DIPF
Leibniz-Institut für Bildungsforschung und Bildungsinformation

IDeA
Individual Development and Adaptive Education

GOETHE UNIVERSITÄT FRANKFURT AM MAIN

Session 3: Inference
Hands-on exercises

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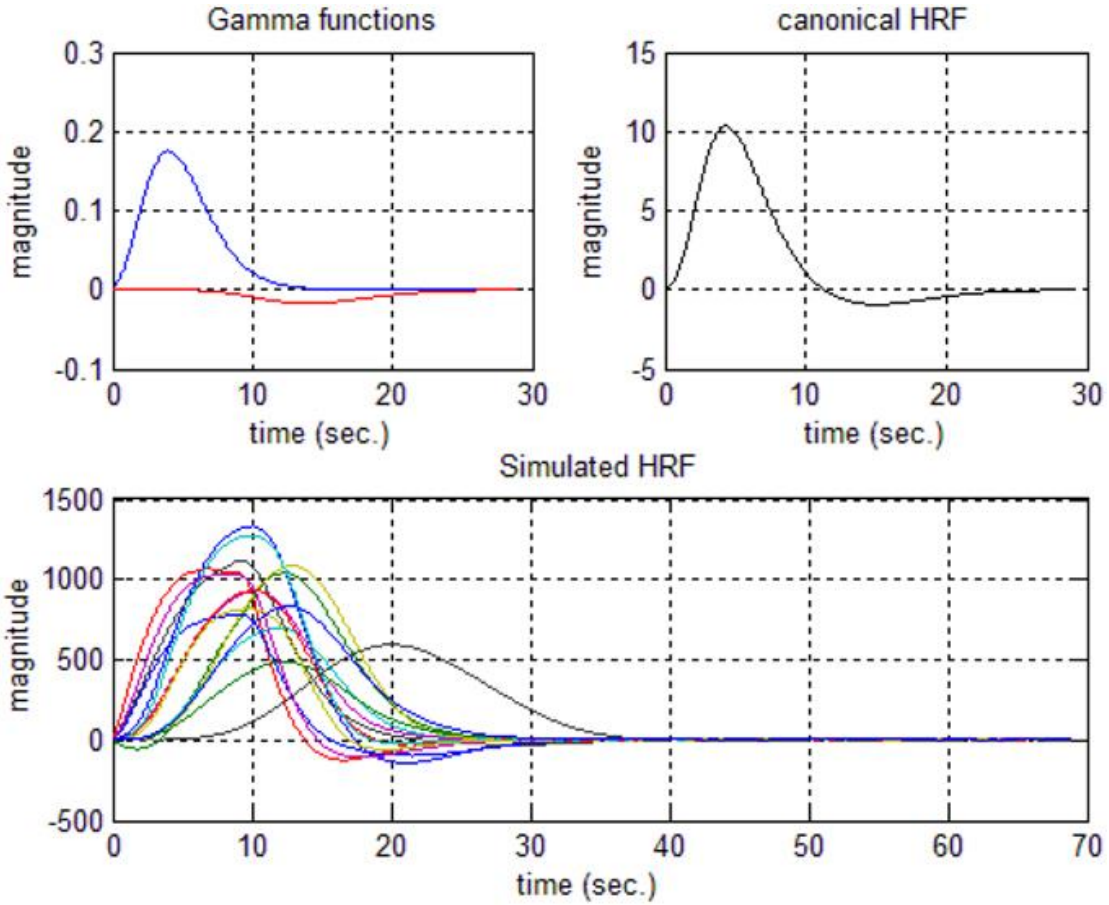
Recap: What is GLM in fMRI?

- Models voxel-wise BOLD time series as a weighted combination of predictors.
- Outputs beta weights per regressor
- To test conditions, we need contrasts

Why HRF convolution?

- Neural events are not seen directly in BOLD.
- The HRF models the delayed, smoothed hemodynamic response.
- Convolving event vectors with HRF models BOLD correctly.



Building the Design Matrix

Step-by-Step

- Extract event onsets from events.tsv (congruent, neutral, incongruent).
- Convert to binary event vectors.
- Convolve with canonical HRF.
- Add constant term for intercept (baseline).

Applying Contrasts

Define contrast vectors:

- Left > Rest: `[1 0 0]`
- Left > Right: `[1 -1 0]`

Compute:

$$t = \frac{c^T \hat{\beta}}{\sqrt{MSE \times c^T (X^T X)^{-1} c}}$$

Example t-map**

- Show `imagesc` of t-map for Left > Rest.
- Discuss expected activation (right motor cortex).

