

ABCD Human Subjects Study

Adolescent Brain Cognitive Development – ABCDSTUDY.org

Release Notes: Adolescent Brain Cognitive Development StudySM (ABCD) Data Release 3.0

Diffusion Magnetic Resonance Imaging (dMRI)

<http://dx.doi.org/10.15154/1519007>

October 2020

Change Log

October 2020 – ABCD Data Release 3.0

- Initial release

List of Instruments

Name of Instrument	Short Name
ABCD dMRI DTI Part 1	abcd_dti_p101
ABCD dMRI DTI Part 2	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	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 DevelopmentSM (ABCD) Study Data Release 3.0 available from <https://nda.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*.

- 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
 - B₀ distortions were corrected using the reversing gradient method with FSL's TOPUP (Andersson et al., 2003, Smith et al., 2004)
 - gradient nonlinearity distortion correction (Jovicich, et al., 2006)
 - T₂-weighted b=0 images to T₁w 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_{IS}): b values > 1000 excluded from tensor fitting to avoid need for nonlinear estimation; metric prefix is "dti"
 - DTI full shell (DTI_{FS}): 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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