

Zpracování fMR

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fMR vyhodnocení (1. cvičení)

Pipeline

1. **Konverze** formátů dat: DICOM -> NIFTI ✓ (již hotovo; přípona*.nii)
2. **Slice Timing** – korekce dat v čase (TR vs. HRF) ✗ (nebudeme dělat u našich dat)
3. **Realign** funkčních dat - prostorová korekce dat v čase
4. **Smooth** Gaussovským filtrem
5. **Model specification + Review**
6. **Estimate Model**
7. **Results + Display**

SW potřebný ke zpracování: Matlab + SPM12 toolbox (Win, MacOS)

Statistical **P**arametric **M**apping

SPM12 download:

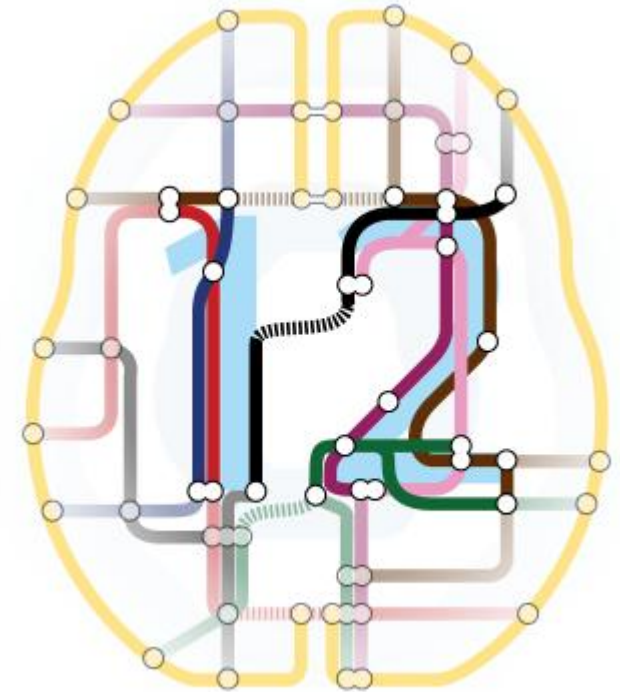
<https://www.fil.ion.ucl.ac.uk/spm/software/spm12/>

SPM12 manual:

„../toolbox/spm12/man/manual.pdf“

4 základní okna:

- Menu
- Results
- Graphic
- Batch Editor



Doporučené zdroje

SPM12

<https://www.fil.ion.ucl.ac.uk/spm/doc/>

GLM

https://www.fil.ion.ucl.ac.uk/mfd_archive/2011/page1/mfd2011_GLM.pdf

fMR vyhodnocení (1. cvičení)

Data

Paradigma:

- | | | |
|------------------------|-------------------------|------------------------------|
| 1. Neurotracker | (pohybující se balónky) | 125vol, TR=2000ms, 60 slices |
| 2. 2-back test | (detekce písmen v řadě) | 110vol, TR=2000ms, 60 slices |
| 3. Visual | (blikající šachovnice) | 135vol, TR=2000ms, 60 slices |

Data dobrovolníků: adresáře **zk84, zk 85, zk86, zk87, zk88, zk89**

Struktura adresářů: **fMR_neurotracker** (125 nii-files)
fMR_2back (110 nii-files)
fMR_visual (135 nii-files)
t1 (1 nii-file)

zk84	F-O	1997	16.02.2022
zk85	D-K	1996	16.02.2022
zk86	J-Š	1998	23.02.2022
zk87	J-S	1998	23.02.2022
zk88	B-R	1998	02.03.2022
zk89	Y-F	1997	02.03.2022

SPM12 (7771): Menu

Spatial pre-processing

Realign (Esti... | Slice timing | Smooth

Coregister (... | Normalise (E... | Segment

Model specification, review and estimation

Specify 1st-level | Review

Specify 2nd-level | Estimate

Inference | Results

Dynamic Causal Modelling

SPM for functional MRI

Display | Check Reg | Render... | FMRI

Toolbox: | PPIs | ImCalc | DICOM Import

Help | Utils... | Batch | Quit

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SPM12 (7771): Graphics

Help File Edit View Insert Tools Desktop Window SPM Figure

Crosshair Position | Origin

mm: 0.0 -59.4 13.7

vx: 40.0 27.3 42.9

Intensity: -0.695892

right (mm)	0
forward (mm)	0
up (mm)	0
pitch (rad)	0
roll (rad)	0
yaw (rad)	0
resize (x)	1
resize (y)	1
resize (z)	1

Set Origin | Reorient...

File: .lspmT_0001.nii

Dimensions: 79 x 95 x 79

Datatype: float32

Intensity: Y = 1 X

SPM(T_[19.0]) - contrast 1: BASKET>TENIS

Vox size: -2 x 2 x 2

Origin: 40 57 36

Dir Cos: 1.000 0.000 0.000
0.000 1.000 0.000
0.000 0.000 1.000

Full Volume | Hide Crosshair

World Space | Trilinear interp.

Auto Window | Add Overlay...

SPM12 (7771): SPM(T): Results

Design Contrasts Atlas

p-values | Multivariate | Display

whole brain | eigenvariate | CVA | plot

current cluster | multivariate Bayes | overlays...

small volume | BMS | p-value | save...

Hemodynamics | clear | ext

co-ordinates | statistic

x = 0.00 | y = 0.00 | z = 0.00

Batch Editor

File Edit View SPM BasicIO

Module List

Smooth <-X

Current Module: Smooth

Help on: Smooth

Images to smooth <-X

FWHM [8 8 8]

Data Type SAME

Implicit masking No

Filename prefix s

Current Item: Images to smooth

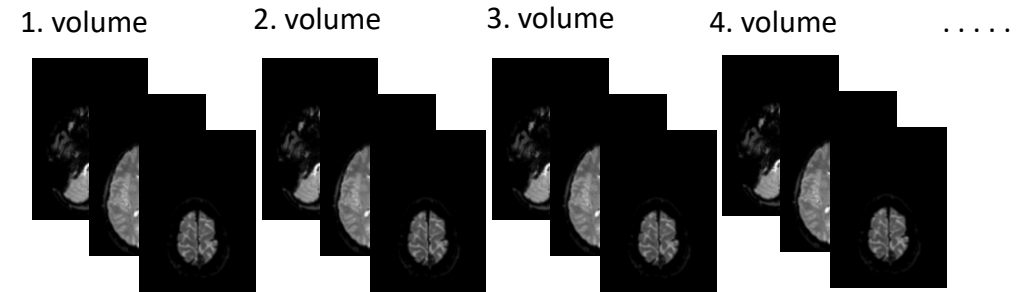
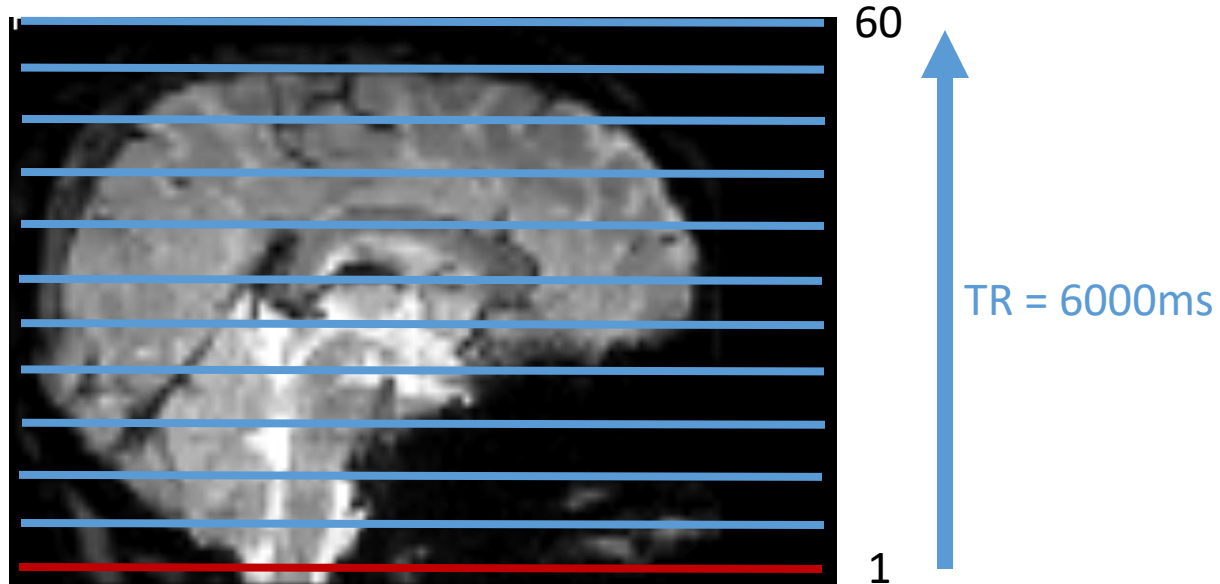
Specify...