Basics of MRI and preprocessing.
Hands-on exercises.

Topic:

- Contrasts

Recap of the exercises from last week

Process-specific dataset:

This dataset contains brain activity during a Stroop task.

Neutral	Congruent	Incongruent
dog	red	red
chair	yellow	yellow
boat	green	green
window	blue	blue
block	red	red
fan	blue	blue
wheel	yellow	yellow
tray	green	green
bottle	blue	blue
fence	red	red

Figure from: https://www.simplypsychology.org/

> J Neurophysiol. 2014 Nov 15;112(10):2457-69. doi: 10.1152/jn.00221.2014. Epub 2014 Aug 20.

The organization and dynamics of corticostriatal pathways link the medial orbitofrontal cortex to future behavioral responses

Timothy D Verstynen [1]

Affiliations + expand

PMID: 25143543 DOI: 10.1152/jn.00221.2014

Free article

Contrast analysis

Up until now we have run the basic steps of most task-fMRI analysis (i.e., obtaining beta estimates).

fMRI analysis are very rarely run on raw activity signals and voxel-wise beta estimates are generally preferred as a finer measure of task-related brain activity.

Once we have obtained beta estimates, we need to decide which kind of analysis we want to carry out.

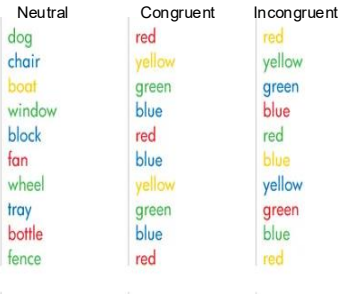


Figure from: https://www.simplypsychology.org/

Contrast analysis

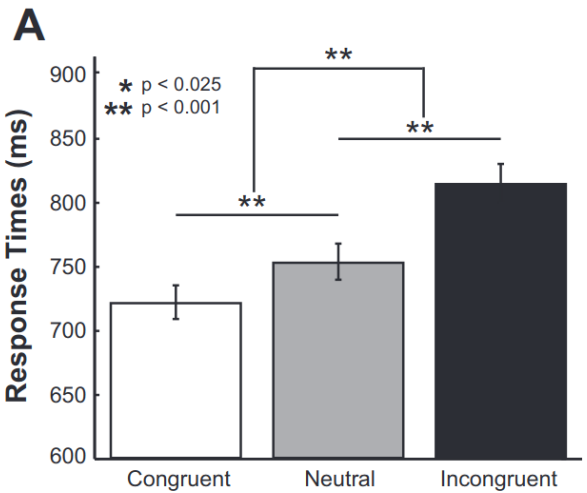
This dataset contains brain data from participants performing a Stroop task.

Neutral	Congruent	Incongruent
dog	red	red
chair	yellow	yellow
boat	green	green
window	blue	blue
block	red	red
fan	blue	blue
wheel	yellow	yellow
tray	green	green
bottle	blue	blue
fence	red	red

Task:
"Name the color of the ink".

Stimuli:
Visually presented words with the same font type and size but different colors. Some of the words refer colors.

Results:



In this case we will run a *mass-univariate* contrast analysis (suited for overall differences between experimental conditions).

Contrast analysis

QUESTION:
Which questions would it be possible with this dataset?

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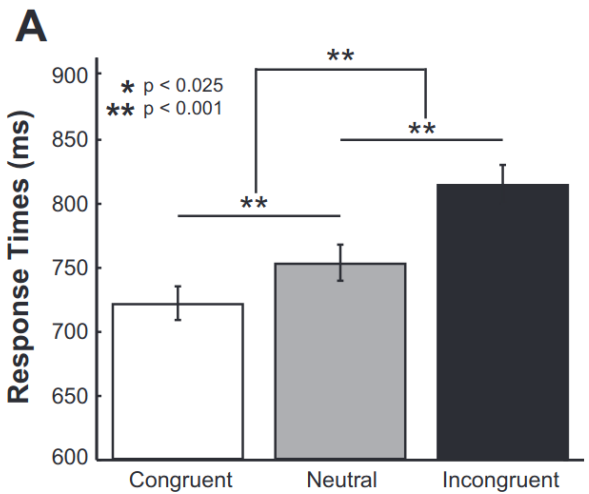

In this case we will run a *mass-univariate* contrast analysis (suited for overall differences between experimental conditions).

