



Image Registration with 3D Slicer

Sonia Pujol, Ph.D.

Director of Training & Education, 3D Slicer
Assistant Professor of Radiology
Brigham and Women's Hospital
Harvard Medical School

Objective

- Guiding you step-by-step through the process of automatically registering two structural MR datasets acquired on two different subjects using rigid and non-rigid registration
- This tutorial is built upon the Registration Case Libray 31 tutorial available at http://www.na-mic.org/Wiki/index.php/Projects:RegistrationLibrary:RegLib_C19

Motivation

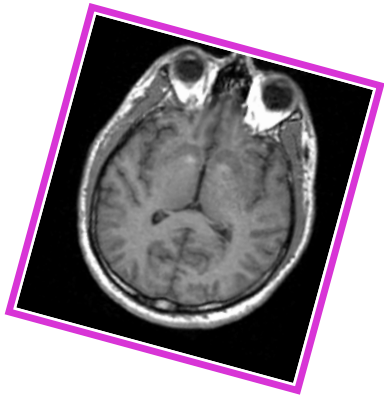


Image 1

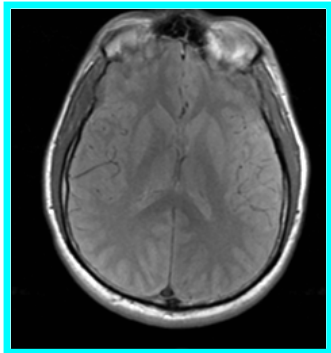
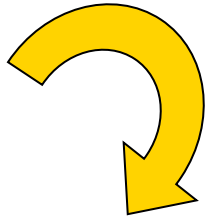


Image 2

Registration algorithms bring different image datasets into spatial alignment, in order to achieve **anatomical agreement**.

Before Image Registration

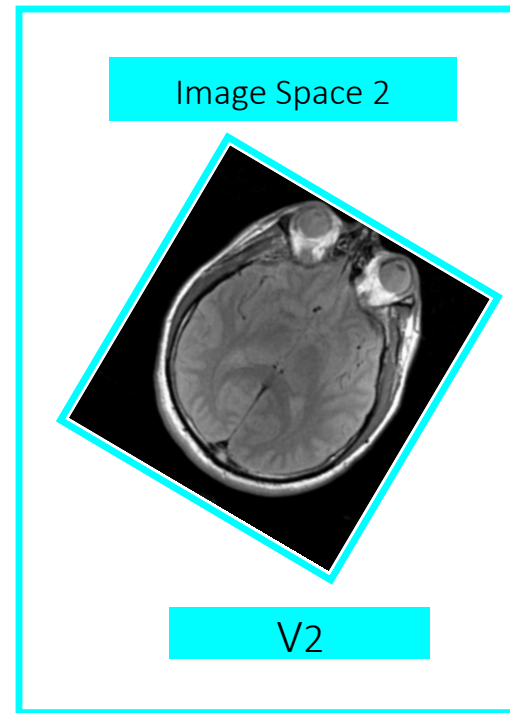
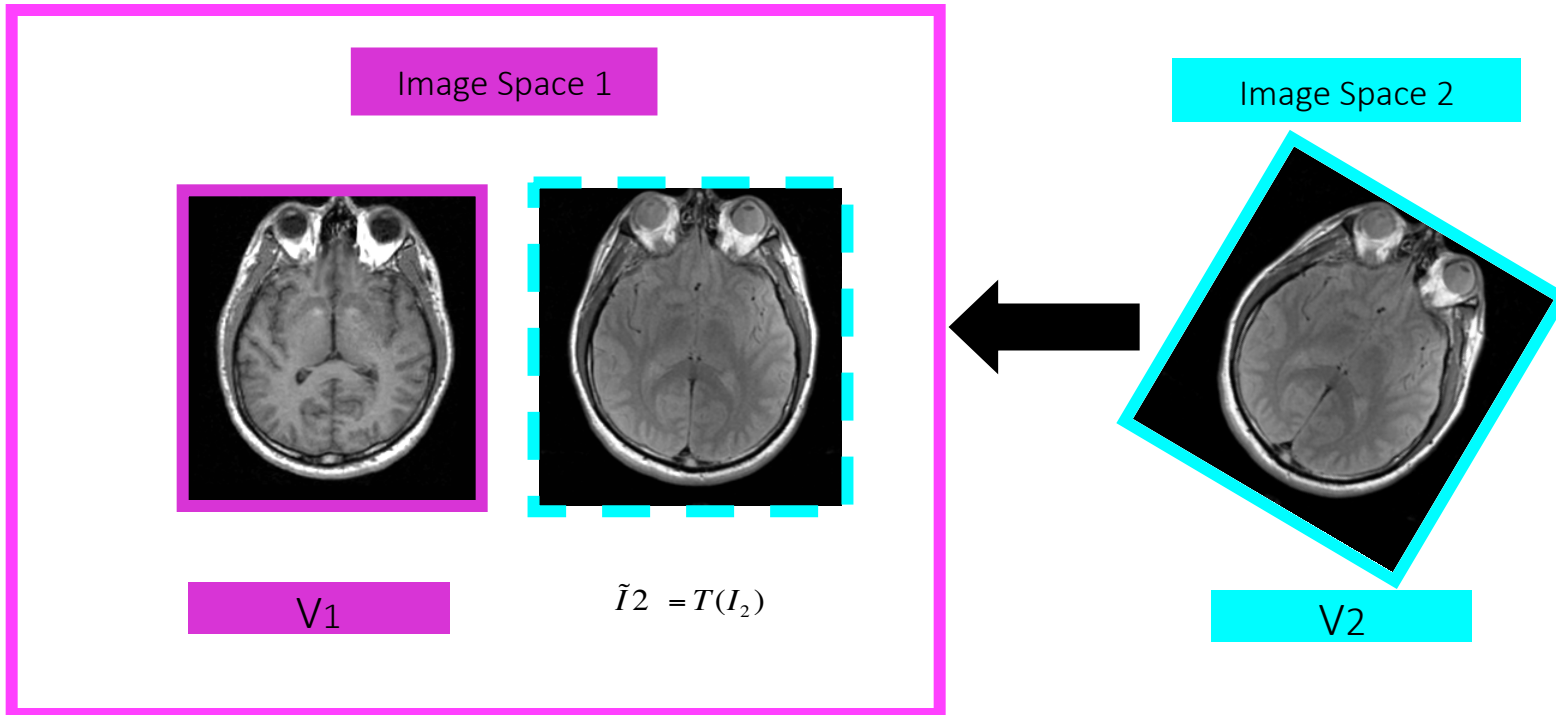


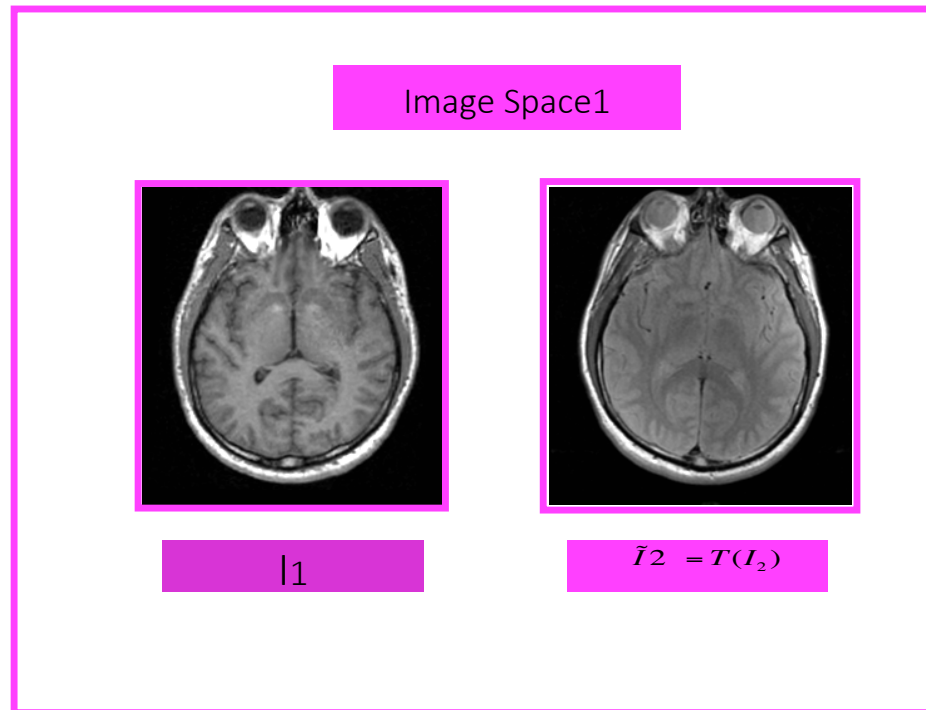
Image Registration



By applying the registration transform T to the initial volume I_2 , we generate a new volume spatially aligned with the volume I_1 .

Image registration enables the extraction of complementary information from the two volumes.

After Image Registration

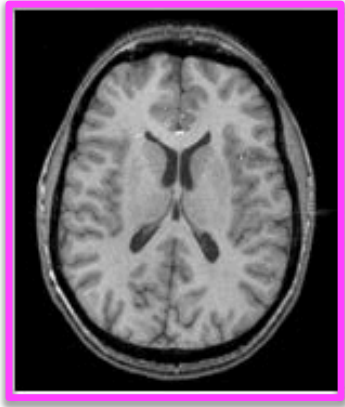


\tilde{I}_1

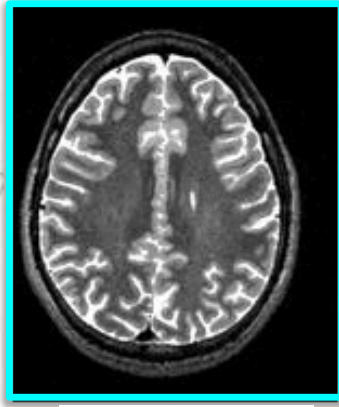
Tutorial Dataset

- Clinical study: Multi-contrast group analysis
- The case includes **T1-weighted** and **T2-weighted MRI scans** of two subjects A and B.
- This dataset is Registration Case #19 of the NA-MIC registration case library (P.I. Dr. Dominik Meier, Ph.D.)

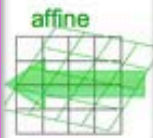
Registration pipeline



Subject A: T1



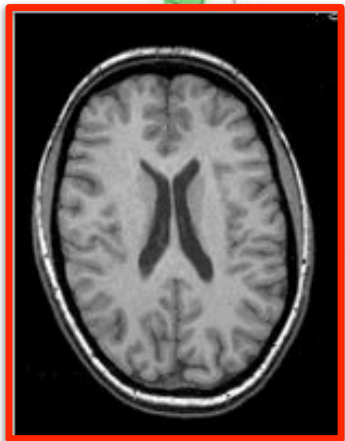
Subject A: T2



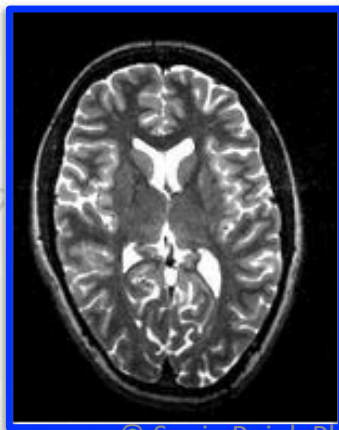
affine



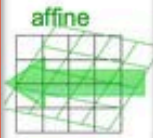
non-rigid



Subject B: T1



Subject B: T2



affine

Step 1:

Subject A, T2 to T1 registration

Step 2:

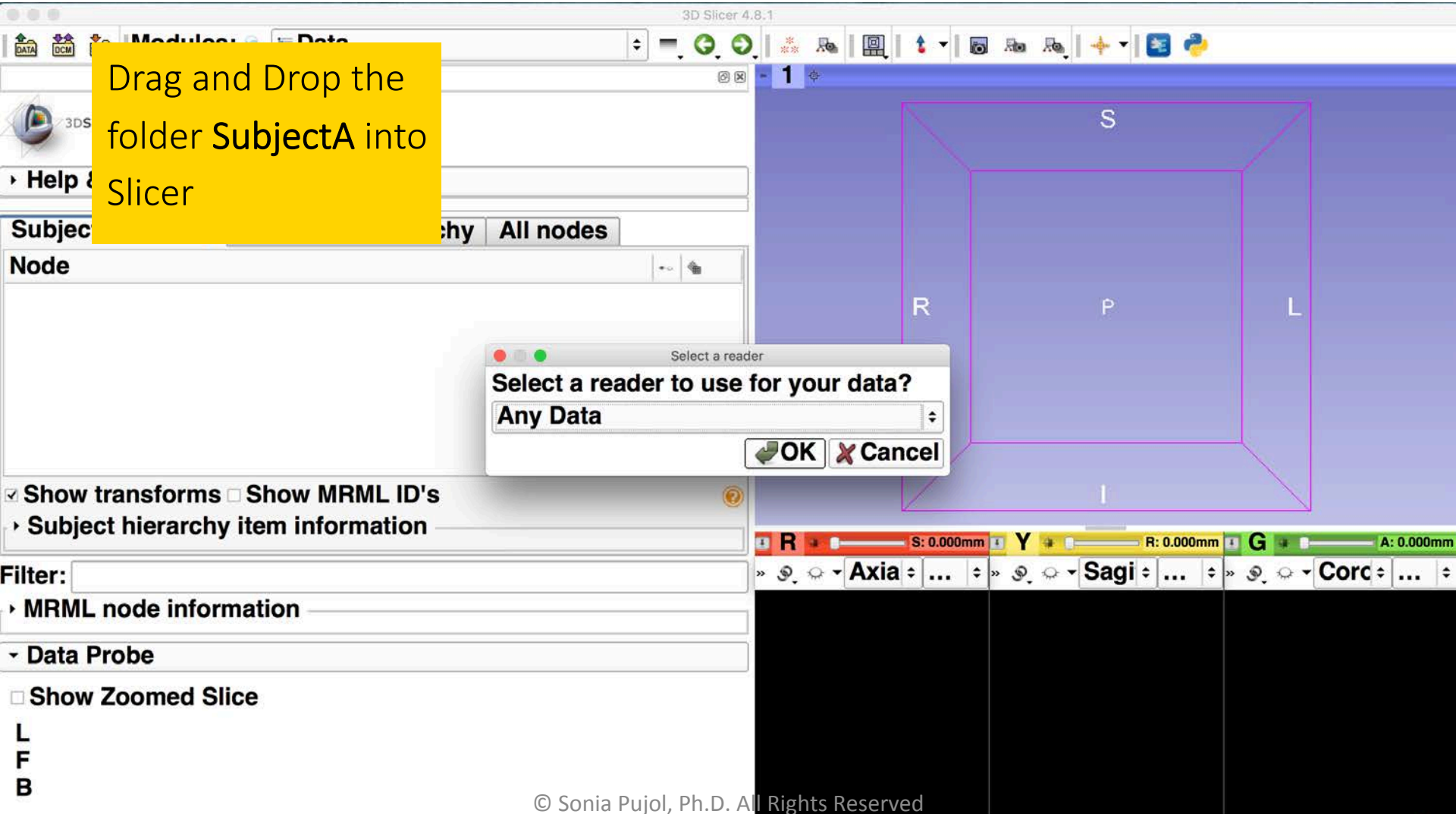
Subject B, T2 to T1 registration

Step 3:

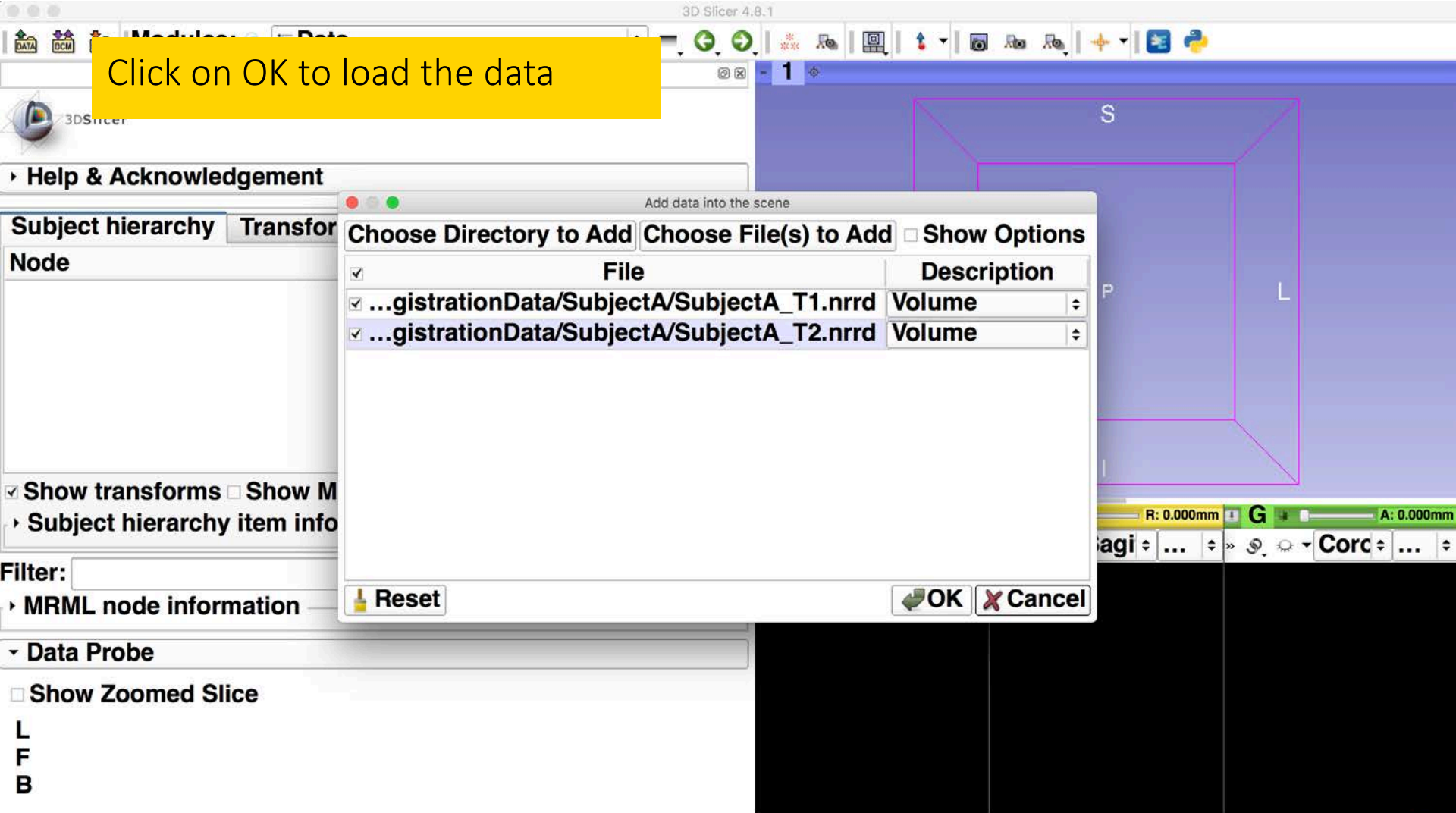
Subject B, T1 to Subject A, T1 registration

Image courtesy
of Dominik
Meier, Ph.D.

