Preregistration

My fMRI preregistration

First Author[1], Ernst-August Doelle[1,2]

[1] Wilhelm-Wundt-University

[2] Konstanz Business School

02. February 2021

Working Title Enter your response here.

Introduction Enter your response here.

Current Study Enter your response here.

Aims & Hypotheses

Essential	**Checklist**
Hypotheses include direction of expected results	____
Interactions describe expected shape	____ or NA
Maniputated variables include manipulation checks or explain why not	____ or NA

Recommended	Checklist
Figure or table to describe expected results	_____
Rationals or frameworks included for why certain hypotheses are being tested	_____
Which outcome would be predicted by which theory	_____ or NA

Exisiting Data

- Registration prior to creation of data
- Registration prior to any human observation of the data
- Registration prior to accessing the data
- Registration prior to analysis of the data
- Registration following analysis of the data

Explanation of Exisiting Data

Enter your response here.

Details of Larger Study

Is your preregistration part of a larger project?

- Yes
- No

Enter your response here.

Data Collection Procedures

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

Enter your response here.

Study timeline

Enter your response here.

Collection	Checklist
Population	_____
Recruitment efforts	_____
Inclusion/Exclusion criteria	_____
Clinical criteria (if applicable)	_____
Matching strategy (if applicable)	_____
Payment for participation	_____
IRB, consent/assent obtained	_____
Number of subjects participated and analyzed	_____
Age	_____
Sex	_____
Handedness	_____

Sample Size & Stopping Rule

Target sample size

Enter your response here.

Justification of sample size

Enter your response here.

Power analyses (e.g., Neuropowertools, fmri power)

From Nichols et al., 2016, include:

Effect Size Estimate	Checklist
Effect size used	_____ or NA*
Source of predicted effect size (prior lit, pilot etc.)	_____ or NA*
Significant level	_____ or NA*
Target power	_____ or NA*
Outcome used to calculate	_____ or NA*

Stopping rule

Enter your response here.

Contingencies for if your target sample size is not met

Enter your response here.

Measured Behavioral Variables

Outcome measures

Enter your response here.

Predictor measures

Enter your response here.

Covariate measures

Enter your response here.

How was behavioral task performance measured?

Enter your response here.

Contingency plans for behavioral analysis

Enter your response here.

Additional Operational Definitions

Region Specificity

Enter your response here.

Any other definitions used across study:

Enter your response here.

Transformations

Enter your response here.

Contingency plans for transformation

Enter your response here.

Code, if applicable: for scoring behavioral data.

Analysis Data Exclusion

Enter your response here.

Experimental Design

Enter your response here.

Design Specifications

Design	Checklist
Design type (task, rest; event-related, block)	_____
Conditions & Stimuli (detailed as possible, pictures encouraged)	_____
Number of blocks, trials or experimental units per session and/or subject	_____
Timing and Duration (length of each trial and interval between trials)	_____
Length of experiment (length of full scan and each run)	_____
Was the design optimized for efficiency, and if so, how?	_____
Presentation software (name, version, operating system; code if possible)	_____

Task Specification

Task	Checklist
Instructions to subjects (what were they asked to do?)	_____
Stimuli (what were they; how many were there; did it repeat across trials?)	_____
Stimuli presentation & response collection	_____
Randomization/pseudo-randomized (why/why not done & how)	_____
Run order (of tasks within scanner)	_____

Data acquisition

Set up & Acquisitions

Set up & Acquisitions	Checklist
Participant Preparation	
Mock scanning (Report type of mock scanner and protocol; i.e. duration, types of sim scans, exper)	_____ or NA