Contrast analysis

Here are a few examples:

Can we find brain regions that are **more active** for *congruent* than *neutral* trials?

Can we find brain regions that are **less active** for *congruent and neutral* than *incongruent* trials?

QUESTION:
Which questions would it be possible to answer with this dataset?

Task:
"Name the color of the ink".

dog	red	red
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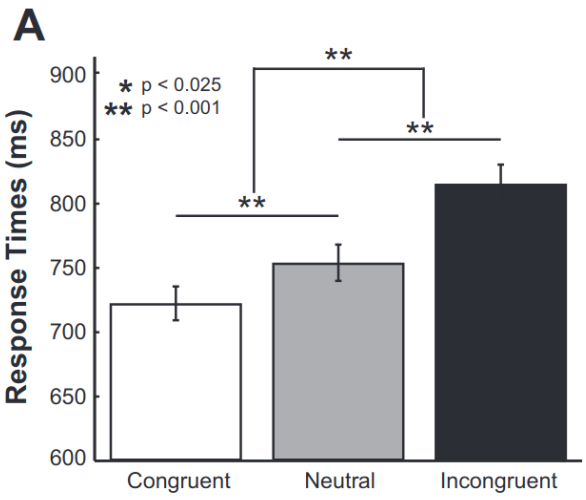
window	blue	blue



Contrast analysis

Here are a few examples:

Can we find brain regions that are **more active** for *congruent* than *neutral* trials?

Can we find brain regions that are **less active** for *congruent and neutral* than *incongruent* trials?

We always need a set of conditions and a **direction**.

We will specify these with contrast vectors.

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Which questions would it be possible to answer with this dataset?

Task:
"Name the color of the ink".

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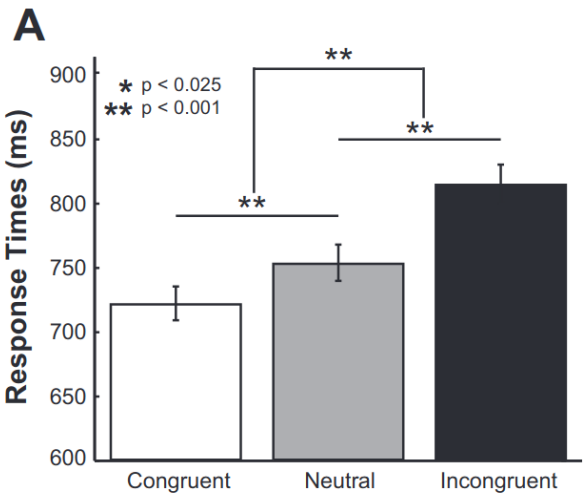


Contrast analysis

Here are a few examples:

Can we find brain regions that are **less active** for *incongruent* than *neutral* trials?

Can we find brain regions that are **less active** for *congruent and neutral* than *incongruent* trials?

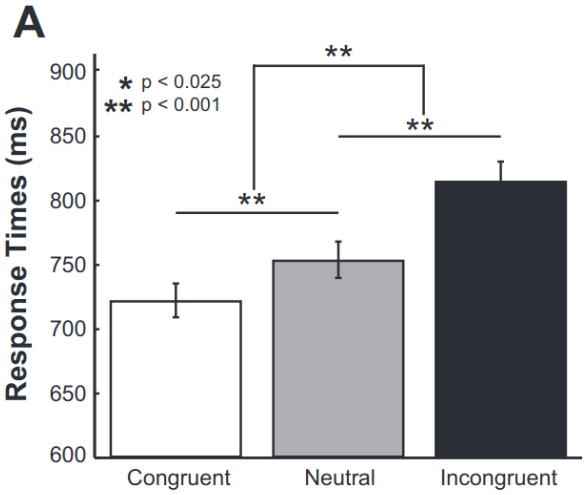
We always need a set of conditions and a **direction**.

We will specify these with contrast vectors.

Congruent	Incongruent	Neutral
0	-1	1
-1	2	-1

QUESTION:
Which questions would it be possible to answer with this dataset?

Task:
"Name the color of the ink".



Stroop GLM (Hands-on exercises 3)

Open Matlab and script 3

- stroop_events.tsv,
- sub-002_task-stroop_space-MNI152NLin2009cAsym_desc-brain_mask.nii

Answer questions on Worksheet