DOCUMENTATION

of

BRAIN MEASURES

in

MIDUS 3
Neuroscience Project (P5)

University of Wisconsin ♦ Institute on Aging
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INTRODUCTION

This document is an updated reference for the extracted structural and diffusion brain measures in the MIDUS 3 Neuroscience Project data sets and includes information regarding the Neuroscience Project's (P5) MIDUS 3 MRI data collection and processing protocols. This update includes both a correction to the original brainage documentation in regard to the Cole brainage estimates as described in https://github.com/james-cole/brainageR, and the addition of other brainage estimates from publicly shared algorithms and deep learning models trained on other external datasets. The diffusion measures in the JHU and IIT regions were updated using the regional masks that were derived by applying linear followed by non-linear transformations between MNI and the MIDUS specific coordinate system. In the previous release the order of these transformations was swapped. Additionally in this release, the diffusion kurtosis imaging (DKI) and the white matter tract integrity (WMTI) measures are updated using spatially adaptive smoothing to better address spatial discontinuities informally referred to in the literature as 'black holes'. In the previous release, spatially uniform smoothing was applied. Finally, this release contains median values of estimated diffusion measures from regions defined by the Harvard-Oxford subcortical atlas (Cortex, White Matter, Nucleus Accumbens, Amygdala, Caudate, Hippocampus, Putamen, Pallidum and Thalamus).

Partial variable names have been provided where appropriate. For more detailed information on variable names and data collection procedures, please see (*M3_P5_VARIABLE_NAMES_20231219* and *M3_P5_README_20231219*). Raw MRI data (including structural, task functional, resting functional, diffusion-weighted imaging, and resting perfusion) are available through a separate data sharing mechanism. Please see https://midus.wisc.edu/midus_neuro_data.php for instructions on how to access these data.

MRI scans typically began between 8:00 a.m. and 10:00 a.m. following the completion of our Psychophysiology protocol the preceding day (see *M3_P5_DOCUMENTATION_OF_PSYCHOPHYSIOLOGY_20230407* for details regarding psychophysiology procedures). Data collection took place at the Waisman Brain Imaging laboratory on the UW-Madison campus using a 3T MR750 GE Healthcare MRI scanner (Waukesha, WI) and a 32-channel NOVA head coil. In total, the scanning protocol had a duration of approximately 90 minutes and included the acquisition of a BRAVO T1-weighted scan, field map images, 3 task functional MRI scans/EPIs, a resting-state fMRI scan, a diffusion-weighted scan, and an arterial spin labeling scan. Additionally, part way through the study, T2 Cube and T2 Cube Flair scans were added to the end of the protocol if time allowed. Questionnaire data, including PANAS-NOW and STAI-State, both prior to and after the scanning procedure, has been provided as well.

A subset of the participants who completed the Psychophysiology protocol completed the MRI protocol. In some cases, data could not be collected due to claustrophobia, back problems, or other issues that prevented the participant from completing the MRI scan. A filter variable is provided, indicating whether participants completed at T1-weighted [C5IC]. However, a small number of scans contained artifacts that made accurate structural measurements unfeasible. In all cases, the appropriate missing value was listed. A second filter indicates whether a radiologist flagged the scan for an abnormality during review [C5IF]. Flags are commonly indicating small vessel ischemic disease, presence of meningiomas or other masses, and/or referrals to specialists. Users of the data should review the images for themselves to determine whether any flagged data should be included or excluded from an analysis.

T1w-Derived Structural Brain Measurements & Brain-Predicted Age

Measures derived from BRAVO T1-weighted (T1w) structural images with 1 mm^3 isotropic voxels (TR = 8.2 ms, TE = 3.2 ms, flip angle = 12°, FOV = 256 mm, 256 x 256 matrix, 160 axial slices, inversion time = 450 ms, total duration = 7.5 minutes) are described below. For details on processing procedures, see *M3_P5_INSTRUMENTS_20231219*.

