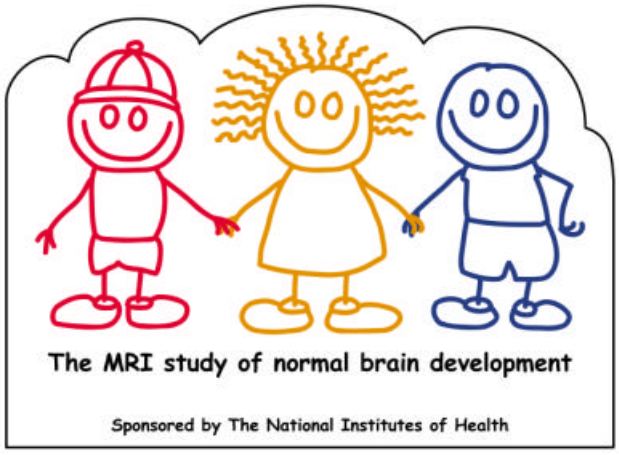
The MRI Study of
Normal Brain Development

MRI PROCEDURE MANUAL



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INTRODUCTION

A copy of this MRI Procedure Manual has been distributed to each site participating in this study. Please note that the scope of this manual is restricted to the acquisition and transfer of MRI data only. Other aspects of the study are covered in their respective documents.

Important Points

- All participating sites will be using either a GE or Siemens scanner. The acquisition details in this manual are provided separately for each type of scanner. Please ensure that you use the appropriate protocols for your site.
- **Ensure that scans are properly labeled**.
- Ensure you are sending the correct dataset and that it is of acceptable quality. **All MRI data should undergo a visual QC at the site prior to being transferred.**
- Please complete an MRI Parameter Form for each scan and fax it to the attention of Rozie Arnaoutelis at the DCC (fax: 514-221-2229). Please file it for future reference. This will serve as an important source of information in the event of queries.
- All imaging data will be reviewed at the DCC in Montreal. Sites will be notified whether the scans are acceptable or need to be repeated. Depending on the age of the subject, repeating a scan at a significantly later date may require the re-administration of behavioral/clinical procedures as well. **For this reason, it is important that imaging data be transferred to the DCC as soon as possible.**
- Sites should alert the DCC beforehand when they are about to send data that is questionable. The scans can then be flagged and reviewed as a priority at the DCC.

Study Overview

The purpose of **The MRI Study of Normal Brain Development** is to collect a representative sample of normal, healthy infants and children for a magnetic resonance imaging study that will serve two purposes: 1) to provide the largest normative database to date of the developing human brain for comparison with brain scan studies of children with neurological, developmental, and psychiatric disorders; and 2) provide longitudinal data for investigating brain maturation in relationship to behavioral and cognitive development in a normal sample. Such data will allow a greater understanding of deviations in brain structural development associated with pediatric brain disorders.

The study involves six sites or Pediatric Study Centers (PSC) in the United States, a Clinical Coordinating Center (CCC) in St. Louis, MO, USA and a Data Coordinating Center (DCC) in Montreal, QC, Canada. Approximately 546 children, ages 0 through 18 years 3 months (at first scan) will be recruited and studied using anatomic magnetic resonance imaging (aMRI), diffusion tensor imaging (DTI), magnetic resonance spectroscopy (MRS) and behavioral testing at three (or more) different time points over a five to six year period.

Objectives

The MRI Study of Normal Brain Development has two main objectives and two ancillary objectives.

Objective 1: Anatomic MRI and cognitive/behavioral cross-sectional and longitudinal studies of children between the ages 4 years, 6 months and 18 years, 3 months (at time of first scan).

Objective 2: Anatomic MRI and cognitive/behavioral cross-sectional and longitudinal studies of children between the age of newborn and 4 years, 6 months (at time of first scan).

Ancillary A: MR Spectroscopy (MRS) of children between the ages of newborn to 18 years, 3 months (at time of first scan). May include MRSI at specific sites.

Ancillary B: Diffusion Tensor Imaging (DTI) of children between the ages of newborn and 4 years, 6 months (at time of first scan). However this was broadened to include subjects of all ages. An expanded DTI (eDTI) protocol was developed and acquisitions began in the spring of 2006.

Pediatric Study Centers (PSC) and Objectives

Table 1: PSCs, Objectives and Ancillary Studies

PSC	Objective 1	Objective 2	Ancillary A MRS/MRSI	Ancillary B DTI	
				Standard DTI	Expanded DTI
Boston	x	x	x	x	x
Cincinnati	x			x	
Houston	x				
Irvine‡	x‡				
Los Angeles	x		x	x	
Philadelphia	x	x†	x	x	x
St. Louis 1	x			x	x
St. Louis 2		x		x	x

‡ Irvine (since discontinued as a site) initially recruited subjects who were subsequently followed at the UCLA site
† Philadelphia initially recruited some Objective 2 subjects who were discontinued

Subject Identifiers

Each candidate is assigned two identifiers, the DCC-ID and the PSC-ID, which will be used throughout the study to identify that subject. The **DCC-ID** is a six-digit number randomly assigned by the database (e.g. 654321). The **PSC-ID** consists of the Site ID and a four-digit number randomly assigned by the database (e.g. cin2345). This information will be provided to the MR technologist by the principal investigator or the coordinator on a completed **MR Technologist's Form**.

In order to preserve subject confidentiality, all imaging data should be identified by assigned DCC-ID, PSC-ID and the subject's date of birth *ONLY*.

Site Identifiers

SITE	Site ID
Boston	bos
Cincinnati	cin
Houston	hou
Los Angeles (UCLA)	ucl
Philadelphia	phi
St. Louis – Objective 1	st1
St. Louis – Objective 2	st2

IMAGING DATA IDENTIFICATION PROCEDURES

I. Purpose

These procedures have been developed to ensure that all of the imaging data collected for the NIHPD project are properly identified. These procedures are crucial to the success of the project since none of the data stored in the DCC (Data Coordinating Center) database can contain any patient identifiers such as names, initials, or hospital ID's. To prevent any of the imaging data from being orphaned and unidentifiable, it is essential that all data sent to the DCC are properly labeled with the identifiers established for this project (DCC-ID, PSC-ID, and visit number). Additionally, each series from a study must be properly labeled by sequence type. Finally, all of these identifiers must be stored in a consistent manner across sites to ensure that all of the data can be processed in the same manner regardless of which PSC (Pediatric Study Center) collected the data. The methods described below will ensure that every file containing imaging data will be properly labeled and easily identifiable.

II. New Imaging Data Collection

All imaging data collected from this point forward must use the system and methods described below to label every image from every MRI study. Data not properly labeled in the manner prescribed will require corrective action on the part of the PSC.

a) Scan Identifiers

Subject Scans:

The following three subject identifiers must be stored in the ***Patient Name*** field of every subject image: PSC-ID + DCC-ID + visit number. These identifiers must be entered consecutively separated by an underscore in the following manner:

e.g. BOS9876_123456_V1

where the PSC-ID is bos9876, the DCC-ID is 123456, and this scan corresponds to the first visit for this subject. This key should be the only information stored in the Patient Name field.

ACR Phantom Scans:

The ACR phantom scans should have the following label entered in the ***Patient Name*** field: ACR_PHANTOM_PSC_YYYYMMDD where PSC is the 3-character abbreviation for your site (same as the 3 characters in a candidate's PSC-ID), YYYY is the 4-digit year, MM the 2-digit month, and DD is the 2-digit day.

e.g. ACR_PHANTOM_BOS_20030131

Living Phantom Scans:
The scans of the living phantom should have the following label entered as the ***Patient Name*** field: LIVING_PHANTOM_PSC_YYYYMMDD where PSC is the 3-character abbreviation for your site (same as the 3 characters in a candidate's PSC-ID), YYYY is the 4-digit year, MM the 2-digit month, and DD is the 2-digit day.

e.g. LIVING_PHANTOM_BOS_20030131

DTI Phantom Scans:
The scans of the DTI phantom should have the following label entered as the ***Patient Name*** field: DTI_PHANTOM_PSC_YYYYMMDD where PSC is the 3-character abbreviation for your site (same as the 3 characters in a candidate's PSC-ID), YYYY is the 4-digit year, MM the 2-digit month, and DD is the 2-digit day.

e.g. DTI_PHANTOM_BOS_20030131

MRI Test Scans:
Occasionally a site may need to acquire data on a volunteer (e.g. scanner upgrade, trouble-shooting). These scans should have the following label entered as the ***Patient Name*** field: MRI_TEST_PSC_YYYYMMDD where PSC is the 3-character abbreviation for your site (same as the 3 characters in a candidate's PSC-ID), YYYY is the 4-digit year, MM the 2-digit month, and DD is the 2-digit day.

e.g. MRI_TEST_BOS_20030131

Repeat & Multiple Scans for a Single Subject Visit:
Repeat and/or multiple scans corresponding to a single subject visit no longer need to be designated as such by adding the R1, R2… suffix at the end of the label. As long as the dataset is properly labeled as per the instructions above, all data corresponding to a single time point will be grouped together.

b) Sequence/Series Identifiers

Information identifying each MRI sequence must be stored in the Series Description field of every image from the same sequence. Appendix A lists the labels that should be used for each sequence. These labels should be the only information stored in the Series Description field.

c) MRS/MRSI Raw Data Files

The raw data files generated by the MRS and MRSI sequences need to be manually transferred from the scanner to the SWS. The filenames for these files should follow the conventions defined in Appendix B.

III. Existing Imaging Data

All of the existing imaging data will must have the Patient Name field relabeled at the scanner console at each PSC. All sites are required to relabel the Patient Name field in accordance with the Scan Identifiers defined in section II.a) (see above). After an existing study has been relabeled as described, it must be resent via the DICOM transfer mechanism to the SWS (Study Workstation).

IV. Quality Control

Upon completion and installation of the quality control software, all data will need to be rated by the PI at each PSC identifying those scans that should and should not be sent to the DCC. This procedure will supplant the existing automatic transfer of data from the PSC's SWS to the DCC. After the study has been transferred from the scanner to the SWS via the DICOM transfer mechanism each PI will need to review each scan at the SWS, rate the scan, and add it to the send queue if it meets the quality standards defined by the MNI. Further details on the use of this tool and the quality standards will forthcoming in additional procedure manuals.

V. Concurrence

These procedures were developed with input from the PSC's in two series of email discussions and in a series of PI conference calls. Several email discussions and tests were conducted in June 2002 with Tomoyuki (Tom) Nishino representing the St. Louis Objective 1 PSC (Botteron) and the DCC. Input from all of the PSC's was elicited by Rozie Arnaoutelis of the DCC in an email on October 16, 2002. Responses to that request were obtained from Boston, Philadelphia, and St Louis (Objective 2, McKinstry). An additional survery of all sites was conducted in November 2002 by John VanMeter with responses from all of the PSC's. Lastly, these methods were formally agreed upon in the October 31st, 2002 PI conference call.

