

ABCD Human Subject Study

Adolescent Brain Cognitive Development – ABCDSTUDY.org

Release Notes: Adolescent Brain Cognitive Development Study (ABCD) Fix Release 2.0.1

ABCD Imaging Instruments

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March 2019

Change Log

March 2019 – ABCD Data Release 2.0

- Initial release.

July 2019 – ABCD Fix Release 2.0.1

- Added notice of Data Release 2.0.1 and updated instrument names.
- Minimally Processed MRI file sharing: added additional information on format, dMRI diffusion gradients and fMRI event timing.
- Updated ABCD_release_2.0_mapping_file to ABCD_release_2.0.1_mapping_file.
- Expanded Fast Track DICOM file sharing section.
- Updated MID task inclusion criteria to ensure all tasks are performed (tfMRI_mid_all_beh_t_nt = 100).
- In the DEAP inclusion criteria, rearranged so that the performance criteria is after the degrees of freedom criteria for task fMRI.
- Recommended dMRI inclusion criteria removed DTI QC and added OK dMRI series (iqc_dmri_ok_ser>0).

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General Information

We are happy to announce the Adolescent Brain Cognitive Development (ABCD) Study Data Release 2.0 available from <https://data-archive.nimh.nih.gov/abcd>. This release contains spreadsheet data and minimally processed imaging data for all ABCD baseline MRI visits.

An overview of the ABCD Study is at <https://abcdstudy.org> and detailed descriptions of elements of the study are listed in <https://abcdstudy.org/scientists/protocols/>. Qualified researchers can request access to ABCD shared data. To get started, create an NIMH Data Archive (NDA) account or login to your existing one. Once approved, you will have access to query and download all data available in the repository. To get started go to <https://data-archive.nimh.nih.gov/abcd/request-access>.

NDA provides extensive tutorials to aid researchers in how to use various query tools. This training is useful for anyone seeking to access and use shared data in an NDA repository. For more information, head to <https://data-archive.nimh.nih.gov/training/modules/accessing-shared-data.html>

This document details how to query the NDA database to obtain information, metrics, and imaging files from the magnetic resonance imaging (MRI) components of the ABCD Study. This document is the second part of the essential reading for the fix release. For essential non-imaging components, ABCD collaborators should also read the preceding document *Release Notes ABCD README FIRST*. An in-depth discussion and reference resource on the ABCD processing pipeline is available at <https://doi.org/10.1101/457739>.

July 2019 Fix Release 2.0.1 Please ensure curated data (data sheets, minimally processed data) from the original Data Release 2.0 are replaced with data from 2.0.1 Fix Release. For downloading only updated minimally processed data, add the 2.0.1 Fix Release and fmri results to the filter cart and download as per usual.

The following release notes were updated to reflect these changes:

- *NDA 2.0.1 Release Notes ABCD README FIRST*
- *NDA 2.0.1 Release Notes Imaging Instruments*
- *NDA 2.0.1 Changes between Release 1.1 and 2.0_Known Issues Release 2.0*
- *NDA 2.0.1 Diffusion Magnetic Resonance Imaging*
- *NDA 2.0.1 Task-Based Functional Magnetic Resonance Imaging*
- *NDA 2.0.1 Mental Health*
- *NDA 2.0.1 Culture and Environment*
- *NDA 2.0.1 Genetics*

To keep up-to-date with news on ABCD Data Releases, join the mail group by sending an email to abcd-data-releases-l-join@mailman.ucsd.edu. A reply email will provide further instructions.

Nomenclature

Within the ABCD study, all measures provided are referred to as instruments. Changes of instrument names between releases are detailed in the *ABCD_release_2.0.1_mapping_file*. Abbreviations of anatomical locations are detailed in *NDA 2.0 Supplementary Imaging Tables*.

MRI Scanner Information

Measure	NDA Short Name	Description
ABCD MRI Info	abcd_mri01	MRI Scanner Information

For each subject visit, information on the MRI scanner manufacturer, model, magnetic field strength, device software version etc. are detailed in the *Other Imaging Instruments* Release Notes.

Please note that all scanners use 32 channel head coils with the exception of these Siemens scanners that use 64 channel head coils (mri_info_deviceserialnumber):

- HASH7911780b
- HASH03db707f
- HASH65b39280
- HASHe4f6957a
- HASH31ce566d

MRI File Sharing

Measure	NDA Short Name	Description
Processed MRI Data	fmrresults01	Index of minimally processed data
Image	image03	Index of Fast Track raw data

Minimally processed MRI file sharing

The ABCD Data Release 2.0 contains minimally processed neuroimaging data for all the baseline ABCD Study participants, including:

- High-resolution structural data (3D T1w and T2w scans)
- Advanced diffusion MRI (multiple b-values and directions)
- Resting State fMRI
- Task fMRI (Monetary Incentive Delay, Stop-Signal, and Emotional N-Back), with event files for each fMRI run

These series have been run through standard modality-specific pre-processing stages including conversion from raw to compressed files, distortion correction, movement correction, alignment to standard space, and initial quality control (refer to *MRI Quality Control (QC)* Release Notes).

This is to enable researchers to use the ABCD neuroimaging data in their own processing pipelines more quickly and efficiently than starting with raw data. Note that minimal processing is identical for rs-fMRI and task-fMRI and does not include analysis-specific pre-processing steps (e.g. removal of initial TRs, normalization by mean, etc.). Researchers intending to use minimally processed data should take note of the appropriate acknowledgement language to include in any public disclosure of results (refer <https://data-archive.nimh.nih.gov/abcd/results>). The available minimally processed files are detailed in the *Other Imaging Instruments Release Notes*.