Measures of cortical thickness, curvature, surface area, and volume calculated via FreeSurfer software (v. 6.0.0; http://surfer.nmr.mgh.harvard.edu) using the Destrieux (Fischl *et al.,* 2004), Desikan-Killiany (Desikan *et al*., 2006), and Desikan-Killiany-Tourville (Klein & Tourville, 2012) brain atlases, as well as subcortical volumes derived via the FreeSurfer aseg atlas (Fischl *et al*., 2002), are provided for 159 participants.

Brain-predicted age was calculated using multiple publicly shared algorithms and deep learning models which have been pretrained with cross-validation on of other external T1-weighted MRI datasets:

(1) Cole brainageR v1.0 and (2) Cole brainageR v2.0 both using Gaussian Processes regression described in detail on https://github.com/james-cole/brainageR and according to the GitHub description using similar but not identical methods as Cole, J. H., Leech, R., Sharp, D. J., & Initiative, A. D. N. (2015). Prediction of brain age suggests accelerated atrophy after traumatic brain injury. *Annals of Neurology*, *77*(4), 571–581. doi: 10.1002/ana.24367.

(3) **PMID:** 34086565 Cheng, J., Liu, Z., Guan, H., Wu, Z., Zhu, H., Jiang, J., … Liu, T. (2021). Brain Age Estimation From MRI Using Cascade Networks With Ranking Loss. *IEEE Transactions on Medical Imaging*, *40*(12), 3400–3412. doi: 10.1109/tmi.2021.3085948

Liu, Z., Cheng, J., Zhu, H., Zhang, J., & Liu, T. (2020). Medical Image Computing and Computer Assisted Intervention – MICCAI 2020, 23rd International Conference, Lima, Peru, October 4–8, 2020, Proceedings, Part VII. *Lecture Notes in Computer Science*, 198–207. doi: 10.1007/978-3-030-59728-3_20

(4) **PMID:** 36595679 Yin, C., Imms, P., Cheng, M., Amgalan, A., Chowdhury, N. F., Massett, R. J., … Fernandez, D. (2023). Anatomically interpretable deep learning of brain age captures domain-specific cognitive impairment. *Proceedings of the National Academy of Sciences*, *120*(2), e2214634120. doi: 10.1073/pnas.2214634120

Diffusion Weighted Imaging Measures

Measures derived from diffusion-weighted images are described below. A Stejskal-Tanner [J. Chem. Phys. 42, 288 (1965)] diffusion prepared spin echo EPI sequence was used with the following parameters: 74-75 x 2 mm axial slices, within plane field of view = 256mm x

256 mm, acquisition matrix 128 x 128 (readout R/L), partial Fourier encoding 62.5% and ASSET (SENSE) x 2. Additional parameters TR/TE = 8575 ms/Minimum. Six reference scans (b=0 s/mm^2) and three concentric shells (b=500 s/mm^2, b=800 s/mm^2, and b=2000 s/mm^2) were acquired with 9, 18, and 36 uniformly spread directions respectively. For details on processing procedures, see *M3_P5_INSTRUMENTS_20231219.*

The DWI data were used to estimate the diffusion kurtosis imaging (DKI) (Fieremans et al., 2011) model which was then used to extract the diffusion tensor imaging (DTI) (Alexander et al., 2011; Jones & Leemans, 2011; Le Bihan et al., 2001) as well as the white matter tract integrity (WMTI) (Fieremans et al., 2013; Jelescu et al., 2015) metrics. The DKI and WMTI measures were smoothed to address spatial discontinuities ('black holes') and underestimation bias in the kurtosis estimates. Similar to the tissue specific, smoothing-compensated (T-SPOON, Lee et al., 2009) approach used in DTI analysis, spatially adaptive smoothing was performed using a mask where mean kurtosis > 0.3. The DWI data were also used to fit the multi-tissue neurite orientation dispersion and density imaging (NODDI) (Adluru et al., 2014; Fick et al., 2019; Guerrero et al., 2019; H. Zhang et al., 2012) model and derive the corresponding metrics. Below is a brief summary of the different measures from these models.

