

# ABCD Human Subjects Study

Adolescent Brain Cognitive Development – ABCDSTUDY.org

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

### Diffusion Magnetic Resonance Imaging (dMRI)

<http://dx.doi.org/10.15154/1503209>

March 2019

#### Change Log

March 2019 – ABCD Data Release 2.0

- Initial release

July 2019 – ABCD Fix Release 2.0.1

- Added notice of Fix Release 2.0.1 and updated instrument name

#### List of Instruments

NB: Short names associated with the 2.0 Release that have been renamed are indicated by the ~~striketrough text~~.

| Name of Instrument                                           | Short Name                                    |
|--------------------------------------------------------------|-----------------------------------------------|
| 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)                    | <del>abcd_dmdtifp201</del><br>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_drsidp101                                |
| ABCD dMRI RSI Destrieux Parcellation Part 2                  | abcd_drsidp201                                |
| ABCD dMRI RSI Destrieux Parcellation Part 3                  | abcd_drsidp301                                |

## General Information

The following information refers to the Adolescent Brain Cognitive Development (ABCD) Study Annual Release 2.0 available from <https://data-archive.nimh.nih.gov/abcd>. 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>.

This document describes the contents of various instruments available for download. To understand the context of this information, see *Release Notes ABCD README FIRST* and *Release Notes ABCD Imaging Instruments*.

**July 2019 Fix Release 2.0.1** Please ensure updated instruments contained in Fix Release 2.0.1 replace instruments downloaded from the original Data Release 2.0 as indicated in the above table. Short names associated with the 2.0 Release that have been renamed in Release 2.0.1 are indicated by the ~~strikethrough text~~.

- Image types
  - field maps: non-diffusion weighted images with opposite phase encode polarity
  - multi-b-value, multi-direction diffusion weighted images
- Image processing
  - eddy current distortion correction with a nonlinear estimation using diffusion gradient orientations and amplitudes to predict the pattern of distortions (Zhuang, et al., 2006)
  - head motion corrected by registering to images synthesized from tensor fit (Hagler, et al., 2009)
  - diffusion gradients adjusted for head rotation (Hagler, et al., 2009; Leemans and Jones, 2009)
  - robust diffusion tensor estimation (Chang, et al., 2005) used to identify and replace dark slices caused by abrupt head motion
  - B<sub>0</sub> distortion correction using reversing gradient method (Holland, et al., 2010)
  - gradient nonlinearity distortion correction (Jovicich, et al., 2006)
  - T<sub>2</sub>-weighted b=0 images to T<sub>1</sub>w structural images using mutual information (Wells, et al., 1996)
  - resampled into a standard orientation with 1.7 mm isotropic resolution
- Diffusion tensor imaging (DTI) analysis
  - conventional DTI methods (Basser, et al., 1994; Le Bihan, et al., 2001; Pierpaoli, et al., 1996)
  - two modeling approaches
    - DTI inner shell (DTI<sub>IS</sub>): b values > 1000 excluded from tensor fitting to avoid need for nonlinear estimation; metric prefix is “dti”
    - DTI full shell (DTI<sub>FS</sub>): all b values used in the tensor fitting; metric prefix is “dti\_full”

- measures of microstructural tissue properties
  - fractional anisotropy (FA)
  - mean diffusivity (MD)
  - longitudinal (or axial) diffusivity (LD)
  - transverse (or radial) diffusivity (TD)
- Restriction Spectrum Imaging (RSI)
  - linear estimation approach allowing for mixtures of “restricted” and “hindered” diffusion pools within individual voxels (White, et al., 2013a; White, et al., 2014; White, et al., 2013b)
  - takes advantage of multiple b-value acquisition
  - two volume fractions modeled as fiber orientation density (FOD) functions
    - longitudinal diffusivity constant for both fractions, with a value of  $1 \times 10^{-3} \text{ mm}^2/\text{s}$
    - restricted fraction (e.g. intracellular): transverse diffusivity modelled as 0
    - hindered fraction (e.g. extracellular): transverse diffusivity modelled as  $0.9 \times 1 \times 10^{-3} \text{ mm}^2/\text{s}$
  - primary measures derived from the RSI model fit
    - restricted normalized isotropic (N0)
      - square of the 0th order spherical harmonic coefficient of the restricted fraction divided by the sum of squares of all model coefficients
    - restricted normalized directional or “neurite density” (ND)
      - sum of squared 2nd and 4th order spherical harmonic coefficients of the restricted fraction divided by the norm of the model coefficients
    - hindered normalized isotropic (N0\_s2)
      - square of the 0th order spherical harmonic coefficient of the hindered fraction divided by the sum of squares of all model coefficients
    - hindered normalized directional (ND\_s2)
      - sum of squared 2nd and 4th order spherical harmonic coefficients of the hindered fraction divided by the norm of the model coefficients
- Regions of interest (ROIs)
  - subcortical structures labeled with atlas-based segmentation (Fischl, et al., 2002)
  - cortical regions labeled with the Desikan atlas-based classification (Desikan, et al., 2006)
  - cortical regions labeled with the Destrieux atlas-based classification (Destrieux, et al., 2010)
    - white and gray matter values sampled near gray/white boundary (Elman, et al., 2017)
  - major white matter tracts labelled using AtlasTrack (Hagler, et al., 2009)
    - voxels containing primarily gray matter or cerebral spinal fluid excluded from analysis

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