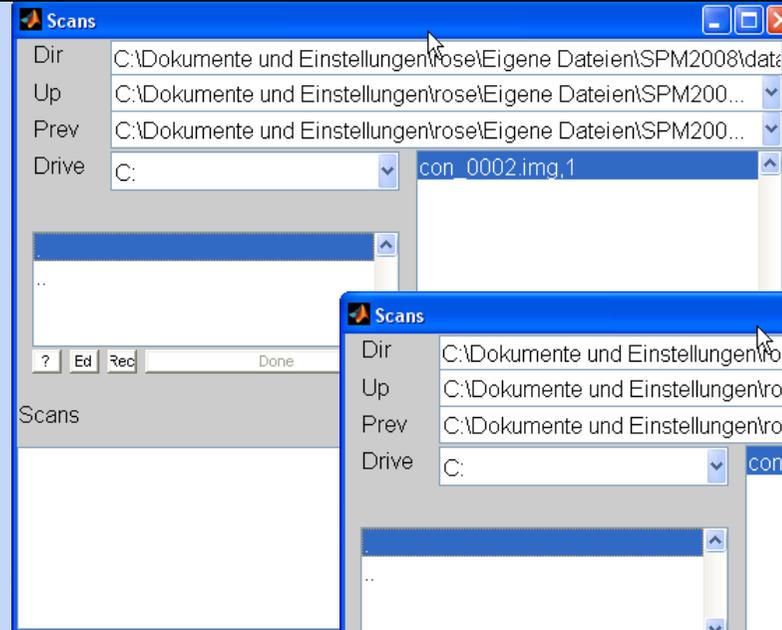
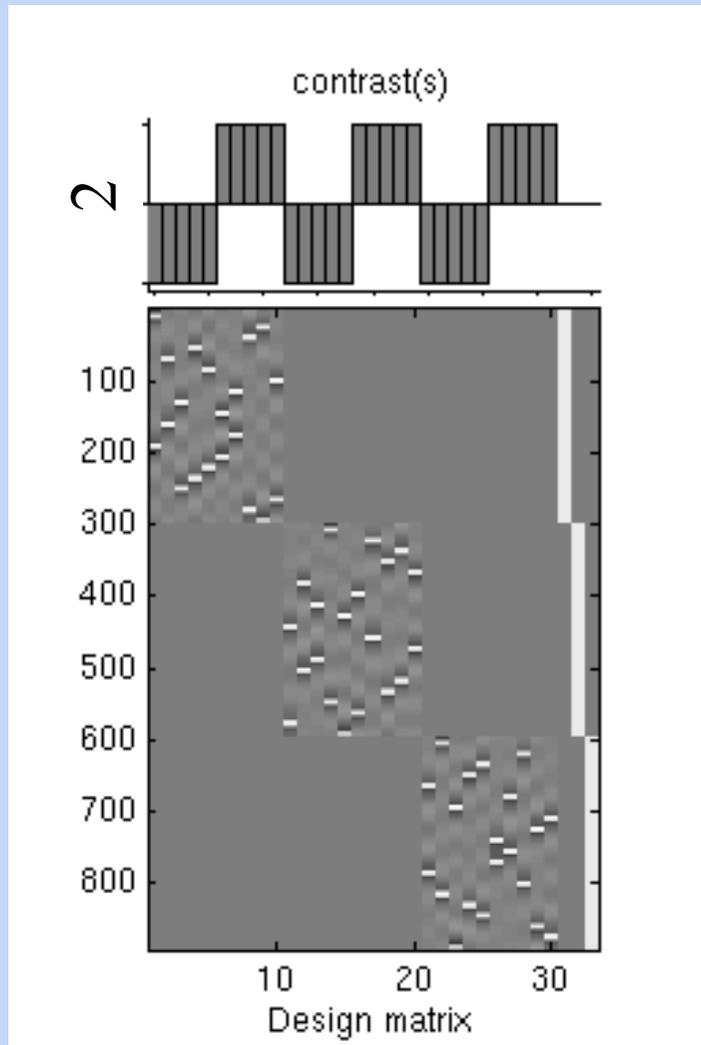
$$\hat{\beta}_e$$

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

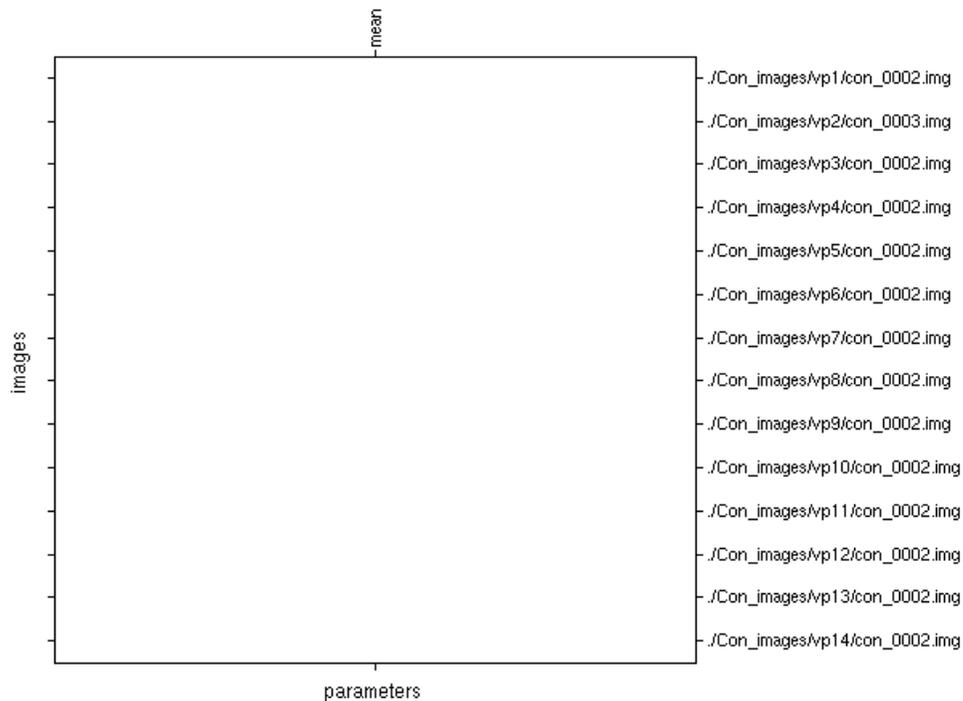
One sample t-test (Neues Model)



One sample t-test: Differentieller Effekt

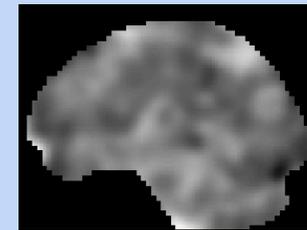
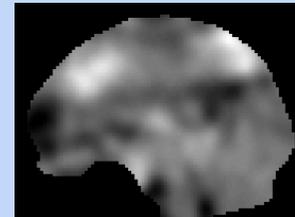


One sample t-test: Differentieller Effekt



Design description...