Preprocessed imaging data are packaged in archive files (tgz) for each image series containing BIDS formatted directory trees and NIfTI format data files (software to share preprocessed data: https://scicrunch.org/resolver/SCR_016016; consistent with BIDS specifications version 1.1.1: http://bids.neuroimaging.io/bids_spec.pdf). Imaging metadata derived from the original DICOM files are packaged along with each preprocessed data series as JSON files. Additional dMRI-specific information included diffusion gradients adjusted for head rotation (bvecs.txt), diffusion gradient strengths (bvals.txt), and a rigid-body transformation matrix specifying the registration between the dMRI image and the corresponding processed sMRI T₁w image (stored in the JSON file). Additional fMRI-specific information includes estimated motion time courses and a rigid-body transformation matrix specifying the registration between the fMRI image and the T₁w image (stored in the JSON file). For task-fMRI series, event timing information is included as tab-separated value (tsv) files. The results of additional processing and ROI analysis are shared in tabulated form to the NDA database (https://scicrunch.org/resolver/SCR_016010), from which users can export spreadsheet files (tsv).

Fast Track DICOM file sharing

If unprocessed raw imaging data is needed, DICOM files are also made publicly available via a Fast Track mechanism. These DICOM files are released on NDA (<https://data-archive.nimh.nih.gov/abcd>) on a continual basis within approximately one month of data collection using the ABCD fast-track image sharing scripts (RRID: SCR_016021). DICOM files are arranged in BIDS-compliant directory trees and packaged in individual archive files (tgz) for each series. Metadata are included in the form of json-format text files, and for task-fMRI series, also included are the files containing stimulus and behavioral response timing information exported from the stimulus program (E-prime). A copy of the metadata is uploaded to NDA's image (version 03) database to link information to non-imaging-based assessments for the same participants. Raw DICOM Fast Track data have not undergone quality control or curation. The up-to-date index of Fast Track shared DICOM files can be downloaded in a separate image03 instrument.

Some Siemens fMRI data have been reported to have negative values for the Siemens CSA slice timing parameter which can prevent the conversion of DICOMs files in some software. This issue has been overcome in some software (e.g. current version of dcm2niix available for download at <https://github.com/rordenlab/dcm2niix>).

GE scanners are unable to correctly encode complex multi-shell EPI gradient table into the DICOM header (a generic default is applied instead). Raw diffusion gradient tables (b values and vectors) per scanner manufacturer have been provided as an accompanying compressed file (ABCD_Diffusion_Tables.zip).

dmRI gradient tables for Fast Track dmRI DICOMs

Raw diffusion gradient tables (b values and vectors) per scanner manufacturer have been provided as an accompanying compressed file (ABCD_Diffusion_Tables.zip). This is primarily provided for ease of use. Additionally, this is to overcome the limitation of GE scanners which are unable to correctly encode complex multishell EPI gradient table into the DICOM header (a generic default is applied instead). Note that these tables are for raw Fast Track dmRI DICOM data: for minimally processed data, new vector tables are generated following motion correction.

High density, phased array head coils

The ABCD acquisition sites use either 32 channel head or 64 channel head/neck coils, depending on availability. Standard correction methods, such as those used by FreeSurfer, are limited when compensating for steep spatial intensity variation, leading to inaccurate brain segmentation or cortical surface reconstruction. For example, brain tissue farther from the coils, such as the temporal and frontal poles, typically have lower intensity values resulting in focal underestimation of the white matter surface or the elimination of large pieces of the cortical surface reconstruction. Furthermore, brain tissue close to coils with extremely high intensity values may be mistaken for non-brain tissue (e.g., scalp). To overcome this, the ABCD minimally processed structural MRI (sMRI) files include an improved intensity inhomogeneity correction, using a smoothly varying bias field optimized to standardize image intensities within all white matter voxels.

Siemens normalized sMRI DICOMs

Siemens scanners provide an intensity normalization procedure to correct for bias fields. As a result, Siemens scanners have two sets of DICOMs for each sMRI data series (i.e. T1, T1_NORM, T2, and T2_NORM). The non-normalized images with large intensity ranges (e.g. with a 64 channel head coil) may be clipped at 4095, impairing cortical reconstruction. The ABCD pipeline uses only the normalized sMRI (T1_NORM and T2_NORM).

Expected File Sets

The number of expected files changes due to subject scheduling, scanner manufacturer requirements, and repeat acquisitions during scanning. Scanning sessions are typically performed in one session for ~2 hours. However, sometimes the family prefer to do this over two 1 hour sessions within a few days of each other. If the scanning is split over two sessions, an initial T1 is acquired for reference at both sessions, leading to two T1 images. Additionally, because the T1 is the first, short essential scan of the session, the operator will repeat the scan if there is a problem with the acquisition (e.g. excessive motion). Other series may also have a repeat acquisition if there is enough time. If there are multiple acquisitions beyond the expected number of files please manually inspect the images for quality.

