SPM8 for Basic and Clinical Investigators

Reporting an fMRI Study

Reporting an fMRI Study

- Experimental design
  - Design specification
  - Task specification
  - Planned comparisons
- Human subjects
  - Details on subject sample
  - Ethics approval
  - Behavioral performance

Reporting an fMRI Study

- Data acquisition
  - Image properties as acquired
- Data preprocessing
  - Pre-processing: general
  - Intersubject registration
  - Smoothing

Reporting an fMRI Study

- Statistical modeling
  - General issues
  - Intrasubject fMRI modeling info
  - Group modeling info

Statistical inference

Inference on statistic image (thresholding)

Design specification

All designs

- Number of blocks, trials or experimental units per session and/or subject
- Length of each trial and interval between trials
- If variable interval, report the mean and range of ISIs and how they were distributed

Blocked designs

- Length of blocks

Event-related designs

- Was the design optimized for efficiency, and if so, how?

Mixed designs

- Report correlation between block and event regressors

Task specification

Instructions

What were subjects asked to do?

Stimuli

What were the stimuli and how many were there?

Did specific stimuli repeat across trials?

Planned comparisons

If the experiment has multiple conditions, what are the specific planned comparisons, or is an omnibus ANOVA used?

HUMAN SUBJECTS

Details on subject sample

Number of subjects

Age (mean and range)

Handedness

Number of males/female

Additional inclusion/exclusion criteria, if any (including specific sampling strategies that limit inclusion to a specific group, such as laboratory members)

If any subjects were scanned but then rejected from analysis after data collection, state how many and reasons for rejection

For group comparisons, what variables (if any) were equated across groups?

Ethics approval

State which IRB approved the protocol

Behavioral performance

How was behavioral performance measured (e.g., response time, accuracy)?

Image properties as acquired

MRI system:

Manufacturer, field strength (in Tesla), model name

MRI acquisition:

Number of experimental sessions and volumes acquired per session

Pulse sequence type (gradient/spin echo, EPI/spiral)

If used, parallel imaging parameters (e.g., method [SENSE/GRAPPA] and acceleration factor)

Field of view, matrix size, slice thickness, interslice skip

Acquisition orientation (axial, sagittal, coronal, oblique; if axials co-planar with AC\u2013PC, the volume coverage in terms of Z in mm)

Whole brain? if not, state area of acquisition (preferably with a figure)

Order of acquisition of slices (sequential or interleaved)

TE/TR/flip angle

Data preprocessing

For each piece of software used, give the version number (or, if no version number is available, date of last application of updates)

If any subjects required different processing operations or settings in the analysis, those differences should be specified explicitly

Pre-processing: general

Specify order of preprocessing operations

Describe any data quality control measures

Unwarping of B0 distortions

Slice timing correction

Reference slice and type of interpolation used (e.g., \u201cSlice timing correction to the first slice as performed, using SPM5's Fourier phase shift interpolation\u201d)

Motion correction

Reference scan, image similarity metric, type of interpolation used, degrees-of-freedom (if not rigid body) and, ideally, optimization method,

Motion susceptibility correction used

Intersubject registration

Intersubject registration method used

Illustration of the voxels present in all subjects can be helpful, particularly for restricted fields of view (to illustrate overlap of slices across all subjects). Better still would be an indication of average BOLD sensitivity within each voxel in the mask

Transformation model and optimization

Transformation model (linear/affine, nonlinear), type of any non-linear transformations (polynomial, discrete cosine basis), number of parameters (e.g., 12 parameter affine, 3 × 2 × 3 DCT basis), regularization, image-similarity metric, and interpolation method

Object image information (image used to determine transformation to atlas)
Anatomical MRI? Image properties (see above)
Co-planar with functional acquisition?
Functional acquisition co-registered to anatomical? if so, how?
Segmented gray image?
Functional image (single or mean)
Atlas/target information
Brain image template space, name, modality and resolution

Coordinate space

Typically MNI, Talairach, or MNI converted to Talairach

If MNI converted to Talairach, what method? e.g., Brett's mni2tal?

How were anatomical locations (e.g., gyral anatomy, Brodmann areas) determined? (e.g., paper atlas, Talairach Daemon, manual inspection of individuals' anatomy, etc.)