VI. Appendix A - Series Description Labels

Acquisition Details and Labeling for GE - Objective 1 and Ancillary A & B

SEQUENCE DETAILS	SERIES DESCRIPTION LABEL
1. Multi-Planar Localizer Scan	GE Localizer
2a. 3D T1W Acquisition	GE 3D T1W
2b. Fallback T1W	GE Fallback T1W
3a. 2D PDW/T2W Acquisitions	GE 2D PDW/T2W
3b. Fallback PDW/T2W	GE Fallback PDW/T2W
Ancillary A: Single Voxel Proton MRS	GE Voxel MRS *region-abbreviation* *Left frontal white matter – fwm* *Left thalamus – th* *Occipital gray matter – ocg* *Left parietal white matter – pwm*
Ancillary A: Proton MRSI	GE Proton MRSI
Ancillary B: Multi-Slice DTI Acquisition *Subject to change*	GE Multi-Slice DTI (e.g. GE Multi-slice DTI)

Acquisition Details and Labeling for GE - Objective 2 and Ancillary A & B

SEQUENCE DETAILS	SERIES DESCRIPTION LABEL
1. Multi-Planar Localizer Scan	GE Localizer
2. T1W Acquisition	GE T1W
3. PDW/T2W Acquisition	GE PDW/T2W
4. T1 Relaxometry	GE T1 Relaxometry
Ancillary B: Multi-Slice DTI Acquisition *Subject to change*	GE Multi-Slice DTI (e.g. GE Multi-slice DTI)
Ancillary A: Single Voxel Proton MRS	GE Voxel MRS region-abbreviation *Left frontal white matter – fwm* *Left thalamus – th* *Occipital gray matter – ocg* *Left parietal white matter – pwm*
5. Dual Contrast T2W Acquisition	GE Dual Contrast T2W

Acquisition Details and Labeling for Siemens - Objective 1 and Ancillary A & B

If the data are collected on a Siemens Sonata use the SS variant of the label. If the data are collected on a Siemens Vision scanner use the SV variant.

SEQUENCE DETAILS	SERIES DESCRIPTION LABEL
1. Multi-Planar Localizer Scan	SS Localizer **or** SV_Localizer
2a. 3D T1W Acquisition	SS 3D T1W **or** SV_3D_T1W
2b. Fallback T1W	SS Fallback T1W **or** SV_Fallback_T1W
3a. 2D PDW/T2W Acquisitions (double echo)	SS 2D PDW_T2W **or** SV_2D_PDW_T2W
3b. Fallback PDW/T2W	SS Fallback PDW_T2W **or** SV_Fallback_PDW_T2W
Ancillary B: Multi-slice DTI *Subject to change*	SS Multi-slice DTI (e.g. SS Multi-slice DTI) **or** SV_Multi-slice_DTI (e.g. SV_Multi-slice_DTI)
Ancillary A: Single Voxel Proton MRS:	SS Voxel MRS region-abbreviation **or** SV_Voxel_MRS *region-abbreviation* *Left frontal white matter – fwm* *Left thalamus – th* *Occipital gray matter – ocg* *Left parietal white matter – pwm*
Ancillary A: Proton MRSI	SS Proton MRSI **or** SV_Proton_MRSI

Acquisition Details and Labeling for Siemens-Objective 2 & Ancillary A & B

If the data are collected on a Siemens Sonata use the SS variant of the label. If the data are collected on a Siemens Vision scanner use the SV variant.

SEQUENCE DETAILS	SERIES DESCRIPTION LABEL
1. Multi-Planar Localizer Scan	SS Localizer **or** SV_Localizer
2. T1W Acquisition	SS T1W **or** SV_T1W
3. PDW/T2W Acquisition (double echo)	SS PDW_T2W **or** SV_PDW_T2W
4. T1 Relaxometry	SS T1 Relaxometry **or** SV_T1_Relaxometry
Ancillary B: Multi-slice DTI Acquisition *Subject to change*	SS Multi-slice DTI (e.g. SS Multi-slice DTI) **or** SV_Multi-slice_ DTI (e.g. SV Multi-slice DTI)
Ancillary A: Single Voxel Proton MRS	SS Voxel MRS region-abbreviation **or** SV_Voxel_MRS *region-abbreviation* *Left frontal white matter – fwm* *Left thalamus – th* *Occipital gray matter – ocg* *Left parietal white matter – pwm*
5. Dual Contrast T2W Acquisition (double echo quantitative T2)	SS Quantitative T2 **or** SV_Quantitative_T2
Ancillary A: Proton MRSI	SS Proton MRSI **or** SV_Proton_MRSI

Appendix B – MRS/MRSI Raw Data Filename Conventions

GE Scanners – Boston, UCLA

Voxel	File Name
left frontal white matter	bos1234_567890_v1_mrs_fwm
Left thalamus	bos1234_567890_v1_mrs_th
Occipital grey matter	bos1234_567890_v1_mrs_ocg
Left parietal white matter	bos1234_567890_v1_mrs_pwm
MRSI data (UCLA only)	ucl1234_567890_v1_mrsi

Siemens Scanner – Philadelphia

VOXEL	File Name MRS (without water suppression)	File Name MRS (with water suppression)
left frontal white matter	phi1234_567890_v1_mrs_fwm_us	phi1234_567890_v1_mrs_fwm_ws
Left thalamus	phi1234_567890_v1_mrs_th_us	phi1234_567890_v1_mrs_th_ws
Occipital grey matter	phi1234_567890_v1_mrs_ocg_us	phi1234_567890_v1_mrs_ocg_ws
Left parietal white matter	phi1234_567890_v1_mrs_pwm_us	phi1234_567890_v1_mrs_pwm_ws
MRSI data	phi1234_567890_v1_mrsi	

LABELING INSTRUCTIONS FOR eDTI DATA

File/Dataset Labeling:

- For the eDTI data, sites should adhere to the current naming convention for naming files/datasets, i.e.: PSCID_DCCID_v# (e.g. bos1234_567890_v3)
- The eDTI data will be grouped together with any other imaging data corresponding to the same time point.
- If the subject had a Objective 1 V2 scan in 2005 and is invited back only for an eDTI, make sure to label the file as "V2". If the acquisition corresponds to V3, please label the file as "V3"

Important Note: Only "V2" or "V3" labels are allowed. Do NOT use any other visit labels (e.g. v2a, v2i, v2edti…) since these incorrectly named files cannot be stored in the DB.

Completeness of Data:

Sites need to acquire at least 80% of the eDTI protocol for it to be considered complete.

- For Siemens scanners, 80% completeness corresponds to the first 7 series.
- For GE scanners, 80% completeness corresponds to the first 5 series.

PSCs should transfer only data that are at least 80% complete.

eDTI Series Descriptors Labeling:

Labeling of series uses the convention currently in place with some modifications for the eDTI.

The eDTI series descriptor name consists of: scanner + eDTI + direction acquisition series. For example; SS_eDTI_G17

- In the case of Siemens scanners, "G17" is the direction acquisition series which is run first followed by G16, G15, G14…G07 (in that order and skipping G12). ***The series should be acquired in that order and labeled sequentially as shown in the table below.***

- If a direction acquisition series needs to be repeated, an "R1" should be added at the end. For example, if G15 was repeated, that series should be named SS_eDTI_G15_R1

EDTI series Descriptors

Scanner	Series	Series Label	Repeat Series Label
Siemens & GE	Additional T1W acquired for registration ***Note: This series label applies for any T1 (3D T1W, T1Wf or MPRAGE) acquired only for eDTI registration.***	T1_reg	
Siemens Sonata	G17 acquisition direction	SS_eDTI_G01	SS_eDTI_G01_R1
	G16 acquisition direction	SS_eDTI_G02	
	G15 acquisition direction	SS_eDTI_G03	
	G14 acquisition direction	SS_eDTI_G04	
	G13 acquisition direction	SS_eDTI_G05	
	G11 acquisition direction	SS_eDTI_G06	
	G10 acquisition direction	SS_eDTI_G07	
	G09 acquisition direction	SS_eDTI_G08	
	G08 acquisition direction	SS_eDTI_G09	
	G07 acquisition direction	SS_eDTI_G10	
Siemens Avanto	G17 acquisition direction	SA_eDTI_G01	SA_eDTI_G01_R1
	G16 acquisition direction	SA_eDTI_G02	
	G15 acquisition direction	SA_eDTI_G03	
	G14 acquisition direction	SA_eDTI_G04	
	G13 acquisition direction	SA_eDTI_G05	
	G11 acquisition direction	SA_eDTI_G06	
	G10 acquisition direction	SA_eDTI_G07	
	G09 acquisition direction	SA_eDTI_G08	
	G08 acquisition direction	SA_eDTI_G09	
	G07 acquisition direction	SA_eDTI_G10	
GE	1st group of 17 directions	GE_eDTI_G01	GE_eDTI_G01_R1
	2nd group of 17 directions	GE_eDTI_G02	
	3rd group of 17 directions	GE_eDTI_G03	
	4th group of 17 directions	GE_eDTI_G04	
	5th group of 17 directions	GE_eDTI_G05	
	6th group of 17 directions	GE_eDTI_G06	
	7th group of 17 directions	GE_eDTI_G07	

Note: PSCs should transfer only data that are at least 80% complete.

ACQUISITION PRIORITIES AND ORDERING

Objective 1 MRI Protocol:

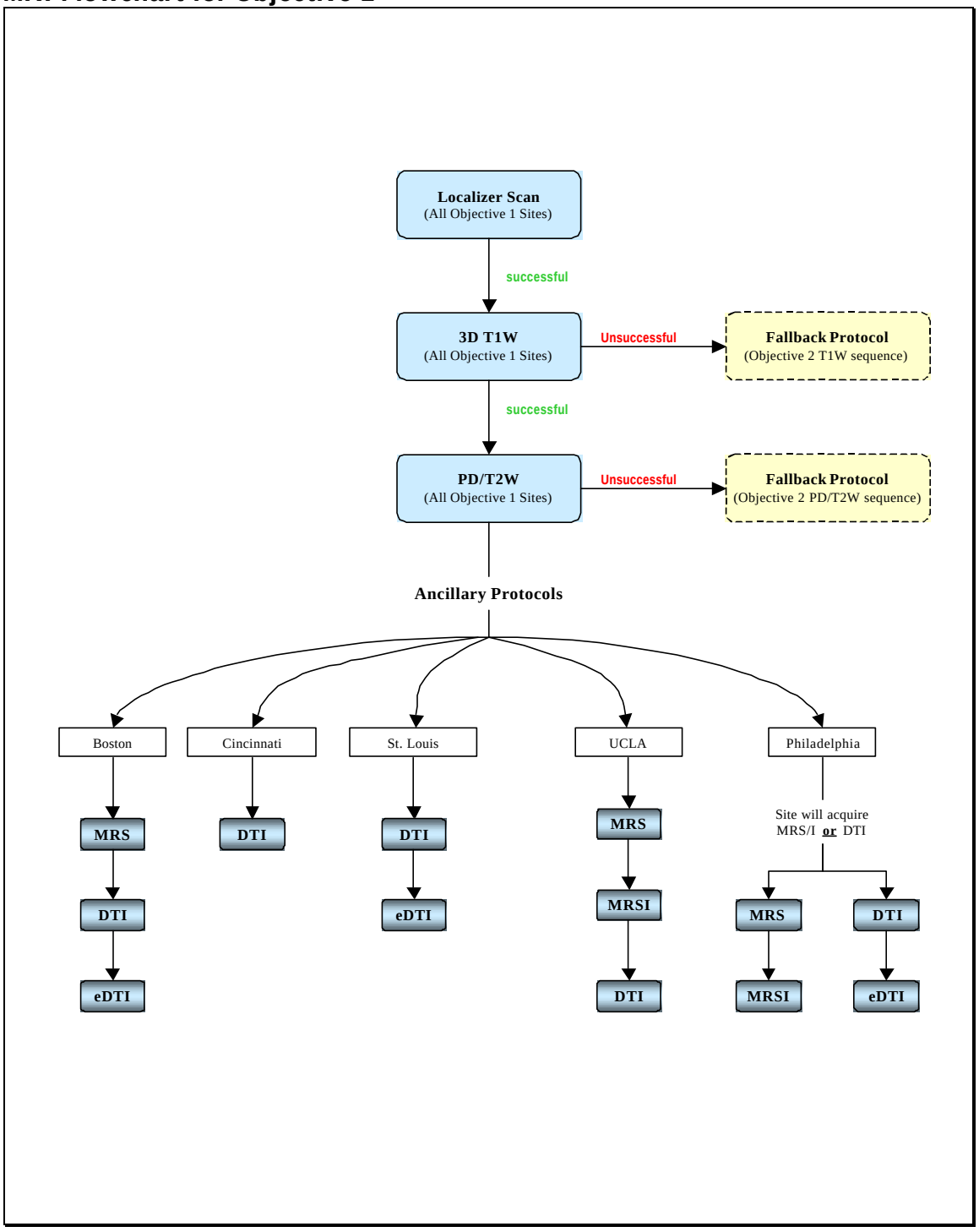
The most important portion of the Objective 1 MRI protocol is the 3D T1W acquisition since it provides the best data for brain tissue segmentation in this age range. If motion artifacts are observed on this scan (as judged by the appropriate individual at your site), it should be repeated ***before*** proceeding to PDW/T2W acquisition.