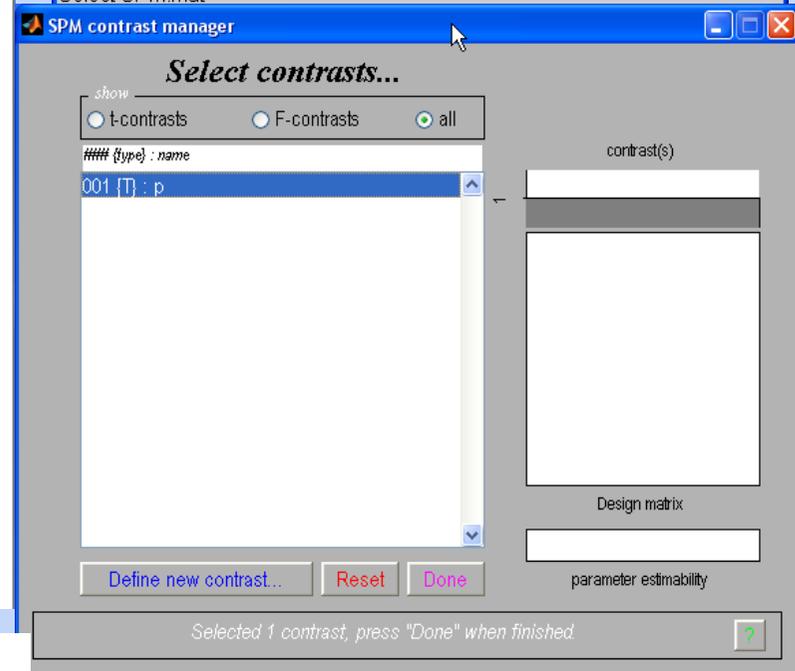
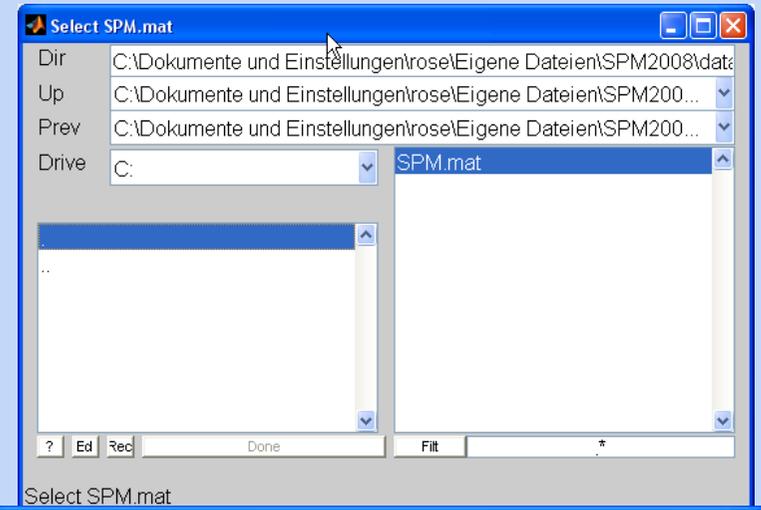
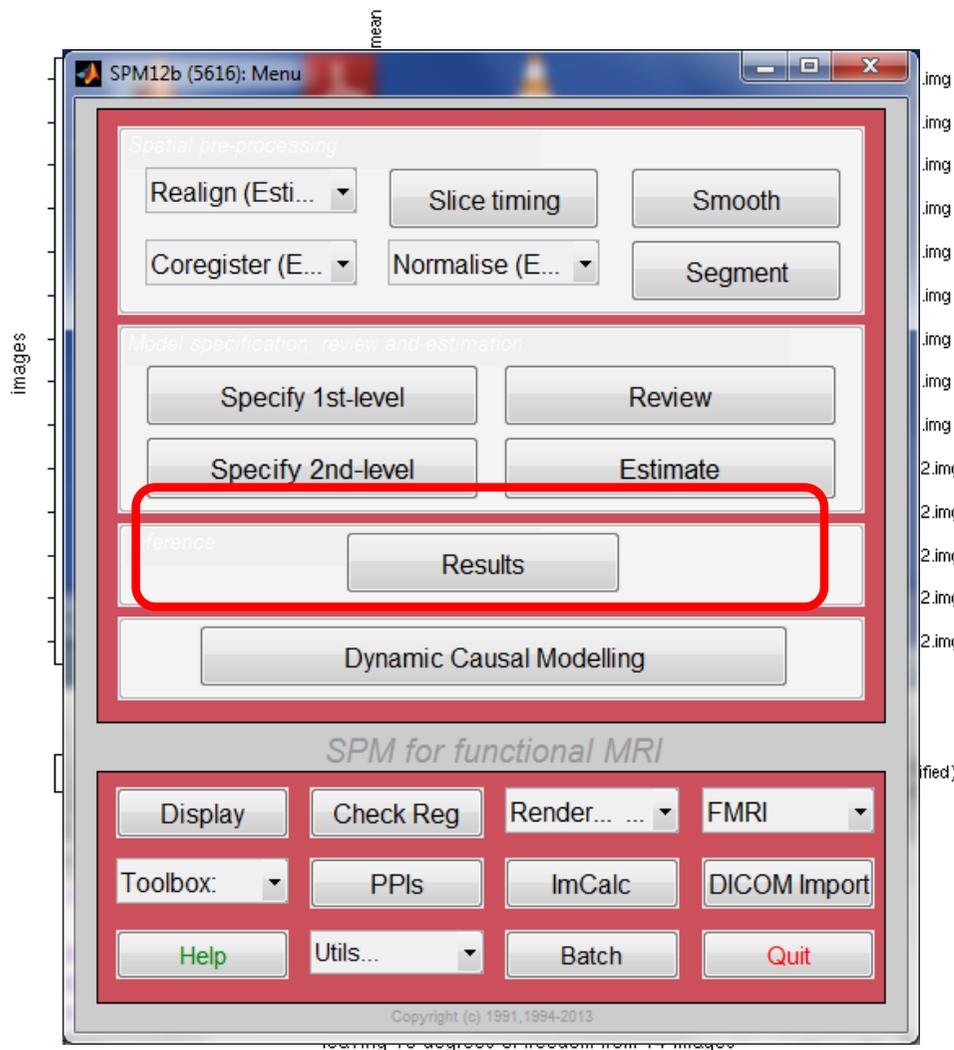
Design : One sample t-test
Global calculation : omit
Grand mean scaling : <no grand Mean scaling>
Global normalisation : <no global normalisation>
Parameters : 1 condition, +0 covariate, +0 block, +0 nuisance
 1 total, having 1 degrees of freedom
 leaving 13 degrees of freedom from 14 images



