Neuropower: a toolbox for fMRI sample size and power calculations.

Joke Durnez[1], Jasper Degryse[2], Beatrijs Moerkerke[2], Jean-Baptiste Poline[3], Vanessa Sochat[1], Russell Poldrack[1], Thomas E. Nichols[4]

[1]Department of Psychology and Stanford Center for Reproducible Neuroscience, Stanford University, USA. [2]Department of Data Analysis, Ghent University, Belgium. [3]Helen Wills Neuroscience Institute, Brain Imaging Center, University of California Berkeley, USA [4]Department of Statistics and manufacturing group, University of Warwick, Coventry, UK.

Stanford University

Introduction

- There is increasing concern about statistical power in neuroscience research: an underpowered study has poor predictive power (Ioannidis, 2005).
  $\Rightarrow$ **A power analysis is a critical component of any study**
- We presented a simple way to characterize the spatial signal in a fMRI study, and a direct way to estimate power based on an existing pilot study in Durnez et al. (2016).
- **Neuropower** is a **web application** with the power estimation procedure.

Power estimation procedure

- We estimate π_1, proportion of peak p-values that are non-null, from peaks and their uncorrected p-values in a group level analysis.
- Assuming an exponential null distribution for peak values (Friston, 2007) and a truncated normal distribution (truncation at excursion threshold u) for the alternative distribution, the distribution of peak values can be written as a mixture:

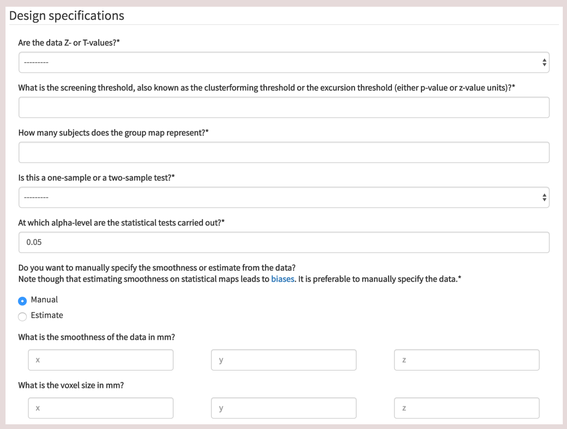
$$f(z^u|\pi_0,\mu_1,\sigma_1,u) = (1-\pi_1)\underbrace{u\exp(-u(z^u-u))}_{\text{null distribution}} + \pi_1 \underbrace{\frac{\frac{1}{\sigma_1}\varphi\left(\frac{z^u-\mu_1}{\sigma_1}\right)}{1-\Phi\left(\frac{u-\mu_1}{\sigma_1}\right)}}_{\text{alternative distribution}}$$

- μ_1 and σ_1 are estimated using maximum likelihood, where μ_1 is the expected peak height in activated regions. Power can be estimated for a given threshold t as $P(T>t|H_a)$ with T the T-statistic of the peak.
- Validation in Durnez et al. (2016): extensive validation for multiple effect heights, sizes, significance testing procedures on simulated and real data.
- Power interpretation: 'the average probability that a peak will surpass the significance threshold'

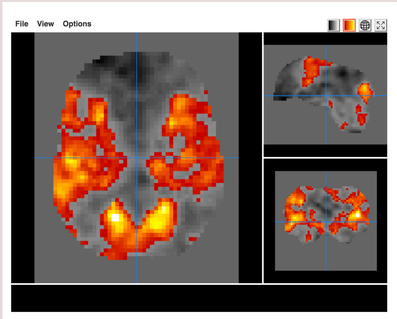
www.neuropowertools.org

1. Input

- **Pilot data**
  - Pilot data of new experiment
  - Data with comparable experimental design, for example from www.neurovault.org
  - Previous experiment
  - See **2220** about interim analysis.
- **Mask** (optional)
- **Design parameters**