In the event of a restless subject, a shorter alternative T1W protocol has been specified which is the T1W sequence used in Objective 2. The site may proceed with the specified alternative protocol only after having attempted the initial Objective 1 protocol.

After the successful acquisition of the T1W, the PDW/T2W should be acquired. Again, a shorter alternative protocol has been specified which is the PDW/T2W used in Objective 2. This alternative acquisition is to be used only if one of the following circumstances arises: 1) if the alternative protocol was used for the T1W acquisition or, 2) if an attempt at the Objective 1 PDW/T2W fails due to a restless subject. **Note that for both the T1W and PDW/T2W acquisitions, only the Objective 1 or Objective 2 (alternative) protocol should be followed. No other protocol is to be used.**

Some sites will be conducting ancillary studies involving MRS, MRSI and DTI. These acquisitions should be done last. It is very important that the acquisitions are performed in the order described above and as outlined on the flowcharts on the subsequent pages.

MRI Flowchart for Objective 1

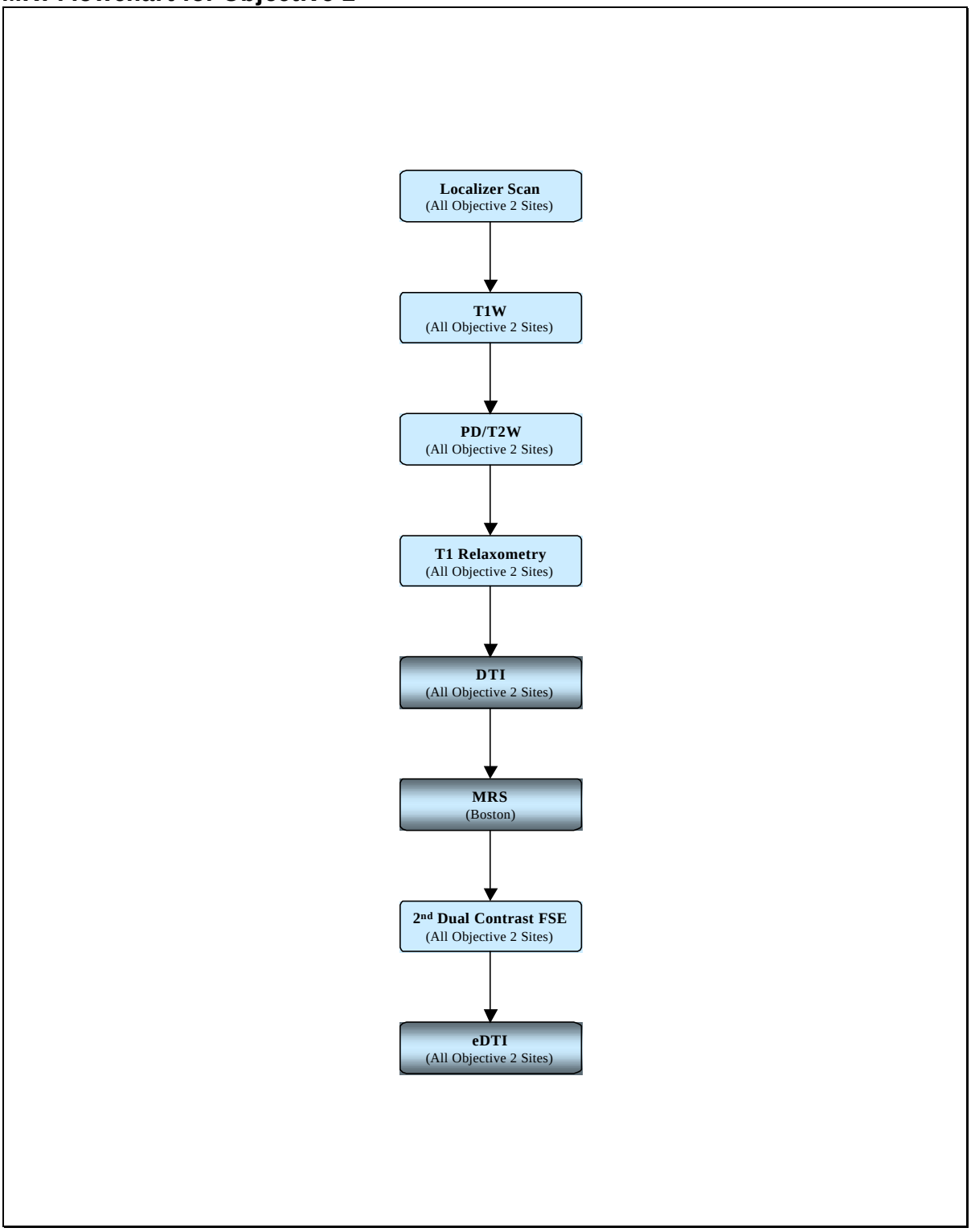


Objective 2 MRI Protocol:

The most important acquisitions in the Objective 2 MRI protocol are the T1W and PDW/T2W protocols. The T1W is more valuable for children from 1 to 4 years old while the PDW/T2W is more important for children less than one year old. **Both the T1W and PDW/T2W acquisitions should be repeated until they are satisfactorily acquired before proceeding with the next acquisitions.**

After the localizer scan, the T1W should be acquired followed by the PDW/T2W, T1 relaxometry, DTI, MRS, the 2nd dual contrast FSE, MRSI and eDTI in that order. Only the sites participating in the ancillary studies will be acquiring DTI, MRS, MRSI and eDTI. All these details are outlined in a flowchart on the next page.

MRI Flowchart for Objective 2



Expanded DTI (eDTI) Acquisition:

Acquisitions for Objective 1 eDTI subjects:

For Recalled Objective 1 Subjects:
(i.e. Subjects who had a V2 scan in 2005 and will be invited back only for the eDTI acquisition)

1. T1W fallback for registration purposes *(3D T1W is acceptable)*
2. eDTI

For Ongoing Objective 1 Subjects:
(i.e. Subjects who are scheduled for regular visit and will be invited back for an eDTI to be acquired during a separate session)

1. Regular MRI battery (T1W, PD/T2W, DTI, MRS, MRSI)
2. eDTI *(acquired during a separate scanning session if necessary)*

Acquisitions for Objective 2 eDTI subjects:

Ongoing and Recalled Objective 2 Subjects:
(i.e. Subjects who continue to be recruited/followed as per the original contract)

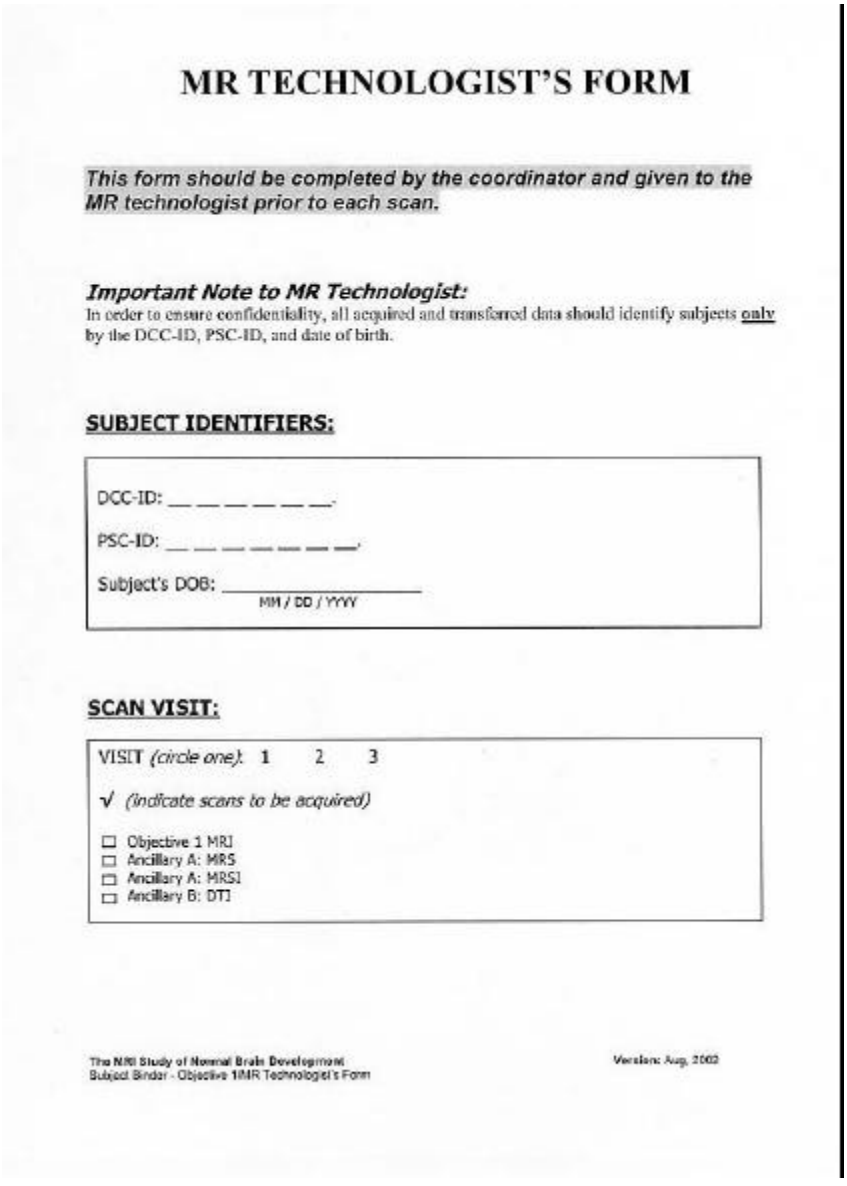
1. Regular MRI battery (T1W, PD/T2W, T1 Relaxometry, DTI, MRS, 2nd dual, MRSI)
2. eDTI *(acquired during a separate scanning session)*

Newly Recruited Objective 2 eDTI Subjects:
(i.e. Subjects recruited above the contractual requirements. Although the priority will be on eDTI, subjects will be administered the whole battery of procedures).
For these Objective 2 subjects, sites will acquire T1W + PD/T2W + eDTI in this order!

1. Objective 2 T1W
2. Objective 2 PD/T2W
3. eDTI
4. Remainder of the Objective 2 battery (T1 Relaxometry, DTI, MRS, 2nd dual, MRSI)

SAMPLE OF MR TECHNOLOGIST'S FORM

In order to properly label MR data, the technologist needs to be provided with identifier information from the coordinator. The MR Technologist Form is provided as a tool for this purpose.



MR TECHNOLOGIST'S FORM

This form should be completed by the coordinator and given to the MR technologist prior to each scan.

Important Note to MR Technologist:
In order to ensure confidentiality, all acquired and transferred data should identify subjects only by the DCC-ID, PSC-ID, and date of birth.