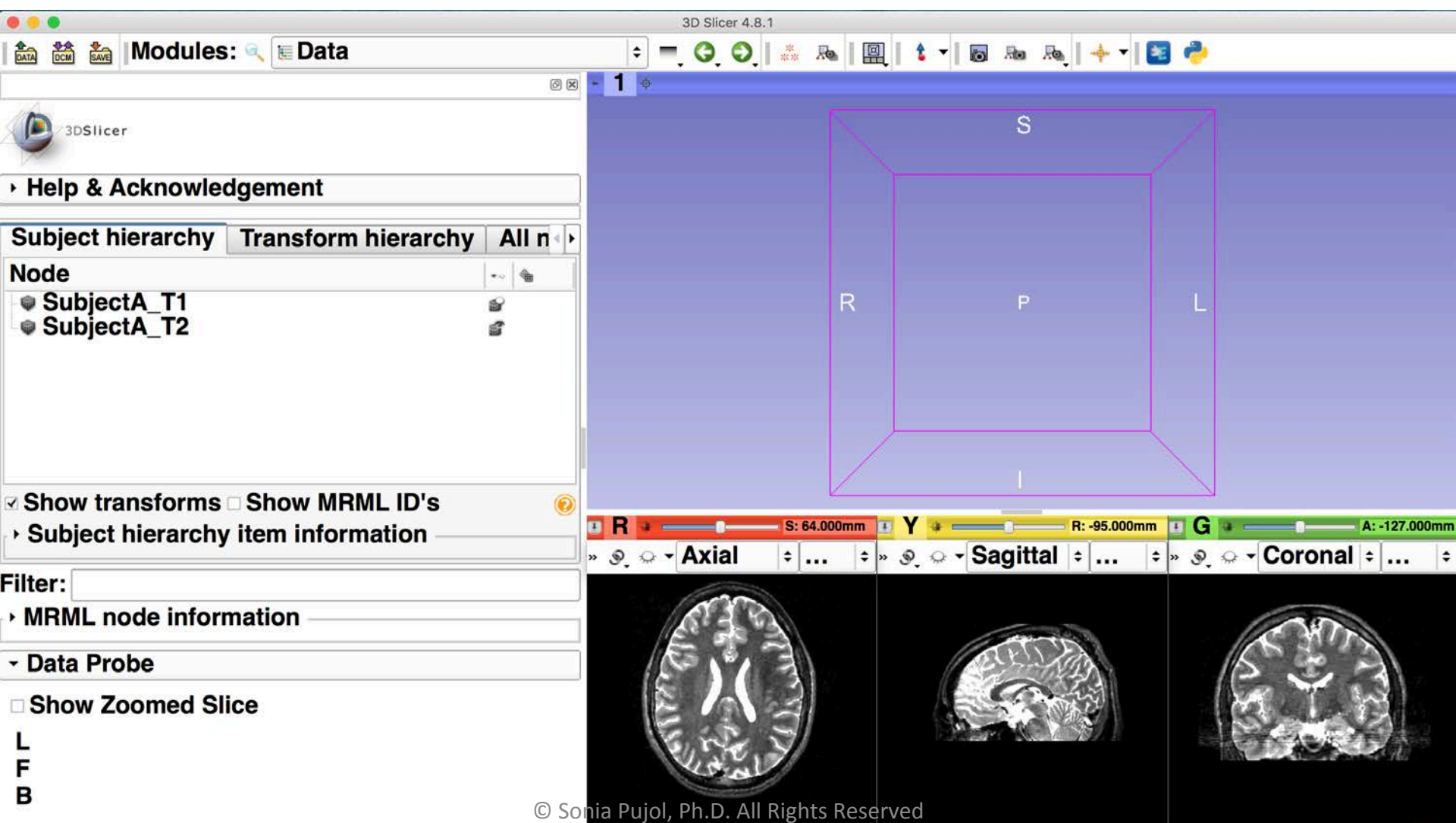
Subject A: Data loading



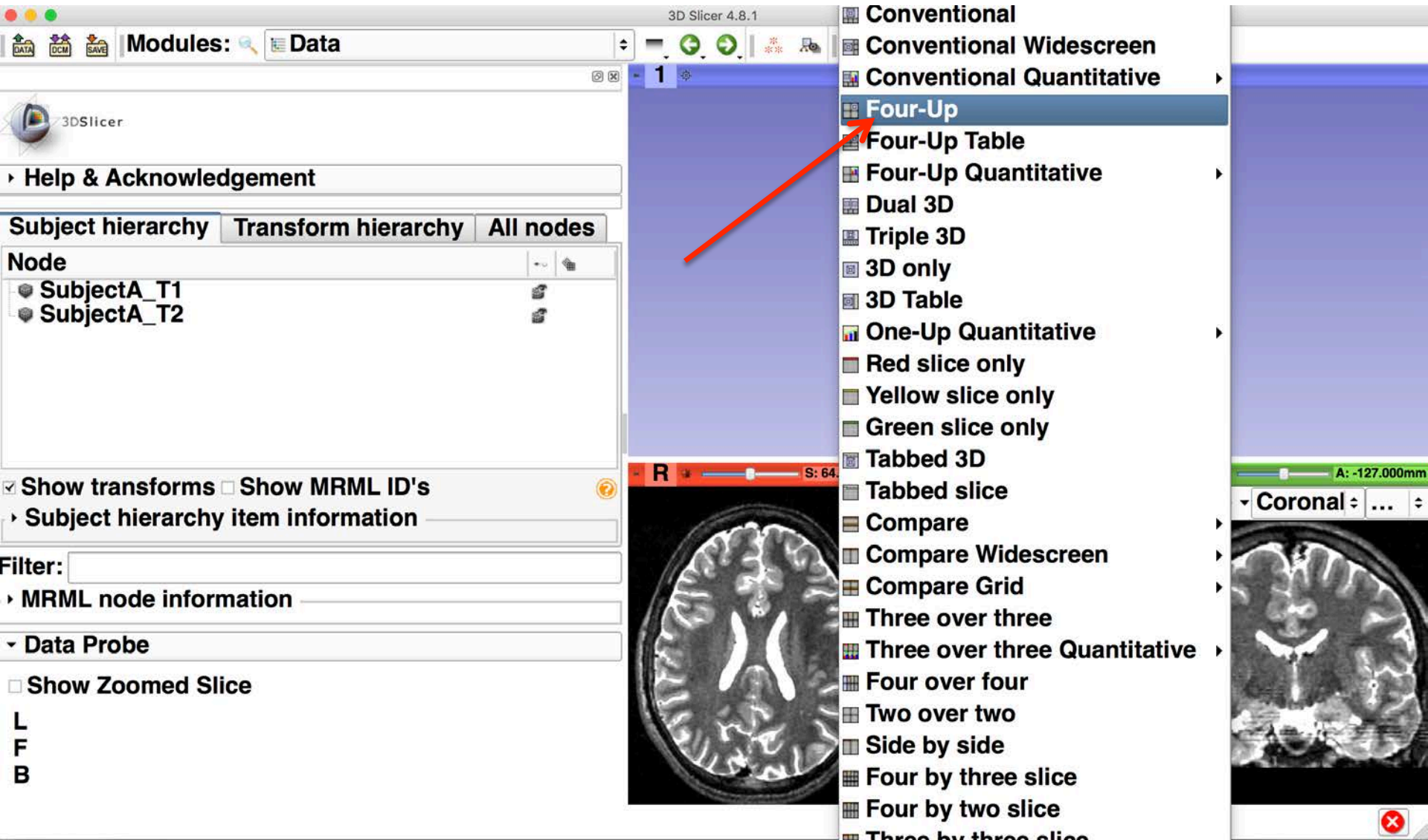
Subject A: Data loading



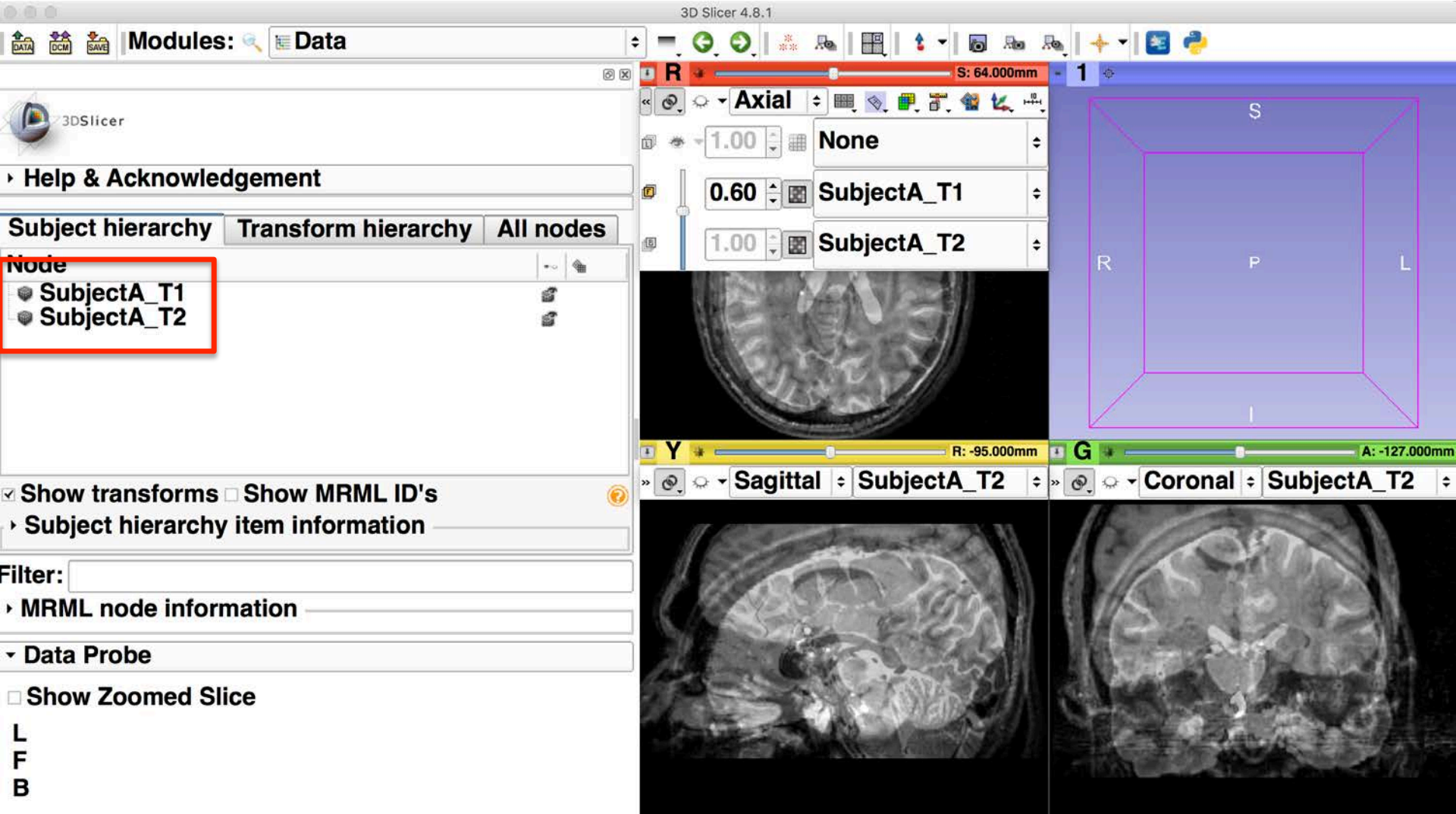
Subject A: Data loading



Subject A: Data loading



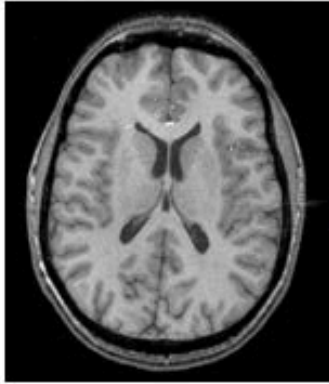
Subject A: Initial mis-registration



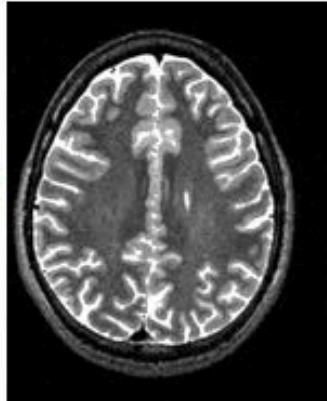
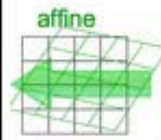
Registration pipeline

Step 1:

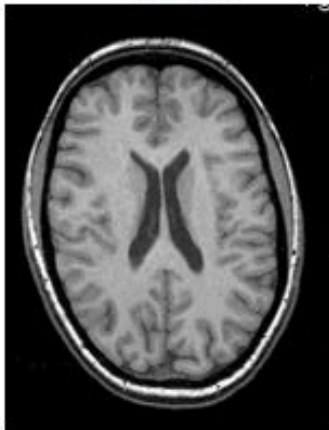
Subject A, T2 to T1 registration



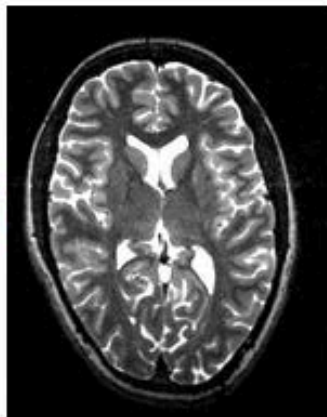
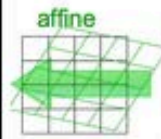
Subject A: T1