Below is a guide to the expected number of files per modality/scanner manufacturer:

Modality	GE	Philips	Siemens
sMRI	1 T1 1 T2	1 T1 1 T2	1 T1_NORM 1 T2_NORM
dMRI	1 Field map 1 DWI	2 Field maps 2 DWIs	2 Field maps 1 DWIs
rs-fMRI	2 Field maps 4 BOLD	4 Field maps 4 BOLD	4 Field maps 4 BOLD
MID task fMRI	1 Field map 2 BOLD runs	2 Field maps 2 BOLD runs	2 Field maps 2 BOLD runs
nBack task fMRI	1 Field map 2 BOLD runs	2 Field maps 2 BOLD runs	2 Field maps 2 BOLD runs
SST task fMRI	1 Field map 2 BOLD runs	2 Field maps 2 BOLD runs	2 Field maps 2 BOLD runs

Table 1: Expected file sets

Note that the order of the fMRI series acquisition is randomized per subject.

Individual instruments can be identified on NDA by the short name (second column) in the following table. Data dictionaries for all data types can be downloaded at this link: https://ndar.nih.gov/data_dictionary.html?source=ABCD%2BRelease%2B2.0&submission=ALL

Tabulated ROI-based Analysis

Measure	NDA Short Name
ABCD sMRI Part 1	abcd_smrip101
ABCD sMRI Part 2	abcd_smrip201
ABCD sMRI Destrieux Parcellation Part 1	abcd_mrisdp101
ABCD sMRI Destrieux Parcellation Part 2	abcd_mrisdp201
ABCD dMRI DTI Part 1 (Release 2.0.1)	abcd_dti_p101
ABCD dMRI DTI Part 2 (Release 2.0.1)	abcd_dti_p201
ABCD dMRI DTI Destrieux Parcellations Part 1 (Release 2.0.1)	abcd_ddtidp101
ABCD dMRI DTI Destrieux Parcellations Part 2 (Release 2.0.1)	abcd_ddtidp201
ABCD dMRI DTI Full Part 1	abcd_dmdtifp101
ABCD dMRI DTI Full Part 2 (Release 2.0.1)	abcd_dmdtifp201 abcd_dmdtifp202
ABCD dMRI DTI Full Destrieux Parcellation Part 1	abcd_ddtifp101
ABCD dMRI DTI Full Destrieux Parcellation Part 2	abcd_ddtifp201
ABCD dMRI RSI Part 1	mri_rsi_p102
ABCD dMRI RSI Part 2	mri_rsi_p202
ABCD dMRI RSI Destrieux Parcellation Part 1	abcd_drsidep101
ABCD dMRI RSI Destrieux Parcellation Part 2	abcd_drsidep201

ABCD dMRI RSI Destrieux Parcellation Part 3	abcd_drsidep301
ABCD rsfMRI Gordon Network Correlations	abcd_betnet02
ABCD rsfMRI Network to Subcortical ROI Correlations	mrirscor02
ABCD rsfMRI Temporal Variance	abcd_mrirstv02
ABCD rsfMRI Destrieux	abcd_mrirsfd01
ABCD Task fMRI MID Run 1 Beta Weights Part 1 (Release 2.0.1)	abcd_midr1bwp101 abcd_midr1bwp102
ABCD Task fMRI MID Run 1 Beta Weights Part 2 (Release 2.0.1)	abcd_midr1bwp201 abcd_midr1bwp202
ABCD Task fMRI MID Run 1 Beta Weights Destrieux Parcellations Part 1	abcd_midr1bwdp101
ABCD Task fMRI MID Run 1 Beta Weights Destrieux Parcellations Part 2 (Release 2.0.1)	abcd_midr1bwdp201 abcd_midr1bwdp202
ABCD Task fMRI MID Run 1 Standard Error of the Mean Part 1 (Release 2.0.1)	abcd_midsemp101 abcd_midsemp102
ABCD Task fMRI MID Run 1 Standard Error of the Mean Part 2 (Release 2.0.1)	abcd_midsemp201 abcd_midsemp202
ABCD Task fMRI MID Run 1 SEM Destrieux Parcellations Part 1	abcd_tmidr1sem101
ABCD Task fMRI MID Run 1 SEM Destrieux Parcellations Part 2 (Release 2.0.1)	abcd_tmidr1sem201 abcd_tmidr1sem202
ABCD Task fMRI MID Run 2 Beta Weights Part 1 (Release 2.0.1)	midr2bwp101 midr2bwp102
ABCD Task fMRI MID Run 2 Beta Weights Part 2 (Release 2.0.1)	midr2bwp201 midr2bwp202
ABCD Task fMRI MID Run 2 Beta Weights Destrieux Parcellations Part 1	abcd_tr2bwdp01
ABCD Task fMRI MID Run 2 Beta Weights Destrieux Parcellations Part 2 (Release 2.0.1)	abcd_tr2bwdp201 abcd_tr2bwdp202
ABCD Task fMRI MID Run 2 Standard Error of the Mean Part 1 (Release 2.0.1)	abcd_midr2semp101 abcd_midr2semp102
ABCD Task fMRI MID Run 2 Standard Error of the Mean Part 2 (Release 2.0.1)	abcd_midr2semp201 abcd_midr2semp202
ABCD Task fMRI MID Run 2 SEM Destrieux Parcellations Part 1	abcd_tr2sem101
ABCD Task fMRI MID Run 2 SEM Destrieux Parcellations Part 2	abcd_tr2sem201
ABCD Task fMRI MID Average Beta Weights Part 1 (Release 2.0.1)	midaparc02 midaparc03
ABCD Task fMRI MID Average Beta Weights Part 2 (Release 2.0.1)	midaparc202 midaparc203
ABCD Task fMRI MID Average Beta Weights Destrieux Parcellations Part 1	abcd_midabwdp01
ABCD Task fMRI MID Average Beta Weights Destrieux Parcellations Part 2 (Release 2.0.1)	abcd_midabwdp201 abcd_midabwdp202
ABCD Task fMRI MID Average Standard Error of the Mean Part 1 (Release 2.0.1)	abcd_midasemp101 abcd_midasemp102
ABCD Task fMRI MID Average Standard Error of the Mean Part 2 (Release 2.0.1)	abcd_midasemp201 abcd_midasemp202
ABCD Task fMRI MID Average SEM Destrieux Parcellations Part 1	abcd_midasem101
ABCD Task fMRI MID Average SEM Destrieux Parcellations Part 2 (Release 2.0.1)	abcd_midasem201 abcd_midasem202
ABCD Task fMRI SST Run 1 Beta Weights	mriss1bw01
ABCD Task fMRI SST Run 1 Beta Weights Destrieux Parcellations Part 1	abcd_tfs1bwdp01
ABCD Task fMRI SST Run 1 Beta Weights Destrieux Parcellations Part 2	abcd_tfs1bwdp201