SUBJECT IDENTIFIERS:

DCC-ID: __ __ __ __ __ __

PSC-ID: __ __ __ __ __ __ __

Subject's DOB: _____
MM / DD / YYYY

SCAN VISIT:

VISIT *(circle one)*: 1 2 3

√ *(indicate scans to be acquired)*

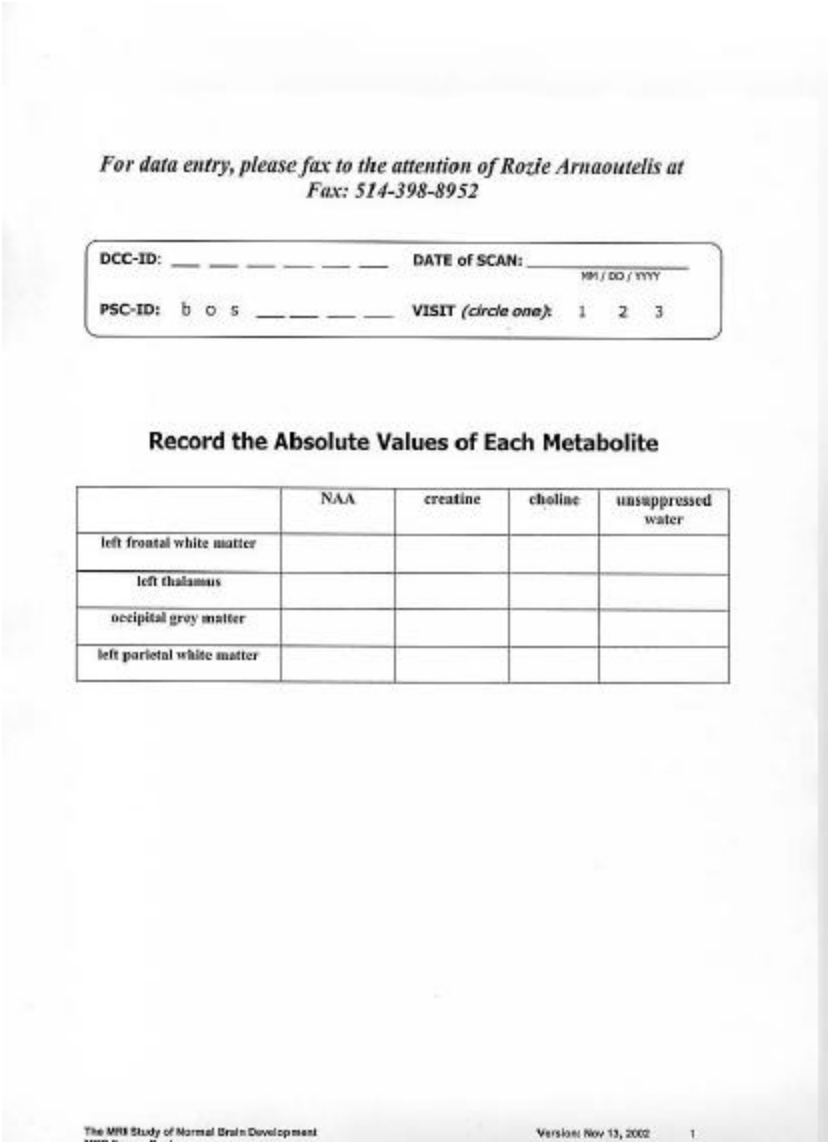
☐ Objective 1 MRI
☐ Ancillary A: MRS
☐ Ancillary A: MRSI
☐ Ancillary B: DTI

The MRI Study of Normal Brain Development
Subject Binder - Objective 1/MR Technologist's Form

Version: Aug, 2002

SAMPLE OF SPECTROSCOPY METABOLITE VALUE FORM

This form should be completed by the sites acquiring spectroscopy data and then faxed to the DCC for data entry.



For data entry, please fax to the attention of Rozie Arnaoutelis at Fax: 514-398-8952

DCC-ID: ___ ___ ___ ___ ___ ___ DATE of SCAN: _____ (MM / DD / YYYY)

PSC-ID: b o s ___ ___ ___ ___ VISIT *(circle one)*: 1 2 3

Record the Absolute Values of Each Metabolite

	NAA	creatine	choline	unsuppressed water
left frontal white matter				
left thalamus				
occipital grey matter				
left parietal white matter				

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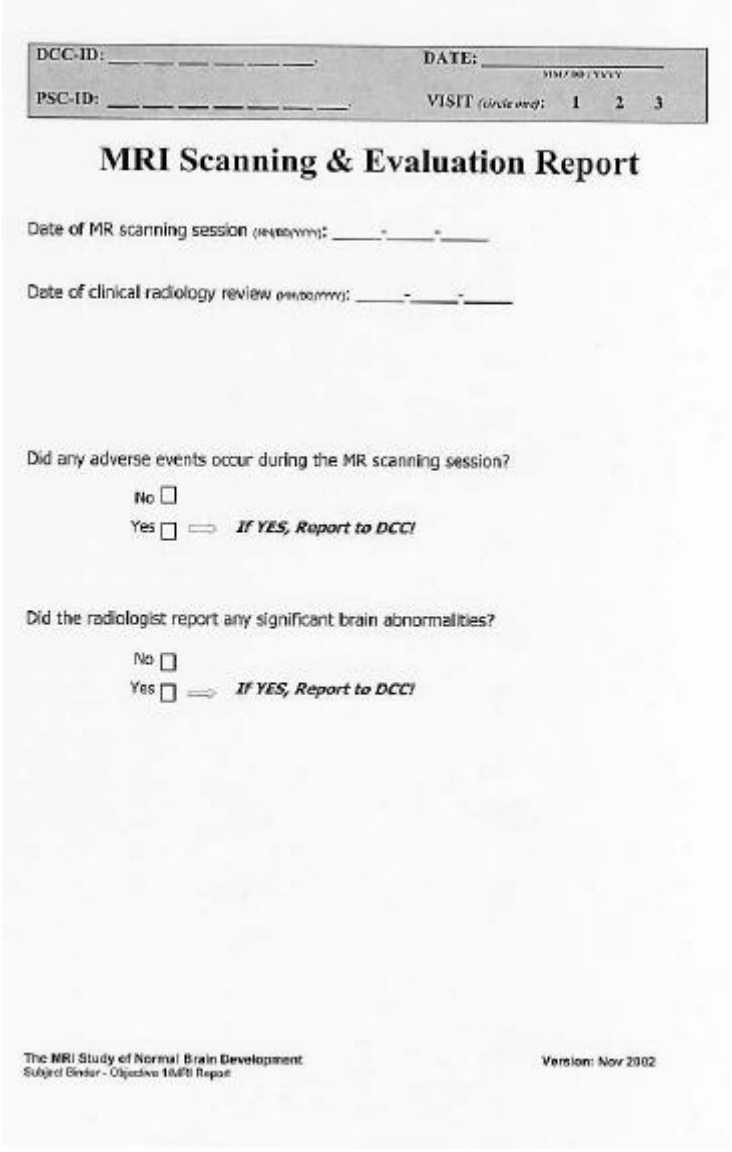
SAMPLE OF MRI SCANNING & EVALUATION REPORT

The NIH requires regular reporting of any MRI-related adverse events and/or significant brain abnormalities reported by the radiologist.

This form is available on the web site and must be completed for each scanning session. The information must be entered into the database at the PSC.



DCC-ID: _____ DATE: _____ (MM/DD/YYYY)

PSC-ID: _____ VISIT (circle one): 1 2 3

MRI Scanning & Evaluation Report

Date of MR scanning session (dd/mm/yyyy): ____-____-____

Date of clinical radiology review (dd/mm/yyyy): ____-____-____

Did any adverse events occur during the MR scanning session?

No ☐

Yes ☐ ⟹ ***If YES, Report to DCC!***

Did the radiologist report any significant brain abnormalities?

No ☐

Yes ☐ ⟹ ***If YES, Report to DCC!***

The MRI Study of Normal Brain Development
Subject Binder - Objective MRI Report

Version: Nov 2002

ACQUISITION DETAILS FOR GE SCANNERS

Objective 1
Objective 2
Ancillary A (MRS, MRSI)
Ancillary B (DTI)
Expanded DTI (eDTI)

Acquisition Details for GE - Objective 1 and Ancillary A & B

1. Multi-Planar Localizer Scan

- 1-2 min (exact details are not critical)

2a. 3D T1W Acquisition

- Sequence type: 3D FLASH/SPGR
- GE sequence: pulse sequence=SPGR, mode=3D
- TR: 22 ms
- TE: 10-11 ms
- excitation pulse angle: 30 degrees
- orientation: sagittal
- FoV: 250 mm IS x 250 mm AP
- matrix: 256 x 256 (x 124 - 180 slices)
- slices: 160-180 slices of 1-1.5 mm thickness (cover entire head). *Note that on GE systems with a 124-slice limitation, slice thickness should be adjusted as necessary in order to cover the entire head with 124 slices.*
- signal averages: 1
- scan time: 11.6 – 16.8 min

2b. Fallback T1W *(Note: To be used only after the above T1W protocol has been attempted!)*

- Sequence type: 2D multi-slice spin-echo
- GE sequence: pulse sequence=SE, mode=2D MS
- TR: 500 ms
- TE: 10 ms
- excitation pulse angle: 90 degrees
- orientation: axial
- FoV: 250 mm AP x 190 mm LR (rectangular FoV)
- matrix: 256 AP x 192 LR
- slice thickness: 3 mm
- slices: 30-60 slices (as needed to cover apex of head to bottom of the cerebellum)
- signal averages: 1
- scan time: 3-5 min

3a. 2D PDW/T2W Acquisitions

- GE sequence: pulse sequence=FSE, mode=2D
- TR: 3500
- TE1 (effective): 17 ms
- TE2 (effective): 119 ms
- ETL: 8
- orientation: axial (parallel to AC-PC)
- FoV: 250 mm AP x 220 mm LR (rectangular FoV)
- matrix: 256 AP x 224 LR
- slices: 80-90 slices of 2 mm thickness (as needed to cover apex of head to bottom of the cerebellum)
- signal averages: 1
- scan time: 7 – 10 min

3b. Fallback PDW/T2W *(Note: To be used only if the T1W fallback protocol was acquired or if the above PDW/T2W protocol has been attempted and not successfully completed!)*

- Sequence type: 2D multi-slice dual-echo fast/turbo spin echo
- GE sequence: pulse sequence=FSE, mode=2D multi-slice
- TR: 3500 ms
- TE1 (effective): 17 ms
- TE2 (effective): 119 ms
- ETL: 8
- orientation: axial (same slice alignment as the T1W acquisition)
- FoV: 250 mm AP x 190 mm LR (rectangular FoV)
- matrix: 256 AP x 192 LR
- slice thickness: 3 mm
- slices: 30-60 slices (as needed to cover apex of head to bottom of the cerebellum)
- signal averages: 1
- scan time: 3-5 min

Cont'd …. Acquisition Details for GE - Objective 1 and Ancillary A & B

Ancillary A: Single Voxel Proton MRS

- Sequence type: single voxel PRESS
- GE sequence: custom to site
- Single voxel shimming
- TR: 1500 ms
- TE: 144 ms
- voxel size: 1.5 x 1.5 x 1.5 cm (3.375 cc; all three dimensions constant within ± 10 %)
- signal averages: 64
- 2-4 voxel locations (in order of priority)
    - left frontal white matter
    - left thalamus
    - occipital gray matter which straddles the mid-line (visual cortex)
    - left parietal white matter
    - scan time: 6-20 min

Ancillary A: Proton MRSI

- The Los Angeles site, will be involved in an MRSI study consisting of multiple slice acquisitions. Details of the Los Angeles MRSI protocol are provided in Appendix A and are under the control of Dr. McCracken and his colleagues.