DTI measures (Alexander et al., 2011) - The following metrics are widely used:

- **Fractional anisotropy (FA)** is the normalized standard deviation of the eigenvalues of the DTI. It is very sensitive to changes in white matter microstructure, but not very specific, as it can be influenced by changes in neurite density and dispersion among other factors. Lower FA is associated with aging.
- **Mean diffusivity (MD)** is the average diffusivity across the three principal directions. It is affected by both membrane density and fluid viscosity. Higher values of MD are associated with aging.
- **Radial diffusivity (RD)** measures diffusivity perpendicular to the axons. Higher values are associated with demyelination.
- **Axial diffusivity (AD)** measures diffusivity along the axons. AD is influenced by several factors, including axonal density, axonal diameter, and myelination, as well as the degree of water restriction along the fiber tract. Higher values of AD are associated with aging.

DKI measures (Jensen et al., 2005) - With higher diffusion weighting (b-values higher than 1000 s/mm^2), non-gaussian diffusion effects arise. Kurtosis represents the deviation of diffusion from a normal displacement distribution and is a measure of the heterogeneity of the diffusion environment (Jensen & Helpern, 2010). DKI provides measures such as

- **mean kurtosis (MK) -** mean of the excess kurtosis for all diffusion directions, indexes the complexity of tissue microstructure. It represents a direction-independent index of diffusional heterogeneity(Coutu et al., 2014).
- **radial kurtosis (RK) -** diffusional kurtosis averaged over its perpendicular directions.
- **axial kurtosis (AK) -** diffusional kurtosis in the principal diffusion direction

These measures show strong age-dependence, declining with old age with regional differences(Das et al., 2017) and have been shown to discriminate individuals with mild cognitive impairment from controls (Falangola et al., 2013).

WMTI measures (Fieremans et al., 2013; Fieremans et al., 2011) - DTI and DKI are both model-independent metrics that are not necessarily specific to biological changes. To enable interpretation, WMTI uses a two-compartment model (intra-axonal and extra-axonal space, IAS and EAS) yielding the following metrics:

- **Axonal water fraction (AWF):** lower values suggest reduction in axons potentially due to Wallerian degeneration after distal cortical atrophy.
- **Intra-axonal diffusivity (ias_Da):** intrinsic diffusivity within axons, may be a marker of axonal injury.
- **Extra-axonal radial diffusivity (eas_de_perp):** marker for changes in diffusion transverse to fibers due to myelin breakdown.
- **Extra-axonal tortuosity (eas_tort):** indirect measure of myelinated axonal fraction/myelin density; higher values for lower EAS volume fraction

NODDI measures (Adluru et al., 2014; Fick et al., 2019; Guerrero et al., 2019; H. Zhang et al., 2012) - The NODDI approach uses a multi-compartment model and allows estimation of the following metrics:

- **Neurite density index (NDI)** is an indicator of myelination and axonal integrity (Nazeri et al., 2020). Lower NDI is suggestive of demyelinating processes, potentially including neuronal loss.
- **Orientation dispersion index (ODI)** indicates the spread of neurites (dendrites and axons). Higher ODI in white matter may reflect axonal disorganization with aging (Billiet et al., 2015).
- **Fraction of isotropic diffusion (FISO or CSF)** is indicative of free water or cerebrospinal fluid (CSF) content. Higher values are associated with aging (Billiet et al., 2015).

For 153 participants, median (or weighted median for the IIT v5.0 regions) estimates of DWI-based metrics are provided for

- global summary of the major tissue types (white matter, gray matter, and cerebrospinal fluid)
- tract-specific measures extracted using
    - the JHU ICBM-DTI-81 (http://cmrm.med.jhmi.edu/; Hua et al., 2008; Mori et al., 2008; Wakana et al., 2007) with FSL v6.0.4 (https://fsl.fmrib.ox.ac.uk/fsl/fslwiki/Atlases),
    - IIT v5.0 (https://www5.iit.edu/~mri/IITHumanBrainAtlas.html; Qi & Arfanakis, 2021; S. Zhang & Arfanakis, 2018) white-matter atlases
- the Harvard-Oxford Subcortical Atlas (Makris et al., 2006; Frazier et al., 2005; Desikan et al., 2006; Goldstein et al., 2007) regions with a 50% probability threshold with FSL v6.0.4

BRAIN MEASURES: VARIABLE NAMING

<u>Scan type:</u>

[C5E]: T1-weighted (Extracted structural measures)