ABCD Task fMRI SST Run 1 Standard Error of the Mean	mrisstr1sem01
ABCD Task fMRI SST Run 1 SEM Destrieux Parcellations Part 1	abcd_tfsstr1sem01
ABCD Task fMRI SST Run 1 SEM Destrieux Parcellations Part 2	abcd_tfsstr1sem02
ABCD Task fMRI SST Run 2 Beta Weights	mrisstr2bw01
ABCD Task fMRI SST Run 2 Beta Weights Destrieux Parcellations Part 1	abcd_tfsstr2bw01
ABCD Task fMRI SST Run 2 Beta Weights Destrieux Parcellations Part 2	abcd_tfsstr2bw02
ABCD Task fMRI SST Run 2 Standard Error of the Mean	mrisstr2bwsem01
ABCD Task fMRI SST Run 2 SEM Destrieux Parcellations Part 1	abcd_tfsstr2sem01
ABCD Task fMRI SST Run 2 SEM Destrieux Parcellations Part 2	abcd_tfsstr2sem02
ABCD Task fMRI SST Average Beta Weights	mrisst02
ABCD Task fMRI SST Average Beta Weights Destrieux Parcellations Part 1	abcd_tfsstabw01
ABCD Task fMRI SST Average Beta Weights Destrieux Parcellations Part 2	abcd_tfsstabw02
ABCD Task fMRI SST Average Standard Error of the Mean	mrisstsem01
ABCD Task fMRI SST Average SEM Destrieux Parcellations Part 1	abcd_tfsstasem01
ABCD Task fMRI SST Average SEM Destrieux Parcellations Part 2	abcd_tfsstasem02
ABCD Task fMRI nBack Run 1 Beta Weights	nbackr101
ABCD Task fMRI nBack Run 1 Beta Weights Destrieux Parcellations Part 1	abcd_tfnr1bw01
ABCD Task fMRI nBack Run 1 Beta Weights Destrieux Parcellations Part 2	abcd_tfnr1bw02
ABCD Task fMRI nBack Run 1 Standard Error of the Mean	nbackr1sem01
ABCD Task fMRI nBack Run 1 SEM Destrieux Parcellations Part 1	abcd_tfnr1sem01
ABCD Task fMRI nBack Run 1 SEM Destrieux Parcellations Part 2	abcd_tfnr1sem02
ABCD Task fMRI nBack Run 2 Beta Weights	nbackr201
ABCD Task fMRI nBack Run 2 Beta Weights Destrieux Parcellations Part 1	abcd_tfnr2bw01
ABCD Task fMRI nBack Run 2 Beta Weights Destrieux Parcellations Part 2	abcd_tfnr2bw02
ABCD Task fMRI nBack Run 2 Standard Error of the Mean	nbackr2sem01
ABCD Task fMRI nBack Run 2 SEM Destrieux Parcellations Part 1	abcd_tfnr2sem01
ABCD Task fMRI nBack Run 2 SEM Destrieux Parcellations Part 2	abcd_tfnr2sem02
ABCD Task fMRI nBack Average Beta Weights	nback_bw01
ABCD Task fMRI nBack Average Beta Weights Destrieux Parcellations Part 1	abcd_tfabw01
ABCD Task fMRI nBack Average Beta Weights Destrieux Parcellations Part 2	abcd_tfabw02
ABCD Task fMRI nBack Average Standard Error of the Mean	nbackallsem01
ABCD Task fMRI nBack Average SEM Destrieux Parcellations Part 1	abcd_tnbasem01
ABCD Task fMRI nBack Average SEM Destrieux Parcellations Part 2	abcd_tnbasem02

MR images are corrected for distortions and head motion, and cross-modality registrations are performed. Using the T1w sMRI scan, the cortical surface is reconstructed, and subcortical and white matter regions of the brain are segmented. From this, we carry out modality-specific analyses and extract imaging-derived measures using a variety of regions of interest (ROI). Finally, ROI analysis results are compiled across subjects and summarized in tabulated form.

Information on the different tabulated data is detailed in modality-specific release notes:

- Structural Magnetic Resonance Imaging (sMRI)
- Diffusion Magnetic Resonance Imaging (dMRI)
- Resting-State Functional Magnetic Resonance Imaging (rs-fMRI)
- Task-Based Functional Magnetic Resonance Imaging (task-fMRI)
- Behavioral Performance During task-fMRI

Despite the convenience of ROI-based analyses and the advantages related to reduced numbers of statistical comparisons, there are inherent limitations to this approach. Effects of interest (e.g., associations between cortical morphometry and cognitive variables, or task-related fMRI activation) could potentially straddle multiple ROIs, or occupy a small region of a large ROI, thereby reducing the sensitivity of an ROI-based analysis relative to mapping-based approaches. For this reason, users should be cautious about interpreting the results of ROI-based analyses, particularly for task fMRI.