Set up & Acquisitions	**Checklist**
Specific accommodations (e.g., pediatric, parent present? Asleep?)	_____ or NA
Experimental personnel (number of planned personnel to interact with subjects)	_____ or NA
MRI System	
Manufacturer, field strength (in Tesla), model name	_____
MRI acquisition	
Pulse sequence (gradient/spin echo etc.)	_____
Image type (EPI, spiral, 3D etc.)	_____
Essential sequence & imaging parameters	
For All	
Echo time (TE)	_____
Repetition time (TR)	_____
For multi-shot acquisitions, additionally the time per volume	_____ or NA
Flip angle (FA)	_____
Acquisition time (duration of acquisition)	_____
Functional MRI	
Number of volumes	_____
Inversion Recovery Sequences	
Sparse sampling delay (delay in TR) if used	_____ or NA
B0 Field Maps	
Inversion time (TI) for inversion recovery sequence	_____ or NA
Echo time difference (dTE). Diffusion MRI	_____ or NA
Number of directions	_____ or NA
Direction optimization, if used and type	_____ or NA
b-values	_____ or NA
Number of b=0 images	_____ or NA
Number of averages (if any)	_____ or NA
Single shell, multi-shell (specify equal or unequal spacing)	_____ or NA
Single- or dual-spin-echo, gradient mode (serial or parallel)	_____ or NA
If cardiac gating used	_____ or NA
Imaging Parameters	

Set up & Acquisitions	**Checklist**
Field of view	_____ or NA
In-plane matrix size, slice thickness and interslice gap, for 2D acquisitions	_____ or NA
Slice orientation (Axial, sagittal, coronal or oblique)	_____ or NA
Angulation: If acquistion not aligned with scanner axes, specified	_____ or NA
angulation to AC-PC line (see Slice position procedure)	_____ or NA
3D matrix size, for 3D acquisitions	_____ or NA
Additional sequence & imaging parameters	
Phase encoding	_____ or NA
Parallel imaging method & parameters	_____ or NA
Multiband parameters	_____ or NA
Readout parameters	_____ or NA
Fat suppression (for anatomical, state if used)	_____ or NA
Shimming	_____ or NA
Slice order & timing	_____ or NA
Brain coverage (e.g., whole brain, was cerebellum, brain stem included)	_____ or NA
Scanner-side preprocessing*	_____ or NA
Scan duration (in seconds)	_____ or NA
Other non-standard procedures	_____ or NA
T1 stabilization (discarded "dummy" scans acquired discarded by scanner)	_____ or NA
Diffusion MRI gradient table (Also referred to as the b-matrix, but not to be confused with the 3x3 matrix that describes diffusion weighting for a single diffusion weighted measurement) scanner-side preprocessing: (e.g., Including: Reconstruction matrix size differing from acquisition matrix size; Prospective-motion correction (including details of any optical tracking, and how motion parameters are used); Signal inhomogeneity correction; Distortion-correction.)	_____ or NA

Perfusion: Arterial Spin Labelling MRI	**Checklist**
ASL Labelling method (e.g. continuous ASL (CASL), pseudo-continuous ASL (PCASL), Pulsed ALS (PASL), velocity selective ASL (VSASL)	_____ or NA
Use of background suppression pulses and their timing	_____ or NA
label duration	_____ or NA if not PCASL or CASL
Label Duration	_____ or NA if not PCASL or CASL
Post labeling delay (PLD)	_____ or NA if not PCASL or CASL
Location of the labeling plane	_____ or NA
Average labeling gradient	_____ or NA if not PCASL
Slice-selective labeling gradient	_____ or NA if not PCASL
Flip angle of B1 pulses	_____ or NA if not PCASL
Assessment of inversion efficiency	_____ or NA if not PCASL
QC used to ensure off-resonance artifacts not problematic	_____ or NA if not PCASL
signal obtained over whole brain	_____ or NA if not PCASL
Use of a separate labeling coil	_____ or NA if not CASL
Control scan/pulse used	_____ or NA if not CASL
B1 amplitude	_____ or NA if not CASL
TI	_____ or NA if not PASL
Labeling slab thickness	_____ or NA if not PASL
Use of QUIPSS pulses and their timing	_____ or NA if not PASL
TI	_____ or NA if not VSASL

Perfusion: Arterial Spin Labelling MRI	**Checklist**
Choice of velocity selection cutoff ("VENC")	_____ or NA if not VSASL
Perfusion: Dynamic Susceptibility Contrast MRI	
Number of baseline volumes	_____ or NA if not Perfusion: Dynamic Susceptibility Contrast MRI
Type, name and manufacturer of intravenous bolus (e.g. gadobutrol, Gadavist, Bayer)	_____ or NA if not Perfusion: Dynamic Susceptibility Contrast MRI
Bolus amount and concentration (e.g. 0.1 ml/kg and 0.1 mmol/kg). - Injection rate (e.g. 5 ml/s)	_____ or NA if not Perfusion: Dynamic Susceptibility Contrast MRI
Post-injection of saline (e.g. 20 ml)	_____ or NA if not Perfusion: Dynamic Susceptibility Contrast MRI
Injection method (e.g. power injector)	_____ or NA if not Perfusion: Dynamic Susceptibility Contrast MRI