Images to smooth

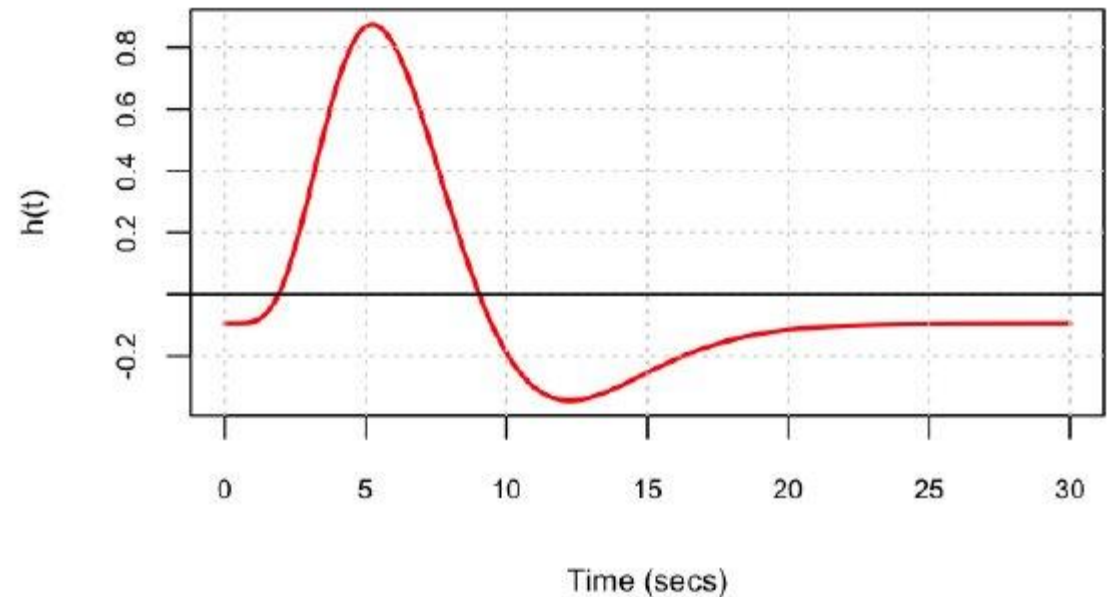
Specify the images to smooth.

The smoothed images are written to the same subdirectories as the original images with a configurable prefix.

Slice timing (u našich cvičebních dat neprovádíme, TR=2s)



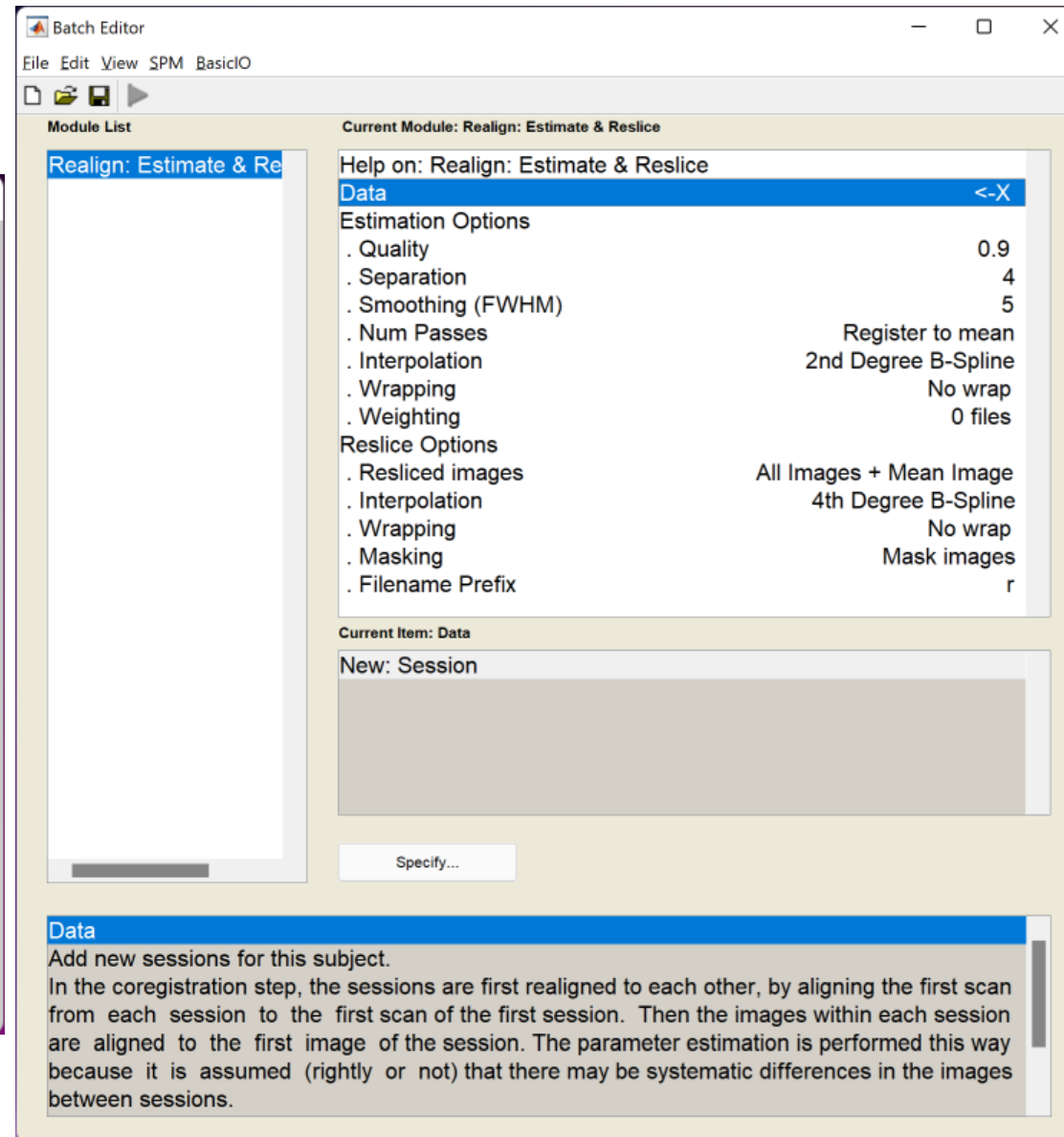
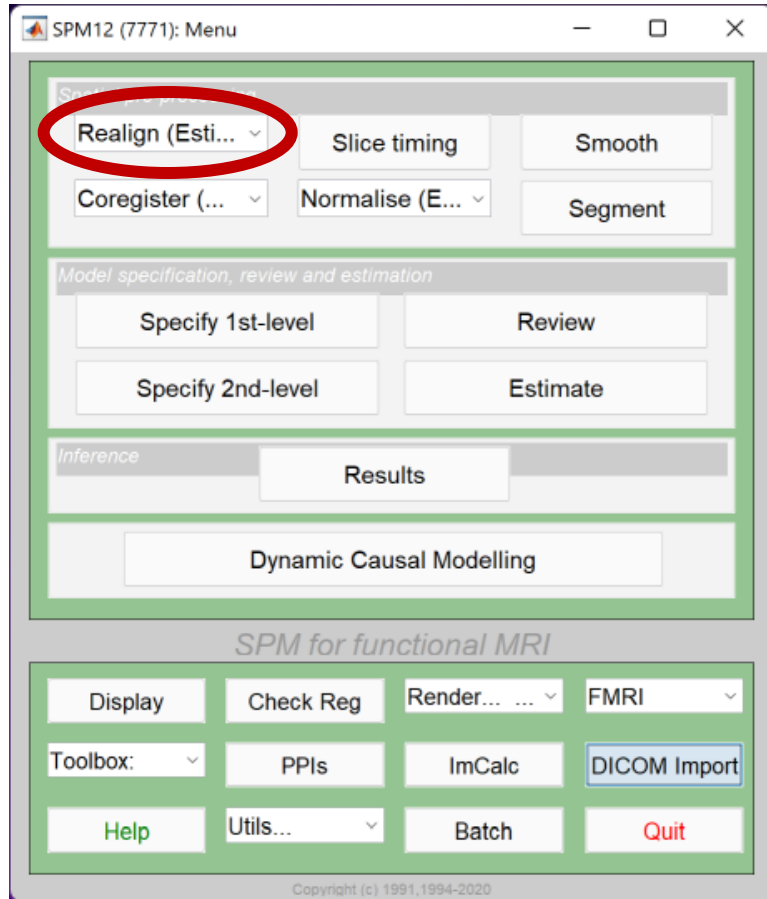
Hemodynamic Response Function