Subject A: T2

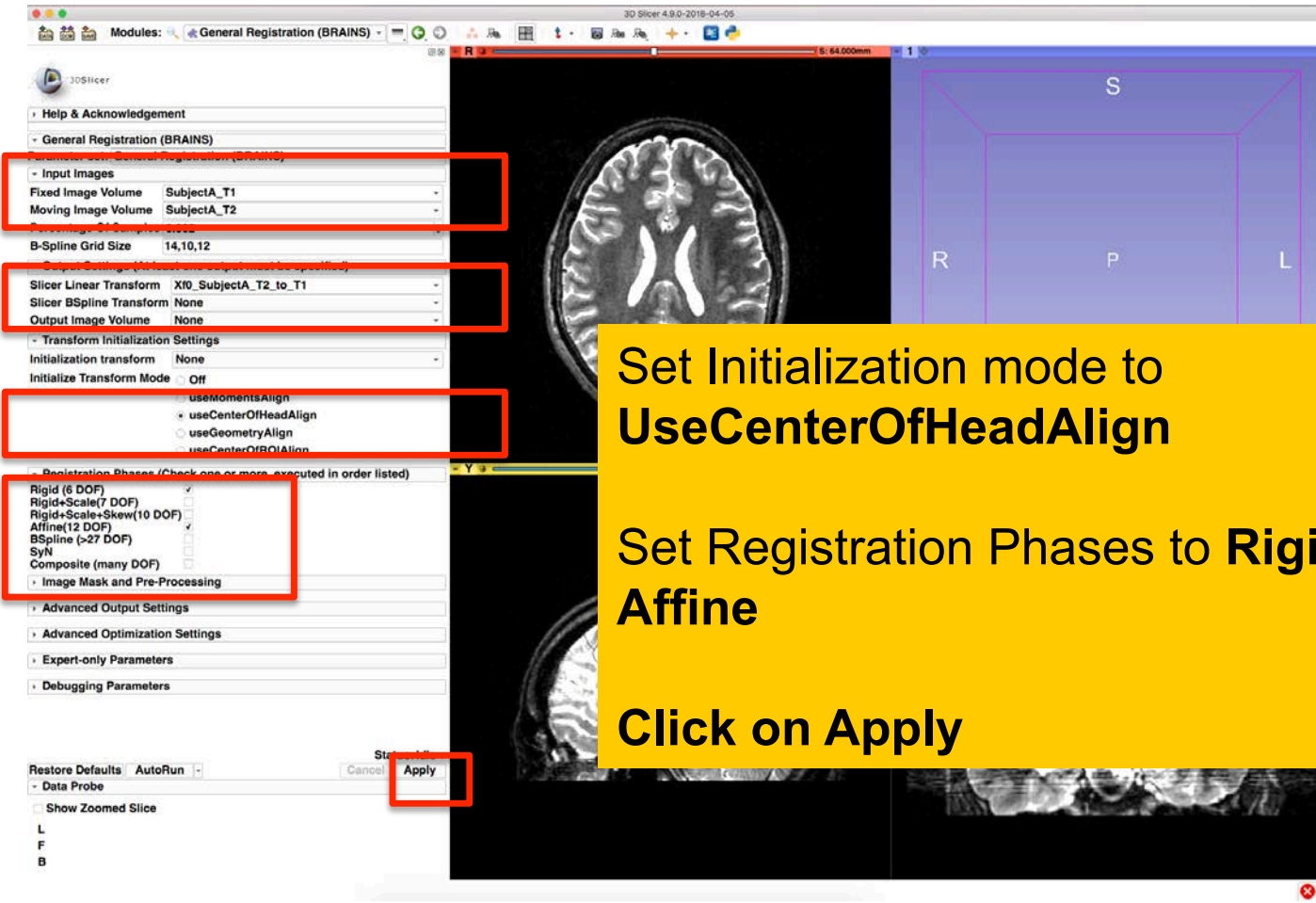


Subject B: T1

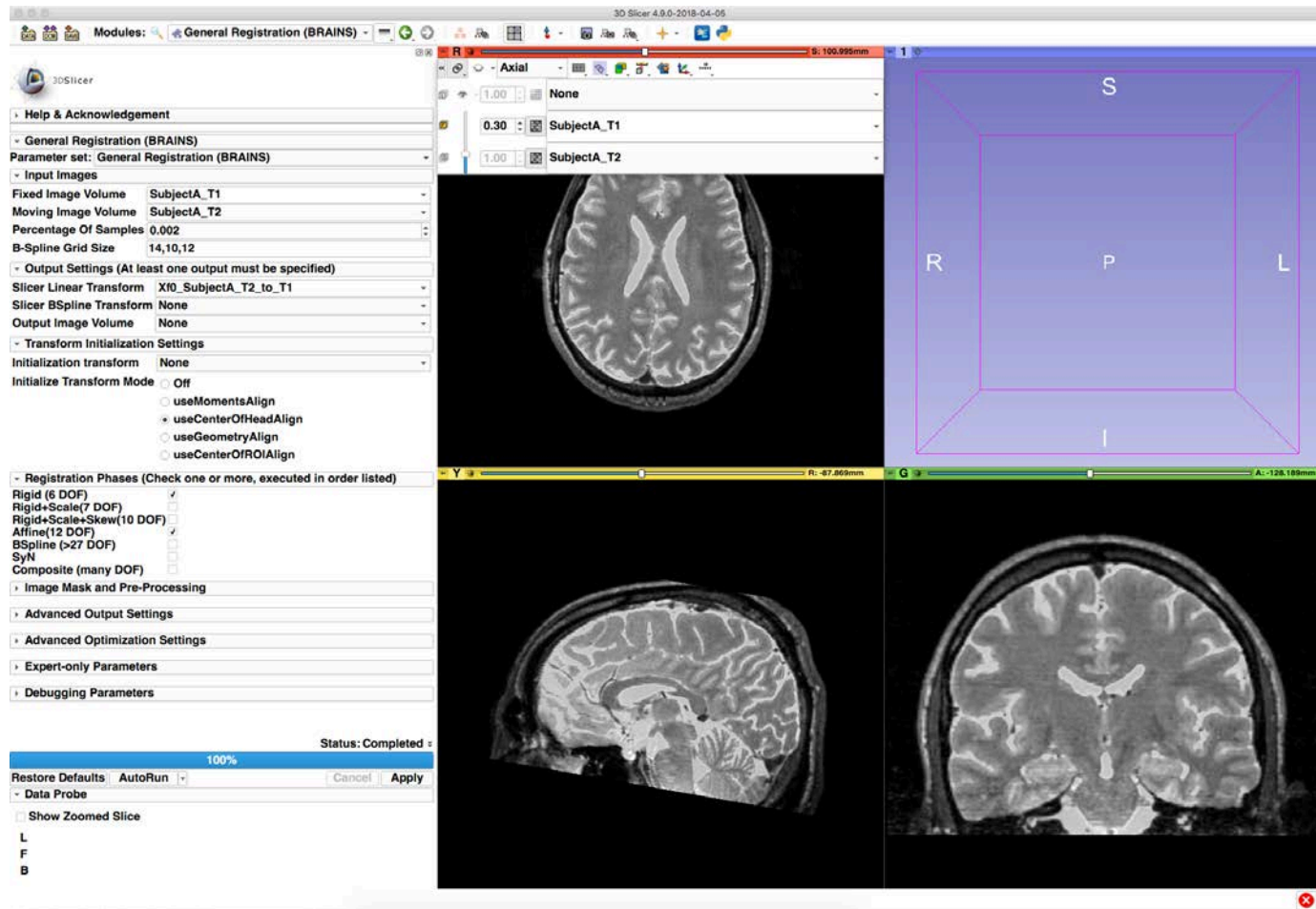


Subject B: T2

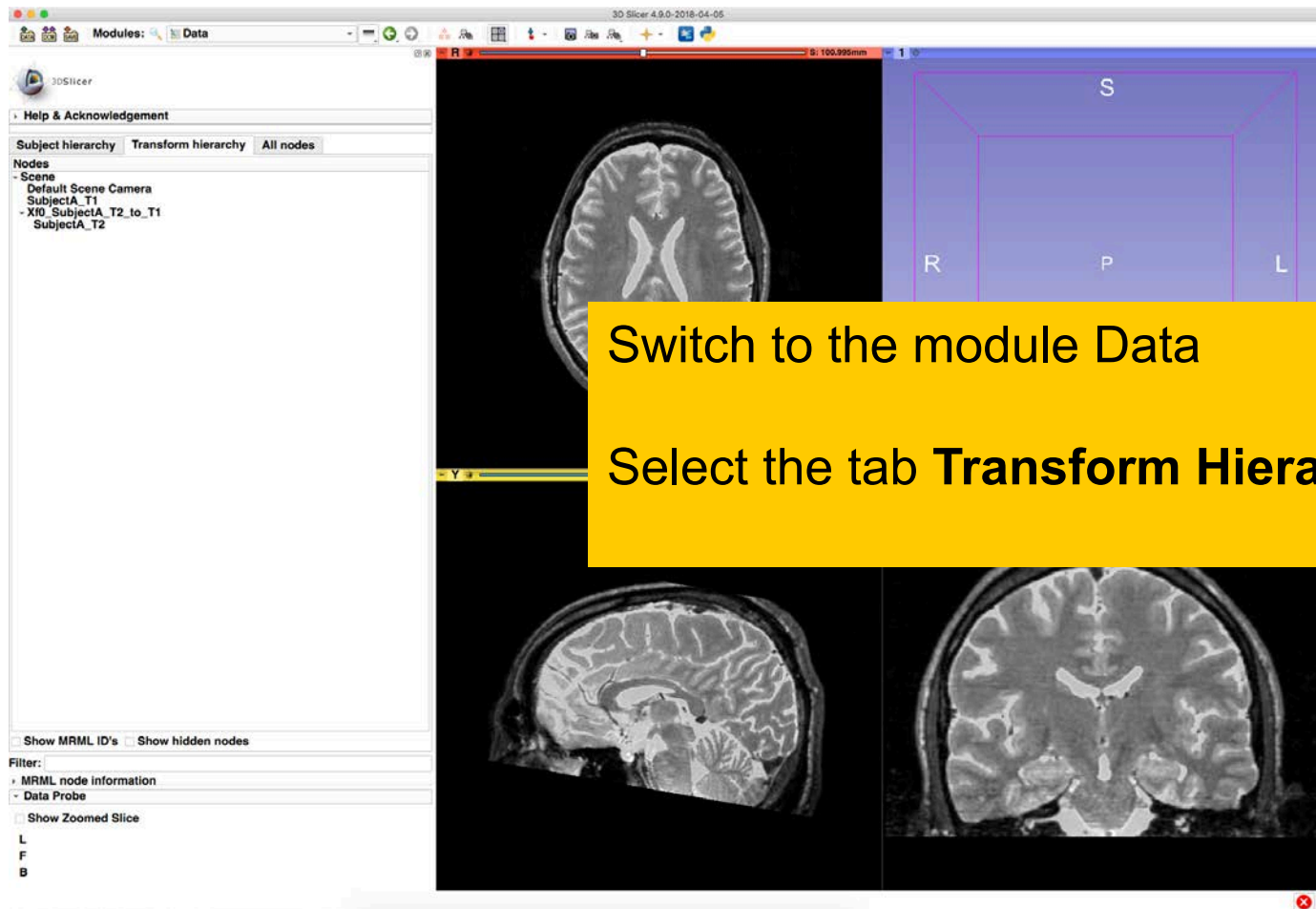
Subject A: Data registration



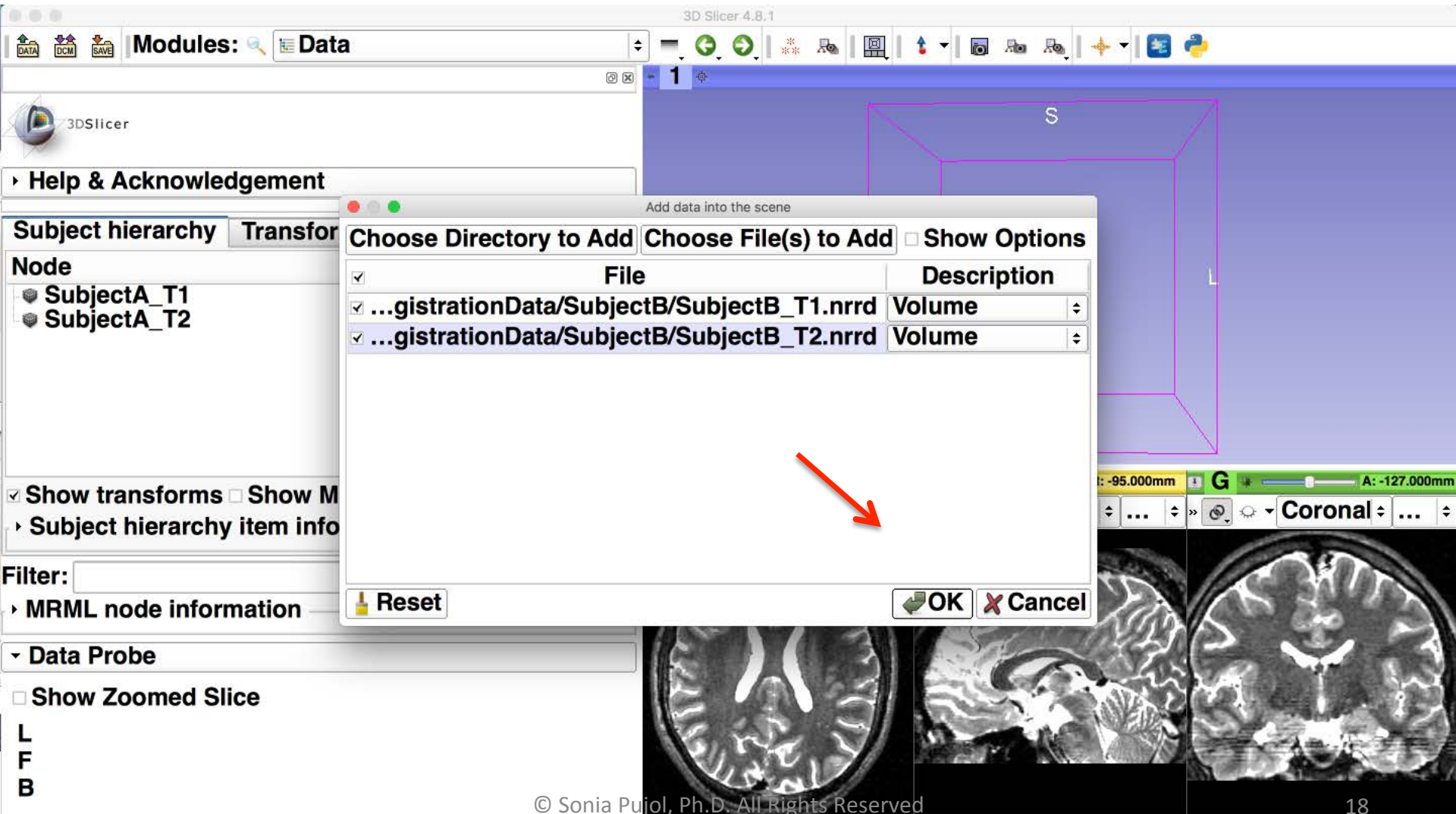
Subject A: Data registration



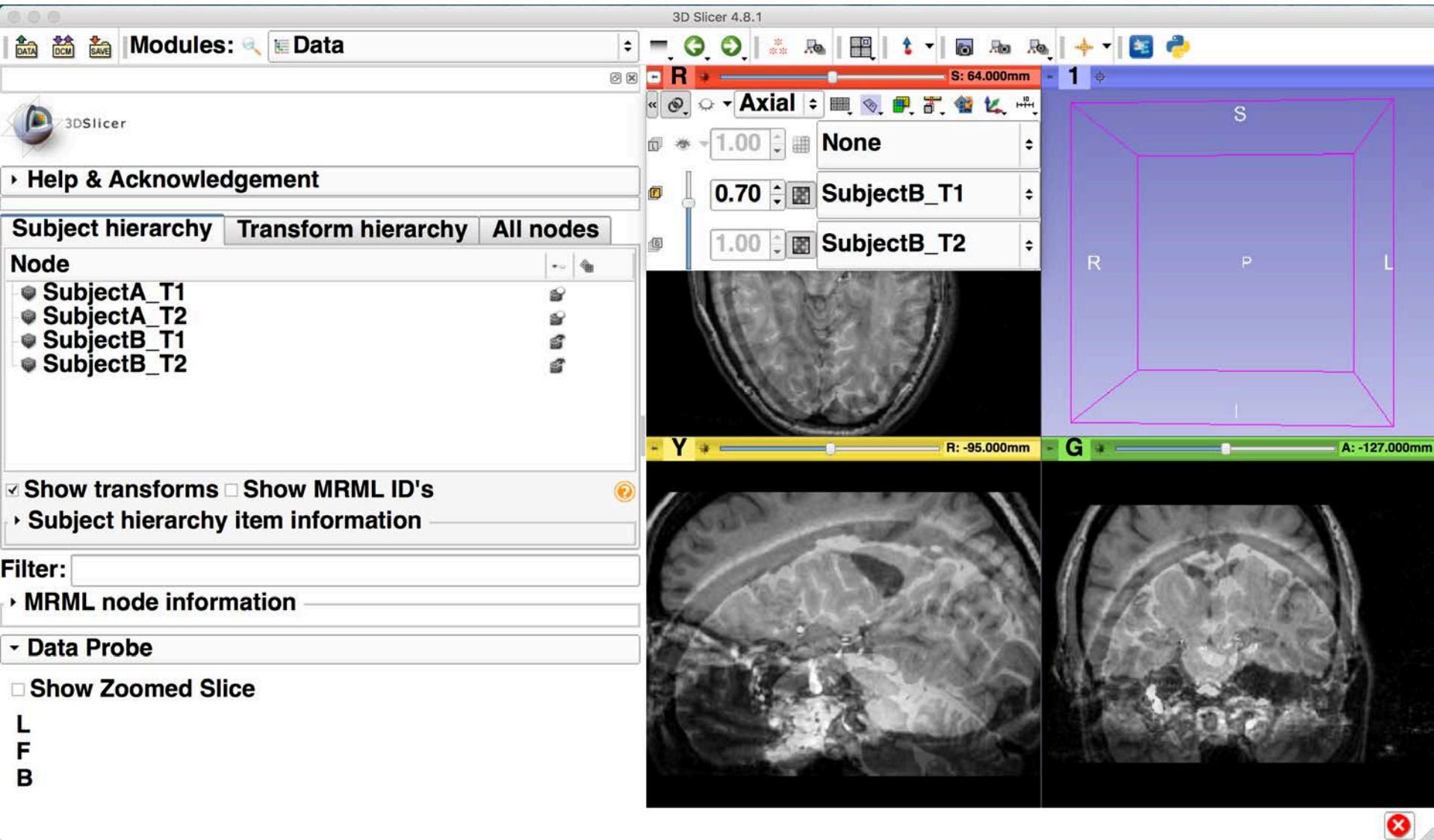
Subject A: Data registration



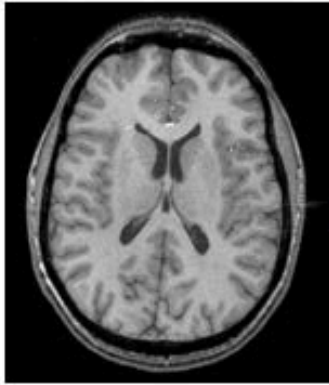
Subject B: Data Loading



