Basic Operating Procedures for an Experiment

This document describes the basic procedures to use the MRI scanner in the Center for Cognitive and Behavioral Brain Imaging at the Ohio State University. The details to operate ancillary equipment will be described in a separate document.

This document will be available online and will be updated when needed. Comments and feedback are welcome.

Center Approval

All studies conducted at the Center must be reviewed and pre-approved by the Center's Proposal Review Committee. Please allow at least two weeks for this process. This approval must be confirmed before scanning time can be reserved on the scheduling calendar.

PIs and approved lab members must submit the funded study application.

IRB Approval

Funded studies must be approved by the IRB. We provide sample IRB applications. For security reasons, the link will be sent to only the Center users.

Safety Training

In advance of reserving scanning time, all PI's and lab personnel are required to complete annual safety training. The safety training can be scheduled through the Center's technologist, Deborah Hardesty.

PIs and approved lab members must review the Safety Manual.

Scheduling MRI time

You are required to schedule MRI time before you can perform a scan.

The Scheduling Procedure and Policy can be accessed online.

PIs and approved lab members can access the scheduling calendar.

Before the experiment

For a new experiment, you are required to provide a description of what sequences and the ancillary equipment you will be using. Make sure you have the scan protocols and stimulus program(s) ready before you bring your participant in.

It is recommended that you send the screening form to the participant before he/she comes. You can ask them to review the form, and ask if there are any YES answers. Any YES answer will normally exclude the participant, but if you are unsure, consult Center staff. The purpose of reviewing the screening form

with the participant in advance is that, in case of any exclusion criterion, you will have time to find another participant. It is recommended that you inform the participant of preparations for the day of the MRI, such as removing piercings and metal jewelry and wearing a non-underwire bra.

Before your scheduled time, you are advised to have both the screening form and the consent form signed. The screening and consent process can be done in your lab, or in the intake room (PS 24A). If, for any reason, you need to simulate the experiment for the participant, you can also reserve time on the mock scanner (PS 24). The interview rooms (B55C & D) can also be used to test your stimuli.

Pre-experiment preparation

It is important for the experimenter to begin the participant's de-metaling process 15 minutes before the actual scan reservation time.

If your participant's glasses are not MRI safe, you will need to help him/her find the correct lens from our MRI-safe lens set.

It is important for experimenter to anticipate needing time for stimulus set up prior to starting a scan. The technologist will ensure that the projector and audio amplifier (if applicable) and assist in connecting the stimulus computer to Center's system.

See Ancillary Equipment Operation for details of stimulus computers and other equipment.

No food or beverages is allowed in the control room and strictly prohibitive near any of the computer equipment.

Entering magnet room

The experimenter can only enter the magnet room with certified Center personnel. Right outside the magnet room door, always do a last minute check of your own pockets.

The participant must remove their shoes before entering the magnet room. Metal lodged in the bottom of a shoe could be dangerous to the participant within the magnet room.

Setting up the participant

Ear plugs and/or headsets are required to reduce acoustic noise. If you use the HiFi audio system, you will need special ear plugs. For each new participant, a hygienic paper will be placed on the head pad, as well as fresh table paper on the patient table. The emergency squeeze ball must be provided to the participant. If needed, the response pad(s) and speech recording microphone should be set up properly.

If you are testing a new sequence, you may want to attach a vitamin E capsule to the LEFT side of the participant's head. It is important to place the vitamin E Capsule in the correct area of the forehead to prevent the capsule's signal from polluting the brain image.

When scanning with an Anterior/Posterior phase encoding direction the capsule should be placed on

the side of the participant's head, not near the middle of the forehead. This way, signal of the spot should only appear near the scalp tissue.

For Right/Left phase encoding, the opposite applies. The capsule should be placed near the middle of the forehead, but offset enough from the middle so that it will still be easy to distinguish right/left hemispheres later.

Make sure the participant's head is centered within the head coil, and align the eyebrows with the markers on the coil. The participant will be asked to close their eyes so we can adjust the red light line to align with the eyebrows. After the table is moved into the bore, please make sure the participant is comfortable.

Close the magnet room door. From the control room, turn off the lights in the magnet room if needed.