Realign data

- This routine realigns a time-series of images acquired from the same subject using a **least squares approach and a 6 parameter (rigid body) spatial transformation**. The first image in the list specified by the user is used as a reference to which all subsequent scans are realigned. The reference scan does not have to be the first chronologically and it may be wise to choose a "representative scan" in this role.
- The aim is primarily to remove movement artefact in fMRI and PET time-series (or more generally longitudinal studies). The headers are modified for each of the input images, such that they reflect the relative orientations of the data. The details of the transformation are displayed in the results window as plots of translation and rotation. A set of realignment parameters are saved for each session, named `rp_*.txt`. These can be modelled as confounds within the general linear model

Realign data

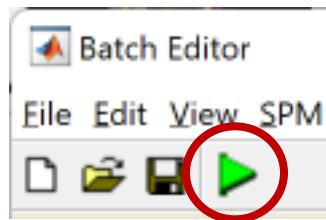


Realign data

MENU: Realign (Estimate & Reslice)

BATCH EDITOR:

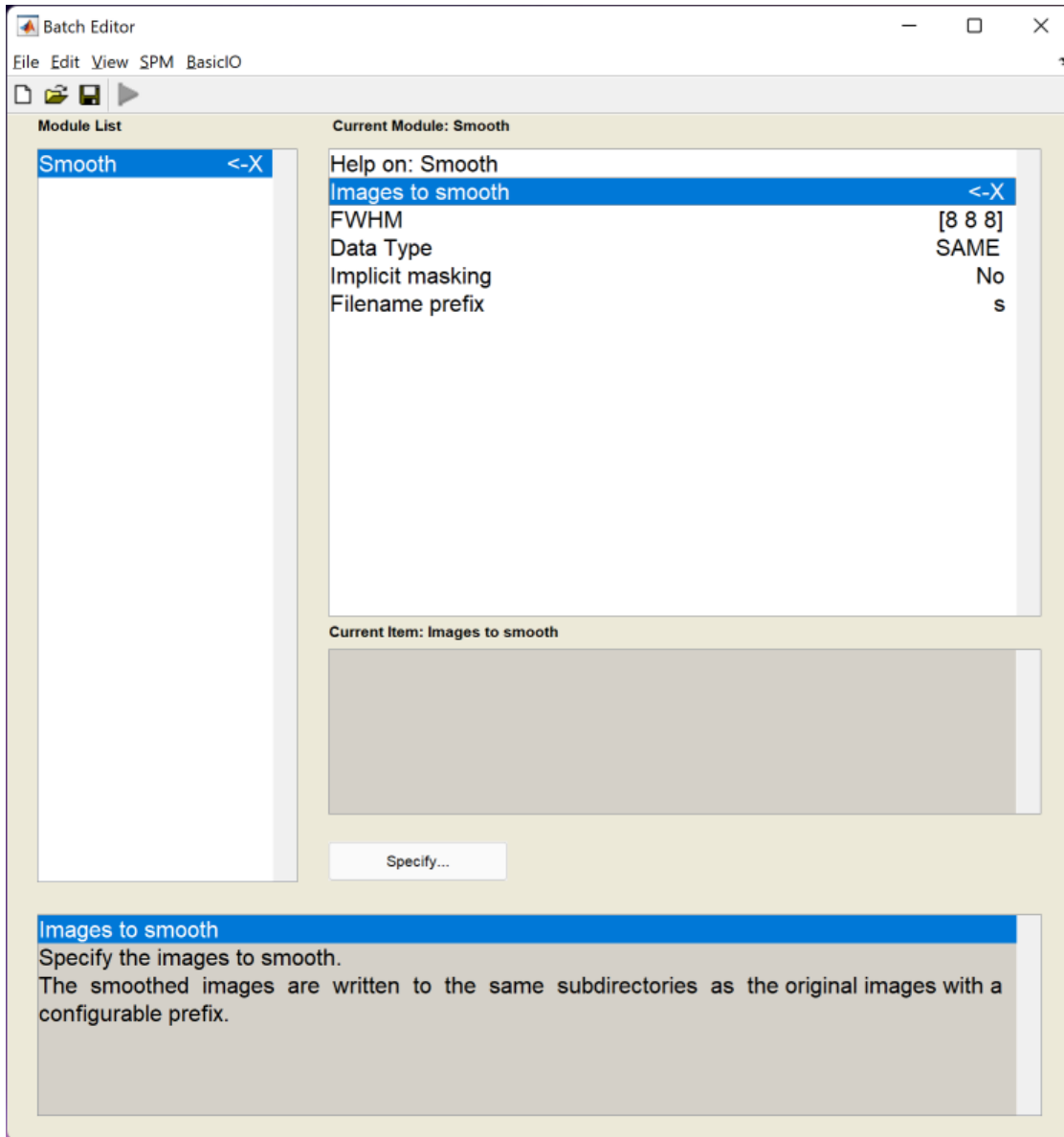
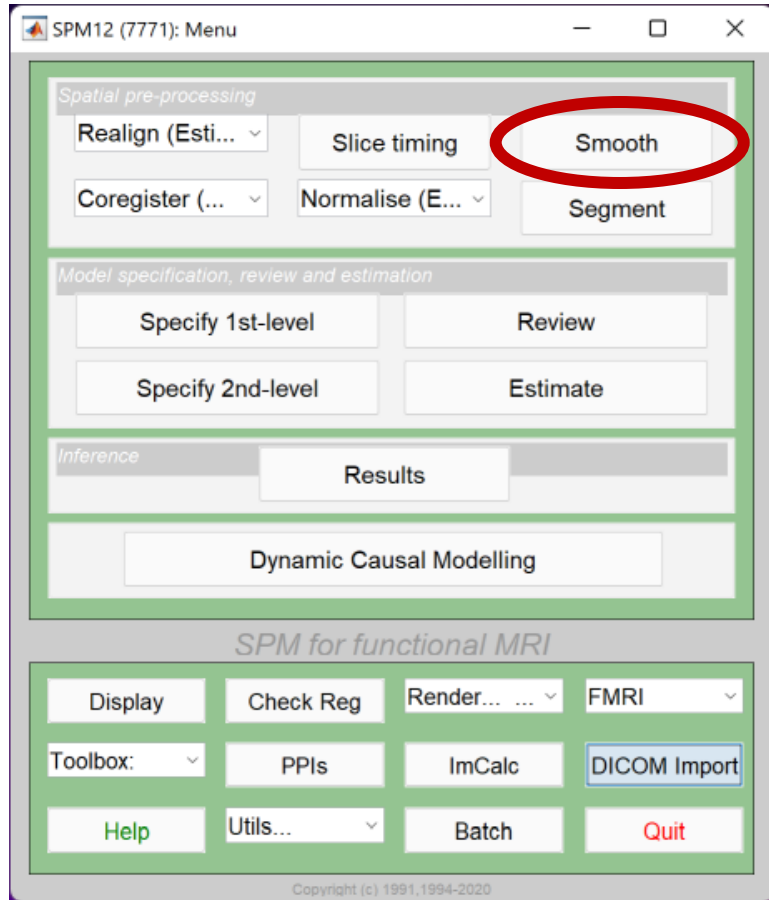
- a) Data – Session ... vybrat všechny soubory fMR
- b) Run batch



Výstup:

- Reslicované soubory (před každým souborem „r*.nii“)
- „mean*.nii“ soubor, ke kterému jsou všechny zarovnány
- Soubor s parametry zarovnání „rp_*.txt“

Smooth

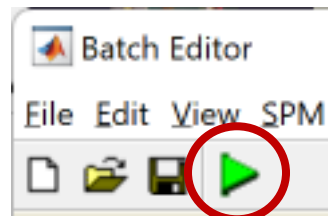


Smooth

MENU: Smooth

BATCH EDITOR:

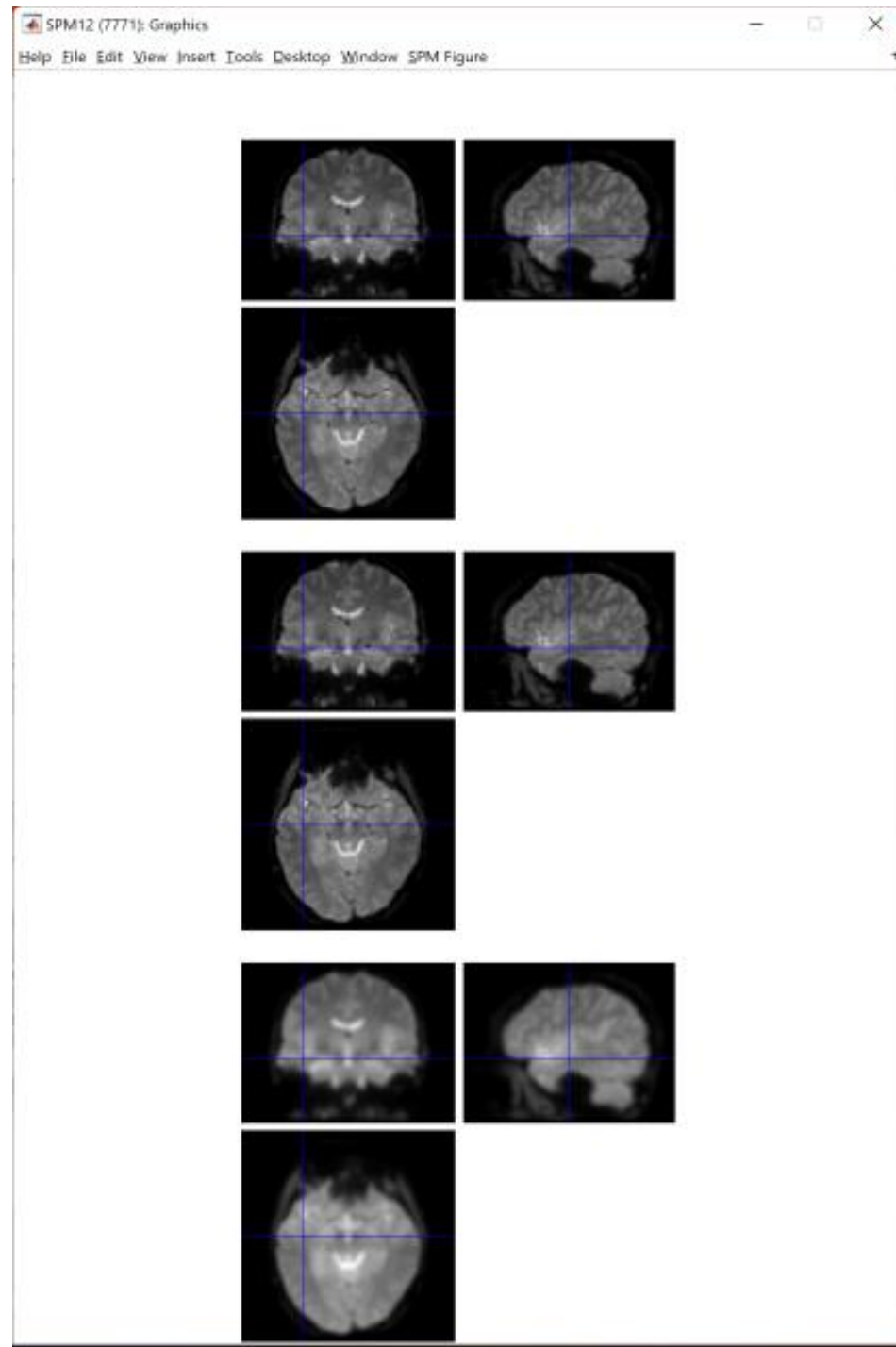
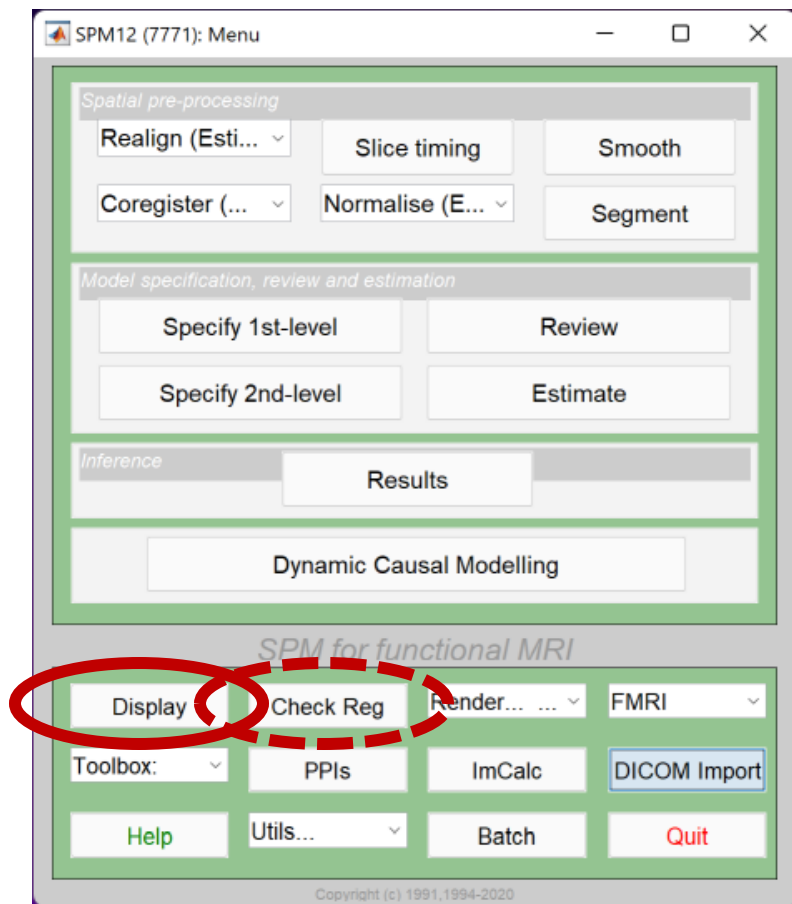
- a) Images to smooth ... vybrat všechny soubory s předponou r*.nii
- b) FWHM ... [4 4 4] (Full width at half maximum of the Gaussian smoothing kernel in mm, doporučen dvojnásobek velikosti voxelu)
- c) Run batch



Výstup:

- Smoothované soubory (před každým souborem „s*.nii“)

Data check (!)



