DOCUMENTATION

of

BRAIN MEASURES

in

MIDUS Refresher
Neuroscience Project (P5)

University of Wisconsin ♦ Center for Healthy Minds
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INTRODUCTION

This document is a reference for the extracted structural and diffusion brain measures in the MIDUS Refresher Neuroscience Project data sets and includes information regarding the Neuroscience Project's (P5) MIDUS Refresher MRI data collection and processing protocols. Partial variable names have been provided where appropriate. For more detailed information on variable names and data collection procedures, please see (*MR_P5_VARIABLE_NAMES_08-02-19.doc* and *MR_P5_MEMO_README_20190802.doc*). Raw MRI data (including structural, task functional, resting functional, diffusion-weighted imaging, and resting perfusion) are available through a separate data sharing mechanism by contacting Stacey Schaefer at stacey.schaefer@wisc.edu and Barry Radler at bradler@wisc.edu.

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 *MR_P5_DOCUMENTATION_OF_PSYCHOPHYSIOLOGY-08-02-19.doc* 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 an 8-channel head coil. In total, the scanning protocol had a duration of approximately 70 minutes and included the acquisition of a BRAVO T1-weighted scan, field map images, 3 functional scans/EPIs, a resting-state scan, a diffusion-weighted scan, an arterial spin labeling scan, as well as a second BRAVO T1-weighted scan when circumstances allowed. Questionnaire data, including PANAS-NOW and STAI-State, both prior to and after the scanning procedure, has been provided as well.

T1w-Derived Structural Brain Measurements & Brain-Predicted Age

Measures derived from BRAVO T1-weighted structural images with 1-mm 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 *MR_P5_INSTRUMENTS_08-02-19.doc*.

Measures of cortical thickness, curvature, surface area, and volume calculated via FreeSurfer software (v. 5.3.0; http://surfer.nmr.mgh.harvard.edu) using both the Destrieux (Fischl *et al.,* 2004) and Desikan-Killiany (Desikan *et al.*, 2006) brain atlases, as well as subcortical volumes derived via the FreeSurfer aseg atlas (Fischl *et al.*, 2002), are provided for 127 participants. Brain-predicted age was also calculated for the same 127 participants (Cole *et al.,* 2018; Cole *et al.,* 2017; Cole & Franke, 2017; Cole *et al.,* 2015; https://github.com/james-cole/brainageR). The Waisman Brain Imaging MRI scanner was updated between MIDUS2 and MIDUS Refresher; due to limitations in scan quality at the time of data collection, the MIDUS2 structural data was of insufficient quality, therefore the Refresher wave represents the first instance of these measures. In some cases, data could not be collected due to claustrophobia, back problems, or other issues that prevented the participant from completing the scan. Additionally, a small number of scans contained artifacts that made accurate structural measurements unfeasible. In these cases, the appropriate missing value was listed. (See *MR_P5_MEMO_README_20190802.doc* and *MR_P5_DOCUMENTATION_OF_SCALES_08-02-19.doc* for further information on missing values).

Diffusion Tensor 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: 65 x 2 mm axial slices with in 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 = 7000ms/68.7ms. Four reference scans (b=0 s/mm^2) and two concentric shells (b=400 s/mm^2 and b=1200s/mm^2) were acquired with 6

and 70 directions respectively. For details on processing procedures, see *MR_P5_INSTRUMENTS_08-02-19.doc.*

Measures of fractional anisotropy (FA), corresponding to a summary measure of microstructural integrity, mean diffusivity (MD), corresponding to an inverse measure of the membrane density, radial diffusivity (RD), which can represent de/dis-myelination and axonal diameters, and axial diffusivity (AD), which can represent brain maturation, were calculated. Global values for the four DTI-based metrics are provided for 118 participants, along with tract-specific measures extracted using both the JHU ICBM-DTI-81 v. 1.0 (http://cmrm.med.jhmi.edu/, Hua et al. 2008, Mori et al. 2005, and Wakana et al. 2007) with fsl v. 5.0.11 (https://fsl.fmrib.ox.ac.uk/fsl/fslwiki/Atlases), and IIT v. 4.1 (http://www.iit.edu/~mri/IITHumanBrainAtlas.html, Zhang & Arfanakis 2018) DTI-based white-matter atlases. Measures derived from population-based manual tractography are also provided. For publication of the DTI processing, see Pedersen et al., 2021. Diffusion-weighted scanning was not performed at MIDUS2, therefore the Refresher wave represents the first instance of these measures. In some cases, data could not be collected due to claustrophobia, back problems, or other issues that prevented the participant from completing the scan. In these cases, the appropriate missing value was listed. (See *MR_P5_MEMO_README_20190802.doc* and *MR_P5_DOCUMENTATION_OF_SCALES_08-02-19.doc* for further information on missing values).

STRUCTURAL BRAIN MEASURES: VARIABLE NAMING

Scan type:

[RA5E]: T1-weighted (Extracted structural measures)

[RA5W]: Diffusion-weighted (Extracted diffusion Tensor Imaging measures)

Measurement type:

[RA5EB]: Brain-Predicted Age (yrs).

[RA5ET]: Cortical Thickness (mm).

[RA5EC]: Cortical Curvature (mm).

[RA5EA]: Cortical Surface Area (mm^2).

[RA5EV]: Cortical Volume (mm^3)

[RA5ES]: Subcortical Volume (mm^3)

[RA5WF]: Fractional Anisotropy (FA)

[RA5WM]: Mean Diffusivity (MD)

[RA5WR]: Radial Diffusivity (RD)

[RA5WA]: Axial Diffusivity (AD)

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

[RA5*XX*G]: Measurement is global (encompasses entire brain)

[RA5*XX*L]: Measurement is specific to left hemisphere

[RA5*XX*R]: Measurement is specific to right hemisphere

[RA5*XX*N]: Not applicable; measurement is bilateral.

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

[RA5E*XX*D]: Measurement calculated using Destrieux brain atlas (Fischl *et al.,* 2004).

[RA5E*XX*K]: Measurement calculated using Desikan-Killiany brain atlas (Desikan *et al*.,
2006).

[RA5E*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.

[RA5W*XX*I]: Measurement calculated using IIT white matter atlas (Zhang & Arfanakis, 2018).

[RA5W*XX*J]: Measurement calculated using JHU white matter atlas (Hua *et al*., 2008; Mori *et al*., 2005; and Wakana *et al*., 2007).

 [RA5W*XX*T]: Measurement calculated using manual tractography.

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 (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
4th-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

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