Preprocessing **Preliminary quality control**

Preliminary quality control	**Checklist**
Motion monitoring (For functional or diffusion acquisitions, any visual or quantitative checks for severe motion; likewise, for structural images, checks on motion or general image quality.)	_____

Preliminary quality control	**Checklist**
Incidental findings (Protocol for review of any incidental findings, and how they are handled in particular with respect to possible exclusion of a subject's data.)	_____

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	**Checklist**
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., "Slice timing correction to the first slice as performed, using SPM5's	Fourier phase shift interpolation")
Motion correction	_____
Reference scan, image similarity metric, type of interpolation used, degrees-of-freedom (if not rigid body) and, ideally, optimization method, e.g., "Head motion corrected with FSL's MCFLIRT by maximizing the correlation ratio between each timepoint and the middle volume, using linear interpolation."	_____
Motion susceptibility correction used	_____
Smoothing	_____
Size and type of smoothing kernel (provide justification for size; e.g., for a group study, "12 mm FHWM Gaussian smoothing applied to ameliorate differences in intersubject localization"; for single subject fMRI "6 mm FWHM Gaussian smoothing used	to reduce noise")

Intersubject registration	**Checklist**
Intersubject registration method used	_____
Illustration of the voxels present in all subjects ("mask image") 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 x 2 x 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 (e.g., "FSL's MNI Avg152, T1 2 x 2 x 2 mm"; "SPM2's MNI gray matter template 2 x 2 x 2 mm")	_____
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	_____

Intersubject registration	Checklist
Size and type of smoothing kernel (provide justification for size; e.g., for a group study, “12 mm FHWM Gaussian smoothing applied to ameliorate differences in intersubject localization”; for single subject fMRI "6 mm FWHM Gaussian smoothing used	to reduce noise")

Statistical modeling

Planned comparison

Enter your response here.

General issues

Enter your response here.

First level (fx) modeling

First level (fx) modeling	Checklist
Event related design predictors	
Modeled duration, if other than zero	_____
Parametric modulation	_____
Block Design predictors(Note whether baseline was explicitly modeled)	_____
HRF basis, typically one of:	
Canonical only	_____
Canonical plus temporal derivative	_____
Canonical plus temporal and dispersion derivative. Smooth basis (e.g. SPM “informed” or Fourier basis; FSL’s FLOBS)	_____
Finite Impulse Response model	_____
Drift regressors (e.g. DCT basis in SPM, with specified cut-off)	_____
Movement regressors; specify if squares and/or temporal derivative used	_____
Any other nuisance regressors, and whether they were entered as interactions (e.g. with a task effect in 1st level fMRI, or with group effect)	_____

First level (fx) modeling	**Checklist**
Any orthogonalization of regressors, and set of other regressors used to orthogonalize against	_____
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	_____
Autocorrelation model type (e.g., AR(1), AR(1) + WN, or arbitrary autocorrelation function), and whether global or local (e.g., for SPM2/SPM5, 'Approximate AR(1) autocorrelation model estimated at omnibus F-significant voxels ($P < 0.001$), used globally over the whole brain'; for FSL, 'Autocorrelation function estimated locally at each voxel, tapered and regularized in space.')	_____

Second level (group) modeling

Second level (group) modeling	**Checklist**
Statistical model and estimation method, inference type (mixed/random effects or fixed), e.g., "Mixed effects inference with one sample t-test on summary statistic" (SPM2/SPM5), e.g., "Mixed effects inference with Bayesian 2-level model with fast approximation to posterior probability of activation." (FSL)	
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?	