GLM – General Linear Model

$$y = X\beta + e$$

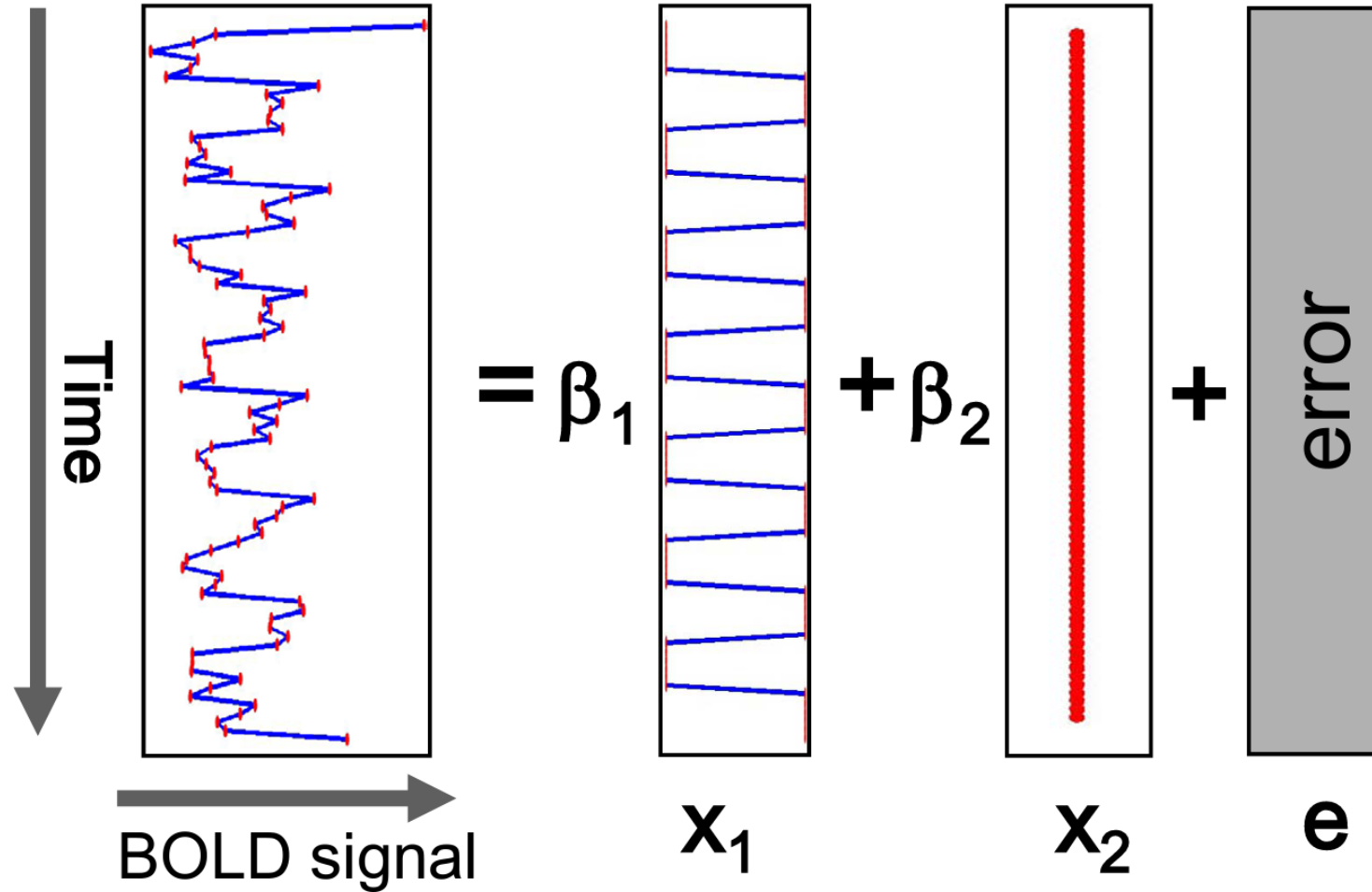
Závislá proměnná
BOLD v jednotlivých voxelech

Nezávislá proměnná (Predictor)
Podmínky experimentu

Parametry beta (regression coeff.)
Podmínky experimentu

Error (Residuals)
Rozptyl hodnot v datech (y), který není vysvětlen lineární kombinací prediktorů

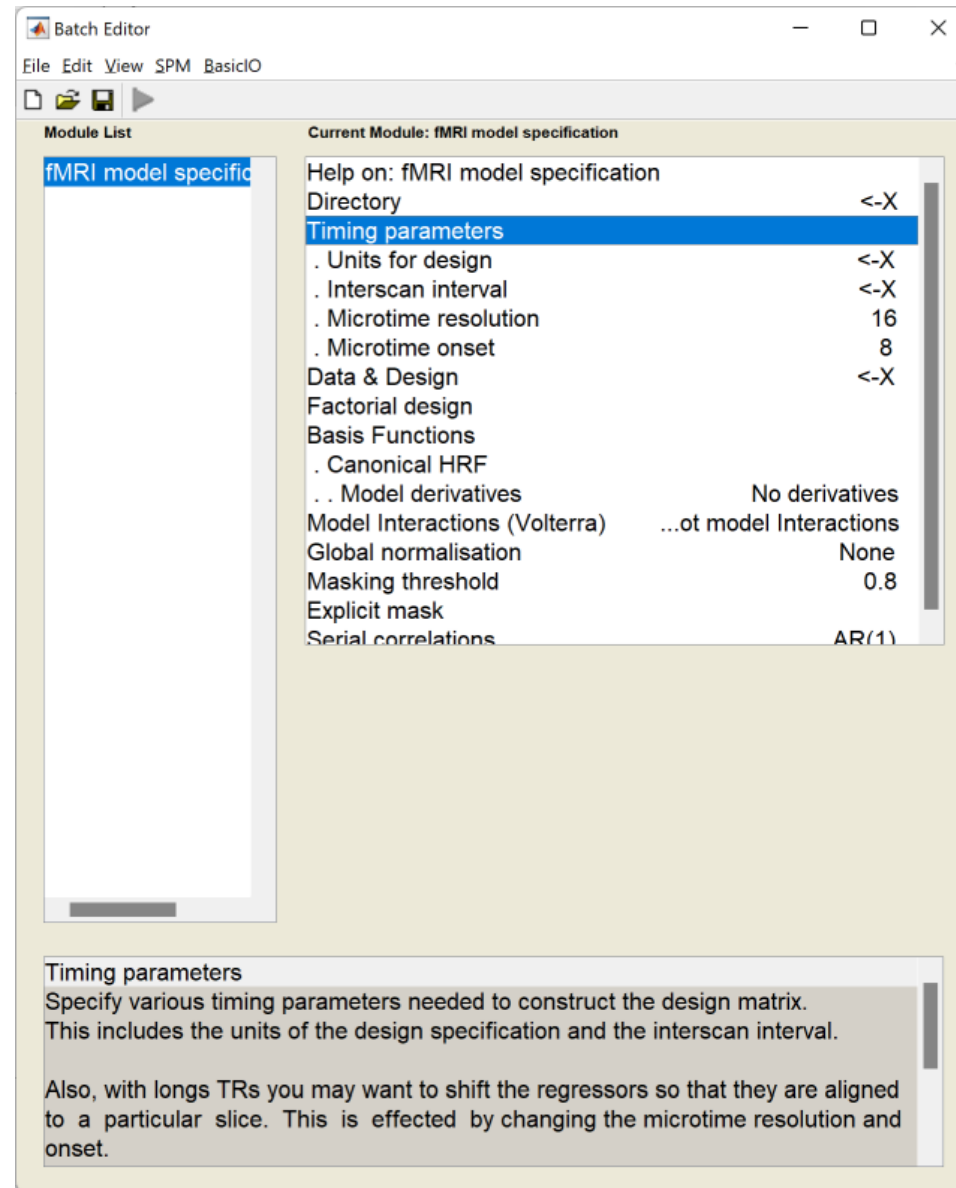
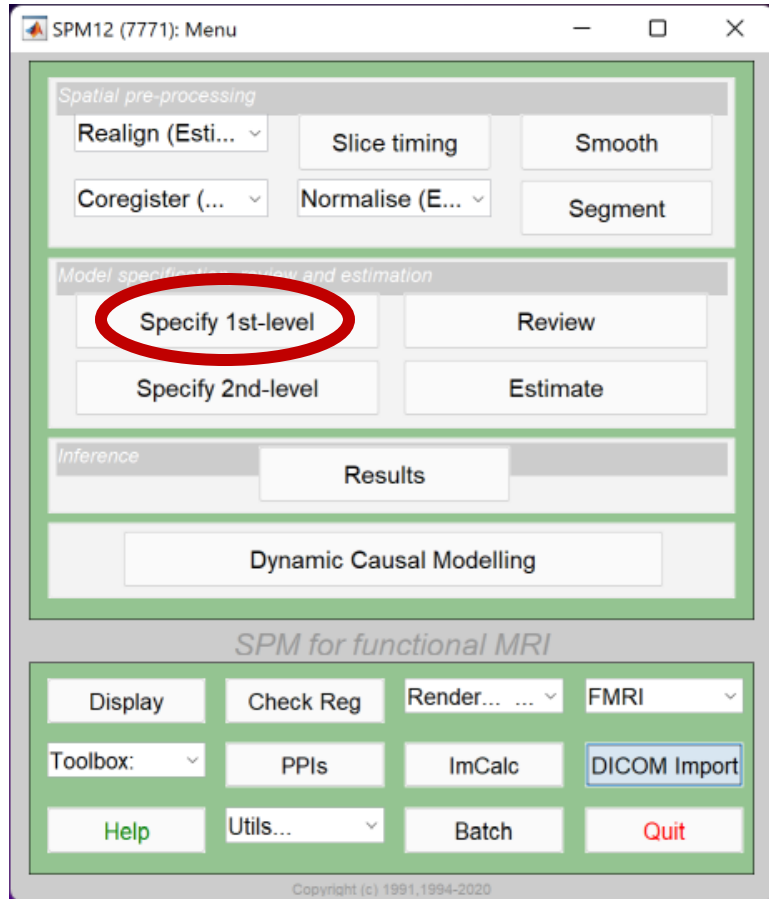
Single voxel regression model



$$y = x_1\beta_1 + x_2\beta_2 + e$$

fMRI Statistics

Model specification



fMR Statistics

Model specification

MENU: Specify 1st-level

BATCH EDITOR:

- a) Directory ... vybrat (předem vytvořený) adresář pro model a výsledky statistiky
- b) Units for design ... Scans
- c) Interscan interval ... 2 (odpovídá TR)
- d) Data & Design
 - a) Scans ... vybrat sr*.nii data
 - b) Conditions
 - a) Condition
 - a) Name ... název pro použité paradigma, např. VISUAL
 - b) Onset ... vektor začátku aktivací v daném paradigmatu (pořadová čísla scanů)
 - c) Durations ... délka aktivace (ve scanech)
- e) Run batch

Výstup:

- **SPM.mat** file (GLM model)

fMR Statistics

Model specification

1. Condition **NEUROTRACKER**

- Name ... NEUROTRACKER
- Onset ... [11 36 61 86 111]
- Durations ... 10

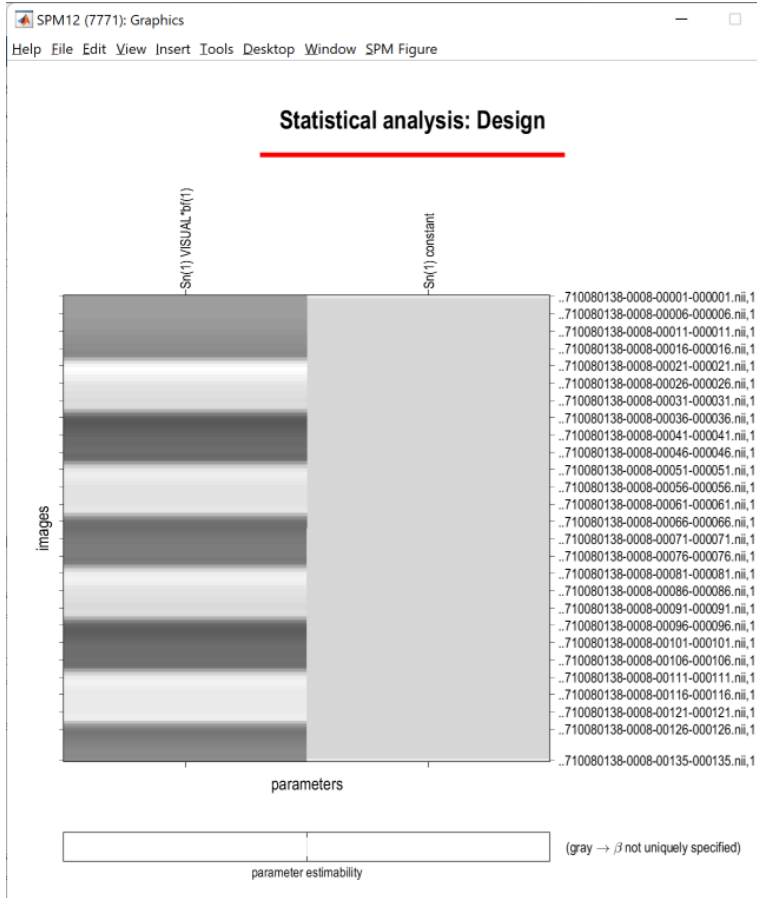
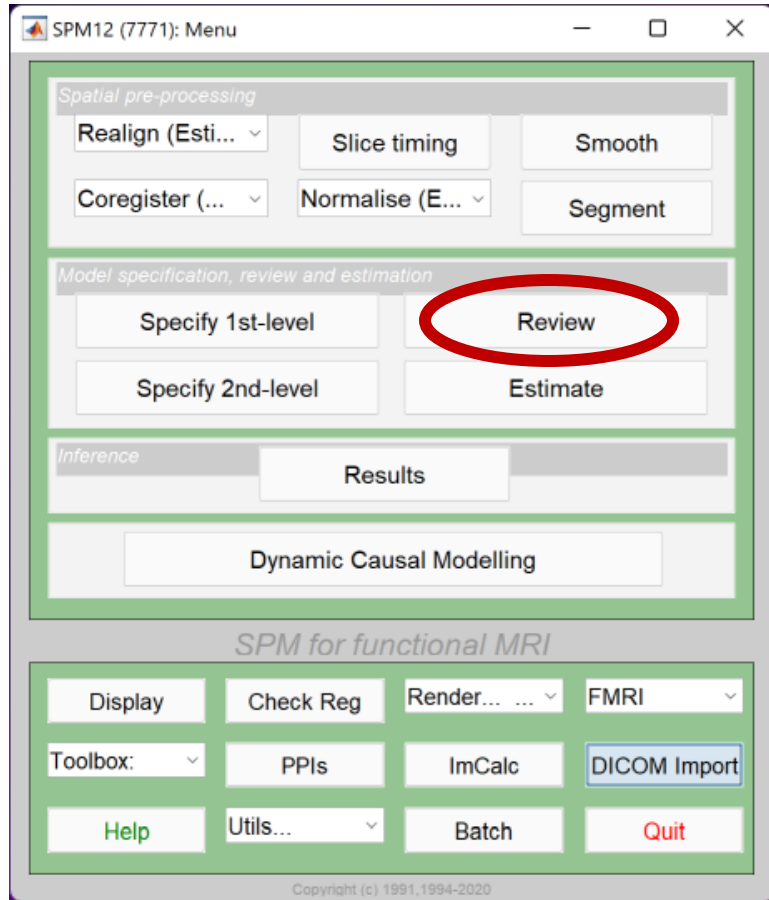
2. Condition **2-BACK**

- Name ... 2BACK
- Onset ... [11 36 61 86]
- Durations ... 15

3. Condition **VISUAL**

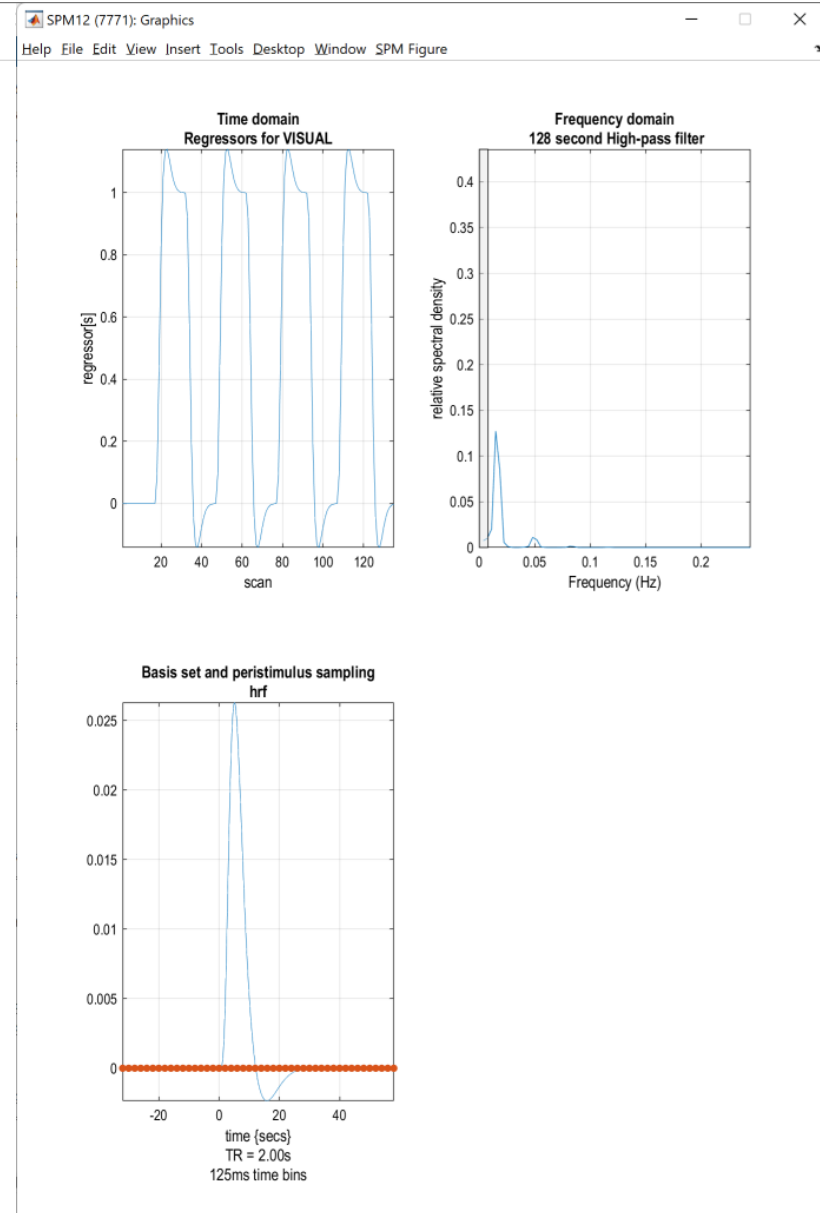
- Name ... VISUAL
- Onset ... [16 46 76 106]
- Durations ... 15

fMR Statistics Model review



Design description...

