fMRI/DTI analysis using Dynasuite

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1 Logging in

Log-in to any of the Dynasuite Windows 7 workstations using your DHE username and password. There are 2 "public" workstations, one in the DMP reading room and one in the Cancer Center MRI suite (Siemens 3T control room). There are 3 other workstations in offices (Petrella, Kranz, & Voyvodic).

Run the DynaSuite software by double clicking the "Dynasuite" icon on the desktop.

This will bring up InVivo’s login window for Dynasuite.

   Leave the Workspace as "dynasuite"
   Enter your Dynasuite username (this may be different than your DHE username)
   Enter your Dynasuite password

If successful this will start Dynasuite, which will fill your screen

2 Finding a patient session

Scan sessions are organized in Dynasuite by scanner manufacturer, or you can find any session by selecting "All Studies" in the navigation pane (upper left side of screen).

Double-click the study you want to examine (loading may take a minute).

If you are already in a patient study, you can get back to the main navigation pane by clicking the up arrow in the extreme upper left corner of the screen.

Studies are typically sorted by date (most recent first) – you can change/check the sort order by right-clicking in the navigation pane and selecting the Sorting option.
Once you enter a study you should see:

**Left side of screen:**
- **Applications**
  - Use "Smart fusion" for most fMRI/DTI analysis
  - Use "General View" to look at specific data sets in "Other Images" or "Results"
- **Other Images**
  - Original images imported to Dynasuite (e.g. from scanners)
- **Reports**
  - Text documents (e.g. from Neuroquant)
- **Results**
  - User-generated DICOM image results made in Dynasuite

**Middle of screen:**
- Image viewing region – layout will depend on application
  - In "Smart Fusion" this will have 3 planes plus a 3D recon window.
  - By default this window will show the 3DT1 reference data set.
  - You can change the base image by dragging another data set to lower-left corner of any of the 3-plane views and replacing the current view
  - You can overlay other images onto the base image by dragging a data set to the lower-left corner and adding it as another view
  - Select which view is active by clicking the arrow in the lower-left corner of the window and then selecting a view

**Right side (top of screen) Images:**
- Dynasuite images for processing and results of automatic processing
  - **Anatomical**
    - Original images recognized as suitable for processing
    - The most important of these is "3DT1" – it is the reference for all others
  - **Diffusion**
    - Map results of DTI analysis (processed "DTI" images in Anatomical list)
  - **fMRI**
    - Map results of fMRI analysis (recognized tasks from Anatomical list)
  - **Neuroquant**
    - Results of automated brain segmentation of 3DT1 images

**Right side, bottom of screen:**
- The lower right portion of screen changes depending on what application you are using, what processing has been done, and which Image data set is currently active.

If you are running the "Smart Fusion" application:
- The upper part of this region is series-dependent, changing each time you select a different image set (by clicking on it). This panel will have adjustment icons to let you check or change image properties. The icons will change depending on what type of image series is currently selected.

The lower part of the region displays ROI's drawn for this patient and lets you generate and manipulate fiber-tracking results.
3 Viewing and adjusting images

Note: These instructions assume you are using the Smart Fusion application, but the basic interactive features are similar for other applications.

Within each orthogonal viewing pane you can manipulate the slice location in the other panes by dragging the crosshair.

Right-clicking the mouse will bring up a control wheel.

- Around the edge of the wheel are display control options; these let you select what the left mouse button controls (e.g. brightness, position, zoom, rotation, etc).
- Inside each display control there is an arrow; these give you more control options.
- The arrow at the top of the wheel allows you to change various display settings.
- The camera icon in the upper-left part of the wheel lets you save a snapshot of the current image, or if you choose its arrow you can save a whole series of images for that pane.

At the lower-left of each viewing pane there is an arrow and legend. Clicking a legend icon selects that portion of the display (i.e. base image or overlay); for example, if an overlay is active then the display adjustments will be applied to the overlay.

Clicking the arrow in the lower-left corner shows what is currently being displayed in that pane. You can turn on and off different components by clicking the 'eye' icon for each.

To change the image series being displayed, drag the new series you want to see from the Image list on the right of the screen and drop it on the current base image in the image legend (e.g. 3DT1). Only one image series will be shown in full gray-scale at a time.

To add another image series as a color overlay on top of the base images, drag that series from the Image list and hover over the legend; you will then be able to either drop it on top of an existing series name (replacing that series), or drop it in an empty legend slot to add it as another overlay.

In the 3D reconstruction pane, the lower-left arrow also lets you manipulate transparency of different components of the 3D scene, and it allows you to select different cutting planes for looking within the reconstructed brain.
4 Checking brain segmentation

Dynasuite uses a whole-brain T1 scan (3DT1) as its reference for all other processing. If it does not recognize a scan as 3DT1 (T1-weighted with more than 50 slices) it will not do any automated processing.

All other images listed on the right side of the screen are automatically registered to the brain based on a mask generated by automated segmentation of the 3DT1 data set. The segmentation is also used to create the 3D brain reconstruction views.

To check/modify the T1 segmentation:
Select the 3DT1 image set by clicking on it in the Anatomical Images list (upper right).
Click on the "3D check" option in the 3DT1 panel in the lower right of the screen.
This should change the middle windows to display the segmentation mask overlaid on the 3DT1 images.
Move through the display by dragging the crosshair in any view.
To remove non-brain regions from the mask click on that region (this will usually remove a portion of the mask).
To add brain regions not included in the mask, click on that region (it doesn't need to be perfect).
Click "Save" in the lower right corner if you have made changes.
Click "Done" (lower right corner) when finished.