[C5W]: Diffusion-weighted (Extracted diffusion weighted imaging measures)

<u>Measurement type:</u>

[C5EB]: Brain-Predicted Age (yrs)

[C5ET]: Cortical Thickness (mm)

[C5EC]: Cortical Curvature (mm)

[C5EA]: Cortical Surface Area (mm^2)

[C5EV]: Cortical Volume (mm^3)

[C5ES]: Subcortical Volume (mm^3)

[C5WF]: Fractional Anisotropy (FA)

[C5WM]: Mean Diffusivity (MD)

[C5WR]: Radial Diffusivity (RD)

[C5WA]: Axial Diffusivity (AD)

[C5WN]: Mean Kurtosis (MK)

[C5WS]: Radial Kurtosis (RK)

[C5WB]: Axial Kurtosis (AK)

[C5WX]: Axonal Water Fraction (AWF)

[C5WI]: Intra-axonal diffusivity (ias_Da)

[C5WP]: Extra-axonal radial diffusivity (eas_de_perp)

[C5WT]: Extra-axonal tortuosity (eas_tort)

[C5WD]: Neurite density index (NDI)

[C5WV]: Orientation dispersion index (ODI)

[C5WC]: Fraction of isotropic diffusion (FISO or CSF)

Hemisphere: Note that '*X*' represents any one of the measurement variables listed above.

[C5*XX*G]: Measurement is global (encompasses entire brain)

[C5*XX*L]: Measurement is specific to left hemisphere

[C5*XX*R]: Measurement is specific to right hemisphere

[C5*XX*N]: Not applicable; measurement is bilateral

Atlas: Note that '*X*' represents any one of the measurement and hemisphere variables listed above.

[C5E*XX*D]: Measurement calculated using Destrieux brain atlas (Fischl *et al.,* 2004).

[C5E*XX*K]: Measurement calculated using Desikan-Killiany brain atlas (Desikan *et al*., 2006).

[C5E*XX*T]: Measurement calculated using Desikan-Killiany-Tourville brain atlas (Klein & Tourville, 2012).

[C5E*XX*A]: Measurement calculated using FreeSurfer aseg subcortical brain atlas (Fischl *et al*., 2002) or Hippocampal Subfield (Iglesias et al., 2015) and Amygdala Nuclei (Saygin & Kliemann et al., 2017) module.

[C5W*XX*H]: Measurement calculated using Harvard-Oxford subcortical structural atlas (Makris et al., 2006; Frazier et al., 2005; Desikan et al., 2006; Goldstein et al., 2007).

[C5W*XX*K]: Measurement calculated using IIT v5.0 white matter atlas (Qi & Arfanakis, 2021; S. Zhang & Arfanakis, 2018).

[C5W*XX*J]: Measurement calculated using JHU white matter atlas (Hua *et al*., 2008; Mori *et al*., 2008; and Wakana *et al*., 2007).

FULL MEASUREMENT NAMES (DESTRIEUX CORTICAL ATLAS)