Quality Control and Recommended Inclusion Criteria

Measure	NDA Short Name	Description
MR Findings	abcd_mrfindings01	Neuroradiology reports - scores, hydrocephalus and herniation
ABCD MRI QC Raw Part 1	mriqc02	Quality control measures (part 1)
ABCD MRI QC Raw Part 2	mriqcp202	Quality control measures (part 2)
FreeSurfer QC	freesqc01	Freesurfer reconstruction quality control measures
ABCD dMRI Post Processing QC	dmriqc01	Processed dMRI data quality control measures

Incidental findings

T1w and T2w images, if available, were screened for incidental findings by a Board Certified Neuroradiologist. Any findings requiring clinical investigation were relayed to appropriate site personnel via the ABCD Coordinating Center (CC). Detailed information on the scoring of this instrument are in the *Other Imaging Instruments* Release Notes.

Protocol Compliance and Quality Control

All ABCD MRI exams have been systematically checked for MRI protocol compliance and completeness, and images have been manually rated for quality by trained MR analysts before and after processing. All MRI data is provided to ABCD collaborators, but we highly recommend that researchers filter subjects by QC results based on the project aims and tolerance for MR artifacts/motion. Severe artifact in all T1w image in a given visit (MRI Quality Control (QC):iqc_t1_ok_ser = 0) results in the inability to produce subsequent MR-metrics for all other modalities. FreeSurfer cortical surface reconstructions were visually inspected, and reviewers

assigned a QC score of 0 or 1, indicating whether it is recommended that a subject be excluded (0) or included (1) in group analyses involving cortical surface ROIs. Please refer to the *MRI Quality Control (QC)* Release Notes for further details.

E-Prime errors in task fMRI

For task fMRI, series were also excluded due to E-Prime problems including missing, corrupted, duplicated or unsynchronized E-Prime files. The variety of E-Prime errors that would invalidate the series are generalized in the *MRI Raw QC Part 3* instrument as being "missing" (iqc_mid_ep_scan_missing > 0; iqc_nback_ep_scan_missing > 0; iqc_sst_ep_scan_missing > 0).

Behavioral performance in task fMRI

Behavioral measures calculated from participant button presses during task fMRI acquisition are also included (see *Behavioral Performance During task-fMRI* Release Notes). Based on those measures, behavioral performance flags were provided, indicating whether a subject's performance for each task was within acceptable standards. It is suggested that users exclude subjects from group analysis based on sub-optimal performance and possibly additional criteria such as the number of degrees of freedom (reduced by motion censoring) in the individual subject task-fMRI analysis or based on outlier detection on the ROI-averages themselves. Users should choose inclusion/exclusion performance criteria that are appropriate for their analyses.

Recommended Inclusion Criteria

Fast Track DICOM data, minimally processed data and tabulated ROI-based data (MR-metric tables) provides the researcher with all the possible ABCD data permitted to be shared.

For projects that require MR artifacts and/or motion, all data can be used. Refer to the *ABCD MRI QC Raw Part 1/2* instruments for details of motion severity and categories of artifacts. For projects that require no MR artifacts and minimal motion, we recommend the following inclusion criteria (Figures 1-2).

Preliminary option

- If needed, review *MR Findings* (abcd_mrfindings01) to exclude clinical referrals (mrif_score = 3 OR mrif_score = 4) or incidental findings (e.g. hydrocephalus, herniation).

T1w analysis

To use quality T1w files

- ABCD MRI QC Raw Part 1: iqc_t1_ok_ser > 0

For T1w FreeSurfer tabulated ROI-based data (ABCD sMRI Part 1/2; ABCD sMRI Destrieux Parcellation Part 1/2)

- FreeSurfer QC: fsqc_qc = 1

T2w analysis

To use quality T2w files

- ABCD MRI QC Raw Part 1: iqc_t2_ok_ser > 0

For T2w FreeSurfer tabulated ROI-based data (ABCD sMRI Part 2; ABCD sMRI Destrieux Parcellation Part 2)

- FreeSurfer QC: fsqc_qc = 1
- ABCD MRI QC Raw Part 1: iqc_t2_ok_ser > 0

dMRI analysis (DTI/RSI)

To use quality dMRI files

- ABCD MRI QC Raw Part 1: iqc_dmri_ok_ser > 0
- ABCD MRI QC Raw Part 1: iqc_t1_ok_ser > 0 (for registration to T1w image)

For dMRI FreeSurfer tabulated ROI-based data (ABCD dMRI Part 1/2; ABCD dMRI DTI Destrieux Parcellations Part 1/2; ABCD dMRI Full Part 1/2; ABCD dMRI DTI Full Destrieux Parcellations Part 1/2; ABCD dMRI RSI Part 1/2; ABCD dMRI RSI Destrieux Parcellations Part 1/2)