$$\hat{\beta}_e$$

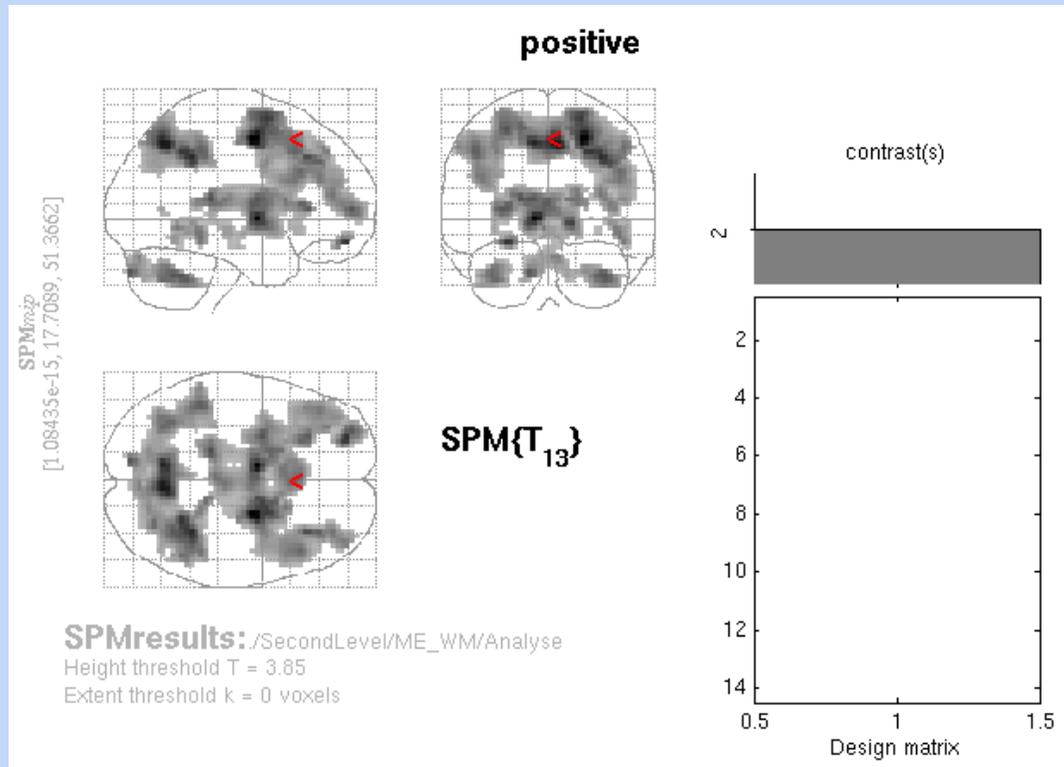
$$\hat{\sigma}_e^2$$

One sample t-test: Differentieller Effekt

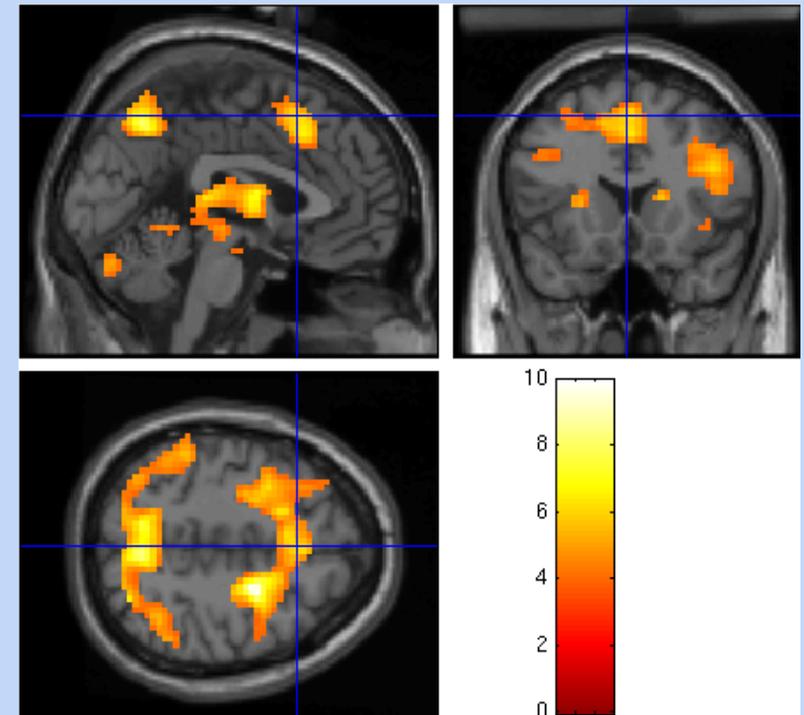


Wichtig: Das ist der statistische Test!

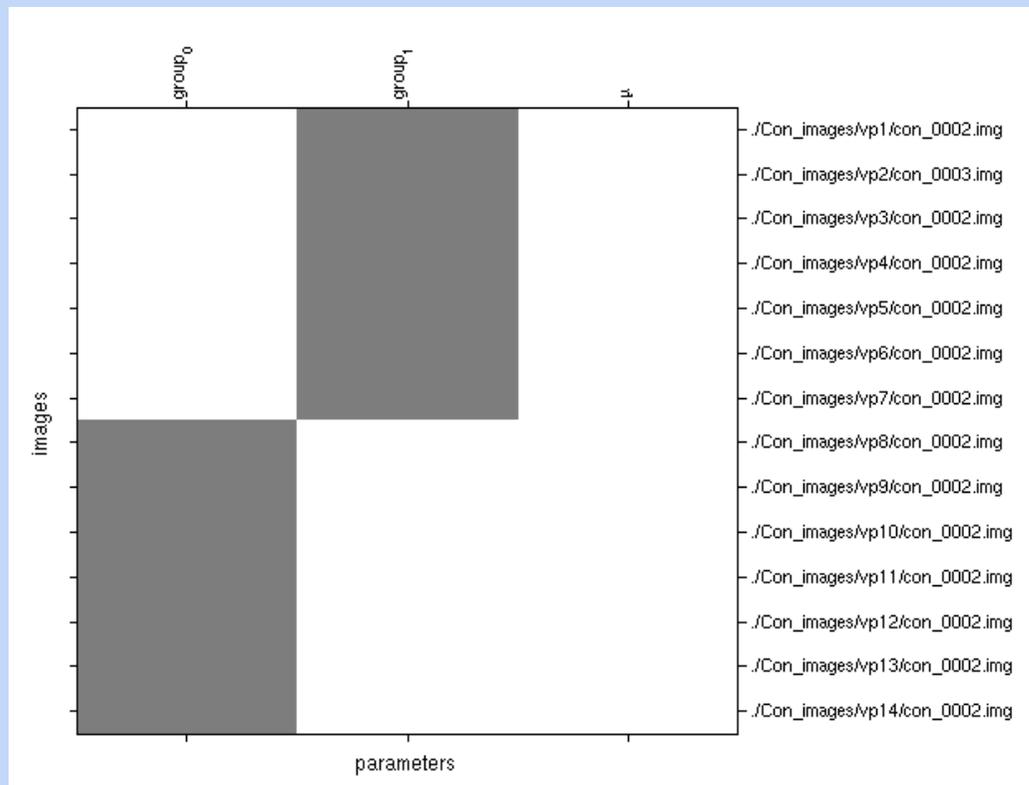
One sample t-test: Differentieller Effekt



$$c=1 \quad t = \frac{\hat{\beta}_e}{\sqrt{\hat{\sigma}_e^2}}$$



Two sample t-test



SPM contrast manager

define contrast...

name: group1>group2

type: t-contrast

contrast weights vector: 1 -1

1 -1 <- (right padded with 1 zero)

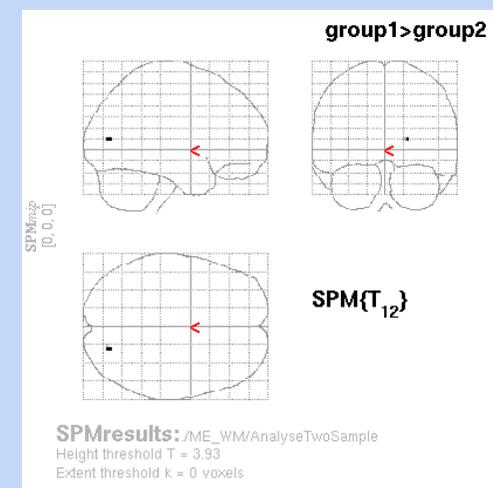
contrast(s):

Design matrix:

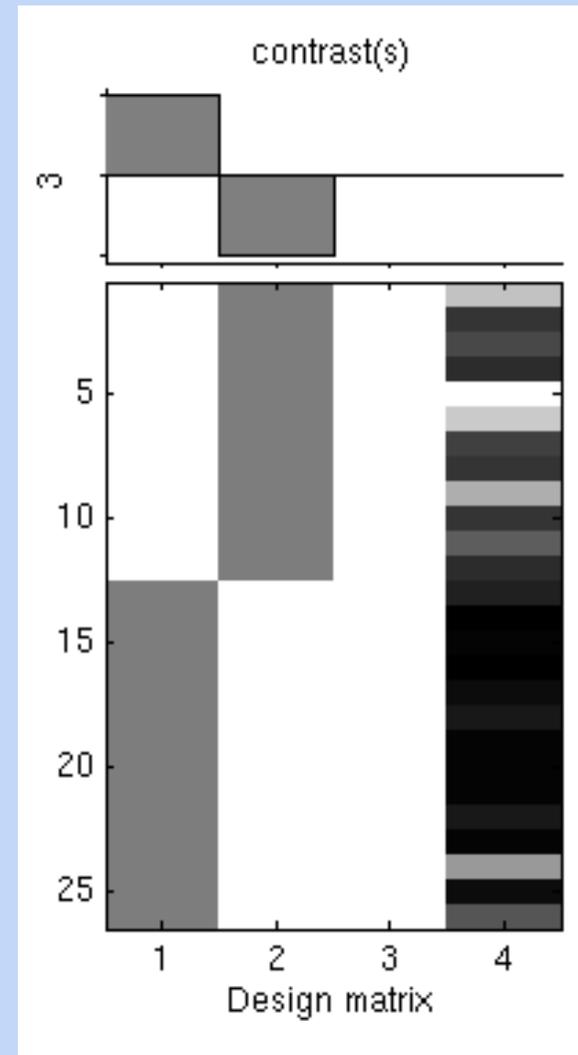
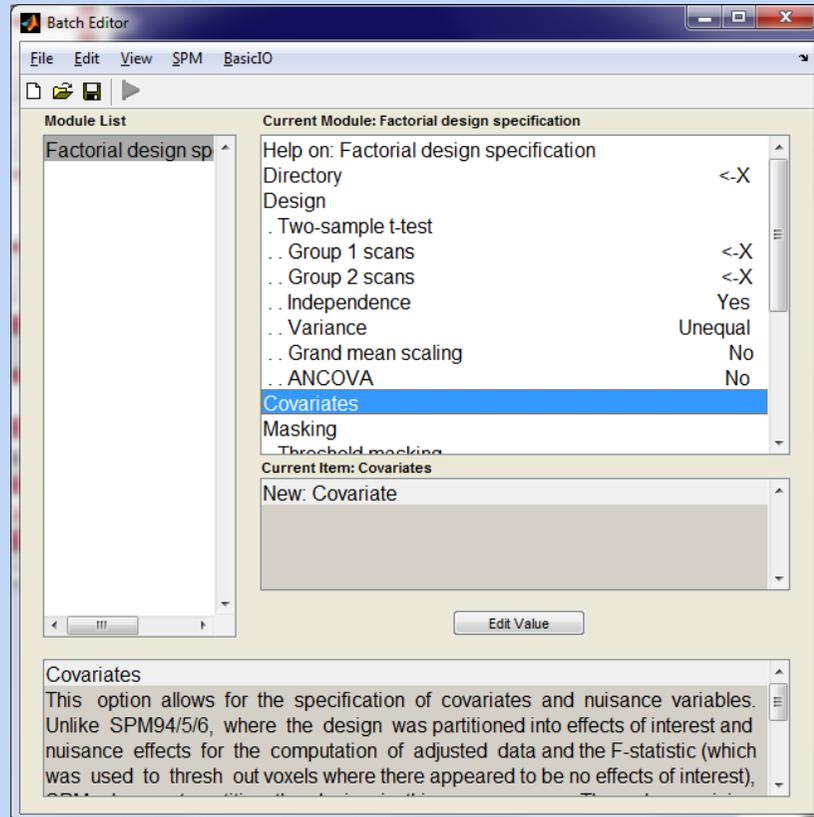
parameter estimability:

Reset Cancel OK

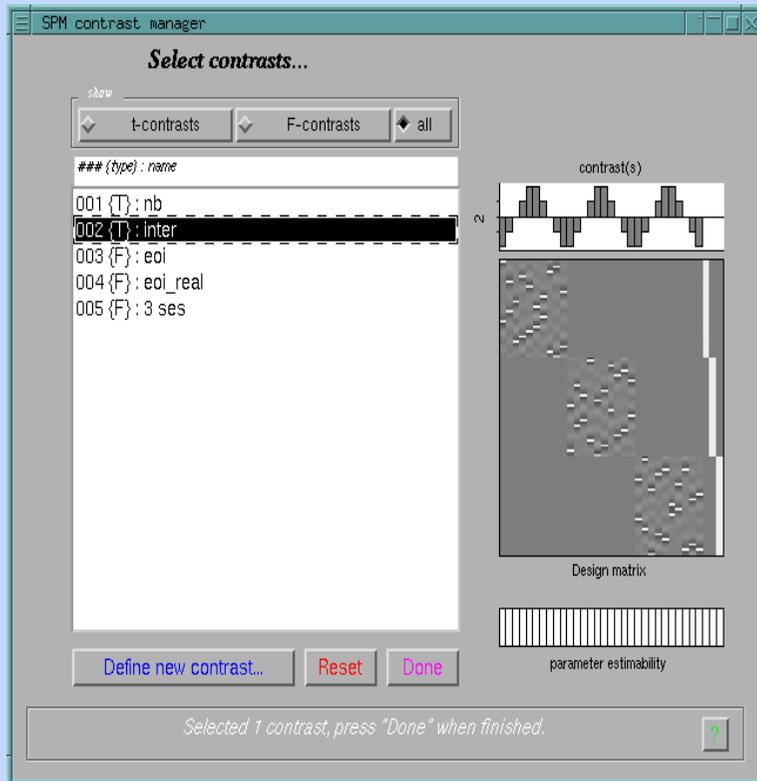
name defined, contrast defined



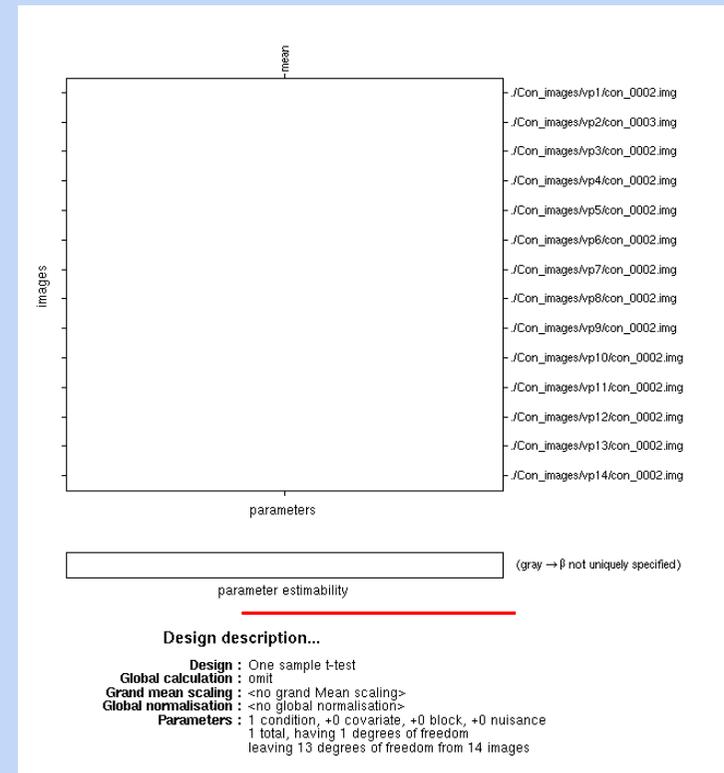
Two sample t-test mit Kovariaten



Komplexe Kontraste als t-test

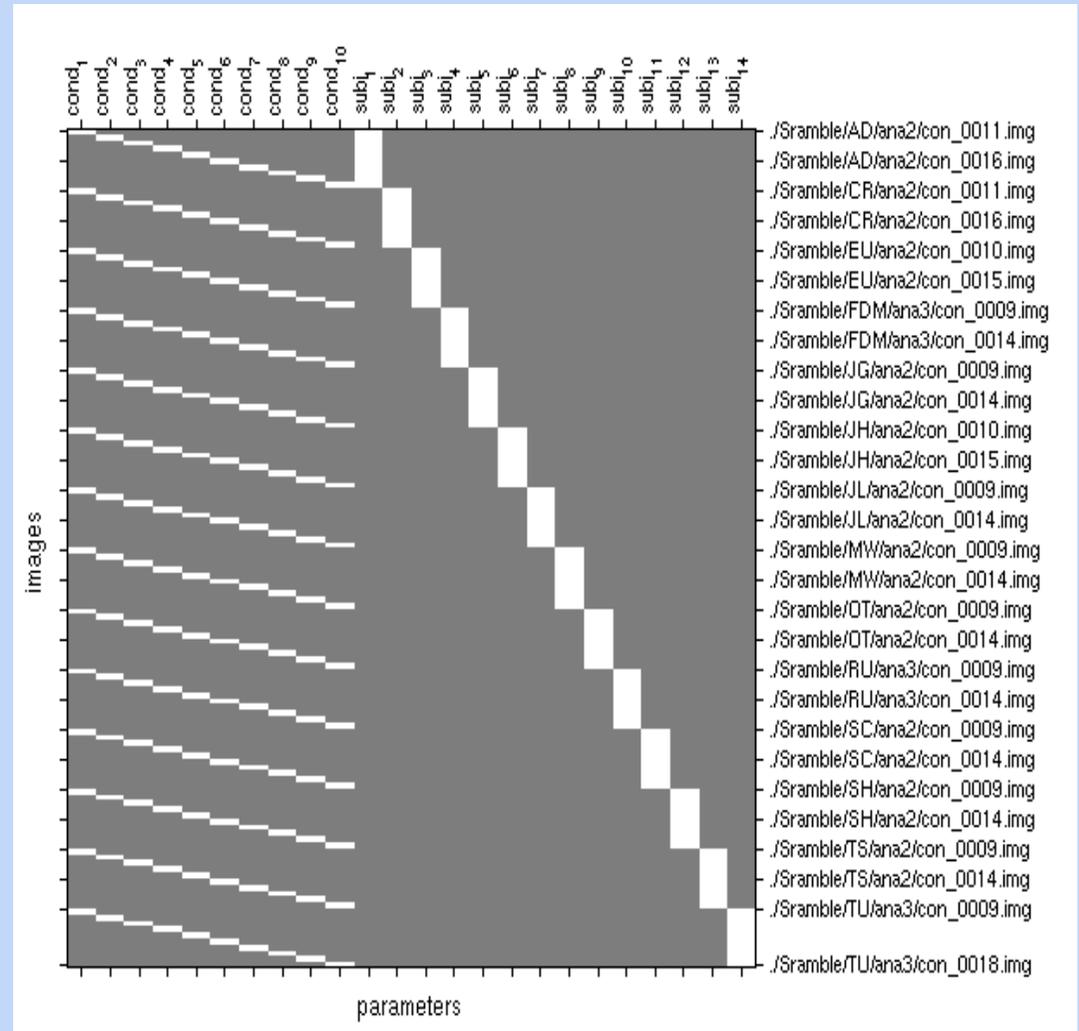
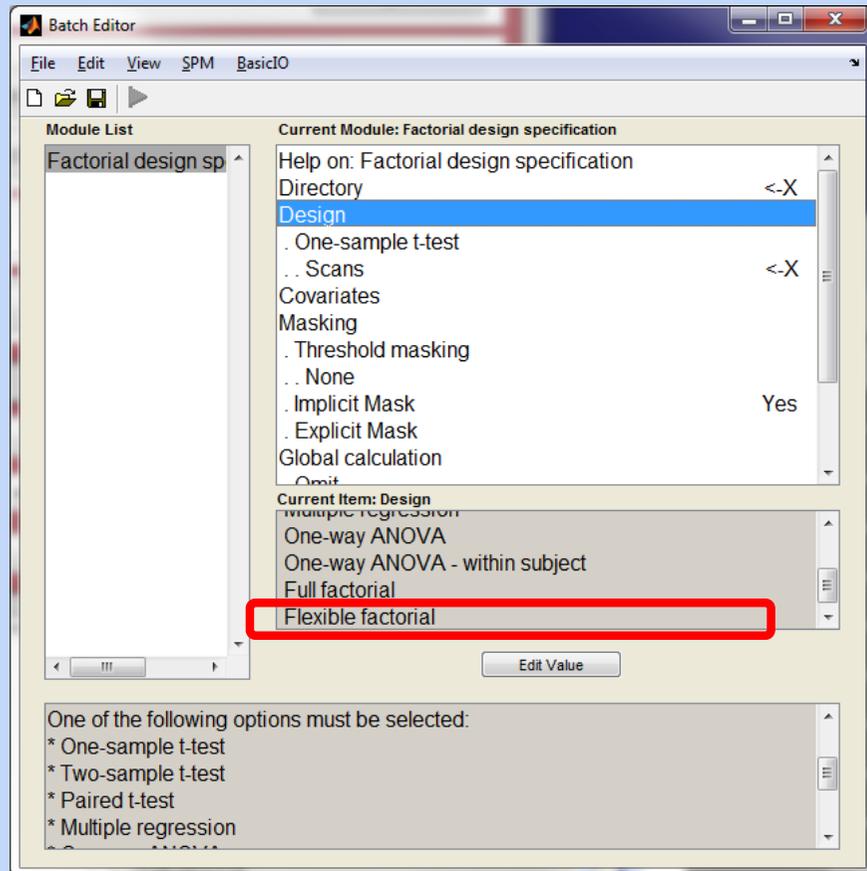


First Level

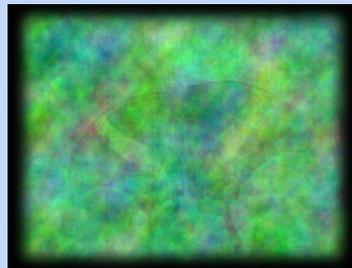
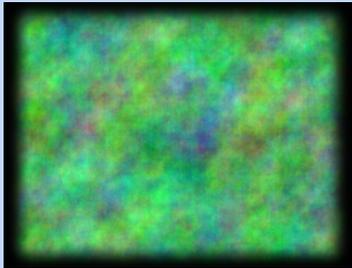