Patient registration

Patient Registration has to be done before any sequence can be run. The Siemens system requires some mandatory information, such as Patient Name, Date of Birth, and Weight etc. In order to protect the participant's privacy, and to facilitate data access and analysis later, we have implemented a specific format for inputting data.

The *Last name field* must be in format of 1234AB, where the 4-digit number is our unique serial participant ID, increasing sequentially by 1 each time. You can find the previous number from the log book. The two letters are the PI's initials, such as JS for John Smith.

The *Patient ID field* may either be the same as the *Last name field,* or, the experimenter may assign their own participant ID in this field.

The *Date of Birth* field must always be 7/1 plus the real birth year. The reason to choose July 1st is that the average age of your participants won't have any bias.

The *Age* field will automatically populate.

The *Height field* is optional.

The *Weight* field is essential for SAR computation, and must be accurate.

The *Requesting physician* field must be populated with the PI's full name. Although this is not mandatory by the system, it is critical that the PI's name is recorded in this field in order to be able to separate and retrieve data. This will allow you access to your own data from our data server.

The Patient position field is a drop down menu. Select "*Head First – Supine"* for this field*.*

The Operator field is the operator's (such as the technologist) first name or initials.

Running an experiment

We are now ready to run a real experiment! Browse to your protocol folder you have prepared.
The first scan will always be localizer or AASCOUT, which takes only about half a minute, and is used to localize the brain for later slice prescription.

For the functional scan, it is suggested to run a functional localizer, which has only 1 or 2 measurements. This will perform the shimming, and will give a chance to quickly check whether the slice prescription is good, and whether there is any image quality problem, such as distortion or inhomogeneity. Once this is completed, you are ready to run the sequences as designed in advance.

Between scans, always ask if your participant is doing well.

At the completion of the reservation, the experimenter will be required to sign the please sign the usage form for billing purposes.

Clean up

You don't like to start your experiment with a mess from the previous experimenter, so you need to clean up before you leave the control room. The basic rule for cleanup is to put everything back to where it belongs. This may include the response pad, headset, squeeze ball, audio recording microphone, and eye glasses. For glasses, you must return the lenses to their original slots. Throw away the used ear plugs, head tissue, and table paper. Turn off the amplifier if you used the HiFi audio.

Data retrieval

After you finish the experiment, the data will be uploaded to our PACS server automatically.

To access your data, go to http://pacs.psy.ohio-state.edu/ from any computer. Each PI will have a user name and password to access the data of his group (This is why we input the PI's name as *Requesting physician* during *Patient Registration*). After logging in, you will see an interface like this:

There are 1 unread studies: **Wednesday March 16th 2011**

Previous Next   Displaying 1-1 of 1 Studies:

Check All   Forward   Export   Download   Mark Study As Read

	Patient ID	Patient Name	Date of Birth	Study ID	Study Date	Study Time	Received On	Accession Number	Referring Physician	Description	Reading Physician	Read By	Requesting Physician	Source AE	Total Number of Instances	Notes & Attachments
☐	2009ZL	2009ZL	1985-07-01	1	2011-03-04	09:24:21	2011-03-04 10:58:28	N/A	Zhong-Lin Lu	SequenceRegion^UserSequences	N/A	N/A	N/A	MRC35445	3520	0 Notes and 0 Attachments

Check All   Forward   Export   Download   Mark Study As Read

We suggest that you download your data on the same day. If you access the data later, you may need to click *Browse*, *Unread Studies,* or *Search* to find your data.

As shown above, you will see some information entered during *Patient Registration*. You could simply click the checkbox at the leftmost side to select the *Patient* then click the *Download* button, but this will download all the images and you may not need some of them.

Before we show how to selectively download data, let's get familiar with the structure of the dicom data, in the console computer and in the PACS server. There are four levels of data, very like four levels of folders. The first is Patient, and the second is Study. In our system, since we use different Patient Name even when running a participant for the second time, we always have only one Study for each Patient. The third level is Series, and the fourth level is images, called Instances here. A Series is generated when you run a protocol from the Siemens console. There may be many Instances within a Series.

If you click Study ID 1 at the example above, you will see the something like following.