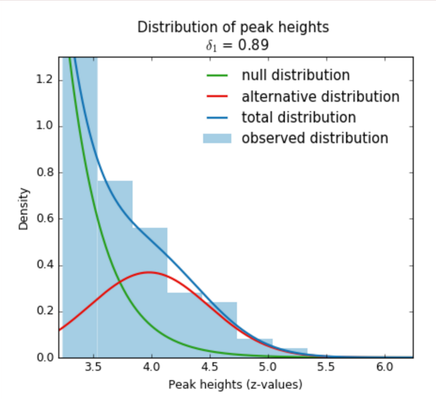


2. Viewer



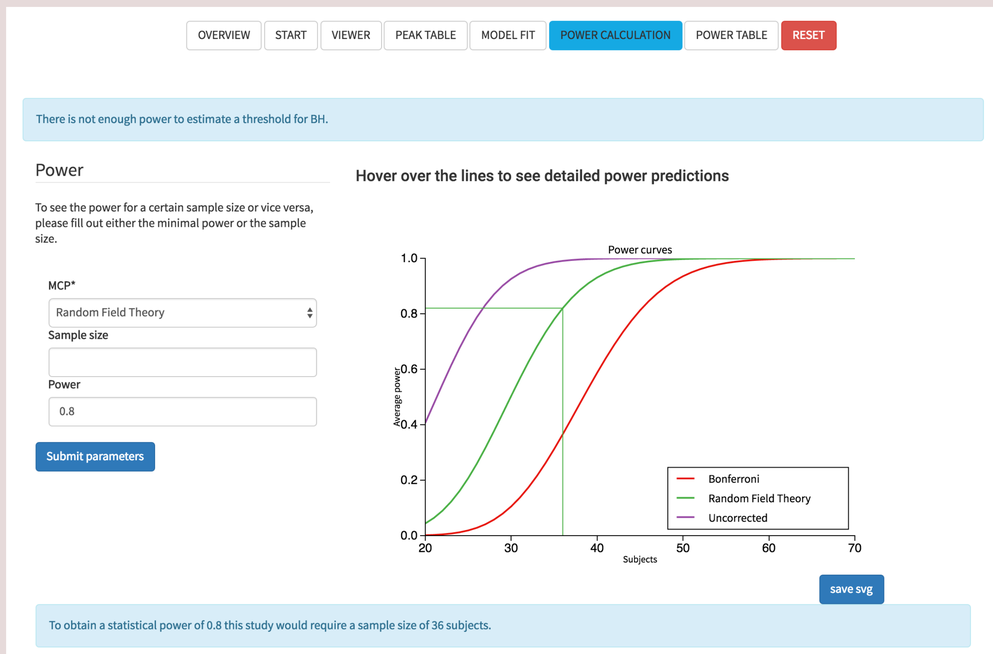
3. Peak extraction

4. Model estimation



5. Power predictions

- Interactive power predictions for different significance testing procedures.
- Example data: reading scrambled vs. letter strings (Moberget et al., 2015). Statistical map obtained from www.neurovault.org

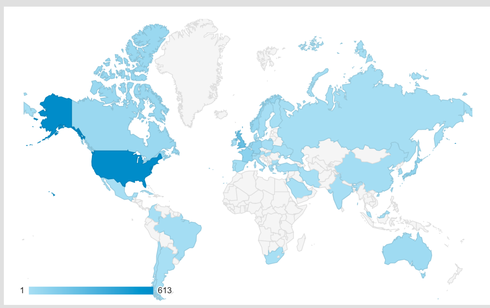


Extra's

- Integrated with **neurovault.org**
- pypi-package: neuropower
- Future plans:
  - Export report + code
  - Include interim analysis, see **2220**
  - Cluster based power

Stats on June 17, 2016

- released: April 18, 2016
- unique visitors: 1021
- power analyses: 67



References

Durnez, Degryse, Moerkerke, Seurinck, Sochat, Poldrack and Nichols (2016). Power and sample size calculations for fMRI studies based on the prevalence of active peaks. bioRxiv doi: 10.1101/049429.
Friston et al. (2007) Statistical Parametric Mapping. Elsevier, London Van Essen et al. (2012). NeuroImage, 62.
Moberget, Hilland, Andersson, Lundar, Due-Tonnessen, Heldal, Ivry, Endestad (2015). Patients with focal cerebellar lesions show reduced auditory cortex activation during silent reading. Advance online publication. doi:10.1016/j.bandl.2015.08.004

Department of Psychology and Center for Reproducible Neuroscience, Stanford University joke.durnez@gmail.com http://poldracklab.stanford.edu