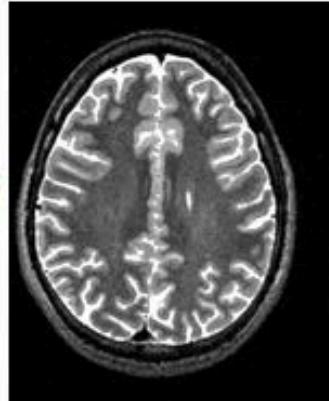
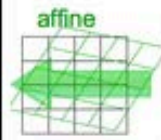
Subject B: Initial mis-registration



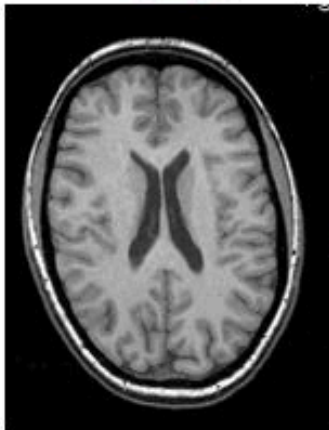
Registration pipeline



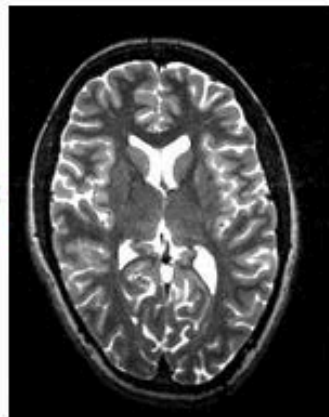
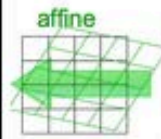
Subject A: T1



Subject A: T2



Subject B: T1

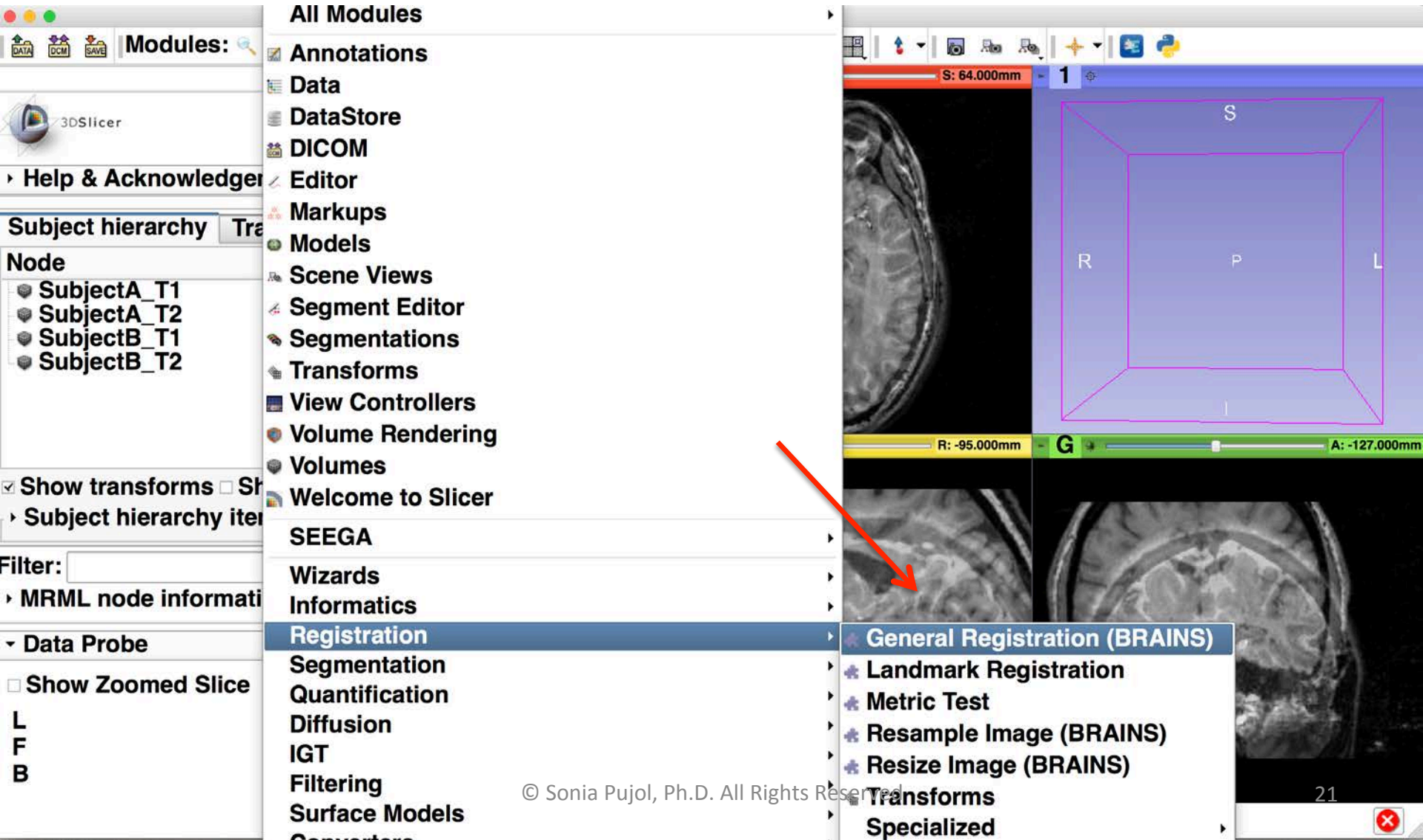


Subject B: T2

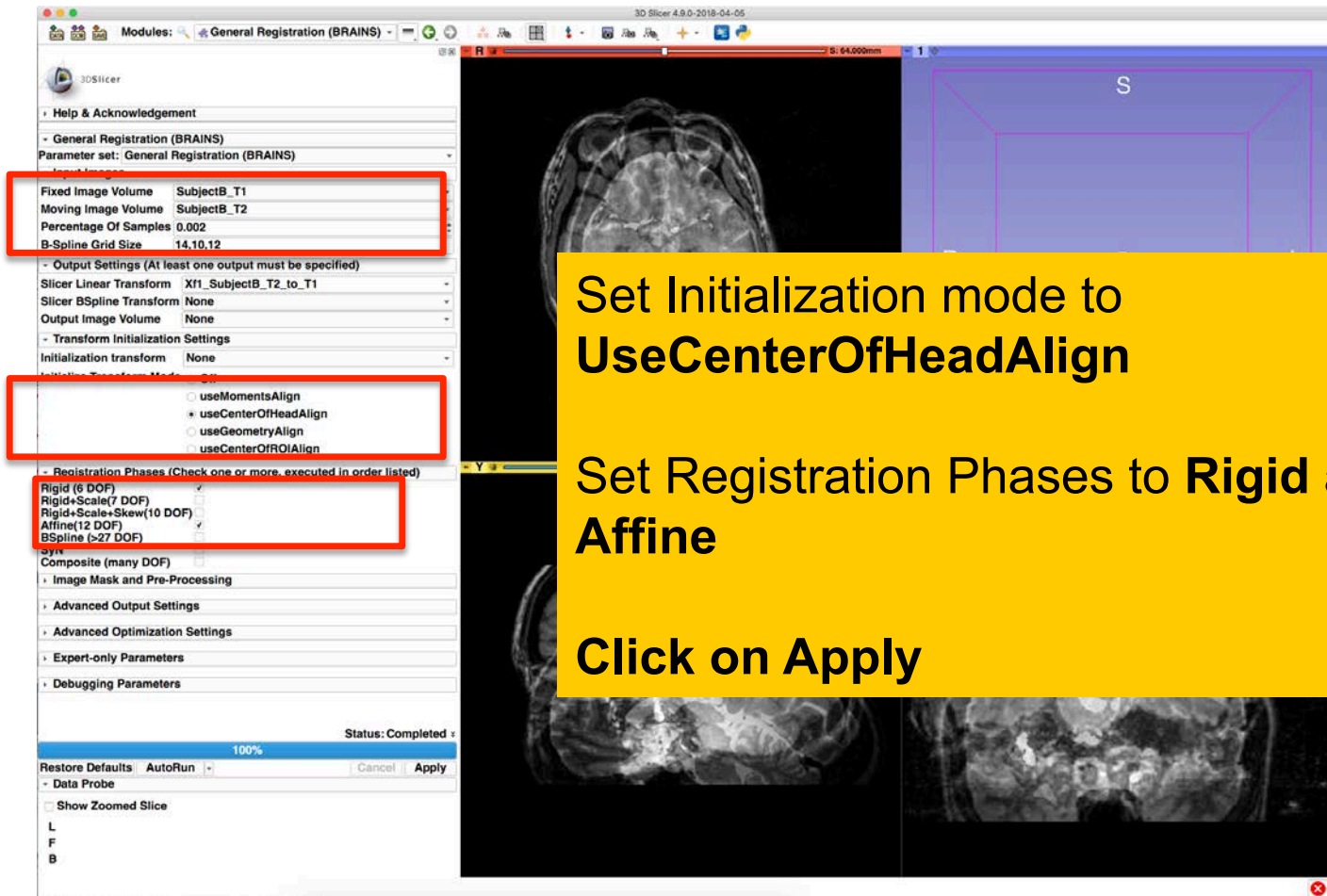
Step 2:

Subject b, T2 to T1 registration

Registration Module



Subject B: Data Registration

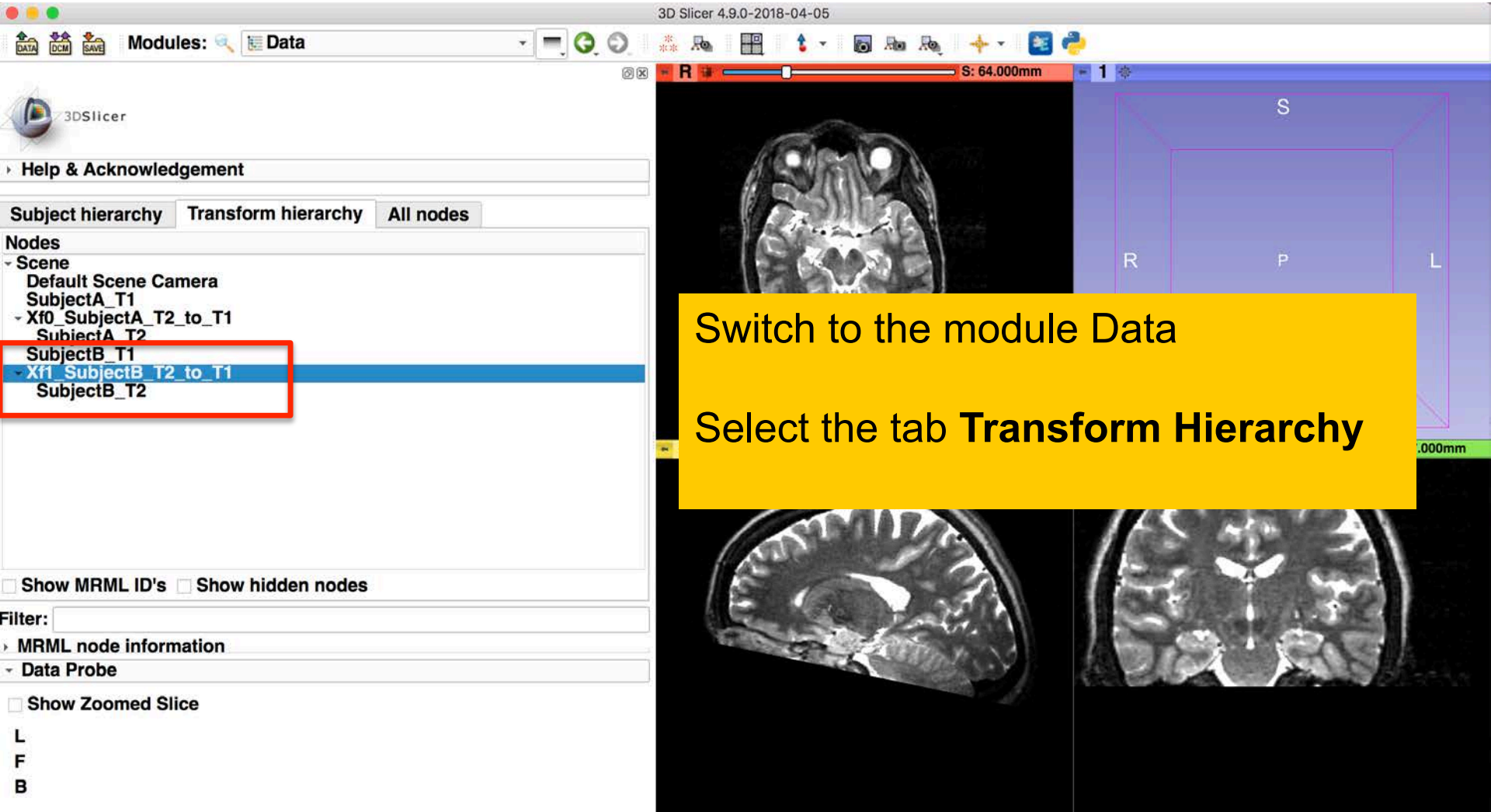


Set Initialization mode to
UseCenterOfHeadAlign

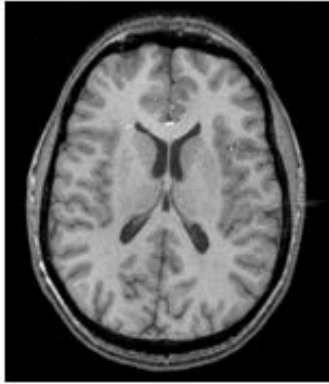
Set Registration Phases to **Rigid** and
Affine

Click on Apply

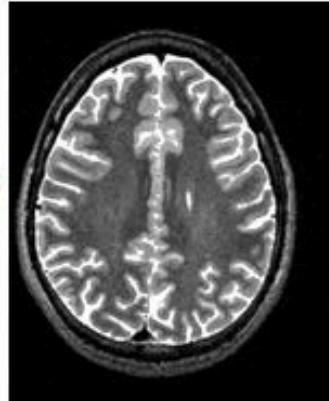
Subject B: Data Registration



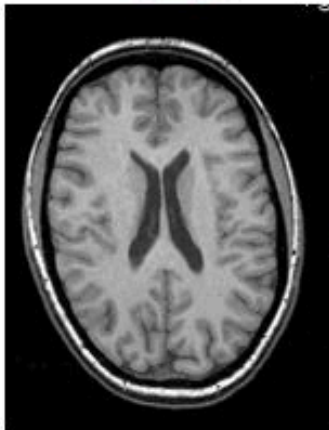
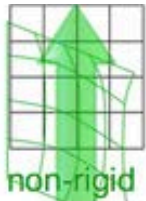
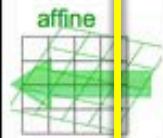
Registration pipeline



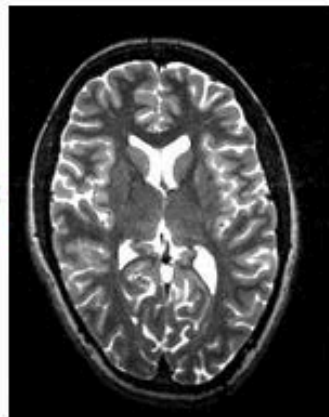
Subject A: T1



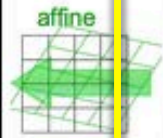
Subject A: T2



Subject B: T1



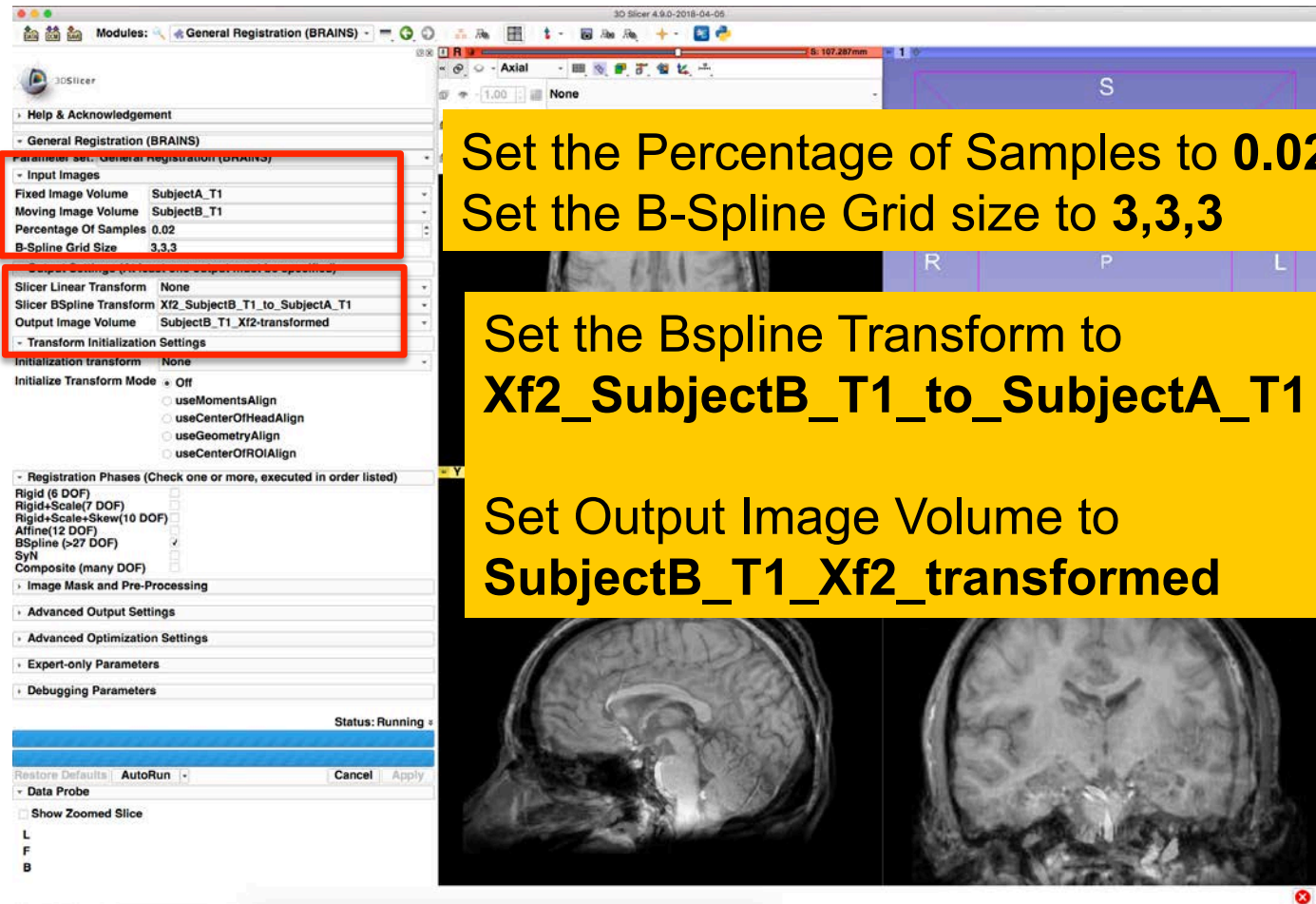
Subject B: T2



Step 3:

Subject B, T1 to Subject A, T1 registration

Registration of Subject B to Subject A



Set the Percentage of Samples to **0.02**
Set the B-Spline Grid size to **3,3,3**