There are 21 series in Study: 1 for Patient: 2009ZL

Previous 1 2 3 Next   Display All   Displaying 1-10 of 21 Series:

Check All   Forward   Export   Download

	Series Number	Date	Time	Modality	Body Part	Operator Name	Total Instances	Description
☐	1	2011-03-04	09:45:00	MR	N/A	Xiangrui	3	localizer
☐	2	2011-03-04	09:46:31	MR	N/A	Xiangrui	1	ep2d_bold_3mm_IPAT2
☐	3	2011-03-04	09:46:31	MR	N/A	Xiangrui	1	MoCoSeries
☐	4	2011-03-04	09:49:54	MR	N/A	Xiangrui	198	gauge_block_r1
☐	5	2011-03-04	09:49:54	MR	N/A	Xiangrui	198	MoCoSeries
☐	6	2011-03-04	09:56:28	MR	N/A	Xiangrui	198	gauge_block_r2
☐	7	2011-03-04	09:56:28	MR	N/A	Xiangrui	198	MoCoSeries
☐	8	2011-03-04	10:03:54	MR	N/A	Xiangrui	198	gauge_block_r3
☐	9	2011-03-04	10:03:54	MR	N/A	Xiangrui	198	MoCoSeries
☐	10	2011-03-04	10:13:14	MR	N/A	Xiangrui	261	gauge_event_r1

Check All   Forward   Export   Download

Now you see the first 10 *Series* out of total of 21 *Series* in the *Study*. You can click *Display all* to show all 21 *Series*. The last column, *Description*, is the protocol name that you used during the scan. You can see *Series* 4, which is the first functional run, has 198 *Instances*, which means there are 198 mosaic images (198 TRs) for this run. Series 5 is the motion-corrected *Series* from *Series* 4.

The *Series* is the level we recommend to select to download the data. For example, if you like to download only the motion-corrected functional data (*Series 5, 7, 9, 11, 15, 17 and 19*) and anatomical data (*Series* 12), you should click to mark those checkboxes, and then click *Download*.

The server will compress all data you select into a zip file. Depending on the data size, this may take several minutes. The time to download the zip file is normally less than a minute, and it is especially fast if you are within the Psychology Building network.

After you extract the zip file, you will see unique, long, but meaningless file names. If you need to NIfTI format of data, the recommended converters are Matlab-based converter by Xiangrui Li, or standalone converter by Chris Rorden. These converters don't require organizing files into series. If you use Matlab, the Matlab-based converter is recommended. It accepts the downloaded zip file as input, and it also saves full dicom header for each series in case you like to check something later. It also contains tools to rename files into meaningful names, if you need to do so for any reason.

It is your responsibility to back up your data to CD/DVD or hard drive after you have downloaded them.

Physiological data retrieval

If pulse and/or respiration are recorded during the experiment, the data will also appear on the PACS server together with the image data. To facilitate the access of this data, we construct the physiological data into dicom images, so you can download and archive it together with the image data.

When you open a *Study* on the PACS server and expand the series by clicking *Display All*, if there is physiological data, you will see *Series* 998 and 999 as last two series, like following picture:

	Series Number	Date	Time	Modality	Body Part	Operator Name	Total Instances	Description
☐	1	2014-11-12	15:06:25	MR	N/A	Deborah	3	localizer
☐	2	2014-11-12	15:15:53	MR	N/A	Deborah	176	MPRAGE_TI950
☐	3	2014-11-12	15:26:24	MR	N/A	Deborah	2	epi_localizer
☐	4	2014-11-12	15:31:13	MR	N/A	Deborah	10	epi_PA
☐	5	2014-11-12	15:31:31	MR	N/A	Deborah	2	epi_localizer
☐	6	2014-11-12	15:32:33	MR	N/A	Deborah	10	epi_PA
☐	7	2014-11-12	15:35:25	MR	N/A	Deborah	207	epi_Study_run1
☐	8	2014-11-12	15:46:13	MR	N/A	Deborah	267	epi_Test_run1
☐	9	2014-11-12	15:55:45	MR	N/A	Deborah	267	epi_Test_run2
☐	10	2014-11-12	16:08:53	MR	N/A	Deborah	132	epi_functional_localizer_run1
☐	11	2014-11-12	16:13:45	MR	N/A	Deborah	132	epi_functional_localizer_run2
☐	12	2014-11-12	16:18:58	MR	N/A	Deborah	62	gre_field_mapping
☐	13	2014-11-12	16:18:59	MR	N/A	Deborah	31	gre_field_mapping
☐	998	N/A	N/A	N/A	N/A	N/A	4	PhysiologyTraces
☐	999	N/A	N/A	N/A	N/A	N/A	4	PhysiologyRegressors