- FreeSurfer QC: fsqc_qc = 1

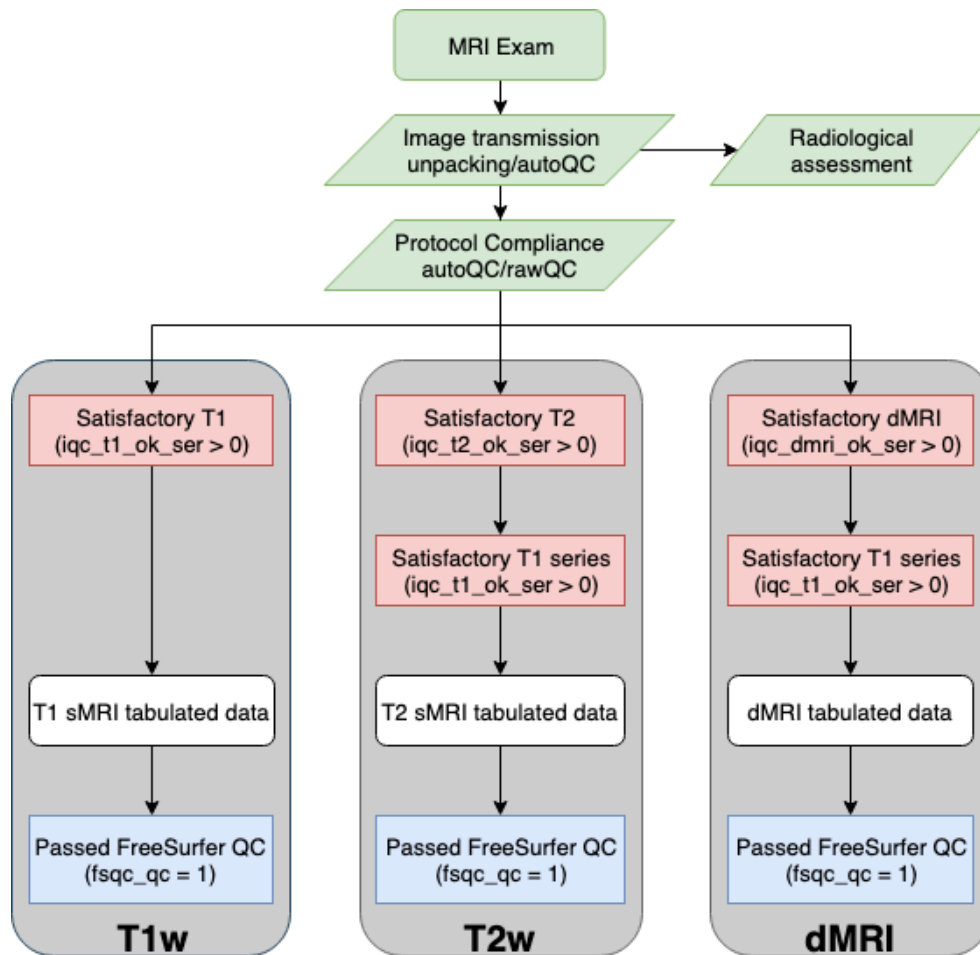


Figure 1. Recommended inclusion criteria for sMRI and dMRI data. A series of filters reduces the number of participants available for a given modality. Initial stages (green) have no filtering. All scanning sessions include a radiological review and researchers may optionally exclude cases due to incidental findings as desired. Next, mandatory filtering (red) of non-compliant and erroneous data is used to censor the minimally processed data. Finally, FreeSurfer/AtlasTrack processing for segmentation/parcellation results in the tabulated data (white). The DAIC recommends (blue) that these data should also be filtered to exclude very poor FreeSurfer QC results.

resting-state fMRI analysis

To use 5 minutes of quality resting-state fMRI results (i.e., 5 mins x 60 secs x 0.8 TR = 375)

- ABCD MRI QC Raw Part 1: `iqc_rsfmri_ok_ser > 0`
- ABCD MRI QC Raw Part 1: `iqc_t1_ok_ser > 0` (for registration to T1w image)
- ABCD rsfMRI Gordon Network Correlations: `rsfmri_c_ngd_ntpoints > 375`
- Exclude top and bottom 0.25% of data

For resting-state fMRI tabulated ROI-based data (ABCD rsfMRI Gordon Network Correlations; ABCD rsfMRI Network to Subcortical ROI Correlations; ABCD rsfMRI Temporal Variance; ABCD rsfMRI Destrieux)

- FreeSurfer QC: fsqc_qc = 1
- ABCD rsfMRI Gordon Network Correlations: rsfmri_c_ngd_ntpoints > 375
- Exclude top and bottom 0.25% of data

task fMRI analysis

To use quality task fMRI files

- ABCD MRI QC Raw Part 1: iqc_t1_ok_ser > 0 (for registration to T1w image)
- Exclude top and bottom 0.25% of data

MID

- ABCD MRI QC Raw Part 1: iqc_mid_ok_ser > 0
- ABCD Task fMRI MID Behavior: tfmri_mid_beh_performflag = 1
tfmri_mid_all_beh_t_nt = 100
- ABCD Task fMRI MID Average Beta Weights Part 1: tfmri_mid_all_b_dof > 200

SST

- ABCD MRI QC Raw Part 2: iqc_sst_ok_ser > 0
- ABCD Task fMRI SST Behavior: tfmri_sst_beh_performflag = 1
- ABCD Task fMRI SST Average Beta Weights Part 1: tfmri_sst_all_b_dof > 200

nBACK

- ABCD MRI QC Raw Part2: iqc_nback_ok_ser > 0
- ABCD Task fMRI nBack Behavior: tfmri_nback_beh_performflag = 1
- ABCD Task fMRI nBack Average Beta Weights Part 1: tfmri_nback_all_b_dof > 200

For task-based fMRI tabulated ROI-based data (ABCD Task fMRI instruments)

- FreeSurfer QC: fsqc_qc = 1 (for registration to T1w image)