Second Level

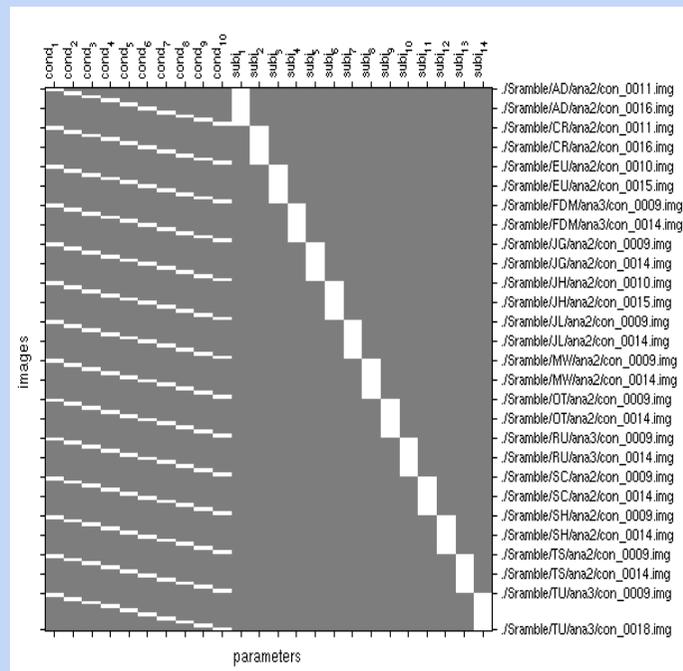
Factorial designs



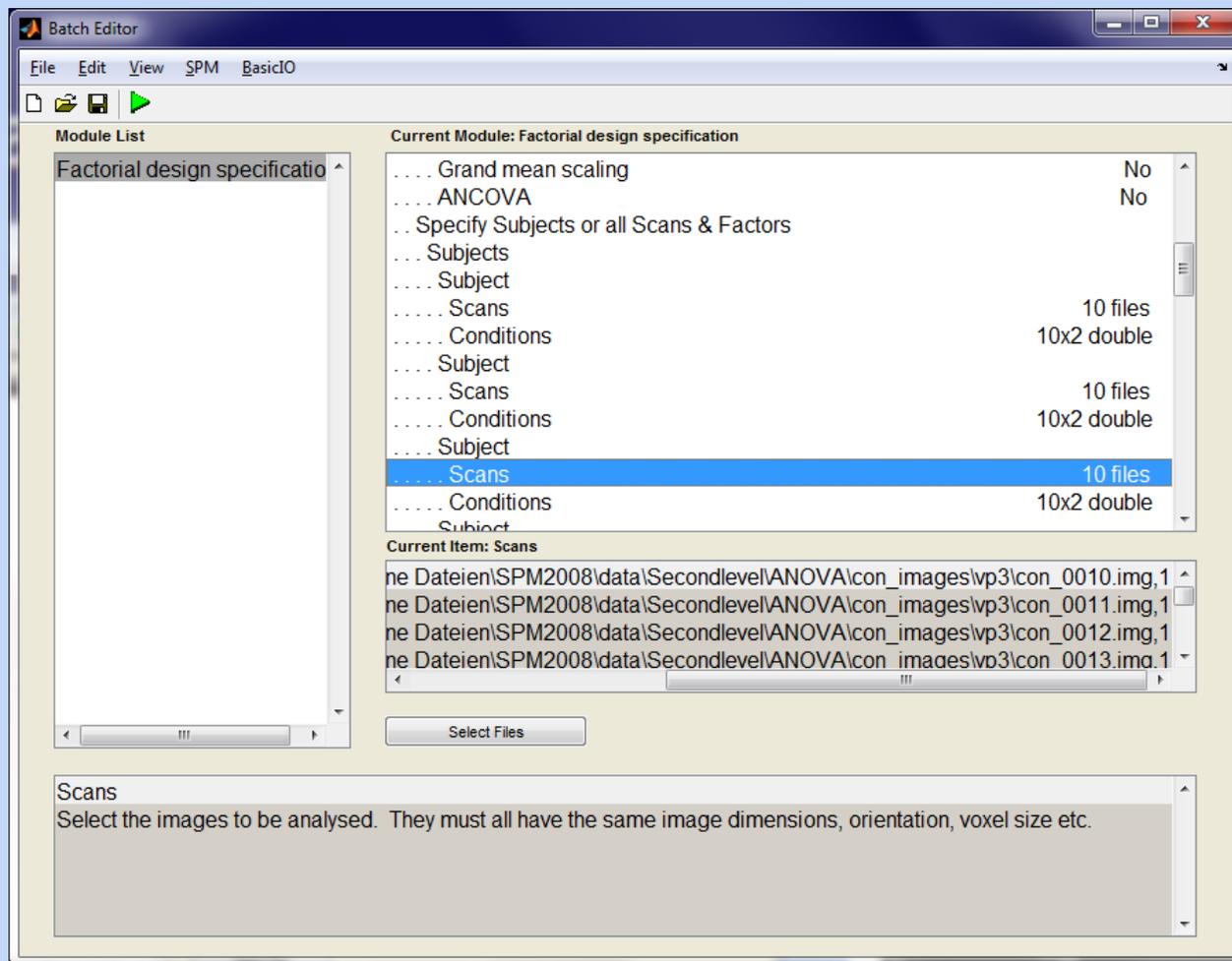
Factorial designs



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



Factorial designs



Factorial designs

The screenshot shows the 'Batch Editor' window with the 'Current Module: Factorial design specification' active. The interface includes a menu bar (File, Edit, View, SPM, BasicIO), a toolbar with icons for file operations and execution, and a 'Module List' on the left. The main area displays a list of design parameters and their values. The 'Conditions' parameter is highlighted in blue.

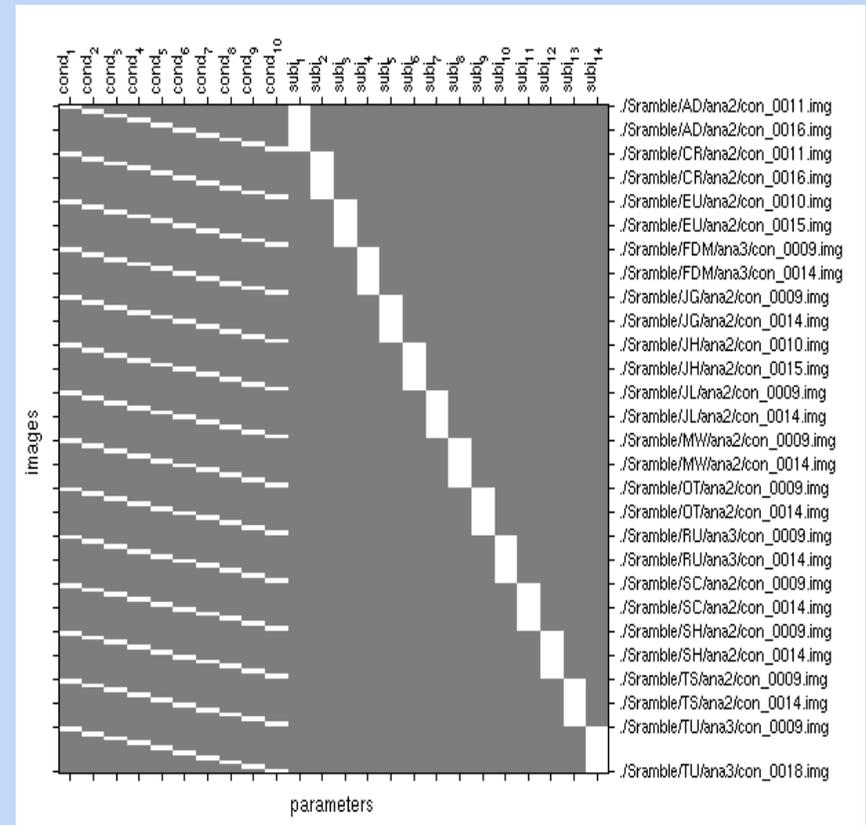
Parameter	Value
Grand mean scaling	No
ANCOVA	No
Specify Subjects or all Scans & Factors	
Subjects	
Subject	
Scans	10 files
Conditions	10x2 double
Subject	
Scans	10 files
Conditions	10x2 double
Subject	
Scans	10 files
Conditions	10x2 double
Subject	
Scans	10 files
Conditions	10x2 double