Check All　Forward　Delete　Export　Show　Download

Series 998 contains dicom files whose image are the physiological traces, and *Series* 999 contains dicom whose image are regressors, as shown by the *Description* in above image. There are often multiple *Instances* in each of these two *Series*. For example, if *Series* 999 above is clicked, you may see something like the following picture. In this example, there are four *Instances* in *Series* 999. The *Instance* Numbers here represent the original Series Numbers in this *Study.* In example below, *Instance* 8 contains the regressors for original *Series* 8: epi_*Test_run1*. The exception is for *Instance* Number of 1 if exists, which contains the continuous traces for the whole session. The AcquisitionTime indicates the start time of the traces.

If you read the dicom header of *Instance* 8 (either by dicm_hdr in the above mentioned Matlab converter, or other dicom reader), you will see its ProtocolName is the ProtocolName of original *Series:* epi_*Test_run1*. There are also other useful information in the dicom header, such as HeatRate is the mean heart rate (beats per minute) during the time of Series 8, RespiratoryIntervalTime is the mean respiratory interval in seconds, and TemporalResolution is the sampling interval in millisecond for the physiological traces, which is fixed at 2.5 ms for Prisma (was 20 ms for Trio).

The traces and regressors *Instances* are only generated for MOSAIC series (normally functional series) with more than 5 volumes. The regressors are constructed based on the method described by Glover et al (Magnetic Resonance in Medicine 44:162–167, 2000).

For each physiological trace *Instance*, the dimension of the dicom image is 2 by 1 by 1 by n, where n equals nVolumes * TR * 400 (400 is sampling rate). The first trace is pulse, and second is respiration. For old Trio image, the image dimension is n by 2. We put the number of points in 4th dimension (NumberOfFrames) since it won't suffer the dicom restriction of length 65535.

For each physiological regressor *Instance*, the dimension of each dicom image is normally nVolumes by 8. The first 4 columns are for pulse, and last 4 for respiration. The 4 regressors for each signal contain 2 for each of the first and second order of Fourier components. If there are only 4 regressors, that means you have only one of the signal recorded, or one of signal is bad for regressor construction.

Note that both *Series* 998 and 999 contain all data corresponding to all volumes of a functional *Series*. Normally, you will discard several volumes at the beginning of a series during data analysis, so you will need to adjust these for traces or regressors accordingly.

Billing and Payment

Please contact Stephanie Fowler (fowler.40@osu.edu) for any billing inquiries.

<u>Payments for Internal Users</u>

Invoices will be sent to the PI once a month.

The PI should review the invoice and submit the invoice to their fiscal processor so that they may enter an eRequest. The CCBBI is listed as an internal vendor under the name: Cognitive & Behavioral Brain Imaging Ctr. Once a month the CCBBI will reference the approved erequest, and will enter an IDB to process the transaction. A copy of the invoice must be attached to the eRequest, and please note the invoice number(s).

<u>Payments for Internal Users Utilizing Grant Funding</u>

The PI should review the invoice and submit the invoice to their fiscal processor so that they may enter an eRequest. The CCBBI is listed as an internal vendor under the name: Cognitive & Behavioral Brain Imaging Ctr. Once a month the CCBBI will reference the approved erequest, and will enter an IDB to process the transaction. A copy of the invoice must be attached to the eRequest, and please note the invoice number(s).

The Center has been asked to notify all PI's that pre-approval is required prior to scheduling any funded study scan time that will be charged to grants. PI's should send an email to their fiscal processor in advance of scheduling scan time at CCBBI when they plan to charge scans to their grant(s). That email should then be attached to the eRequest when they are ready to pay an invoice using those grant funds. The email can be a simple statement such as "I authorize up to $5,500 on my grant 60000000 for fMRI scans conducted in the CCBBI over the next three months."

<u>Payment for External Users</u>

Invoices will be sent to the PI once a month.

Please contact Stephanie Fowler (fowler.40@osu.edu) for any billing inquiries, or if assistance is needed in establishing a purchasing service agreement or purchase order in advance of performing services at the Center.