Smoothing

Size and type of smoothing kernel (provide justification for size; e.g., for a group study, \u201c12 mm FHWM Gaussian smoothing applied to ameliorate differences in intersubject localization\u201d; for single subject fMRI \u201c6 mm FWHM Gaussian smoothing used to reduce noise\u201d)

STATISTICAL MODELING

General issues

For novel methods that are not described in detail in a separate paper, provide explicit description and validation of method either in the text or as an appendix

Intrasubject fMRI modeling info

Statistical model and estimation method

Multiple regression is most common statistical model

Estimation methods are typically ordinary least squares (OLS), OLS with adjustment for autocorrelation (i.e., variance correction and use of effective degrees-of-freedom), or generalized least squares (i.e., OLS after whitening)

Block/epoch-based or event-related model
Hemodynamic response function (HRF)
Assumed HRF model (e.g., SPM's canonical difference of gammas HRF; FSL's canonical gamma HRF), HRF basis (list basis set) or estimated HRF (supply methods for estimating HRF)?
Additional regressors used (e.g., temporal derivatives, motion, behavioral covariates)
Any orthogonalization of regressors
Drift modeling/high-pass filtering
Autocorrelation model type

Contrast construction

Exactly what terms are subtracted from what? Define these in terms of task or stimulus conditions (e.g., using abstract names such as AUDSTIM, VISSTIM) instead of underlying psychological concepts

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Any orthogonalization of regressors
Drift modeling/high-pass filtering (e.g., \u201cDCT with cut off of X seconds\u201d; \u201cGaussian-weighted running line smoother, cut-off 100 seconds\u201d, or \u201ccubic polynomial\u201d)
Autocorrelation model type (e.g., AR(1), AR(1) + WN, or arbitrary autocorrelation function), and whether global

Autocorrelation model type (e.g., AR(1), AR(1) + WN, or arbitrary autocorrelation function), and whether global or local.

(e.g., for SPM2/SPM5, \u2018Approximate AR(1) autocorrelation model estimated at omnibus F-significant voxels (P < 0.001), used globally over the whole brain\u2019; for FSL, \u2018Autocorrelation function estimated locally at each voxel, tapered and regularized in space.\u2019).

Contrast construction

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Group modeling information

Statistical model and estimation method, inference type (mixed/random effects or fixed)

If fixed effects inference used, justify

If more than 2-levels, describe the levels and assumptions of the model (e.g., are variances assumed equal between groups)

Repeated measures?

If multiple measurements per subject, list method to account for within subject correlation, exact assumptions made about correlation/variance

Inference on statistic image (thresholding)

Type of search region for analysis, and the volume in voxels or CC

If not whole brain, state how region was determined; method for constructing region should be independent of present statistic image

If threshold used for inference and threshold used for visualization in figures is different, clearly state so and list each

Explicitly state if inferences are corrected for multiple comparisons, and if so, what method and over what region

If correction is limited to a small volume, the method for selecting the region should be stated explicitly

If no formal multiple comparisons method is used, the inference must be explicitly labeled \u201cuncorrected \u201d

Voxel-wise significance? Corrected for Family-wise error (FWE) or false discovery rate (FDR)?

If FWE found by random field theory list the smoothness in mm FWHM and the RESEL count

If FWE found by simulation (e.g., AFNI AlphaSim), provide details of parameters for simulation

If not a standard method, specify the method for finding significance

Cluster-wise significance

State cluster-defining threshold (e.g., P = 0.001)
State the corrected cluster significance level
If significance determined with random field theory, then smoothness and RESEL count must be supplied

Correction for multiple planned comparisons within each voxel?
False negative discussion
Any discussion of failure to reject the null hypothesis (e.g., lack of activation in a particular region) should be accompanied by SNR or effect size of the actually observed effect (allows reader to infer power to estimate an effect)

Figures and tables

What statistical map is the figure/table based upon (e.g., Z, t, p)?

Thresholds used to create the image or figure (intensity and cluster extent, where appropriate)

Figures

- What is the underlying anatomical image (e.g., average anatomy, template image)?
- Any additional operations (e.g., masking out parts of the image)?

Tables

- Locations in stereotactic space (with the space described specifically)
- Statistics for each cluster (including maximum and cluster extent)