Second level (group) modeling	**Checklist**
If multiple measurements per subject, list method to account for within subject correlation, exact assumptions made about correlation/variance e.g., SPM: "Within-subject correlation estimated at F-significant voxels (P <0.001), then used globally over whole brain"; or, if variances for each measure are allowed to vary, "Within-subject correlation and relative variance estimated. . . "	_____
For group model with repeated measures, specify:	
How condition effects are modeled (e.g. as factors, or as linear trends)	_____
Whether subject effects are modeled (i.e. as regressors, as opposed to with a covariance structure)	_____
For group effects: clearly state whether or not covariates are split by group (i.e. fit as a group-by-covariate interaction)	
Model type (Some suggested terms include:	
"Mass Univariate"	_____
"Multivariate" (e.g. ICA on whole brain data)	_____
"Mass Multivariate" (e.g. MANOVA on diffusion or morphometry tensor data)	_____
"Local Multivariate" (e.g. "searchlight")	_____
"Multivariate, intra-subject predictive" (e.g. classify individual trials in event-related fMRI)	_____
"Multivariate inter-subject predictive" (e.g. classify subjects as patient vs. control)	_____
"Representational Similarity Analysis")	_____
Model settings (The essential details of the model For mass univariate, first level fMRI, these include:	
Drift model, if not already specified as a dependent variable (e.g. locally linear detrending of data & regressors, as in FSL)	_____

Second level (group) modeling	**Checklist**
Autocorrelation model (e.g. global approximate AR(1) in SPM; locally regularized autocorrelation function in FSL)	_____
For mass univariate second level fMRI these include:	
Fixed effects (all subjects' data in one model)	_____
Random or mixed-effects model, implemented with:	
Ordinary least squares (OLS, aka unweighted summary statistics approach; SPM default, FSL FEAT's "Simple OLS")	_____
weighted least squares (i.e. FSL FEAT's "FLAME 1"), using voxel-wise estimate of between subject variance	_____
Global weighted least squares (i.e. SPM's MFX)	_____
With any group (multi-subject) model, indicate any specific variance structure, e.g.	
Un-equal variance between groups (and if globally pooled, as in SPM)	_____
If repeated measures, the specific covariance structure assumed (e.g.	
compound symmetric, or arbitrary; if globally pooled)	_____
For local-multivariate report:	
The number of voxels in the local model	_____
Local model used (e.g. Canonical Correlation Analysis) with any	
constraints (e.g. positive weights only)	_____

ROI analysis

ROI analysis	**Checklist**
How were ROIs defined (e.g., functional, anatomical, parcel localizer)?	_____
How was signal extracted within ROI? (e.g., average parameter estimates, FIR deconvolution?)	_____
If percent signal change reported, how was scaling factor determined (e.g., height of block regressor or height of isolated event regressor)?	_____

ROI analysis	**Checklist**
Is change relative to voxel-mean, or whole-brain mean?	_____
Justify definition of ROI and analysis conducted with it: (e.g., if your ROI is defined based on the cluster; how will you ensure your ROI analyses are not circular?)	_____

Enter your response here.

Statistical inference

Statistical inference

Statistical inference	**Checklist**
Search region (Type of search region for analysis, and the volume in voxels or CC)	_____ or NA
If not whole brain, state how region was determined; method for constructing region should be independent of present statistic image	_____ or NA
Whole brain or "small volume"; carefully describe any small volume correction used for each contrast	_____ or NA
If a small-volume correction mask is defined anatomically, provide named anatomical regions from a publicly available ROI atlas	_____ or NA
If small-volume correction mask is functionally defined, clearly describe the functional task and identify any risk of circularity	_____ or NA
All small-volume corrections should be fully described in the methods section, not just mentioned in passing in the results	_____ or NA
Statistical type (Typically one of:	
Voxel-wise (aka peak-wise in SPM)	_____ or NA
Cluster-wise	_____ or NA
Cluster size	_____ or NA
Cluster mass	_____ or NA
Threshold-free Cluster Enhancement (TFCE)	_____ or NA
For cluster size or mass, report:	
Cluster-forming threshold	_____ or NA