MID

- ABCD MRI QC Raw Part 1: iqc_mid_ok_ser > 0
- ABCD Task fMRI MID Behavior: tfmri_mid_beh_performflag = 1
tfmri_mid_all_beh_t_nt = 100
- ABCD Task fMRI MID Average Beta Weights Part 1: tfmri_mid_all_b_dof > 200

SST

- ABCD MRI QC Raw Part 2: iqc_sst_ok_ser > 0
- ABCD Task fMRI SST Behavior: tfmri_sst_beh_performflag = 1
- ABCD Task fMRI SST Average Beta Weights Part 1: tfmri_sst_all_b_dof > 200

nBACK

- ABCD MRI QC Raw Part2: iqc_nback_ok_ser > 0
- ABCD Task fMRI nBack Behavior: tfmri_nback_beh_performflag = 1
- ABCD Task fMRI nBack Average Beta Weights Part 1: tfmri_nback_all_b_dof > 200

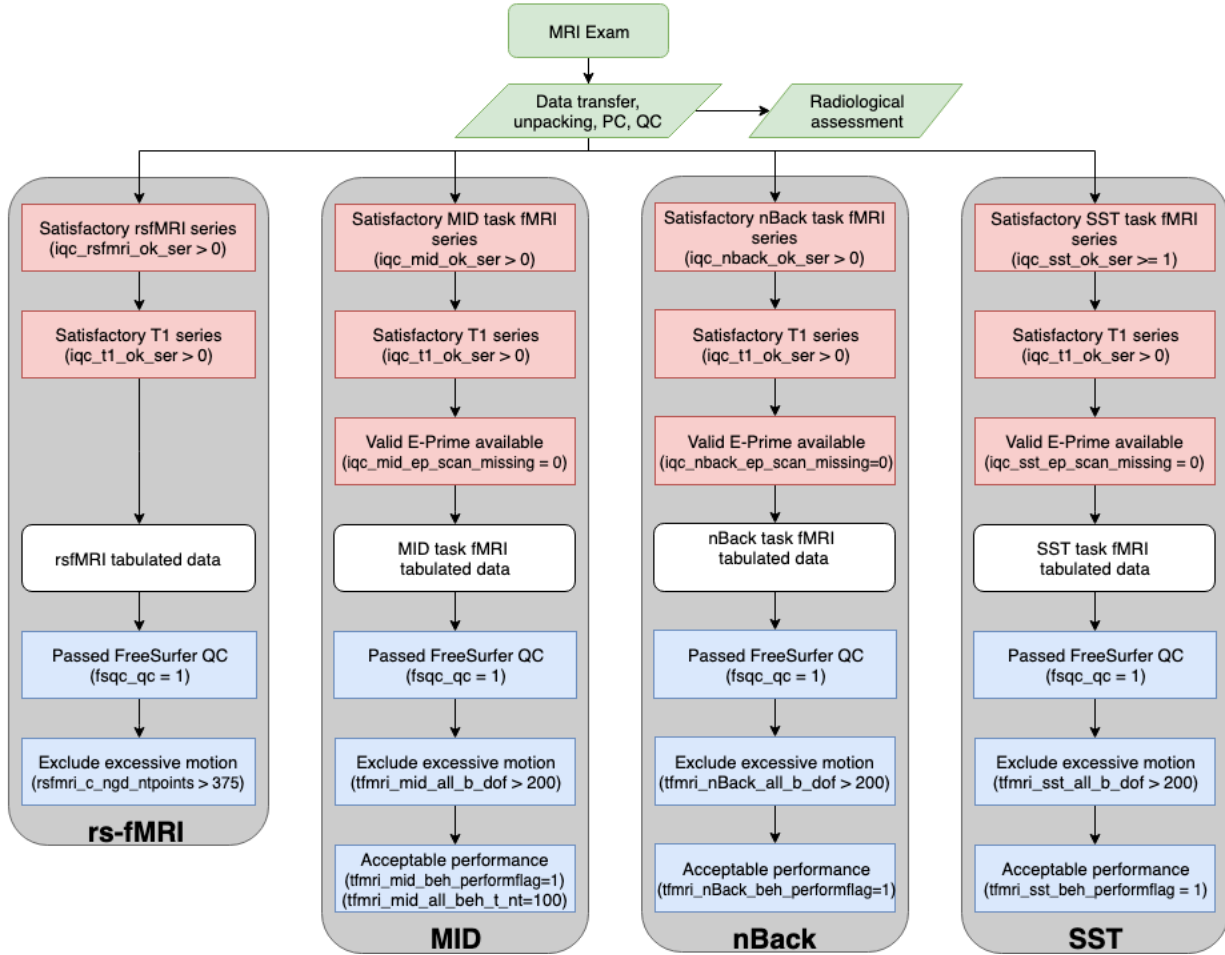


Figure 2. Recommended inclusion criteria for fMRI data. A series of filters reduces the number of participants available for a given modality. Initial stages (green) have no filtering. All scanning sessions receive a radiological review and researchers may optionally exclude cases due to incidental findings as desired. Next, mandatory filtering (red) of non-compliant and erroneous data is used to censor the minimally processed data. Finally, FreeSurfer and fMRI reconstruction result in the tabulated data (white). The DAIC recommends (blue) that these data should be filtered to exclude participants with very poor FreeSurfer QC results, excessive motion, or poor task performance.

Recommended Inclusion Criteria for DEAP

All analysis on DEAP is underpinned by a successful FreeSurfer segmentation/parcellation. Information on the DEAP recommended inclusion criteria and related NDA instruments is detailed in Table 2.