Variable Label (from SPSS file)	Full Name of Parcellation
G_and_S_frontomargin	Fronto-marginal gyrus (of Wernicke) and sulcus
G_and_S_occipital_inf	Inferior occipital gyrus (O3) and sulcus
G_and_S_paracentral	Paracentral lobule and sulcus
G_and_S_subcentral	Subcentral gyrus (central operculum) and sulci
G_and_S_transv_frontopol	Transverse frontopolar gyri and sulci
G_and_S_cingul-Ant	Anterior part of the cingulate gyrus and sulcus (ACC)
G_and_S_cingul-Mid-Ant	Middle-anterior part of the cingulate gyrus and sulcus (aMCC)
G_and_S_cingul-Mid-Post	Middle-posterior part of the cingulate gyrus and sulcus (pMCC)
G_cingul-Post-dorsal	Posterior-dorsal part of the cingulate gyrus (dPCC)
G_cingul-Post-ventral	Posterior-ventral part of the cingulate gyrus (vPCC, isthmus of the cingulate gyrus)
G_cuneus	Cuneus (O6)
G_front_inf-Opercular	Opercular part of the inferior frontal gyrus
G_front_inf-Orbital	Orbital part of the inferior frontal gyrus
G_front_inf-Triangul	Triangular part of the inferior frontal gyrus
G_front_middle	Middle frontal gyrus (F2)
G_front_sup	Superior frontal gyrus (F1)
G_Ins_lg_and_S_cent_ins	Long insular gyrus and central sulcus of the insula
G_insular_short	Short insular gyri
G_occipital_middle	Middle occipital gyrus (O2, lateral occipital gyrus)
G_occipital_sup	Superior occipital gyrus (O1)
G_oc-temp_lat-fusifor	Lateral occipito-temporal gyrus (fusiform gyrus, O4-T4)
G_oc-temp_med-Lingual	Lingual gyrus, ligual part of the medial occipito-temporal gyrus, (O5)
G_oc-temp_med-Parahip	Parahippocampal gyrus, parahippocampal part of the medial occipito-temporal gyrus, (T5)
G_orbital	Orbital gyri
G_pariet_inf-Angular	Angular gyrus
G_pariet_inf-Supramar	Supramarginal gyrus
G_parietal_sup	Superior parietal lobule (lateral part of P1)
G_postcentral	Postcentral gyrus
G_precentral	Precentral gyrus
G_precuneus	Precuneus (medial part of P1)
G_rectus	Straight gyrus, Gyrus rectus
G_subcallosal	Subcallosal area, subcallosal gyrus
G_temp_sup-G_T_transv	Anterior transverse temporal gyrus (of Heschl)
G_temp_sup-Lateral	Lateral aspect of the superior temporal gyrus
G_temp_sup-Plan_polar	Planum polare of the superior temporal gyrus
G_temp_sup-Plan_tempo	Planum temporale or temporal plane of the superior temporal gyrus
G_temporal_inf	Inferior temporal gyrus (T3)
G_temporal_middle	Middle temporal gyrus (T2)
Lat_Fis-ant-Horizon	Horizontal ramus of the anterior segment of the lateral sulcus (or fissure)

Lat_Fis-ant-Vertical	Vertical ramus of the anterior segment of the lateral sulcus (or fissure)
Lat_Fis-post	Posterior ramus (or segment) of the lateral sulcus (or fissure)
Pole_occipital	Occipital pole
Pole_temporal	Temporal pole
S_calcarine	Calcarine sulcus
S_central	Central sulcus (Rolando's fissure)
S_cingul-Marginalis	Marginal branch (or part) of the cingulate sulcus
S_circular_insula_ant	Anterior segment of the circular sulcus of the insula
S_circular_insula_inf	Inferior segment of the circular sulcus of the insula
S_circular_insula_sup	Superior segment of the circular sulcus of the insula
S_collat_transv_ant	Anterior transverse collateral sulcus
S_collat_transv_post	Posterior transverse collateral sulcus
S_front_inf	Inferior frontal sulcus
S_front_middle	Middle frontal sulcus
S_front_sup	Superior frontal sulcus
S_interm_prim-Jensen	Sulcus intermedius primus (of Jensen)
S_intrapariet_and_P_trans	Intraparietal sulcus (interparietal sulcus) and transverse parietal sulci
S_oc_middle_and_Lunatus	Middle occipital sulcus and lunatus sulcus
S_oc_sup_and_transversal	Superior occipital sulcus and transverse occipital sulcus
S_occipital_ant	Anterior occipital sulcus and preoccipital notch (temporo-occipital incisure)
S_oc-temp_lat	Lateral occipito-temporal sulcus
S_oc-temp_med_and_Lingual	Medial occipito-temporal sulcus (collateral sulcus) and lingual sulcus
S_orbital_lateral	Lateral orbital sulcus
S_orbital_med-olfact	Medial orbital sulcus (olfactory sulcus)
S_orbital-H_Shaped	Orbital sulci (H-shaped sulci)
S_parieto_occipital	Parieto-occipital sulcus (or fissure)
S_pericallosal	Pericallosal sulcus (S of corpus callosum)
S_postcentral	Postcentral sulcus
S_precentral-inf-part	Inferior part of the precentral sulcus
S_precentral-sup-part	Superior part of the precentral sulcus
S_suborbital	Suborbital sulcus (sulcus rostrales, supraorbital sulcus)
S_subparietal	Subparietal sulcus
S_temporal_inf	Inferior temporal sulcus
S_temporal_sup	Superior temporal sulcus (parallel sulcus)
S_temporal_transverse	Transverse temporal sulcus