Ancillary B: Multi-Slice DTI Acquisition

Objective 1

- Sequence type: diffusion encoded spin echo EPI
- GE sequence: custom to site
- minimum TR: 3s. (TR=9s for 60 slices)
- TE: minimum full (minimum achievable TE with full echo acquisition)
- excitation pulse angle: 90 degrees
- orientation: Axial (i.e. perpendicular to the z axis of the magnet, not oblique)
- FoV, matrix, and slice thickness adjusted to give 3 x 3 x 3 mm voxels. If brain fits within a 19 cm Fov, use FOV 192, matrix 64x64, otherwise use FOV 384, matrix 128x128
- slices: 48-60 contiguous slices (as needed to cover from bottom of the cerebellum to apex of head)
- b-values: 0, 1000
- 6 diffusion sensitization directions: **{ (**1,0,1), (-1,0,1), (0,1,1), (0,1,-1), (1,1,0), (-1,1,0) **}**
- 4 series acquired with NEX=1, for a total of 28 images/slice (4 *(1*b=0 + 6*b=1000)).
- Images to be reconstructed at their native resolution, without zero filling or interpolation.

Ancillary B: Expanded DTI (eDTI) Acquisition

For GE Scanners:

- 60 slices
- 2.5 mm slice thickness
- FOV 24 cm, 96 x 96 matrix
- Orientation: IMPORTANT that image plane be straight axial not oblique
- Image data reconstructed without zerofilling or interpolation
- Images are acquired in 7 series of 17 images each using entries prescribed in the cdiflist04 file provided separately
- total acquisition time is about 30 minutes with current hardware
- With the maximum b-value set to 1100 s/mm2 the sequence will acquire the following diffusion weighted images at each slice location:

b=0	9 images
b=100	10 images
b=300	10 images
b=500	10 images
b=800	30 images
b=1100	50 images

Completion of Acquisition:
On GE scanners, a minimum of 80% of the data (i.e. the first 6 series) are required for the acquisition to be considered complete. Sites should not transfer data that are less than 80% complete.

Acquisition Details for GE - Objective 2 and Ancillary A & B

1. Multi-Planar Localizer Scan

- 1-2 min (exact details are not critical)

2. T1W Acquisition

- Sequence type: 2D multi-slice spin-echo
- GE sequence: pulse sequence=SE, mode=2D MS
- TR: 500 ms
- TE: 10 ms
- excitation pulse angle: 90 degrees
- orientation: axial
- FoV: 250 mm AP x 190 mm LR (rectangular FoV)
- matrix: 256 AP x 192 LR
- slice thickness: 3 mm
- slices: 30-60 slices (as needed to cover apex of head to bottom of the cerebellum)
- signal averages: 1
- scan time: 3-5 min

3. PDW/T2W Acquisition

- Sequence type: 2D multi-slice dual-echo fast/turbo spin echo
- GE sequence: pulse sequence=FSE, mode=2D multi-slice
- TR: 3500 ms
- TE1 (effective): 17 ms
- TE2 (effective): 119 ms
- ETL: 8
- orientation: axial (same slice alignment as the T1W acquisition)
- FoV: 250 mm AP x 190 mm LR (3/4 rectangular FoV)
- matrix: 256 AP x 192 LR
- slice thickness: 3 mm
- slices: 30-60 slices (as needed to cover apex of head to bottom of the cerebellum)
- signal averages: 1
- scan time: 3-5 min

4. T1 Relaxometry

- Sequence type: inversion recovery single-shot Fast Spin-Echo (IR-SSFSE) sequence
- GE sequence: provided courtesy of Dr. R. Mulkern
    - orientation: axial
    - slice thickness: 3 mm slice interleaved with no gap and sequential slice sampling
    - FoV: 240mm
    - matrix: 256 x 160 (frequency X phase) in-plane matrix
    - ETL = 90
    - 64 kHz receiver bandwidth
    - TR = (single-shot)
    - echo time(effective): ETE =35 ms
    - inversion times (TI): 150, 500, 750, 1000, 1500, 2000, and 4000 ms
    - slices: 30-60 slices (as needed to cover apex of head to bottom of the cerebellum)
    - signal averages: 1
    - total scan time: 12 min

Ancillary B: Multi-Slice DTI Acquisition

Objective 2

- Sequence type: diffusion encoded spin echo EPI
- GE sequence: custom to site
- minimum TR: 3s. (TR=9s for 60 slices)
- TE: minimum full (minimum achievable TE with full echo acquisition)
- excitation pulse angle: 90 degrees
- orientation: Axial (i.e. perpendicular to the z axis of the magnet, not oblique)
- FoV, matrix, and slice thickness adjusted to give 3 x 3 x 3 mm voxels. If brain fits within a 19 cm Fov, use FOV 192, matrix 64x64, otherwise use FOV 384, matrix 128x128
- slices: 48-60 contiguous slices (as needed to cover from bottom of the cerebellum to apex of head)
- b-values: 0, 1000; 0, 500
- 6 diffusion sensitization directions: **{(**1,0,1), (-1,0,1), (0,1,1), (0,1,-1), (1,1,0), (-1,1,0)**}**
- 6 series acquired with NEX=1, for a total of 42 images/slice (4 *(1*b=0 + 6*b=1000) + 2*(1*b=0 + 6*b=500)).
- Recommended acquisition order: [0, 1000], [0, 1000], [0, 500], [0, 500], [0, 1000], [0, 1000]

Cont'd …. Acquisition Details for GE - Objective 2 and Ancillary A & B

Ancillary A: Single Voxel Proton MRS

- Sequence type: single voxel PRESS
- GE sequence: custom to site
- Single voxel shimming
- TR: 1500 ms
- TE: 144 ms
- voxel size: 1.5 x 1.5 x 1.5 cm (3.375 cc)
- signal averages: 64
- 2-4 voxel locations (in order of priority)
    - left frontal white matter
    - left thalamus
    - occipital gray matter which straddles the mid-line (visual cortex)
    - left parietal white matter
    - scan time: 6-20 min

5. Dual Contrast T2W Acquisition

- Sequence type: 2D multi-slice dual-echo fast/turbo spin echo
- GE sequence: pulse sequence=FSE, mode=2D multi-slice
- TR: 3500 ms
- TE1 (effective): 83 ms
- TE2 (effective): 165 ms
- orientation: axial (same slice alignment as the T1W acquisition)
- FoV: 250 mm AP x 190 mm LR (rectangular FoV)
- matrix: 256 AP x 192 LR
- slice thickness: 3 mm
- slices: 30-60 slices (as needed to cover apex of head to bottom of the cerebellum)
- signal averages: 1
- scan time: 3-5 min

Ancillary B: Expanded DTI (eDTI) Acquisition

For GE Scanners:

- 60 slices
- 2.5 mm slice thickness
- FOV 24 cm, 96 x 96 matrix
- Orientation: IMPORTANT that image plane be straight axial not oblique
- Image data reconstructed without zerofilling or interpolation
- Images are acquired in 7 series of 17 images each using entries prescribed in the cdiflist04 file provided separately
- total acquisition time is about 30 minutes with current hardware
- With the maximum b-value set to 1100 s/mm2 the sequence will acquire the following diffusion weighted images at each slice location:

b=0	9 images
b=100	10 images
b=300	10 images
b=500	10 images
b=800	30 images
b=1100	50 images

Completion of Acquisition:
On GE scanners, a minimum of 80% of the data (i.e. the first 6 series) are required for the acquisition to be considered complete. Sites should not transfer data that are less than 80% complete.

ACQUISITION DETAILS FOR SIEMENS SCANNERS

Objective 1
Objective 2
Ancillary A (MRS, MRSI)
Ancillary B (DTI)
Expanded DTI (eDTI)

Acquisition Details for Siemens - Objective 1 and Ancillary A & B

1. Multi-Planar Localizer Scan

- 1-2 min (exact details are not critical)
- scout image

2a. 3D T1W Acquisition

- Sequence type: 3D FLASH/SPGR
- Siemens sequence: fl3d_11b65.wkc
- TR: 25 ms
- TE: 11 ms
- flip angle: 30 degrees
- slab thickness: 160 (or 180). Cover entire head
- slices: 160 (or 180). Make slices 1.0 mm thick
- orientation: sagittal
- matrix: 256 IS x 256 AP
- FoV: 256 mm IS x 256 mm AP
- signal averages: 1
- scan time: 14'58" or 16'50"

2b. Fallback T1W *(Note: To be used only after the above T1W protocol has been attempted!)*

- Sequence type: 2D multi-slice spin-echo
- Siemens sequence: se_12b130
- TR: 500 ms
- TE: 12 ms
- flip angle: 90 degrees
- slices: 22
- slice thickness: 3 mm
- orientation: TRA – tilted to be parallel to the AC-PC line
- distance factor: 1 (or 2) cover from apex of the head to bottom of the cerebellum
- matrix: 256 AP x 192 LR
- FoV: 256 mm AP x 192 mm LR (3/4 RECFOV: phase enc L-R)
- signal averages: 1
- scan time: 3'18 " or 4'50 " (1'39" for each run)
- Repeat the study 1 (or 2) times to fill in the slice gap and change "shift mean" by 3 mm each time.

3a. 2D PDW/T2W Acquisitions (double echo)

- Siemens Sonata sequence: tse5_17b130_119b130.wkc
- TR: 3500
- TE: 17 119 ms
- turbo factor: 7
- slices: 22
- slice thickness: 2 mm
- orientation: TRA – tilted to be parallel to the AC-PC line
- distance factor: 2 (or 3) cover from apex of the head to bottom of the cerebellum
- matrix: 256 AP x 220 LR
- FoV: 256 mm AP x 224 mm LR (RECFOV 7/8 phase enc L-R)
- signal averages: 1
- scan time: 7'39" or 10'12" (2'33" for each run)
- Repeat the scan 2 (or 3) times to fill in the slice gap and change "shift mean" by 2 mm each time.

3b. Fallback PDW/T2W *(Note: To be used only if the T1W fallback protocol was acquired or if the above PDW/T2W protocol has been attempted and not successfully completed!)*

- Sequence type: 2D multi-slice dual-echo fast/turbo spin echo
- Siemens Sonata sequence: tse5_17b130_119b130.wkc
- TR: 3500 ms
- TE (effective): 17 119 ms
- Turbo factor: 7
- slices: 22
- slice thickness: 3 mm
- orientation: TRA – tilted to be parallel to the AC-PC line
- distance factor: 1 (or 2) cover from apex of the head to bottom of the cerebellum
- matrix: 256 AP x 190 LR
- FoV: 256 mm AP x 192 mm LR (6/8 RECFOV: phase enc L-R)
- signal averages: 1
- scan time: 4'26" or 6'45" (2'13" per run)
- Repeat the study 1 (or 2) times to fill in the slice gap and change "shift mean" by 3 mm each time.

Cont'd …. Acquisition Details for Siemens-Objective 1 and Ancillary A & B

Ancillary B: Multi-slice DTI Acquisition

- Sequence type: diffusion encoded spin echo EPI
- Siemens sequence: EP2D_diff
- minimum TR: 3s. (TR=9s for 60 slices)
- TE: minimum full (minimum achievable TE with full echo acquisition)
- excitation pulse angle: 90 degrees
- orientation: Axial (i.e. perpendicular to the z axis of the magnet, not oblique)
- FoV, matrix, and slice thickness adjusted to give 3 x 3 x 3 mm voxels. If brain fits within a 19 cm Fov, use FOV 192, matrix 64x64, otherwise use FOV 384, matrix 128x128
- slices: 48-60 contiguous slices (as needed to cover from bottom of the cerebellum to apex of head)
- b-values: 0, 1000
- 6 diffusion sensitization directions: **{ (**1,0,1), (-1,0,1), (0,1,1), (0,1,-1), (1,1,0), (-1,1,0) **}**
- 4 series acquired with NEX=1, for a total of 28 images/slice (4 *(1*b=0 + 6*b=1000)).
- Images to be reconstructed at their native resolution, without zero filling or interpolation.