Current Item: Conditions

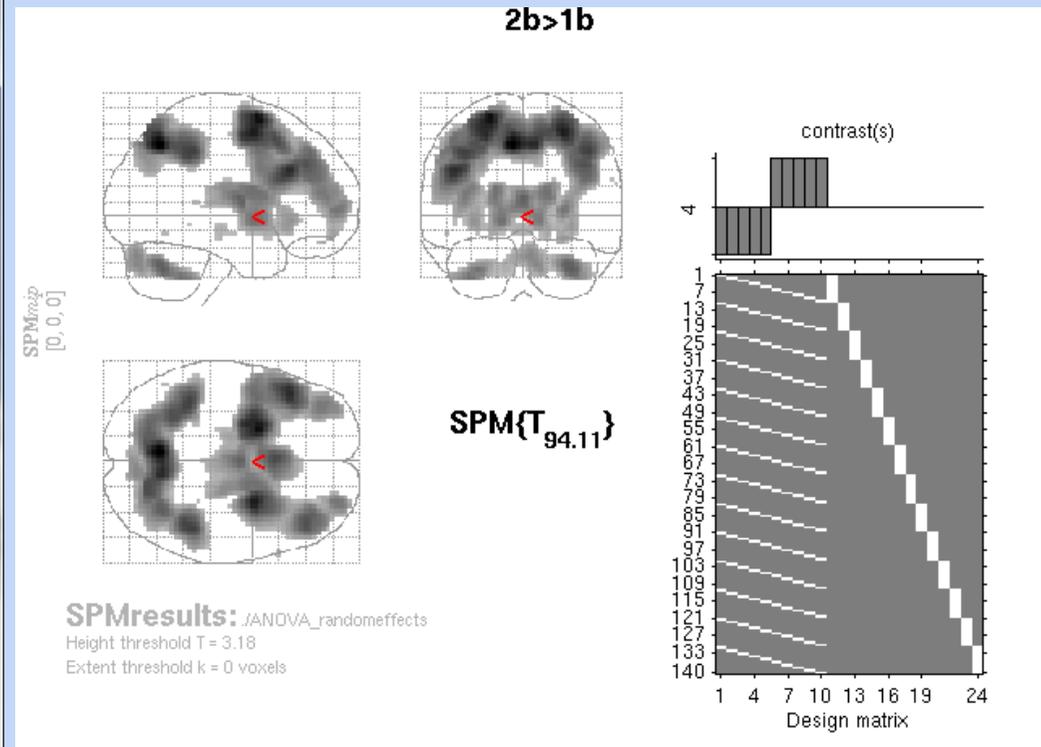
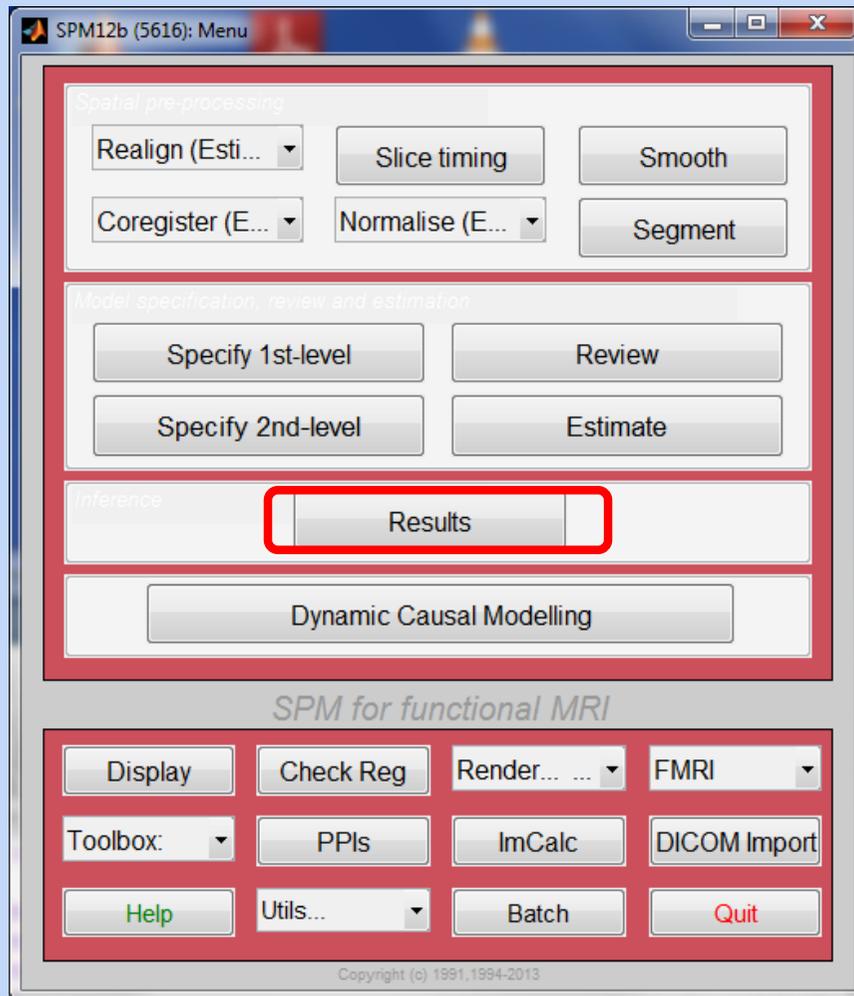
1	1
1	2
1	3
1	4
1	5
1	6
1	7

Conditions

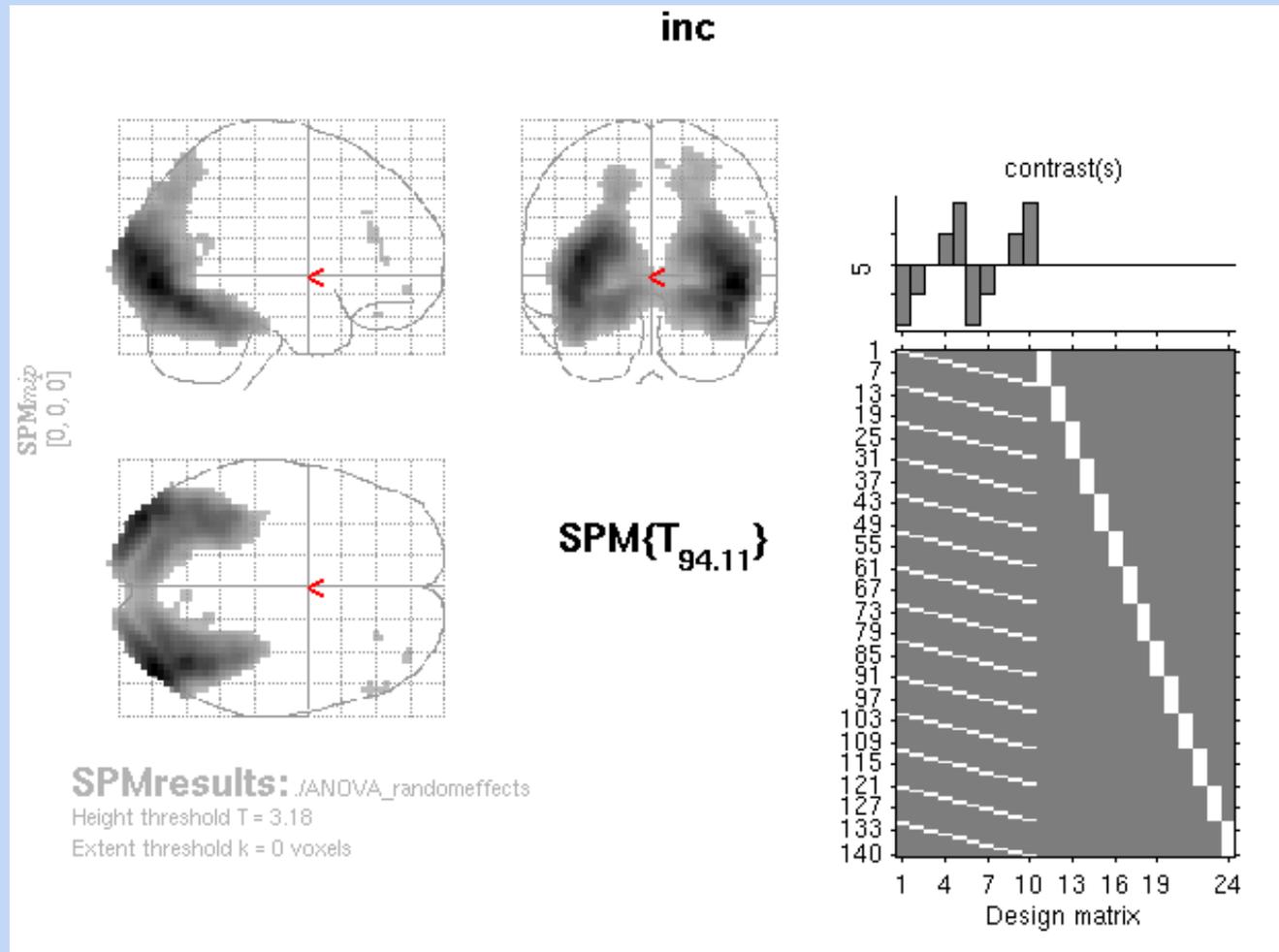
Evaluated statements are entered.
An X-by-X array must be entered.



