Towards reproducible brain imaging research

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Abstract

Like many areas in scientific research, brain imaging is facing a "reproducibility crisis". This has prompted a shift in focus within the neuroimaging community towards more transparent and open research. In this panel session, we will first introduce current practices in brain imaging research and their limitations. Then, we will discuss reproducibility across neuroimaging tools. Finally, we will review recent efforts by the Committee on Best Practice in Data Analysis and Sharing (COBIDAS) to improve reporting practices.

This panel session is composed of three talks discussing neuroimaging reproducibility:

1. Introduction to reproducible neuroimaging research: current practices and limitations (Camille Maumet)
2. Investigating reproducibility across neuroimaging software pipelines (Alexander Bowring)
3. COBIDAS: improving reporting guidelines (Thomas Nichols)

Content of the introductory talk is presented in the *Introduction* section below. The second and third talks are presented in more detail in the *Methods* and *Results* sections.

Introduction

Reproducibility in scientific research covers a broad spectrum ranging from the capacity to which researchers can recompute the results of an experiment using identical conditions, to investigating how general experimental results are under varying settings (e.g. different population, methodology or tool). New research builds on existing literature which makes the ability for a researcher to reproduce their peers' results an essential aspect of their work.

Scientific papers are still regarded as the main output of research experiments. But, with increasing complexity of research data and methods, the textual description included in publications to describe the methods has become insufficient to reproduce published results. Ideally, all the data, tools and scripts used to obtain the results should be published along with the papers to provide a complete description of the experiment[1]. Unfortunately, while there is a growing number of tools and platforms for data and code sharing (e.g. OpenfMRI[2,3], NeuroVault[4,5], GitHub[6]), they are still not commonly used in the neuroimaging community[7].

In this panel, we will first provide an overview of current practices in neuroimaging research and their limitations with respect to reproducibility. We will then present the results of an experiment investigating cross-software variability. Finally we will discuss how transparency can be improved through reporting guidelines as proposed by the COBIDAS[8].

Methods

Investigating reproducibility across neuroimaging software pipelines

We selected three functional Magnetic Resonance Imaging (fMRI) studies from the publically accessible OpenfMRI data repository: ds000001 [9,10], ds000109 [11,12], ds000120 [13,14].

Each of these studies was based on a risk-taking task, social interaction task, and reward task respectively. The studies were chosen as they used relatively simple analysis pipelines, and each study had a supporting publication showing clear, well-defined regions of brain activation to which we could easily compare with our own results. Exclusion criteria included the use of custom software, activations defined using small volume correction, the absence of a related publication or only a data paper. We aimed to reproduce the main figure from each study, by separately reanalysing the data with the three main neuroimaging software packages SPM [15,16], FSL [17,18] and AFNI [19,20].

COBIDAS: improving reporting guidelines

The Committee on Best Practice in Data Analysis and Sharing (COBIDAS) was created by the Organisation of Human Brain Mapping [21] in 2014 and was composed of 15 experts in brain imaging research. The experts held a half-dozen teleconferences over 2 years to complete the report.

Results

Investigating reproducibility across neuroimaging software pipelines

Scripts used to reanalyse the three experiments in each of the three software packages are publically available at: https://github.com/AlexBowring/Software_Comparison/. Fig. 1 presents the results obtained for SPM and FSL on the main contrast ("pump_demean>ctrl_demean") for the ds000001 dataset. Strong similarities to the publication images can be seen in the images we obtained for the reproductions using both neuroimaging software packages.

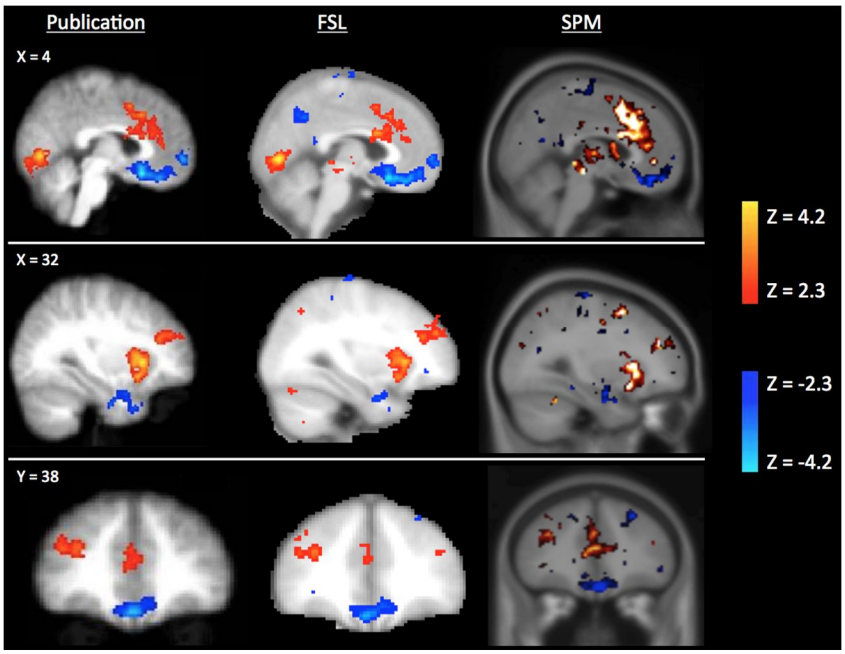

Fig. 1. Significant activations (red) and deactivations (blue) for the contrast "pump_demean>ctrl_demean" of ds000001 obtained in the original publication, FSL and SPM. The publication image was reproduced from [10]

COBIDAS: improving reporting guidelines

COBIDAS developed a set of best practices for reporting of a Magnetic Resonance Imaging (MRI) study, organised in seven sections: "Experimental design", "Acquisition", "Preprocessing", "Statistical Modeling & Inference", "Results", "Data sharing" and "Reproducibility". The document was discussed [22] and approved by the OHBM community and is now publically available online [8].

Discussion & Conclusion

Reproducibility is gaining greater attention in the neuroimaging community and a number of tools, standards and platforms are now available to make data sharing as effortless as possible for neuroimaging researchers.

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