Ancillary A: Single Voxel Proton MRS

- Sequence type: single voxel PRESS
- Siemens sequence: custom to site
- Single voxel shimming
- TR: 1500 ms
- TE: 144 ms
- voxel size: 1.5 x 1.5 x 1.5 cm (3.375 cc)
- signal averages: 64
- 2-4 voxel locations (in order of priority)
  - left frontal white matter
  - left thalamus
  - occipital gray matter which straddles the mid-line (visual cortex)
  - left parietal white matter
  - scan time: 6-20 min

Ancillary B: Expanded DTI (eDTI) Acquisition

For Siemens Scanners

- 60 slices
- 2.5 mm slice thickness
- FOV 24 cm, 96 x 96 matrix
- Orientation: IMPORTANT that image plane be straight axial not oblique
- Image data reconstructed without zerofilling or interpolation
- Images are acquired in 10 series sequentially using all schemes from 17 to 7 directions
- total acquisition time is about 20 minutes
- With the maximum b-value set to 1100 s/mm2 the sequence will acquire the following diffusion weighted images at each slice location:

b=0	10 images
b=100	10 images
b=300	10 images
b=500	10 images
b=800	30 images
b=1100	50 images

Completion of Acquisition:
On Siemens scanners, 80% or the first 7 series are required for the acquisition to be considered complete. Sites should not transfer data that are less than 80% complete.

Acquisition Details for Siemens - Objective 2 and Ancillary A & B

1. Multi-Planar Localizer Scan

- 1-2 min (exact details are not critical)
- scout image

2. T1W Acquisition

- Sequence type: 2D multi-slice spin-echo
- Siemens sequence: se_12b130
- TR: 500 ms
- TE: 12 ms
- excitation pulse angle: 90 degrees
- slices: 22
- slice thickness: 3 mm
- orientation: TRA – tilted to be parallel to the AC-PC line
- distance factor: 1 (or 2) cover from apex of the head to bottom of the cerebellum
- matrix: 256 AP x 192 LR
- FoV: 256 mm AP x 192 mm LR (6/8 RECFOV: phase enc L-R)
- signal averages: 1
- Repeat the study 1 (or 2) times t fill in the slice gap and change "shift mean" by 3 mm each time.

3. PDW/T2W Acquisition (double echo)

- Sequence type: 2D multi-slice dual-echo fast/turbo spin echo
- TR: 3500 ms
- TE: 17 119 ms
- turbo factor: 7
- slices : 22
- slice thickness: 3 mm
- orientation: As for protocol 2 : TRA – tilted to be parallel to the AC-PC line
- distance factor: 1 (or 2) cover from apex of the head to bottom of the cerebellum
- matrix: 256 AP x 190 LR
- FoV: 256 mm AP x 192 mm LR (6/8 RECFOV: phase enc L-R)
- signal averages: 1
- Repeat the scan 2 (or 3) times to fill in the slice gap and change "shift mean" by 3 mm each time.

4. T1 Relaxometry

- Sequence type: 2D multi-slice IR-prepared EPI or HASTE/single shot FSE
- Siemens sequence: wip_j6b_T1.ekc (Vision sequence provided courtesy of Dr. J. Haselgrove)
    - TR =9.990 s
    - TE =46.7 ms
    - TI=50, 400, 800, 1200, 2000
    - slices: 15
    - thickness: 3 mm
    - orientation: As for protocol 2 : TRA – tilted to be parallel to the AC-PC line
    - distance factor: 1 (or 2) cover from apex of the head to bottom of the cerebellum
    - FoV: 6/8
    - matrix: 96 LR x 128 AP
    - FoV: 256 mm x 256 mm
    - signal averages: 1
    - scan time:
    - Repeat the study 1 (or 2) times to fill in the slice gap and change "shift mean" by 3 mm each time.

Cont'd …. Acquisition Details for Siemens-Objective 2 and Ancillary A & B

Ancillary B: Multi-slice DTI Acquisition

Ancillary B: Multi-Slice DTI Acquisition

Objective 2

- Sequence type: diffusion encoded spin echo EPI
- Siemens sequence: EP2D_diff
- minimum TR: 3s. (TR=9s for 60 slices)
- TE: minimum full (minimum achievable TE with full echo acquisition)
- excitation pulse angle: 90 degrees
- orientation: Axial (i.e. perpendicular to the z axis of the magnet, not oblique)
- FoV, matrix, and slice thickness adjusted to give 3 x 3 x 3 mm voxels. If brain fits within a 19 cm Fov, use FOV 192, matrix 64x64, otherwise use FOV 384, matrix 128x128
- slices: 48-60 contiguous slices (as needed to cover from bottom of the cerebellum to apex of head)
- b-values: 0, 1000; 0, 500
- 6 diffusion sensitization directions: **{ (**1,0,1), (-1,0,1), (0,1,1), (0,1,-1), (1,1,0), (-1,1,0) **}**
- 6 series acquired with NEX=1, for a total of 42 images/slice (4 *(1*b=0 + 6*b=1000) + 2*(1*b=0 + 6*b=500)).
- Recommended acquisition order: [0, 1000], [0, 1000], [0, 500], [0, 500], [0, 1000], [0, 1000]

Ancillary A: Single Voxel Proton MRS

- Sequence type: single voxel PRESS
- Siemens sequence: custom to site
- Single voxel shimming
- TR: 1500 ms
- TE: 144 ms
- voxel size: 1.5 x 1.5 x 1.5 cm (3.375 cc)
- signal averages: 64
- 2-4 voxel locations (in order of priority)
    - left frontal white matter
    - left thalamus
    - occipital gray matter which straddles the mid-line (visual cortex)
    - left parietal white matter
    - scan time: 6-20 min

5. Dual Contrast T2W Acquisition (double echo quantitative T2)

- Sequence type: 2D multi-slice dual-echo fast/turbo spin echo
- Siemens sequence:
- TR: 3500 ms
- TE: 83 165 ms
- slices: 22
- thickness: 3 mm
- orientation: As for protocol 2 : tilted to be parallel to the AC-PC line
- distance factor: 3 (or 4) cover from apex of the head to bottom of the cerebellum
- matrix: 256 AP x 192 LR
- FoV: 256 mm AP x 192 mm LR (6/8 RECFOV: phase enc L-R)
- signal averages: 1
- Repeat the study 2 (or 3) times to fill in the slice gap and change "shift mean" by 3 mm each time.

Ancillary B: Expanded DTI (eDTI) Acquisition

For Siemens Scanners

- 60 slices
- 2.5 mm slice thickness
- FOV 24 cm, 96 x 96 matrix
- Orientation: IMPORTANT that image plane be straight axial not oblique
- Image data reconstructed without zerofilling or interpolation
- Images are acquired in 10 series sequentially using all schemes from 17 to 7 directions
- total acquisition time is about 20 minutes
- With the maximum b-value set to 1100 s/mm2 the sequence will acquire the following diffusion weighted images at each slice location:

b=0	10 images
b=100	10 images
b=300	10 images
b=500	10 images
b=800	30 images
b=1100	50 images

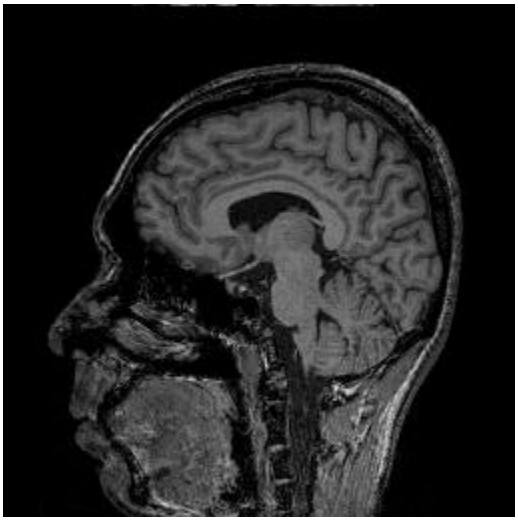
Completion of Acquisition:
On Siemens scanners, 80% or the first 7 series are required for the acquisition to be considered complete. Sites should not transfer data that are less than 80% complete.

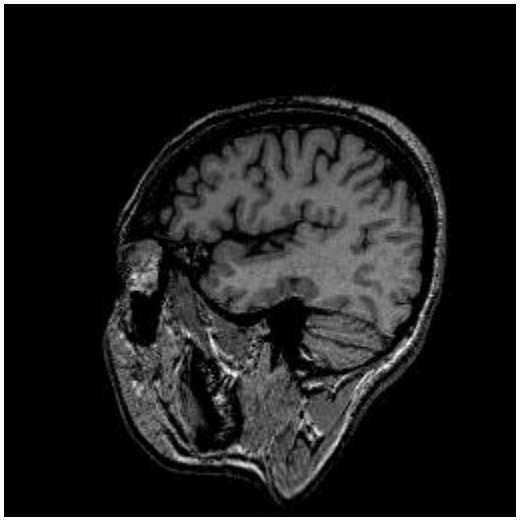
SAMPLE IMAGES

Objective 1 Sample Images:

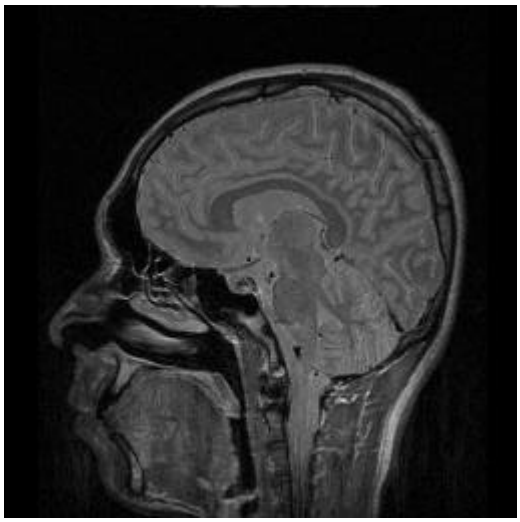
The following sample data were acquired from an adult man with the Objective 1 protocol and are provided courtesy of Dr. R. McKinstry, Washington University, St. Louis. Note: This hardcopy format dictates 2D sample images only but the complete volumetric data sets are available online on our web page.

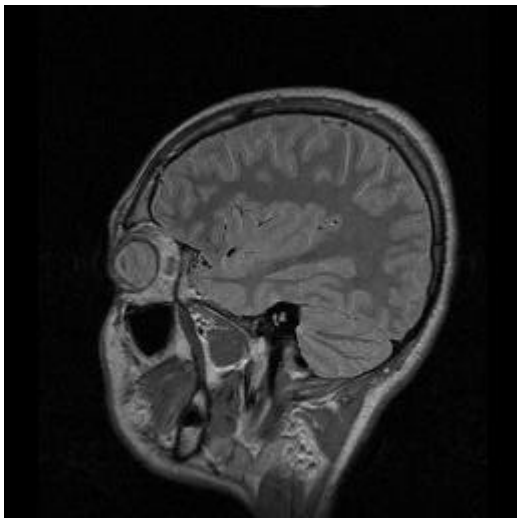
T1W acquisition sample images:



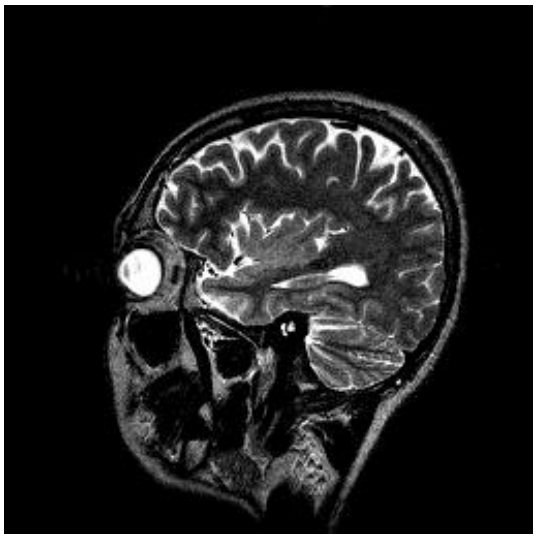


PDW acquisition sample images:





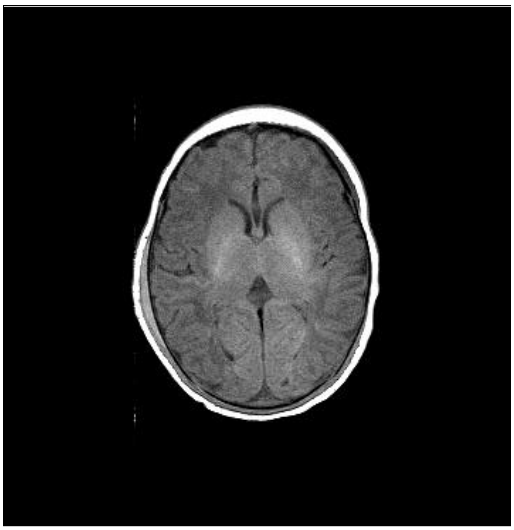
T2W acquisition sample images:



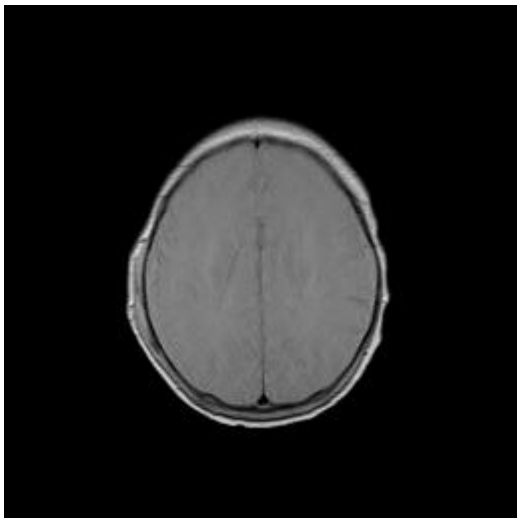
Objective 2 MRI Sample Images:

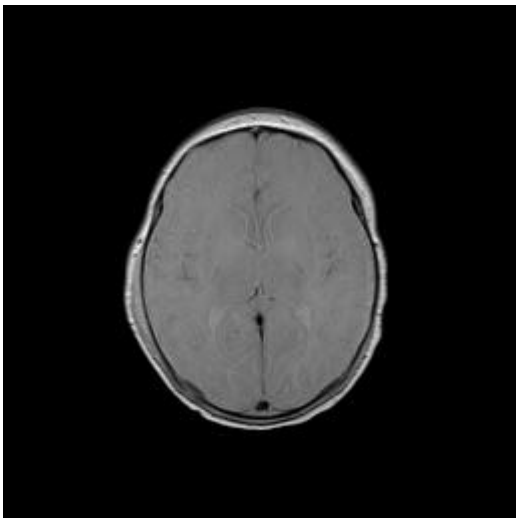
The following sample data were acquired from a normal girl aged 4 days (unless stated otherwise) with the Objective 2 protocol and are provided courtesy of Dr. R. McKinstry, Washington University, St. Louis. Note: this hardcopy format dictates 2D sample images only but the complete volumetric data sets are available online on our web page.

T1W acquisition sample images:

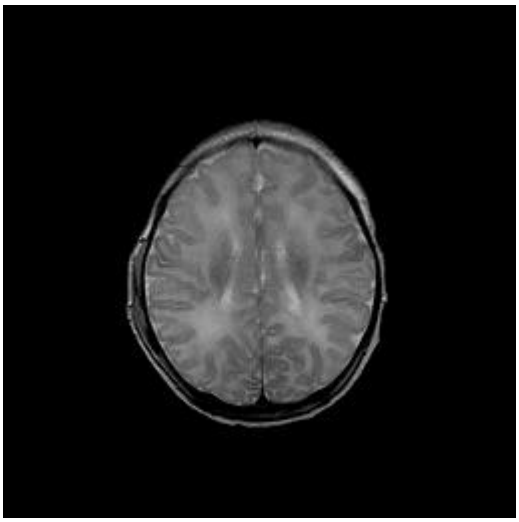


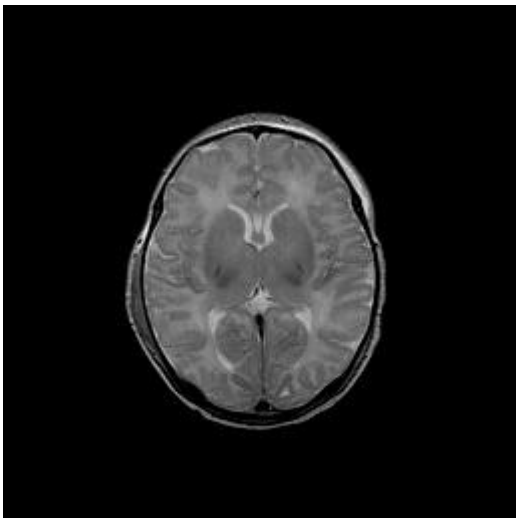
PDW acquisition sample images:





T2W acquisition sample images:

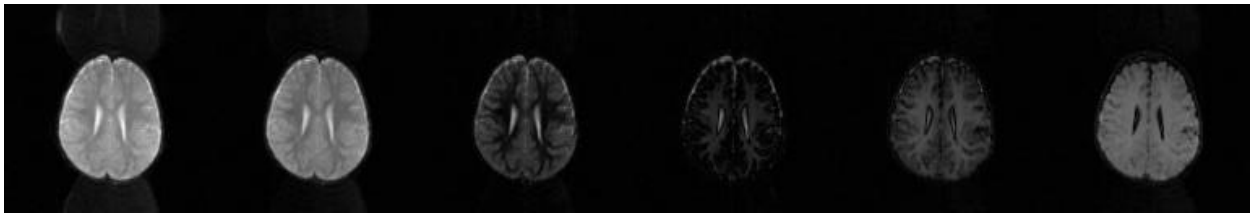




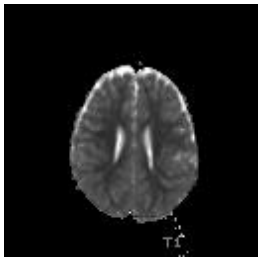
T1-Relaxometry Sample Images:

The following sample data are provided courtesy of Dr. J. Haselgrove, The Children's Hospital of Philadelphia.

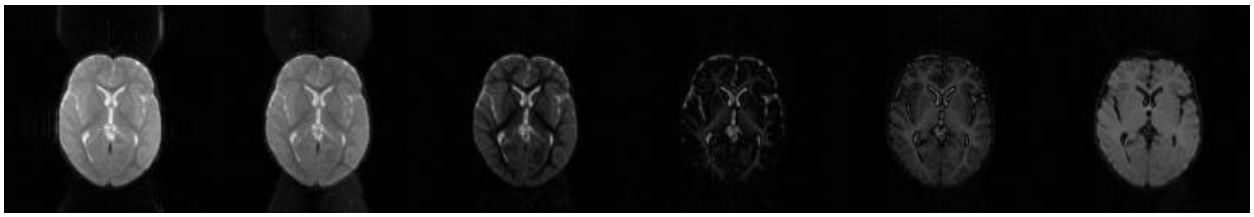
Raw images for third slice of dataset:



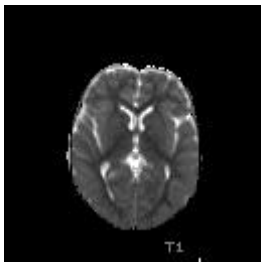
Calculated image for third slice of dataset:



Raw images for sixth slice from the dataset:



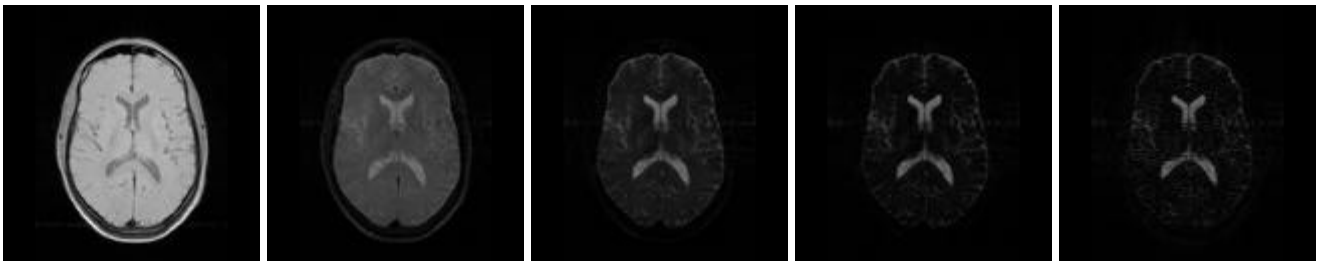
Calculated image for sixth slice:



T2-Relaxometry Sample Images:

The following images were acquired in a normal healthy adult and are provided courtesy of Dr. B. Pike, Montreal Neurological Institute.

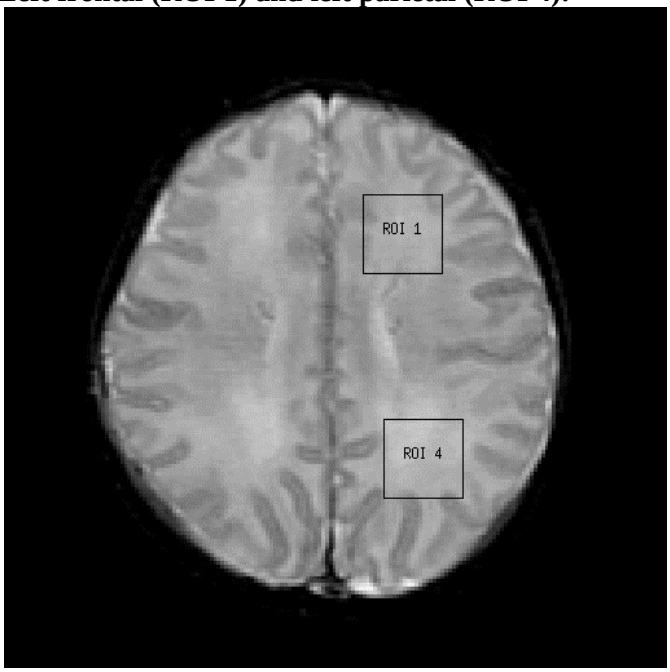
Shown are echos 1, 8, 16, 24, and 32:



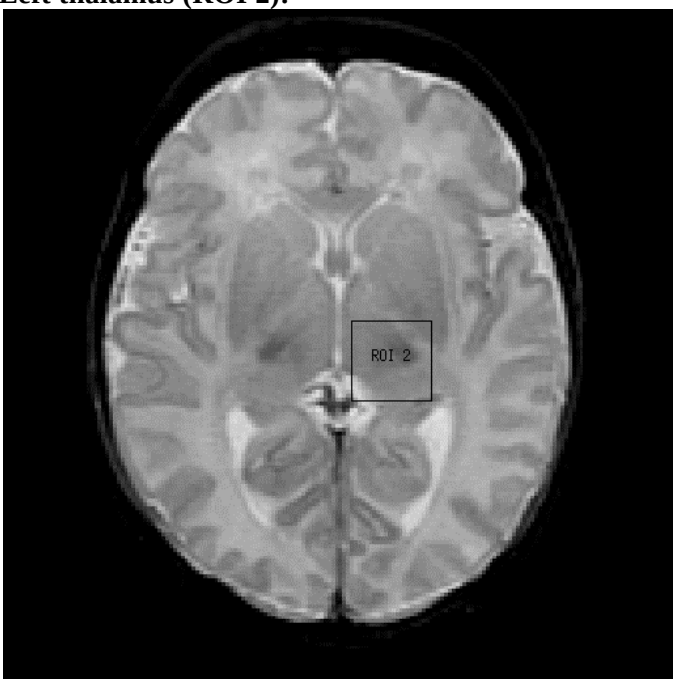
Ancillary A (MRS) Protocol Images:

The following images from a newborn infant represent anatomical MRIs showing MRS voxel locations and were provided courtesy of Dr. D. Vigneron, University of California, San Francisco.