FULL MEASUREMENT NAMES (DESIKAN-KILLIANY CORTICAL ATLAS)

Variable Label (from SPSS file)	Full Name of Parcellation
Bankssts	Banks superior temporal sulcus
caudalanteriorcingulate	Caudal anterior-cingulate cortex
caudalmiddlefrontal	Caudal middle frontal gyrus
Cuneus	Cuneus cortex
Entorhinal	Entorhinal cortex
Fusiform	Fusiform gyrus
inferiorparietal	Inferior parietal cortex
inferiortemporal	Inferior temporal gyrus
isthmuscingulate	Isthmus– cingulate cortex
lateraloccipital	Lateral occipital cortex
lateralorbitofrontal	Lateral orbital frontal cortex
lingual	Lingual gyrus
medialorbitofrontal	Medial orbital frontal cortex
middletemporal	Middle temporal gyrus
parahippocampal	Parahippocampal gyrus
paracentral	Paracentral lobule
parsopercularis	Pars opercularis
parsorbitalis	Pars orbitalis
parstriangularis	Pars triangularis
pericalcarine	Pericalcarine cortex
postcentral	Postcentral gyrus
posteriorcingulate	Posterior-cingulate cortex
precentral	Precentral gyrus
precuneus	Precuneus cortex
rostralanteriorcingulate	Rostral anterior cingulate cortex
rostralmiddlefrontal	Rostral middle frontal gyrus
superiorfrontal	Superior frontal gyrus
superiorparietal	Superior parietal cortex
superiortemporal	Superior temporal gyrus
supramarginal	Supramarginal gyrus
temporalpole	Temporal pole
transversetemporal	Transverse temporal cortex
insula	Insula

FULL MEASUREMENT NAMES (DESIKAN-KILLIANY-TOURVILLE – DKT - CORTICAL ATLAS)

Variable Label (from SPSS file)	Full Name of Parcellation
caudalanteriorcingulate	Caudal anterior-cingulate cortex
caudalmiddlefrontal	Caudal middle frontal gyrus
cuneus	Cuneus cortex
entorhinal	Entorhinal cortex
fusiform	Fusiform gyrus
inferiorparietal	Inferior parietal cortex
inferiortemporal	Inferior temporal gyrus
isthmuscingulate	Isthmus– cingulate cortex
lateraloccipital	Lateral occipital cortex
lateralorbitofrontal	Lateral orbital frontal cortex
lingual	Lingual gyrus
medialorbitofrontal	Medial orbital frontal cortex
middletemporal	Middle temporal gyrus
parahippocampal	Parahippocampal gyrus
paracentral	Paracentral lobule
parsopercularis	Pars opercularis
parsorbitalis	Pars orbitalis
parstriangularis	Pars triangularis
pericalcarine	Pericalcarine cortex
postcentral	Postcentral gyrus
posteriorcingulate	Posterior-cingulate cortex
precentral	Precentral gyrus
precuneus	Precuneus cortex
rostralanteriorcingulate	Rostral anterior cingulate cortex
rostralmiddlefrontal	Rostral middle frontal gyrus
superiorfrontal	Superior frontal gyrus
superiorparietal	Superior parietal cortex
superiortemporal	Superior temporal gyrus
supramarginal	Supramarginal gyrus
transversetemporal	Transverse temporal cortex
insula	Insula

FULL MEASUREMENT NAMES (ASEG SUBCORTICAL ATLAS)