- Basis functions : hrf
- Number of sessions : 1
- Trials per session : 1
- Interscan interval : 2.00 (s)
- High pass Filter : [min] Cutoff: 128 (s)
- Global calculation : mean voxel value
- Grand mean scaling : session specific
- Global normalisation : None



fMR Statistics

Model review

MENU: Review

BATCH EDITOR:

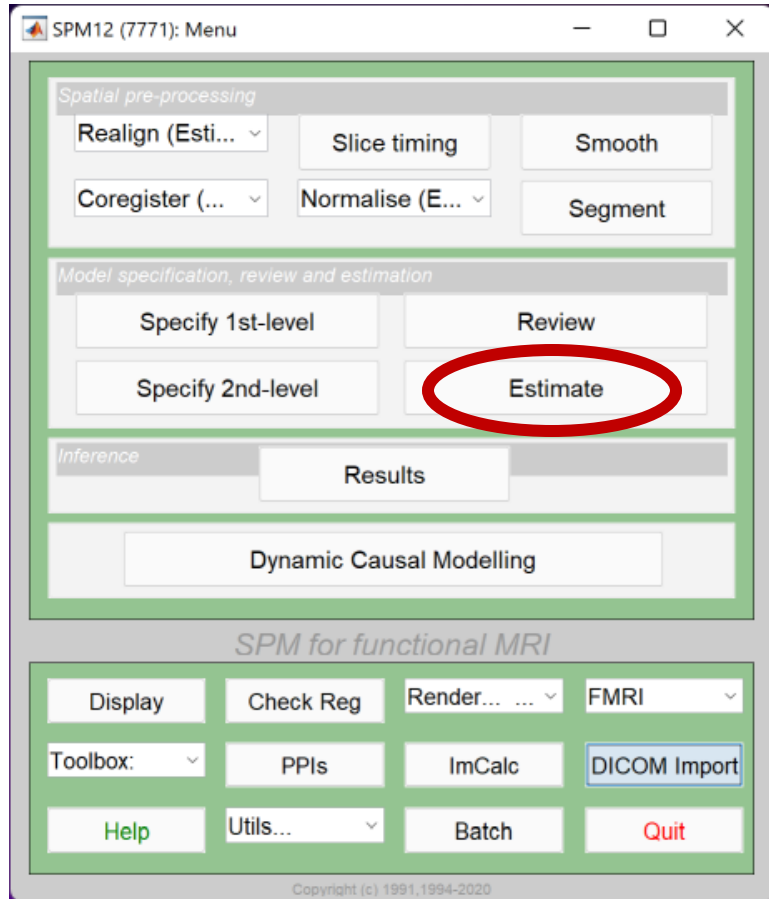
- a) Select SPM.mat ... vybrat SPM.mat příslušného modelu
- b) Run batch

RESULTS:

- Design – Design Matrix (design modelu pro dané parametry)
- Design – Explore – Session 1 – VISUAL (časová a frekvenční doména modelovaného průběhu)

fMR Statistics

Model estimation



fMR Statistics

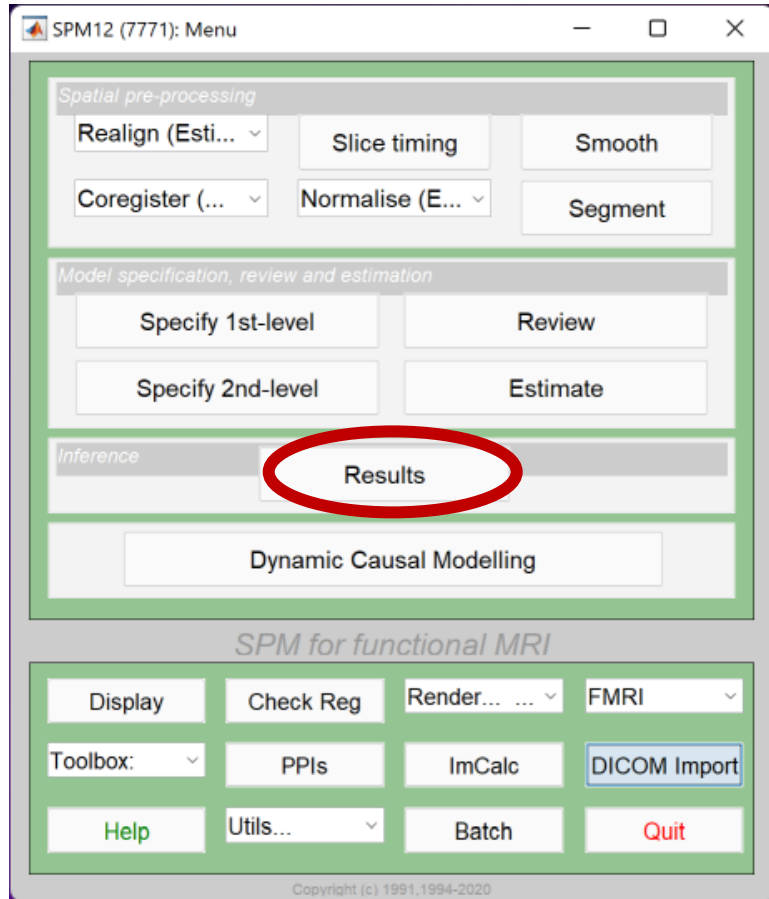
Model estimation

MENU: Estimate

BATCH EDITOR:

- a) Select SPM.mat ... vybrat SPM.mat příslušného modelu
- b) Run batch

fMR Statistics Results



fMR Statistics

Model estimation

MENU: Results
Select SPM.mat

SPM contrast manager:

a) Define new contrast

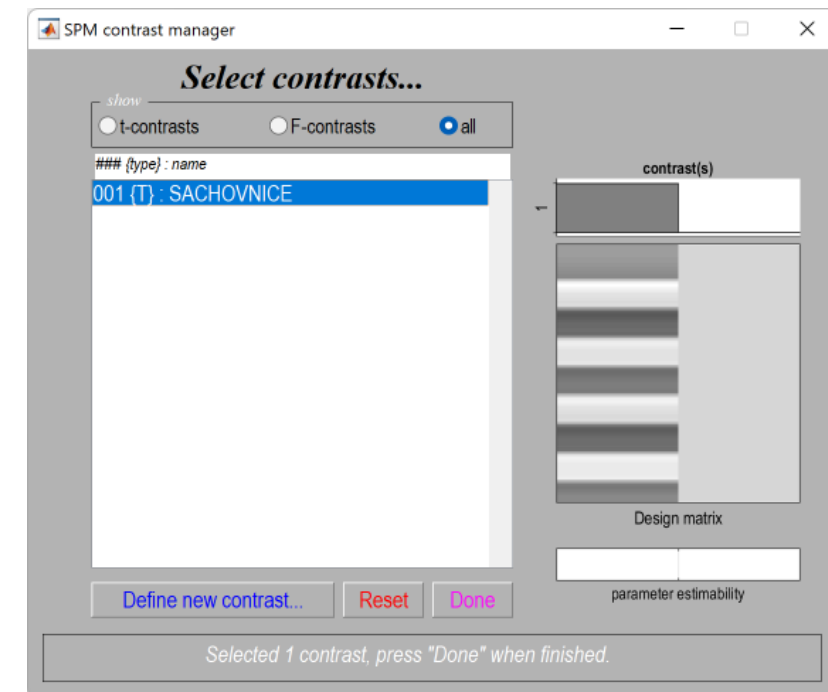
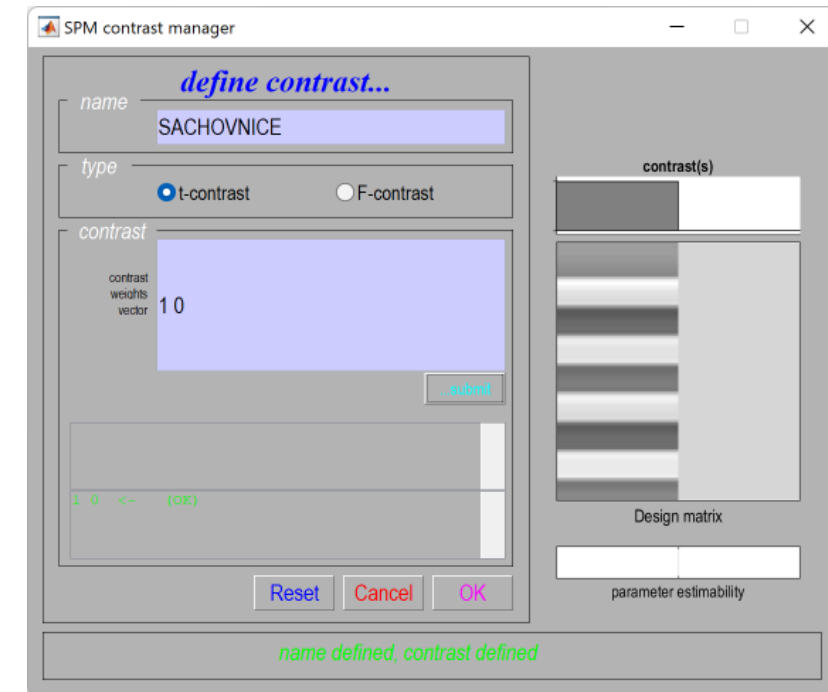
Name: SACHOVNICE (NEUROTRACKER / 2BACK)