Statistical inference	**Checklist**
For all cluster-wise methods, report:	
Neighborhood size used to form clusters (e.g. 6, 18 or 26)	_____ or NA
For TFCE, report:	
Use of non-default TFCE parameters.)	_____ or NA
P value computation (Report if anything but standard parametric inference used to obtain (uncorrected) P-values. If nonparametric method was used, report method (e.g. permutation or bootstrap) and number of permutations/samples used.)	
Multiple test correction (For mass-univariate, specify the type of correction and how it is obtained, especially if not the typical usage.)	_____ or NA
Usually one of:	
Familywise Error	
Random Field Theory (typical)	_____ or NA
Permutation	_____ or NA
Monte Carlo	_____ or NA
Bonferroni	_____ or NA
False Discovery Rate	
Benjamini & Hochberg FDR (typical)	_____ or NA
Positive FDR	_____ or NA
Local FDR	_____ or NA
Cluster-level FDR	_____ or NA
None/Uncorrected	_____ or NA
If permutation or Monte Carlo, report the number of permutations/samples. If Monte Carlo, note the brain mask and smoothness used, and how smoothness was estimated	_____ or NA
If correction is limited to a small volume, the method for selecting the region should be stated explicitly	_____ or NA
If no formal multiple comparisons method is used, the inference must be explicitly labeled “uncorrected.”	_____ or NA

Statistical inference	**Checklist**
If FWE found by random field theory list the smoothness in mm FWHM and the RESEL count	_____ or NA
If FWE found by simulation (e.g., AFNI AlphaSim), provide details of parameters for simulation	_____ or NA
If not a standard method, specify the method for finding significance (e.g., "Custom in-lab software was used to construct statistic maps and thresholded at FDR< 0.05 (Benjamini and Hochberg, 1995)"	_____ or NA
If cluster-wise significance, state cluster-defining threshold (e.g., P = 0.001)	_____ or NA
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)	_____ or NA

Functional Connectivity

Functional Connectivity	**Checklist**
Confound adjustment & filtering Report:	
Method for detecting movement artifacts, movement-related variation, and remediation (e.g. 'scrubbing', 'despiking', etc)	_____ or NA
Use of global signal regression, exact type of global signal used and how it was computed	_____ or NA
Whether a high or lowpass temporal filtering is applied to data, and at which point in the analysis pipeline. Note, any temporal regression model using filtered data should have its regressors likewise filtered	_____ or NA
Multivariate method: Independent Component Analysis	
Report:	
Algorithm to estimate components	_____ or NA

Functional Connectivity	**Checklist**
Number of components (if fixed), or algorithm for estimating number of components	_____ or NA
If used, method to synthesize multiple runs	_____ or NA
Sorting method of IC's, if any	_____ or NA
Detailed description of how components were chosen for further analysis	_____ or NA
Dependent variable definition	
For seed–based analyses report:	
Definition of the seed region(s)	_____ or NA
Rationale for choosing these regions	_____ or NA
For region–based analyses report:	
Number of ROIs	_____ or NA
How the ROI's are defined (e.g. citable anatomical atlas; auxiliary fMRI experiments); note if ROIs overlap	_____ or NA
Assignment of signals to regions (i.e. how a time series is obtained from each region, e.g. averaging or first singular vector)	_____ or NA
Note if considering only bilateral (L+R) merged regions	_____ or NA
Note if considering only interhemispheric homotopic connectivity	_____ or NA
Functional connectivity measure/model Report:	
Measure of dependence used, e.g. Pearson's (full) correlation, partial correlation, mutual information, etc; also specify:	
Use of Fisher's Z-transform (Yes/No) and, if standardised, effective N is used to compute standard error (to account for any filtering operations on the data)	_____ or NA
Estimator used for partial correlation	_____ or NA
Estimator used for mutual information	_____ or NA
Regression model used to remove confounding effects (Pearson or partial correlation)	_____ or NA

Functional Connectivity	**Checklist**
Effectivity connectivity Report:	
Model	_____ or NA
Algorithm used to fit model	_____ or NA
If per subject model, method used to generalize inferences to population. Itemize models considered, and method used for model comparison	_____ or NA
Graph analysis	
Report the 'dependent variable' and 'functional connectivity measure' used (see above). Specify either:	
Weighted graph analysis or	_____ or NA
Binarized graph analysis is used, clarifying the method used for thresholding (e.g. a 10% density threshold, or a statistically -defined threshold); consider the sensitivity of your findings to the particular choice of threshold used	_____ or NA
Itemise the graph summaries used (e.g. clustering coefficient, efficiency, etc), whether these are global or per-node/per-edge summaries. In particular with fMRI or EEG, clarify if measures applied to individual subject networks or group networks	_____ or NA

Follow-up Analyses Enter your response here.

Exploratory Analyses Enter your response here.

References