Variable Label (from SPSS file)	Full Name of Parcellation
Lateral-Ventricle	Lateral Ventricle
Inf-Lat-Vent	Inferior Lateral Ventricle
Cerebellum-White-Matter	Cerebellum White Matter
Cerebellum-Cortex	Cerebellum Cortex
Thalamus-Proper	Thalamus
Caudate	Caudate
Putamen	Putamen
Pallidum	Pallidum
Hippocampus	Hippocampus
Amygdala	Amygdala
Accumbens-area	Accumbens Area
VentralDC	Ventral Diencephalon
vessel	vessel (non-specific)
3rd-Ventricle	Third Ventricle
4^{th}-Ventricle	Fourth Ventricle
Brain-Stem	Brain Stem
CSF	Cerebrospinal Fluid
choroid-plexus	Choroid Plexus
CortexVol	Cortical Gray Matter Volume
CorticalWhiteMatterVol	Cortical White Matter Volume
SurfaceHoles	Number of defect holes in surfaces prior to fixing
BrainSegVol	Brain Segmentation Volume
BrainSegVol-to-eTIV	Ratio of BrainSegVol to eTIV
BrainSegVolNotVent	Brain Segmentation Volume Without Ventricles
BrainSegVolNotVentSurf	Brain Segmentation Volume Without Ventricles from Surf
CC_Anterior	Anterior Corpus Callosum
CC_Central	Central Corpus Callosum
CC_Mid_Anterior	Mid-Anterior Corpus Callosum
CC_Mid_Posterior	Mid-Posterior Corpus Callosum
CC_Posterior	Posterior Corpus Callosum
EstimatedTotalIntraCranialVol	Estimated Total Intracranial Volume
MaskVol	Mask Volume
MaskVol-to-eTIV	Ratio of MaskVol to eTIV
Optic-Chiasm	Optic Chiasm

SubCortGrayVol	Subcortical Gray Matter Volume
SupraTentorialVol	Supratentorial Volume
SupraTentorialVolNotVent	Supratentorial Volume Without Ventricles
SupraTentorialVolNotVentVox	Supratentorial Volume Voxel Count
TotalGrayVol	Total Gray Matter Volume

FULL MEASUREMENT NAMES (AMYGDALA ATLAS)

Variable Label (from SPSS file)	Full Name of Parcellation
Lateral-nucleus	Lateral nucleus
Basal-nucleus	Basal nucleus
Accessory-basal-nucleus	Accessory basal nucleus
Anterior-amygdaloid-area-AAA	Anterior amygdaloid area
Central-nucleus	Central nucleus
Medial-nucleus	Medial nucleus
Cortical-nucleus	Cortical nucleus
Corticoamygdaloid-transitio	Corticoamygdaloid transition area
Paralaminar-nucleus	Paralaminar nucleus
Whole_amygdala	Amygdala

FULL MEASUREMENT NAMES (HIPPOCAMPUS ATLAS)

Variable Label (from SPSS file)	Full Name of Parcellation
Hippocampal_tail	Hippocampal tail
Subiculum-body	Subiculum (body)
CA1-body	Cornu ammonis 1 (body)
Subiculum-head	Subiculum (head)
Hippocampal-fissure	Hippocampal fissure
Presubiculum-head	Presubiculum (head)
CA1-head	Cornu ammonis 1 (head)
Presubiculum-body	Presubiculum (body)
Parasubiculum	Parasubiculum
Molecular_layer_HP-head	Molecular layer (head)
Molecular_layer_HP-body	Molecular layer (body)
GC-ML-DG-head	Granule cell (GC) and molecular layer (ML) of the dentate gyrus (DG) (head)
CA3-body	Cornu ammonis 3 (body)
GC-ML-DG-body	Granule cell (GC) and molecular layer (ML) of the dentate gyrus (DG) (body)

CA4-head	Cornu ammonis 4 (head)
CA4-body	Cornu ammonis 4 (body)
Fimbria	Fimbria
CA3-head	Cornu ammonis 3 (head)
CA4-head	Cornu ammonis 4 (head)
CA4-body	Cornu ammonis 4 (body)
Fimbria	Fimbria
CA3-head	Cornu ammonis 3 (head)
HATA	Hippocampus-amygdala-transition-area
Whole_hippocampal_body	Hippocampal body
Whole_hippocampal_head	Hippocampal head
Whole_hippocampus	Hippocampus

FULL MEASUREMENT NAMES (JHU WHITE MATTER BUNDLES ATLAS)