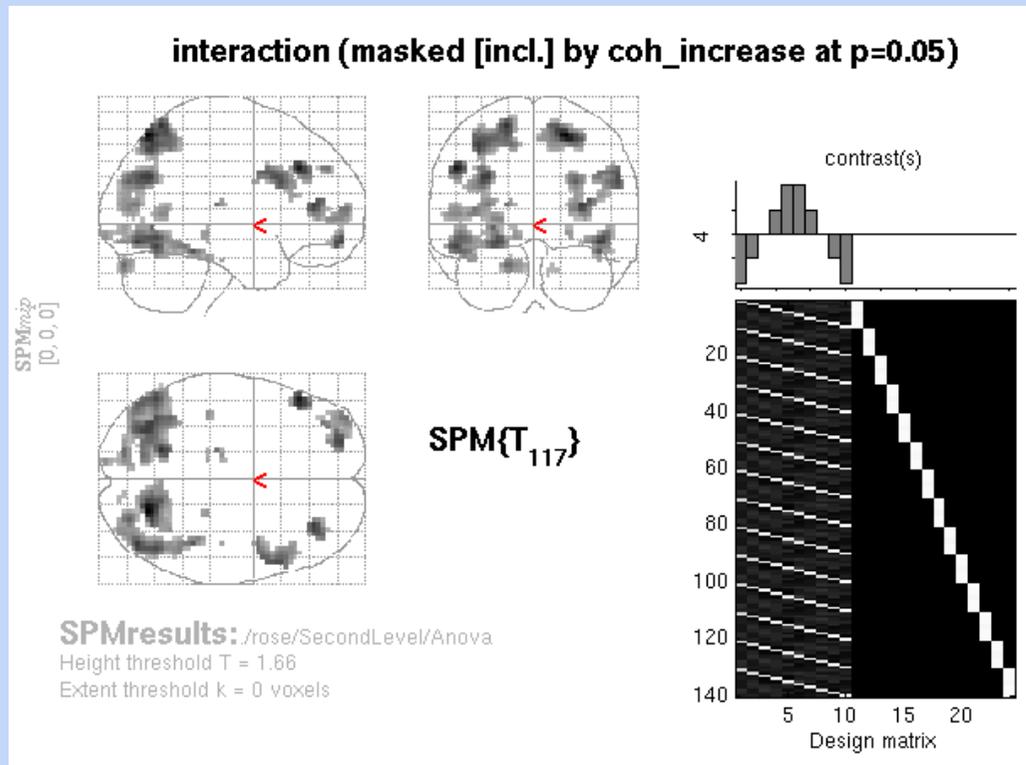
Factorial designs



Factorial designs

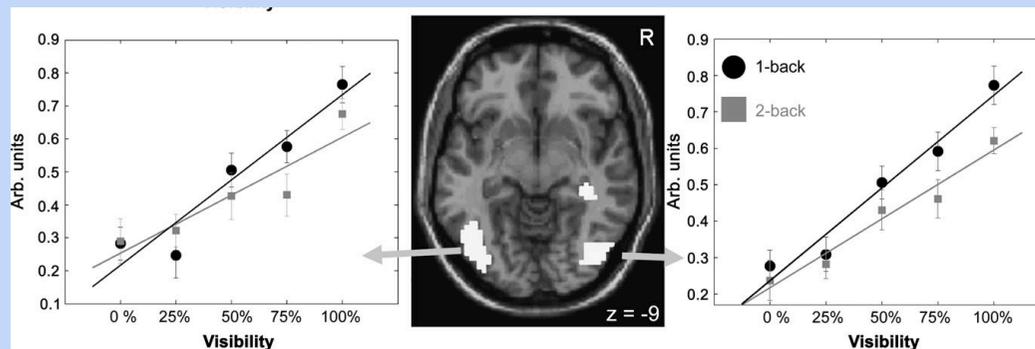


Factorial designs



Vorteile von „factorial designs“:

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

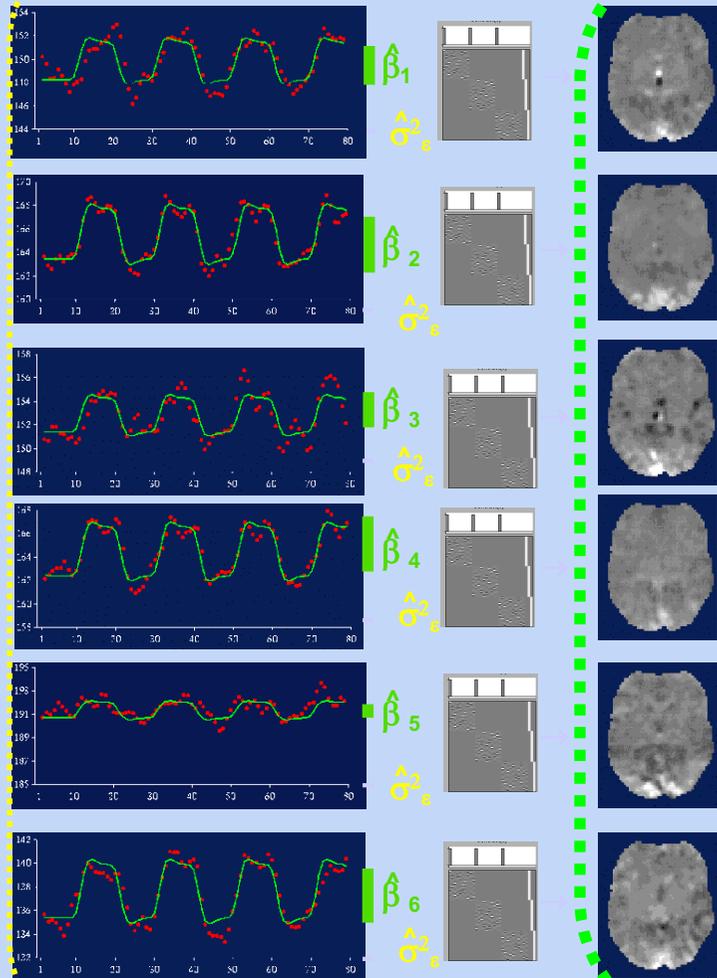


Rose et al (2005)

Summary

1.level
(within-subject)

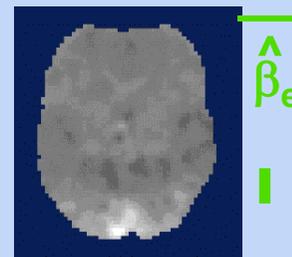
2.level
(between-subject)



timecourses at [03, -78, 00]

contrast images

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



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



images	parameters
-Con_jmepspl1con_0002 img	
-Con_jmepspl2con_0003 img	
-Con_jmepspl3con_0002 img	
-Con_jmepspl4con_0002 img	
-Con_jmepspl5con_0002 img	
-Con_jmepspl6con_0002 img	
-Con_jmepspl7con_0002 img	
-Con_jmepspl8con_0002 img	
-Con_jmepspl9con_0002 img	
-Con_jmepspl10con_0002 img	
-Con_jmepspl11con_0002 img	
-Con_jmepspl12con_0002 img	
-Con_jmepspl13con_0002 img	
-Con_jmepspl14con_0002 img	

parameter estimability (grey → not exactly specified)

Design description...
 Design: 1 One sample t-test
 Global calculation: one
 Grand mean scaling: +no grand Mean scaling
 Global normalization: +no grand normalization
 Parameters: 1 1 coefficient, +0 constraint, +0 block, +0 nuisance
 1 total, leaving 1 degree of freedom
 leaving 13 degrees of freedom from 14 images