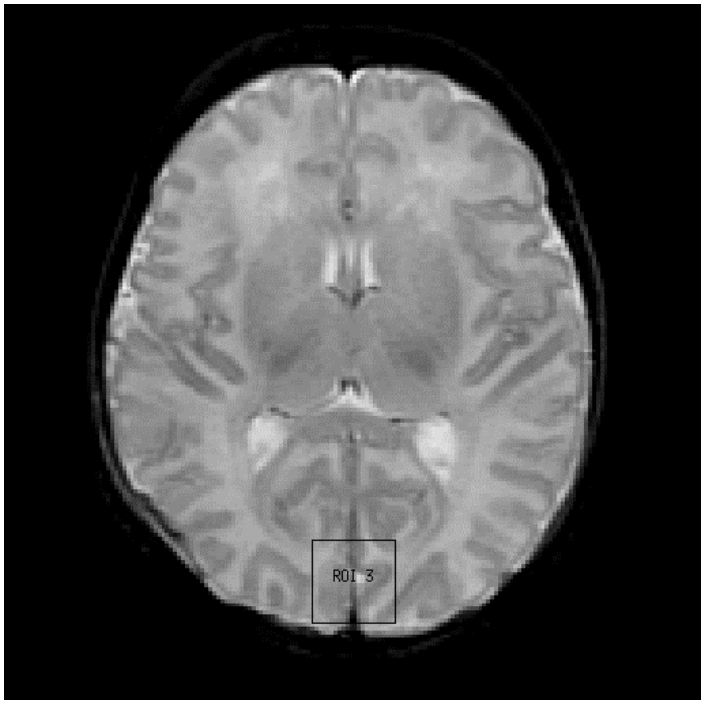
Left frontal (ROI 1) and left parietal (ROI 4):



Left thalamus (ROI 2):



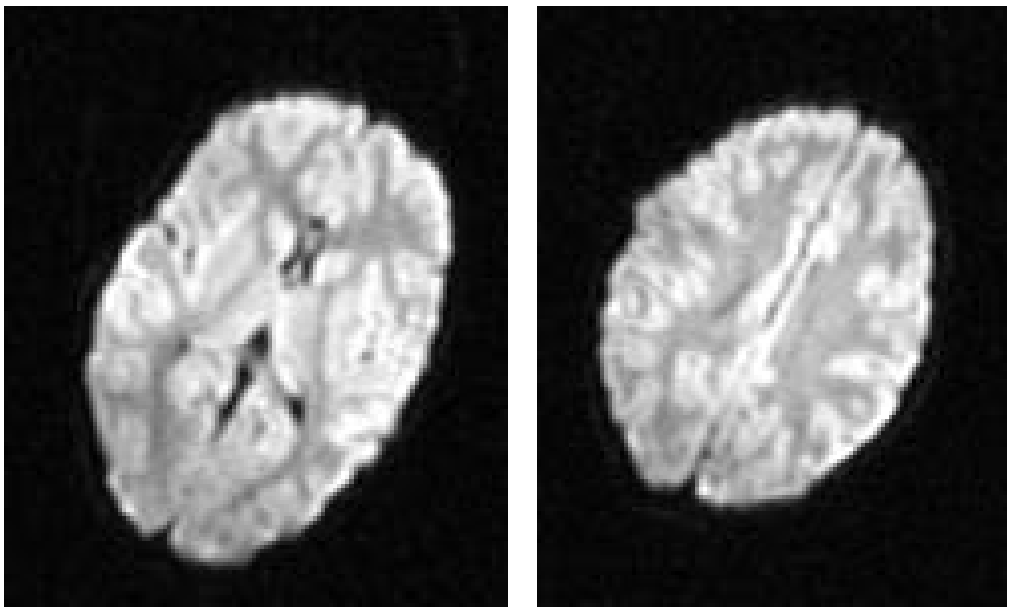
Occipital gray matter straddling the mid-line (ROI 3):



Ancillary B (DTI) Protocol Sample Data:

Dr. R. McKinstry at St Louis collected the following sample diffusion data in an unsedated normal 4-year-old girl.

Shown are two trace images:



DATA TRANSFER

The proposed data transfer mechanism for this project calls for a study workstation (SWS) at each PSC to function as a data transfer conduit. MRI data is to be transferred from the scanner console to the SWS using a DICOM transfer, and from the SWS to the DCC using another (possibly automated) DICOM transfer.

QUALITY CONTROL

The quality control procedure will consist of acquiring the protocol on an ACR phantom and on a living phantom, Nick Lange, at various time points. The data will be sent to the DCC for analysis. If there are any unusual events at a PSC (quench, power failure, hardware/software upgrade, etc) a new phantom scan should be performed. It is the responsibility of the site to closely monitor QC at their site.

For sites recruiting Objective 1 subjects (Boston, Cincinnati, Houston, St. Louis1, UCLA):

- The FULL protocol for which the site is contracted should be acquired on the ACR phantom at the beginning of each scanning phase (years 1, 3, and 5).
- The FULL protocol should also be acquired on the "living phantom" at the beginning of each scanning phase (years 1, 3, and 5). This should be done on the same day as the ACR.
- The site should run the anatomical acquisitions (3D T1W, PD/T2W) monthly on the ACR phantom during each scanning phase. Midway through the project, sites were asked to acquire the DTI on a monthly basis.

For sites recruiting Objective 2 subjects (Boston, St. Louis2):

- The FULL protocol for which the site is contracted should be acquired on the ACR phantom at the beginning of each scanning phase and repeated every six months.
- The FULL protocol should be acquired on the "living" phantom at the beginning of each scanning phase. This should be done on the same day as the ACR.
- The site should run the anatomical acquisitions monthly on the ACR phantom during each scanning phase. Sites recruiting both Objective 1 and 2 subjects should acquire both sets of anatomical scans. The St. Louis-McKinstry site should only acquire the Objective 2 T1W and PD/T2W. Midway through the project, sites were asked to acquire the DTI on a monthly basis.

Important Note:

Due to the size of the ACR phantom, some of the parameters in the anatomical acquisitions required slight revisions in order to obtain complete coverage. ***These revisions apply to the ACR phantom ONLY!*** *Subjects and the "living" phantom should be scanned as per the protocol as specified in this manual and on each site's parameter forms.*

PHANTOM SCANS - OBJECTIVE 1

Important Note for ACR Phantom Scans: Acquiring the standard protocol on the ACR phantom will result in inadequate coverage due to its large size. In order to avoid this problem, specific protocol parameters should be slightly modified. ***Please refer to page 51 for the details!***

If more than one scanner per site is used (strongly discouraged by the DCC!), all phantom data must be collected on both scanners!

Sites planning to switch or upgrade their scanner should contact Rozie Arnaoutelis at the DCC for instructions ASAP.

There may be long time intervals of inactivity between time points. It is not necessary to acquire phantom data during these intervals.

Anatomical ACR Phantom Scans

- Frequency: monthly during each scanning phase
    - Modified 3D T1W
    - Modified PD/T2W
    - Modified T1W fallback
    - DTI (Boston, Cincinnati, Philadelphia, St. Louis, UCLA)

Complete ACR Phantom Scans

- Frequency: once during each scanning phase
- Important Note: This should be acquired on same day or close as possible to Living Phantom Scan
    - Modified 3D T1W
    - Modified PD/T2W
    - Modified T1W fallback
    - DTI (Boston, Cincinnati, Philadelphia, St. Louis, UCLA)
    - eDTI (Boston, Philadelphia, St. Louis)
    - DTI air acquisition *(refer to page 21 for details)*

Complete Living Phantom Scans

- Frequency: once during each scanning phase
- Important Note: This should be acquired on same day or close as possible to the Complete ACR Phantom Scan
    - 3D T1W
    - PD/T2W
    - T1W fallback
    - MRS (Boston, Philadelphia, UCLA)
    - DTI (Boston, Cincinnati, Philadelphia, St. Louis, UCLA)
    - MRSI (Philadelphia, UCLA)
    - eDTI (Boston, Philadelphia, St. Louis)

PHANTOM SCANS – OBJECTIVE 2

Important Note for ACR Phantom Scans: Acquiring the standard protocol on the ACR phantom will result in inadequate coverage due to its large size. In order to avoid this problem, specific protocol parameters should be slightly modified. ***Please refer to page 51 for the details!***

If more than one scanner per site is used (strongly discouraged by the DCC!), all phantom data must be collected on both scanners!

Site planning to switch or upgrade their scanner should contact Rozie Arnaoutelis at the DCC for instructions ASAP.

Scanning phase refers to a period of active scanning around a time point. There may be long time intervals of inactivity between time points. It is not necessary to acquire phantom data during these intervals.

Anatomical ACR Phantom Scans

- Frequency: monthly during each scanning phase
    - Modified T1W
    - Modified PD/T2W
    - DTI

Complete ACR Phantom Scans

- Frequency: Every six months during each scanning phase
- Important Note: This should be acquired on same day or close as possible to Living Phantom Scan
    - Modified T1W
    - Modified PD/T2W
    - T1 Relaxometry
    - DTI
    - Modified 2nd Dual Contrast
    - eDTI
    - DTI air acquisition *(refer to page 52 for details)*

Complete Living Phantom Scans

- Once during each scanning phase
- Important Note: This should be acquired on same day or close as possible to the Complete ACR Phantom Scan
    - T1W
    - PD/T2W
    - T1 Relaxometry
    - DTI
    - MRS (Boston)
    - 2nd Dual Contrast
    - eDTI

** Important Protocol Modifications for ACR Phantom **

Due to the large size of the ACR Phantom, slight modifications to specific aMRI parameters are required in order to ensure adequate coverage. They are:

Objective 1

1) 3D T1W - for the ACR Phantom only:
- FoV=256mm IS x 256mm AP x 124 slices (or 128 on some scanners) at 1.7mm thick LR
  On GE scanners: 250mm IS x 250mm AP x 124 slices at 1.7 mm thick LR
- Matrix=256 x 256 AP

2) PD/T2W - for the ACR Phantom only:
- FoV=256mm AP x 224mm LR x 88 slices at 2mm thick
  On GE scanners: 250mm AP x 220mm LR x 88 slices at 2mm thick
- Matrix=256 AP x 224 LR

3) Fallback T1W - for the ACR Phantom only:
- FoV=256mm AP x 224mm LR x 66 slices at 3mm thick IS
  On GE scanners: 250mm AP x 220mm LR
- Matrix=256 x 224 LR

Objective 2

1) T1W - for the ACR Phantom only:
- FoV=256mm AP x 224mm LR x 66 slices at 3mm thick IS
  On GE scanners: 250mm AP x 220mm LR
- Matrix=256 x 224 LR

2) PD/T2W - for the ACR Phantom only:
- FoV=256mm AP x 224mm LR x 66 slices at 3mm thick IS
  On GE scanners: 250mm AP x 220mm LR
- Matrix=256 x 224

3) 2nd Dual Contrast – for the ACR Phantom only:
- FoV=256mm AP x 224mm LR x 66 slices at 3mm thick IS
  On GE scanners: 250mm AP x 220mm LR
- Matrix=256 x 224

Important Notes for DTI Acquisitions

Ambient Temperature:

When acquiring the DTI protocol on the ACR phantom, please record the ambient temperature on the parameter form.

Air Acquisitions for DTI:

Some have expressed concerns about running a scan with a completely unloaded coil for the acquisition of the DTI scan of air. The DTI Processing Center (DPC) suggested strategies for performing this scan. This "air acquisition" is only required once per scanner.

1) Run the scan without any object in the coil after setting the RF power to zero.

2) Load the coil with a very small phantom or use the ACR phantom only partially inserted in the coil. We do not need all slices to contain only air. Half of the slices would suffice.