Basic FMRI analysis

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Plan of the talk

- imaging, analysis, reproducibility;
- what is an image?
- 3D and 4D images.
- the simplest possible analysis;
- correlation;
- convolution;
- regression and the GLM;
- correction for multiple comparisons.

To follow along

- https://www.anaconda.com/distribution
- https://github.com/matthew-brett/msc_imaging/archive/master.zip

Risks for error

Increased risk of false findings for:

1. small sample size (low power);
2. small effect size (low power);
3. large number of tests (analysis bias);
4. greater flexibility in analysis (analysis bias);
5. greater financial interests (analysis bias);
6. larger numbers of groups studying same effects (publication bias);

John P. A. Ioannidis (2005). "Why most published research findings are false." PLoS medicine 2 (8): e124. See also https://matthew-brett.github.com/teaching/ioannidis_2005.html.

Error in neuroimaging

> *I have occasionally asked respected colleagues what percent of published neuroimaging findings they think would replicate, and the answer is generally very depressing. My own guess is* ***way*** *less than 50%.*

Nancy Kanwisher (2013) commenting on Daniel Bor's blog post.

My straw poll

Let us say you took a random sample of papers using functional MRI over the last five years. For each study in the sample, you repeated the same experiment. What proportion of your repeat experiments would substantially replicate the main findings of the original paper?

Answers from people running neuroimaging labs vary from 5% to 50%.

How not to teach/publish/present

> *Computing results are now being presented in a very loose, "breezy" way—in journal articles, in conferences, and in books. All too often one simply takes computations at face value. This is spectacularly against the evidence of my own experience. I would much rather that at talks and in referee reports, the possibility of such error were seriously examined.*

David L. Donoho (2010). "An invitation to reproducible computational research" Biostatistics 11(3) p385-8

Opening the black box

"What I cannot create, I do not understand"

Found on Richard Feynman's blackboard after his death.

Images, arrays

See: https://github.com/matthew-brett/msc_imaging/blob/master/arrays_and_images.ipynb

3D images

See: https://github.com/matthew-brett/msc_imaging/blob/master/images_3d.ipynb

4D images

See: https://github.com/matthew-brett/msc_imaging/blob/master/images_4d.ipynb

The simplest possible analysis

See: https://github.com/matthew-brett/msc_imaging/blob/master/first_activation.ipynb

Correlation

See: https://github.com/matthew-brett/msc_imaging/blob/master/voxel_time_courses.ipynb

Convolution

- http://matthew-brett.github.io/teaching/on_convolution.html

Regression and the GLM;

- The General Linear Model
  http://matthew-brett.github.io/teaching/glm_intro.html

Correction for multiple comparisons.

- Bonferroni http://matthew-brett.github.io/teaching/bonferroni_correction.html;
- Random Fields http://matthew-brett.github.io/teaching/random_fields.html

The end

That's the end of the talk.