Set the Bspline Transform to
Xf2_SubjectB_T1_to_SubjectA_T1

Set Output Image Volume to
SubjectB_T1_Xf2_transformed

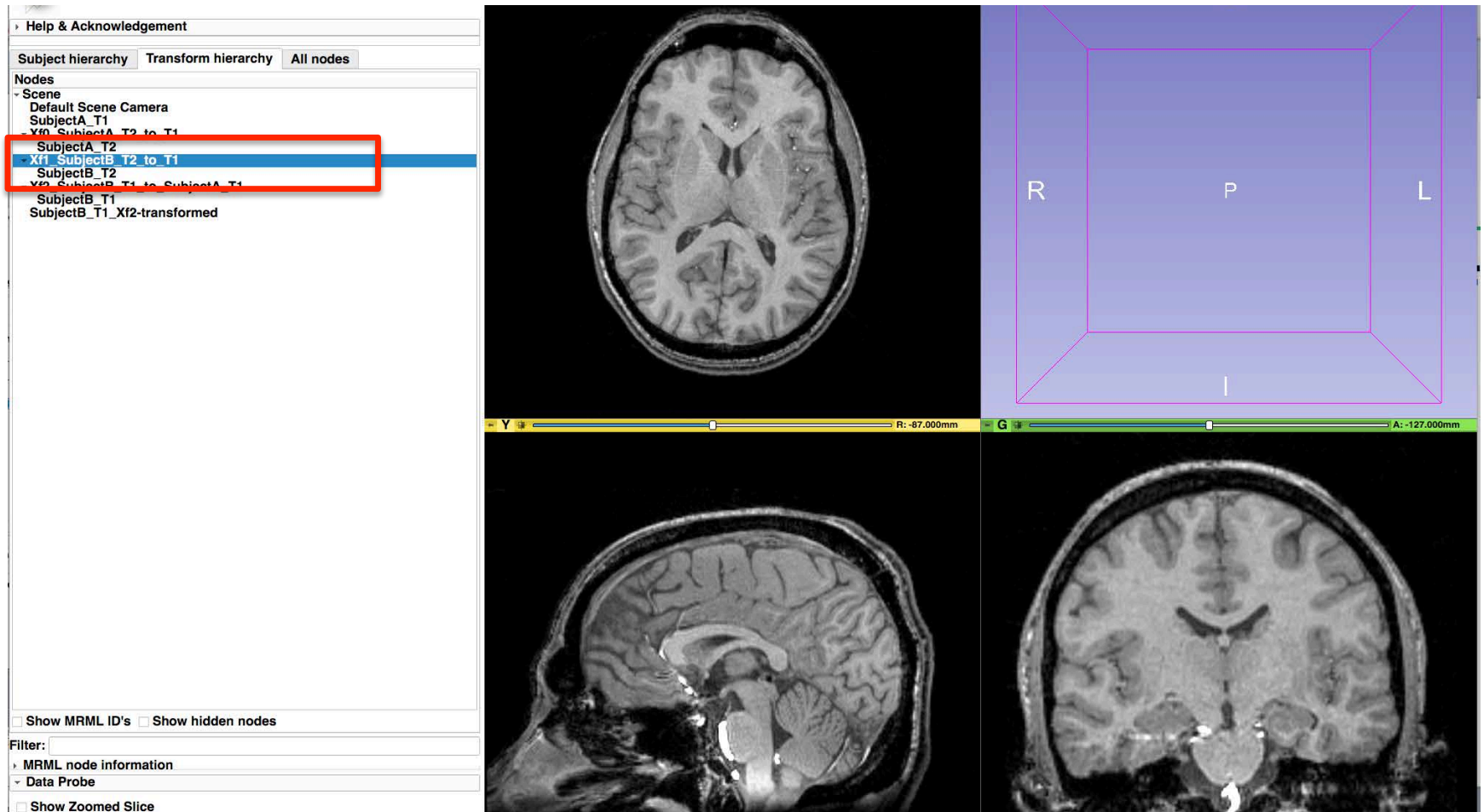
Registration of Subject B to Subject A

The screenshot shows the 3D Slicer 4.9.0-2018-04-05 interface. The 'General Registration (BRAINS)' module is active. The 'Input Images' section shows 'Fixed Image Volume' as 'SubjectA_T1' and 'Moving Image Volume' as 'SubjectB_T1'. The 'Output Settings' section shows 'Slicer Linear Transform' as 'None', 'Slicer BSpline Transform' as 'Xf2_SubjectB_T1_to_SubjectA_T1', and 'Output Image Volume' as 'SubjectB_T1_Xf2-transformed'. The 'Transform Initialization Settings' section is highlighted with a red box, showing 'Initialize Transform Mode' set to 'Off' and 'Registration Phases' set to 'BSpline (>27 DOF)'. A yellow callout box contains the following text:

- Set Initialization mode **Off**
- Set Registration Phases to **Bspline**
- Click on **Apply**

The central image viewer displays three orthogonal views of the brain: Axial, Sagittal, and Coronal. The right-hand panel shows a coordinate system with axes labeled S (Superior), I (Inferior), R (Right), L (Left), and P (Posterior).

Co-registration of Subject B to Subject A



Harden Transform

The screenshot displays the 3D Slicer 4.9.0 interface. The top toolbar includes icons for Data, DCM, Save, and various viewing tools. The left sidebar shows the 'Subject hierarchy' with a tree view containing 'Scene', 'Default Scene Camera', 'SubjectA_T1', and 'Xf0_SubjectA_T2_to_T1'. A right-click context menu is open over 'SubjectA_T2', listing options: 'Harden transform', 'Insert transform', 'Edit properties...', 'Rename', and 'Delete'. The main view area shows a coronal MRI slice of a brain. To the right of the main view is a blue panel with a purple wireframe box and labels 'S', 'R', 'P', and 'L'. Below the main view are two smaller panels showing sagittal and coronal views of the brain. At the bottom, a status bar displays 'Green (L 180.6, P 127.0, S 124.9) Coronal Sp: 1.0' and 'L None', 'F None', 'B SubjectB_T1_...ansformed (181, 127, 125) Out of Frame'.

3D Slicer 4.9.0-2018-04-05

Modules: Data

Help & Acknowledgement

Subject hierarchy Transform hierarchy All nodes

Nodes

- Scene
 - Default Scene Camera
 - SubjectA_T1
 - Xf0_SubjectA_T2_to_T1
 - SubjectA_T2
 - Xf1_S
 - SubjectA_T1
 - Xf2_S
 - SubjectA_T1
 - SubjectA_T1

Right Click on **SubjectA_T2**

Select **Harden Transform**

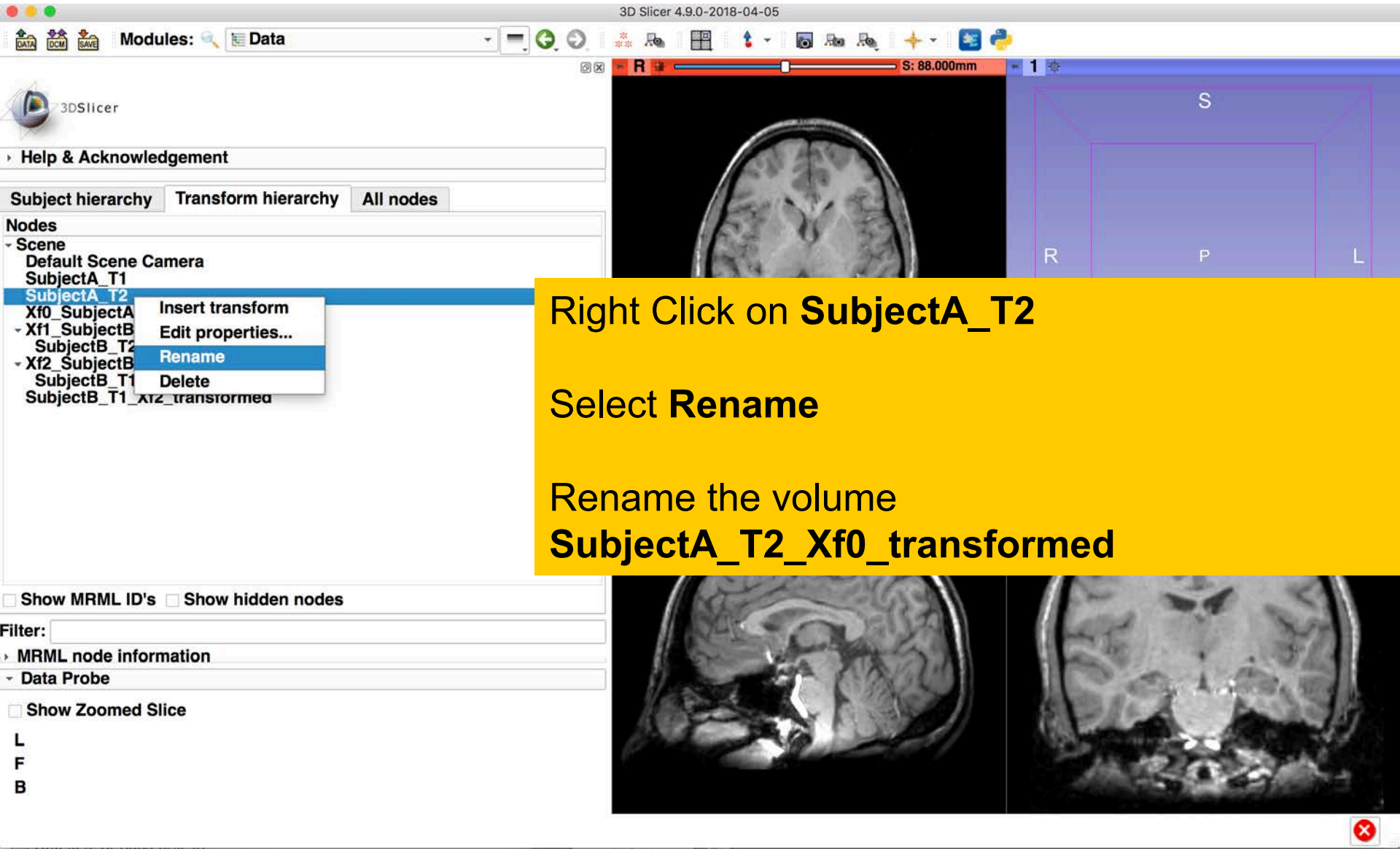
Green (L 180.6, P 127.0, S 124.9) Coronal Sp: 1.0