Variable Label (from SPSS file)	Full Name of Parcellation
Anterior_corona_radiata	Anterior corona radiata
Anterior_limb_of_internal_capsule	Anterior limb of internal capsule
Cerebral_peduncle	Cerebral peduncle
Cingulum_(cingulate_gyrus)	Cingulum (cingulate gyrus)
Cingulum_(hippocampus)	Cingulum (hippocampus)
Corticospinal_tract	Corticospinal tract
External_capsule	External capsule
Fornix_(cres)_-_Stria_terminalis_ (can_not_be_resolved_with_current_resolution)	Fornix (cres) / Stria terminalis (cannot be resolved with current resolution)
Inferior_cerebellar_peduncle	Inferior cerebellar peduncle
Medial_lemniscus	Medial lemniscus
Posterior_corona_radiata	Posterior corona radiata
Posterior_limb_of_internal_capsule	Posterior limb of internal capsule
Posterior_thalamic_radiation_(include_ optic_radiation)	Posterior thalamic radiation (includes optic radiation)
Retrolenticular_part_of_internal_capsule	Retrolenticular part of internal capsule
Sagittal_stratum_(include_inferior_longitidinal _fasciculus_and_inferior_fronto-occipital_fasciculus)	Sagittal stratum (includes inferior longitudinal fasciculus and inferior fronto-occipital fasciculus)
Superior_cerebellar_peduncle	Superior cerebellar peduncle
Superior_corona_radiata	Superior corona radiata
Superior_fronto-occipital_fasciculus_ (could_be_a_part_of_anterior_internal_capsule)	Superior fronto-occipital fasciculus (could be a part of anterior internal capsule)

Superior_longitudinal_fasciculus	Superior longitudinal fasciculus
Tapetum	Tapetum
Uncinate_fasciculus	Uncinate fasciculus
Body_of_corpus_callosum	Body of corpus callosum
Fornix_(column_and_body_of_fornix)	Fornix (column and body of fornix)
Genu_of_corpus_callosum	Genu of corpus callosum
Middle_cerebellar_peduncle	Middle cerebellar peduncle
Pontine_crossing_tract_(a_part_of_MCP)	Pontine crossing tract (a part of MCP)
Splenium_of_corpus_callosum	Splenium of corpus callosum

FULL MEASUREMENT NAMES (IIT V5.0 WHITE MATTER BUNDLES ATLAS)

Variable Label (from SPSS file)	Full Name of Parcellation
Anterior_commissure	Anterior commissure
Arcuate_fasciculus	Arcuate fasciculus
Frontal_aslant_tract	Frontal aslant tract
Cingulum	Cingulum
Corpus_callosum	Corpus callosum
Forceps_major	Forceps major
Forceps_minor	Forceps minor
Middle_corpus_callosum	Middle corpus callosum
Corticospinal_tract	Corticospinal tract
Fornix	Fornix
Frontopontine	Frontopontine
Inferior_cerebellar_peduncle	Inferior cerebellar peduncle
Inferior_frontooccipital_fasciculus	Inferior frontooccipital fasciculus
Inferior_longitudinal_fasciculus	Inferior longitudinal fasciculus
Middle_cerebellar_peduncle	Middle cerebellar peduncle
Middle_longitudinal_fasciculus	Middle longitudinal fasciculus
Medial_lemniscus	Medial lemniscus
Occipitopontine_tract	Occipitopontine tract
Optic_radiation	Optic radiation
Parietopontine_tract	Parietopontine tract
Superior_cerebellar_peduncle	Superior cerebellar peduncle
Superior_longitudinal_fasciculus	Superior longitudinal fasciculus
Spinothalamic_tract	Spinothalamic tract
Uncinate_fasciculus	Uncinate fasciculus
Vertical_occipital_fasciculus	Vertical occipital fasciculus

FULL MEASUREMENT NAMES (HARVARD-OXFORD SUBCORTICAL STRUCTURAL ATLAS)

Variable Label (from SPSS file)	Full Name of Parcellation
Amygdala	Amygdala
Caudate	Caudate
Cerebral Cortex	Cerebral Cortex
Hippocampus	Hippocampus
Accumbens	Nucleus Accumbens
Pallidum	Pallidum
Putamen	Putamen
Thalamus	Thalamus
Cerebral White Matter	Cerebral White Matter

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