type: t-contrast

contrast: 1 0 ...submit

b) OK

c) Done



fMR Statistics

Model estimation

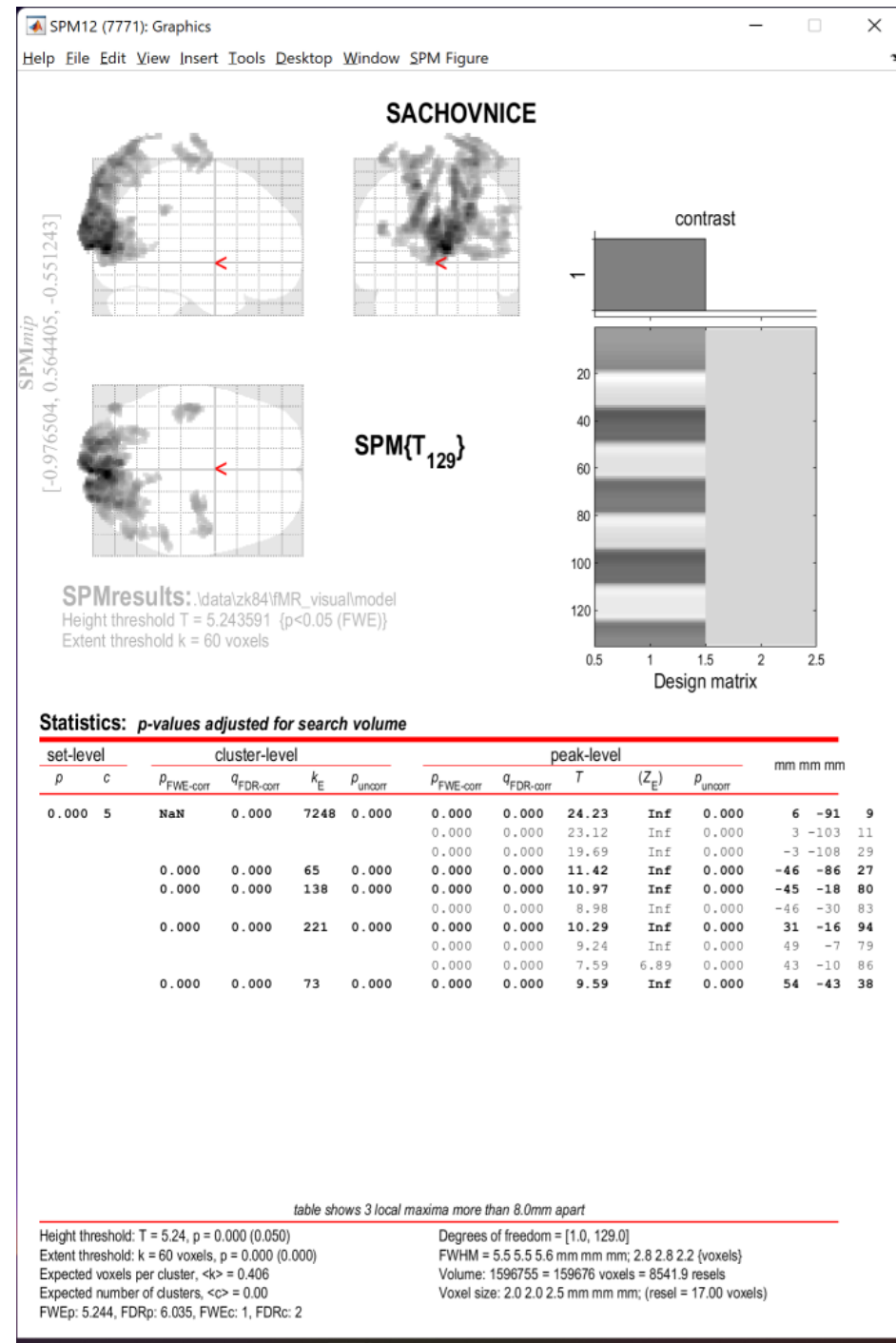
RESULTS:

apply masking ... none

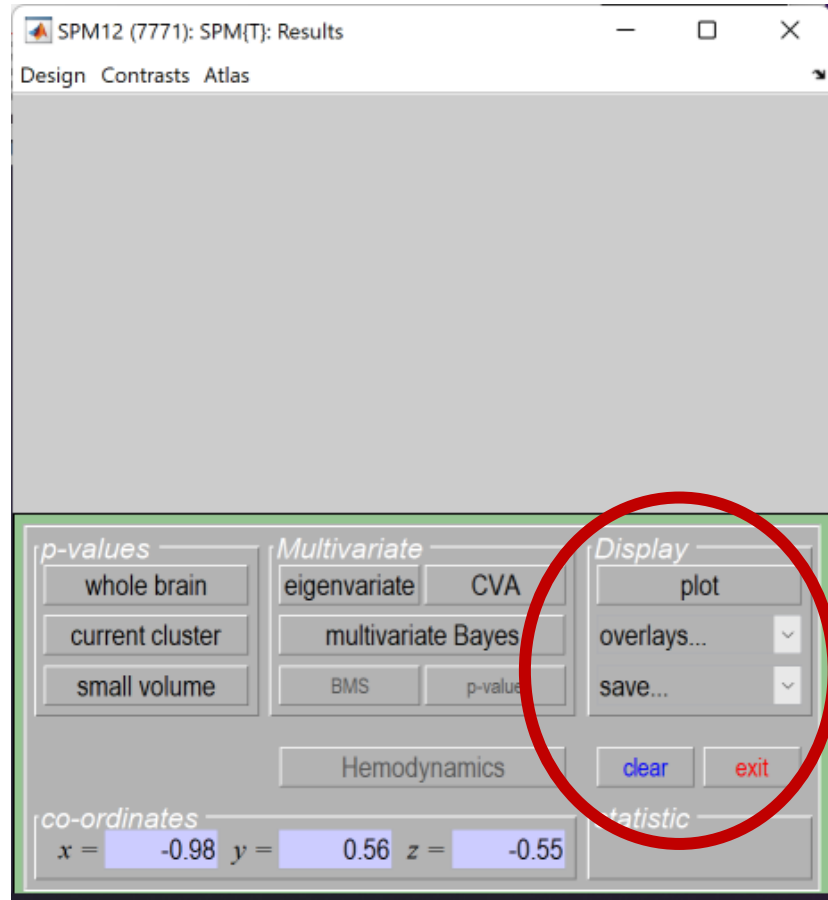
P value adjustment to control ... FWE

P value (FWE) ... 0.05

& extent threshold {voxels} ... 60



fMR Statistics Display



overlays...:

- Slices
- Sections (multiplanar)
- Montage (Axial / Coronal / Sagittal)

mean*.nii

plot:

Plot ... Fitted responses – adjusted

Plot against ... scan or time