By default in the Analyze section of DEAP, one of the recommended random effects for non-imaging analysis is "Site". For imaging analysis that need to account for individual scanner instances, we recommend that "Site" is deselected and in *Other Independent Variables* add "mri_info_deviceserialnumber".

Note for task fMRI, the average degrees of freedom is set at an arbitrary 200 - this can be increased for a more restrictive selection criteria. For single runs, the degrees of freedom are halved (i.e., $dof > 100$).

Imaging Modality	Inclusion Criteria with DEAP	NDA Instrument: Variable Names
MR Findings	mrif_score = 1 OR mrif_score = 2	MR Findings:mrif_score
sMRI - T1w	fsqc_qc = 1	FreeSurfer QC:fsqc_qc
sMRI - T2w	iqc_t2_ok_ser > 0 fsqc_qc = 1	ABCD MRI QC Raw Part 1:iqc_t2_ok_ser FreeSurfer QC:fsqc_qc
dMRI - DTI/RSI	iqc_dmri_ok_ser > 0 fsqc_qc = 1	ABCD MRI QC Raw Part 1:iqc_dmri_ok_ser FreeSurfer QC:fsqc_qc
resting-state fMRI	fsqc_qc = 1 rsfmri_cor_network.gordon_ntpoints > 375	FreeSurfer QC:fsqc_qc rsfMRI Gordon Network Correlations: rsfmri_c_ngd_ntpoints > 375
MID task fMRI	fsqc_qc = 1 tfmri_mid_all_beta_dof > 200 tfmri_mid_beh_perform.flag = 1 tfmri_mid_all_beh_total_numtrials = 100	FreeSurfer QC:fsqc_qc ABCD Task fMRI MID Average Beta Weights Part 1: tfmri_mid_all_b_dof ABCD Task fMRI MID Behavior:tfmri_mid_beh_performflag tfmri_mid_all_beh_t_nt

SST task fMRI	fsqc_qc = 1 tfmri_sst_all_beta_dof > 200 tfmri_sst_beh_perform.flag = 1	FreeSurfer QC:fsqc_qc ABCD Task fMRI SST Average Beta Weights Part 1:tfmri_sa_beta_dof ABCD Task fMRI SST Behavior:tfmri_sst_beh_performflag
nBack task fMRI	fsqc_qc = 1 tfmri_nback_all_beta_dof > 200 tfmri_nback_beh_perform.flag = 1	FreeSurfer QC:fsqc_qc ABCD Task fMRI nBack Average Beta Weights Part 1:tfmri_nback_all_beta_dof ABCD Task fMRI nBack Behavior:tfmri_nback_beh_performflag

Table 2. Recommended inclusion criteria for group analyses with each modality.

Predefined Recommended Subsets

Predefined subsets based on the recommended inclusion criteria (Table 1) are available in DEAP.

1. Login to the DEAP web service <https://deap.nimhda.org>
2. Click on Analyze.
3. Choose your variables of interest.
4. Click on Select subset of sessions and in the Public section choose the recommended inclusion criteria that is appropriate for your variables:
 - Recommended T1w
 - Recommended T2w
 - Recommended dMRI
 - Recommended resting-state fMRI
 - Recommended task fMRI (MID)
 - Recommended task fMRI (SST)
 - Recommended task fMRI (nBack)
5. Submit your analysis.

Please ensure that the subset matches the variables of interest. For example, examining the dMRI data should be used with the Recommended dMRI subset only (Figure 3). For more complex subsetting, the syntax can be combined in the Limit section of DEAP.

GAMM4

Home

Limit

Compact Mode

Dependent Variable (Y-axis)

nihtbx_fluidcomp_uncorrected

Independent Variable (X-axis, for plotting)

dmri_dti.fa_fiber.at_allfibers

Grouping Variable (for interaction and plotting)

Other Independent Variables

Select subset of sessions

Recommended T1w

Recommended T2w

Recommended dMRI

Recommended task fMRI - MID

Recommended task fMRI - SST

Figure 3. Example of selecting recommended subsets in DEAP

Extending Predefined Recommended Subsets with syntax

To further define the cohort of interest, the following is syntax for the predefined subsets that can be extended in the Limit section of DEAP:

Recommended T1w

```
(fsqc_qc="pass")
```

Recommended T2w

```
(fsqc_qc="pass") and (iqc_t2_ok_ser>0)
```

Recommended dMRI

```
(fsqc_qc="pass") and (iqc_dmri_ok_ser>0)
```

Recommended resting-state fMRI

```
(fsqc_qc="pass") and  
(rsfmri_cor_network.gordon_ntpoints>375)
```

Recommended task fMRI (MID)

```
(fsqc_qc="pass") and (tfmri_mid_all_beta_dof>200)  
and (tfmri_mid_beh_perform.flag=1) and  
(tfmri_mid_all_beh_total_numtrials=100)
```

Recommended task fMRI (SST)

```
(fsqc_qc="pass") and (tfmri_sst_all_beta_dof>200)  
and (tfmri_sst_beh_perform.flag=1)
```

Recommended task fMRI (nBack)

```
(fsqc_qc="pass") and (tfmri_nback_all_beta_dof>200)  
and (tfmri_nback_beh_perform.flag=1)
```

Note that in task fMRI, the average beta weights and standard error of the means can be replaced with individual runs (i.e., replace avg with either *run1* or *run2* and *dof>100*). Where only one run is available, the average score is equal to the single run.