5 Checking image registration

You should verify that the other image sets are all properly registered to the 3DT1 images. This should be done for the FLAIR images, the DTI raw image series, and each EPI functional series.

To check registration of a series:
1. Select the series from the “Anatomical” section of the Images list (upper right).
2. Click the “Registration Check” option in the series-dependent panel (middle right).
3. This should result in a blue overlay of that image series on top of the 3DT1 images.
4. Adjust the intensity of the 3DT1 and blue overlays to have contrast in both.
5. Move through the display by dragging the crosshair in any view.
6. If necessary, translate the overlay images to improve registration.
7. You may also need to adjust rotation (especially in the sagittal view).
8. Repeat steps 5-7 until you get good registration (especially near lesion).
9. Click “Save” in the lower right corner if you have made changes.
10. Click “Done” (lower right corner) when finished.

Each series needs to be registered independently.
Once you register the Anatomical image series, the changes you made will be automatically applied to the associated Diffusion and fMRI result images as well.

Image registration is tiresome but essential.
6 Seeing fMRI results

fMRI activation maps can be superimposed onto anatomical (T1 or FLAIR) images using the Smart Fusion application.

To add an activation map, select the result from the “fMRI” Image list (right panel), and drag it to the legend in the lower left corner of any pane in the central viewing region. Depending on where you drop the cursor, you can add an overlay, replace an overlay, or replace the underlay image.

Overlays are color-coded and thresholded according to the parameter settings in the series-dependent section of the right panel.

Adjust the threshold for each fMRI overlay until it “looks reasonable”.

For weak activations, threshold t-values should probably not go below 4.
For strong activations, increase the threshold to reduce false-positive signals.
Identify putative eloquent areas nearest to the lesion and increase threshold until they nearly disappear, then reduce the threshold until the active region bleeds across neighboring sulci.
(This approach approximates the AMPLE algorithm).

If multiple fMRI maps are overlaid at the same time each will appear as a different color. The colors and series names appear in the display legend in the lower left of each view.

Note: positive activation signals (BOLD increase with task) are assigned bright colors with each task result displayed in a different color, whereas negative activations (BOLD increase during rest) are all overlaid as gray. Dynasuite does not allow you to set different thresholds for positive and negative activations. Gray overlays should in general be ignored as their meaning is not well defined.

Combine activation maps, adjusting the threshold for each, as necessary to produce optimal presentation of results.

Note: Dynasuite provides a separate fMRI application ( ) to enable closer inspection of fMRI results than is provided using the Smart Fusion application. The fMRI application allows viewing time series plots for signal fluctuations for individual active regions. Its usefulness is limited, however, because the software does not provide tools for coping with irregularities in the time series if they are present, other than adjusting the statistical threshold.
7 Saving fMRI results

Creating a Results folder
Before creating result images you should make sure you are saving into a new Results folder. If there are already saved Results new images will be added to the same folder by default. If the previous images have already been sent to PACS, adding more images to the same folder may cause problems when you try to send them to PACS because PACS does not like receiving the same image series more than once (all images in a folder get sent as the same series). So if there are already images in Results, it is good practice to create a new Results folder before creating any new images.

To create a new Results folder, right-click the “Results” section header and select “create new folder”.

To name the folder, right-click on the folder title and select “Rename”. Naming folders helps organize results in Dynasuite and on PACS.

Turning off the whole-screen crosshair
Before saving screenshots you probably want to turn off the large crosshair. To do so, right-click in any slice image, select the top arrow, and then “Displayed Information”, then the “Show/hide Cutlines” option.

Saving screenshots
To generate a screenshot of any viewing pane you can right-click on that pane and select the camera icon. That will save a single image.
To send that image to PACS you will need to export it explicitly, either by right-clicking that single Result image, or by right-clicking the folder title and exporting the whole folder. (Do not export a whole folder if some of its images have already been sent to PACS.)

To save a whole series of images of different slices, you should first decide how many slices you want to save, and then identify which is the middle slice of that series. Step through slices until that middle slice is on the screen.
Then right-click on the image, select the arrow under the camera icon, and select “Save Result Series”.
In the dialog window, choose “Around current slice”, then enter the number of slices, give the series a descriptive name, and if desired, select “Forward to default PACS”.
That will create a whole series of images and send them directly to PACS.

8 Seeing DTI results

9 Saving DTI FA overlay results

Saving any overlay results involves the same procedures as described above for saving fMRI images.

10 DTI Fiber tracking
11 Sending images to PACS

If you have not forwarded result series automatically to PACS while you were saving them (see sections 7-10 above), you can send them explicitly by right clicking items in the “Results” panel (lower left of screen) and choosing “Export”. This will open a dialog asking where you want to send the images. To send to PACS, select “PACS SCP”.

To export an entire result folder right-click the title bar for that folder. To export an individual result, right-click that result icon.

Note: all images within a single result folder will be send to PACS as part of the same image series. To separate images into different series put them in different folders.

12 Logging off

To close a patient study, click the check mark icon near the upper left corner of the screen. This will then ask you whether you want to “Defer” or “Complete” the study. Always select “Defer” – this allows someone else to return to that study later.

Dynasuite sometimes crashes while closing a study – just accept it and continue.

To log off, click the “X” in the upper right corner to close the Dynasuite display. This will then ask you if you want to log out of Dynasuite – say yes.

Log off the workstation as usual using the Windows menu in the lower left corner.