L None

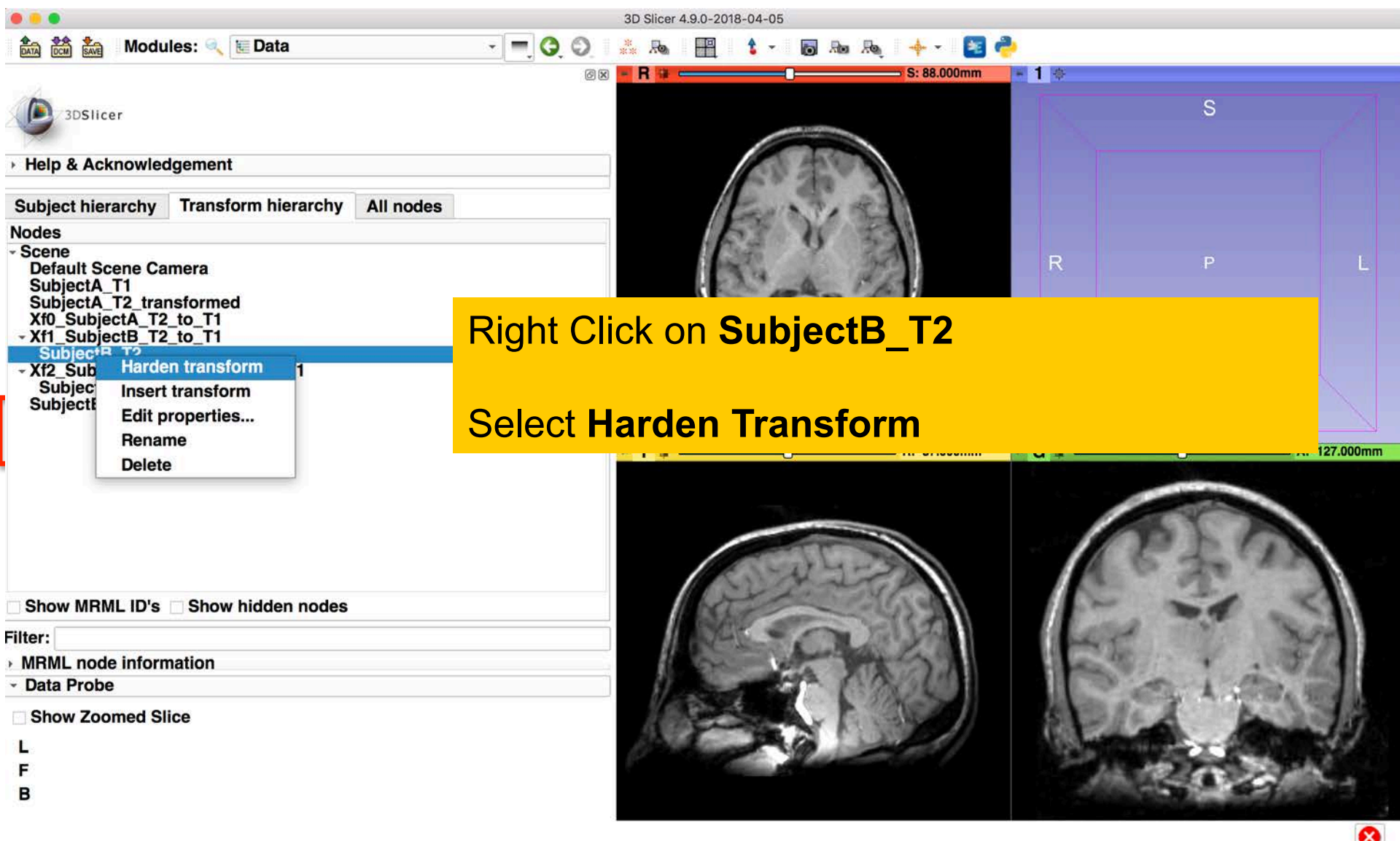
F None

B SubjectB_T1_...ansformed (181, 127, 125) Out of Frame

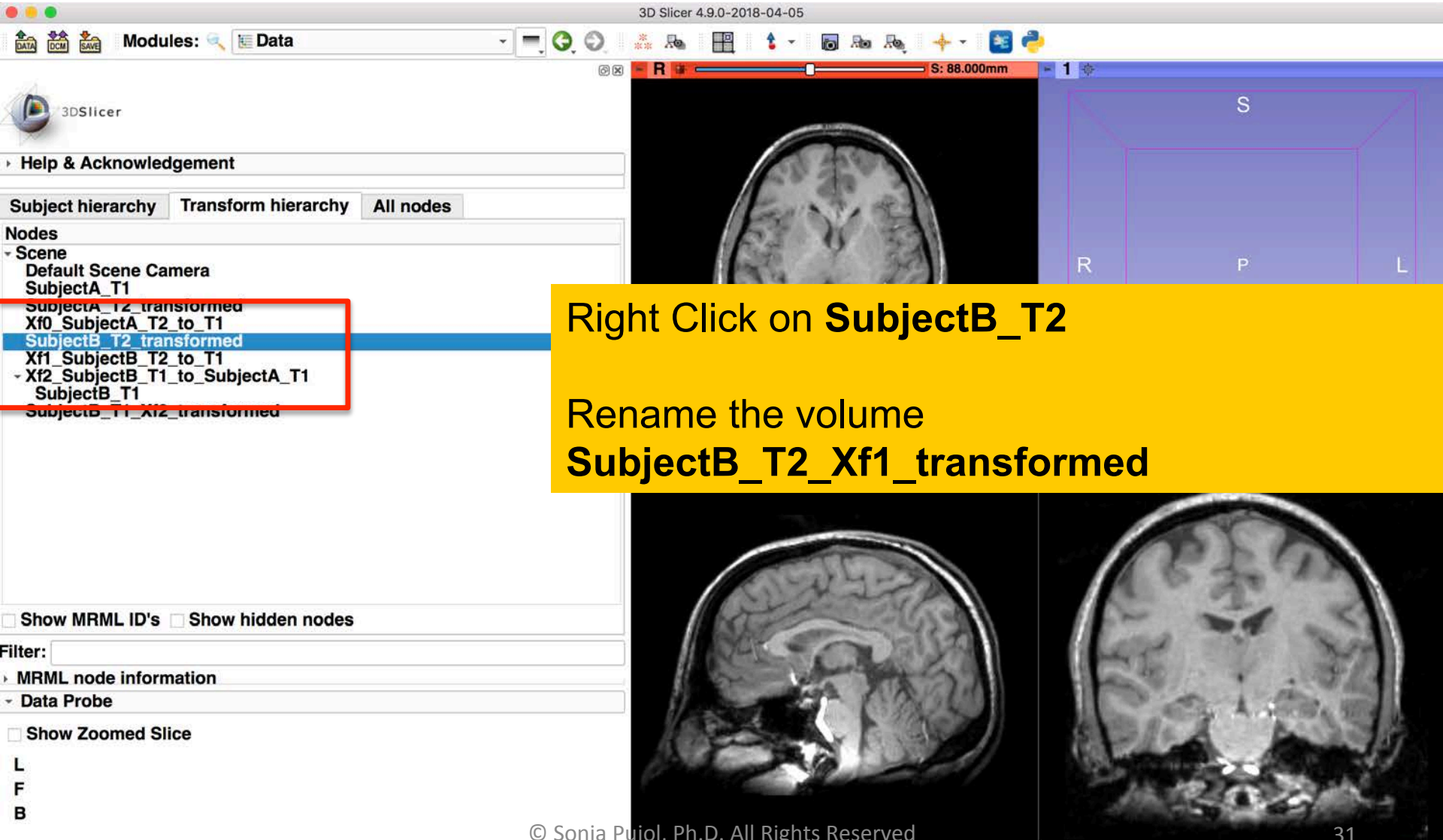
Harden Transform



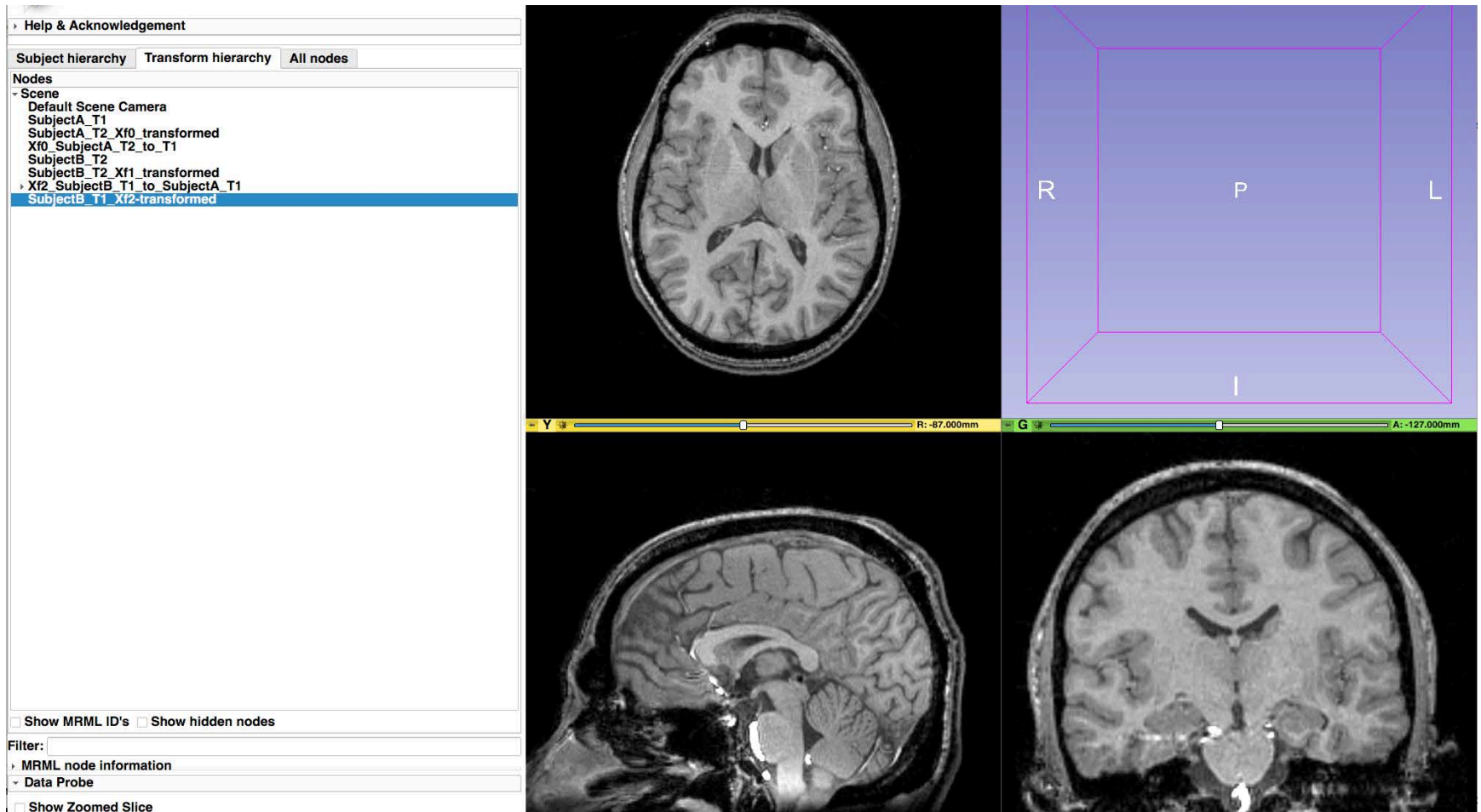
Harden Transform



Harden Transform



Final set of registered volumes



Visualizing the transform

The screenshot shows the 3D Slicer software interface. The 'Modules' panel at the top left has 'Transforms' selected. The 'Active Transform' dropdown shows 'Xf2_SubjectB_T1_to_SubjectA_T1' selected, with a red arrow pointing to it. Below this, the 'Edit' section has 'Identity' and 'Invert' buttons. The 'Display' section has 'Visible in 3D view' checked and 'Visible in slice view' unchecked. The 'Visualization' section has 'Glyph', 'Grid', and 'Contour' options, with 'Glyph' selected and a red arrow pointing to it. The 'Apply transform' section has 'Default Scene Camera' and 'SubjectB T1' options. The bottom status bar shows 'Green (L 179.7, P 127.0, S 98.1) Coronal Sp: 1.0' and 'L None', 'F None', 'B SubjectB_T1_...ansformed (180, 127, 98) Out of Frame'. The main view shows a brain MRI slice with a yellow box highlighting the 'Xf2_SubjectB_T1_to_SubjectA_T1' transform in the 'Transforms' panel. The 'Display' and 'Visualization' tabs are highlighted in yellow, and the 'Visible in 3D view' checkbox is also highlighted in yellow.

Select the module
Transforms

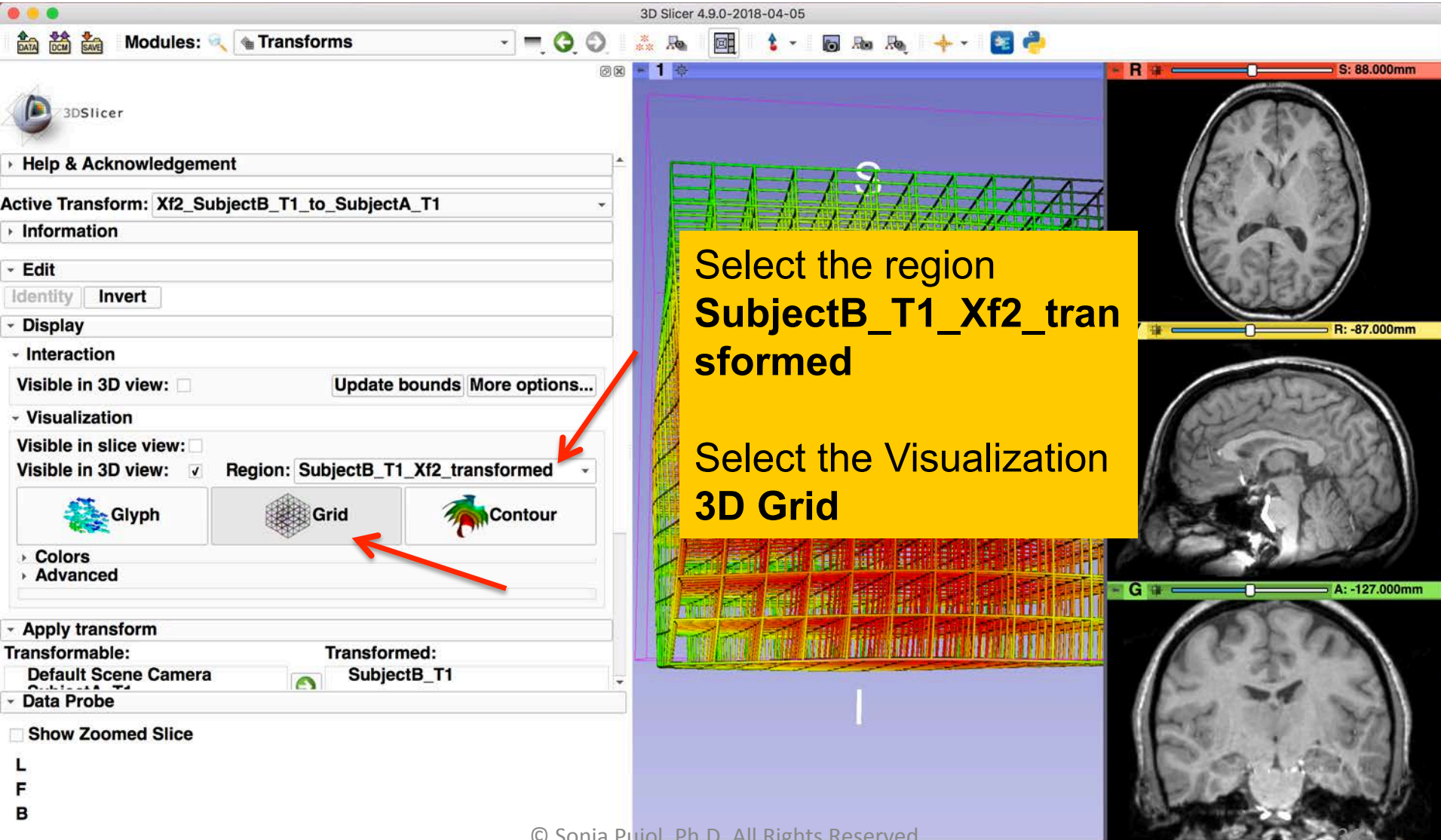
Select the transform
Xf2_SubjectB_T1_to_SubjectA_T1

Click on the **Display** and **Visualization** tab.

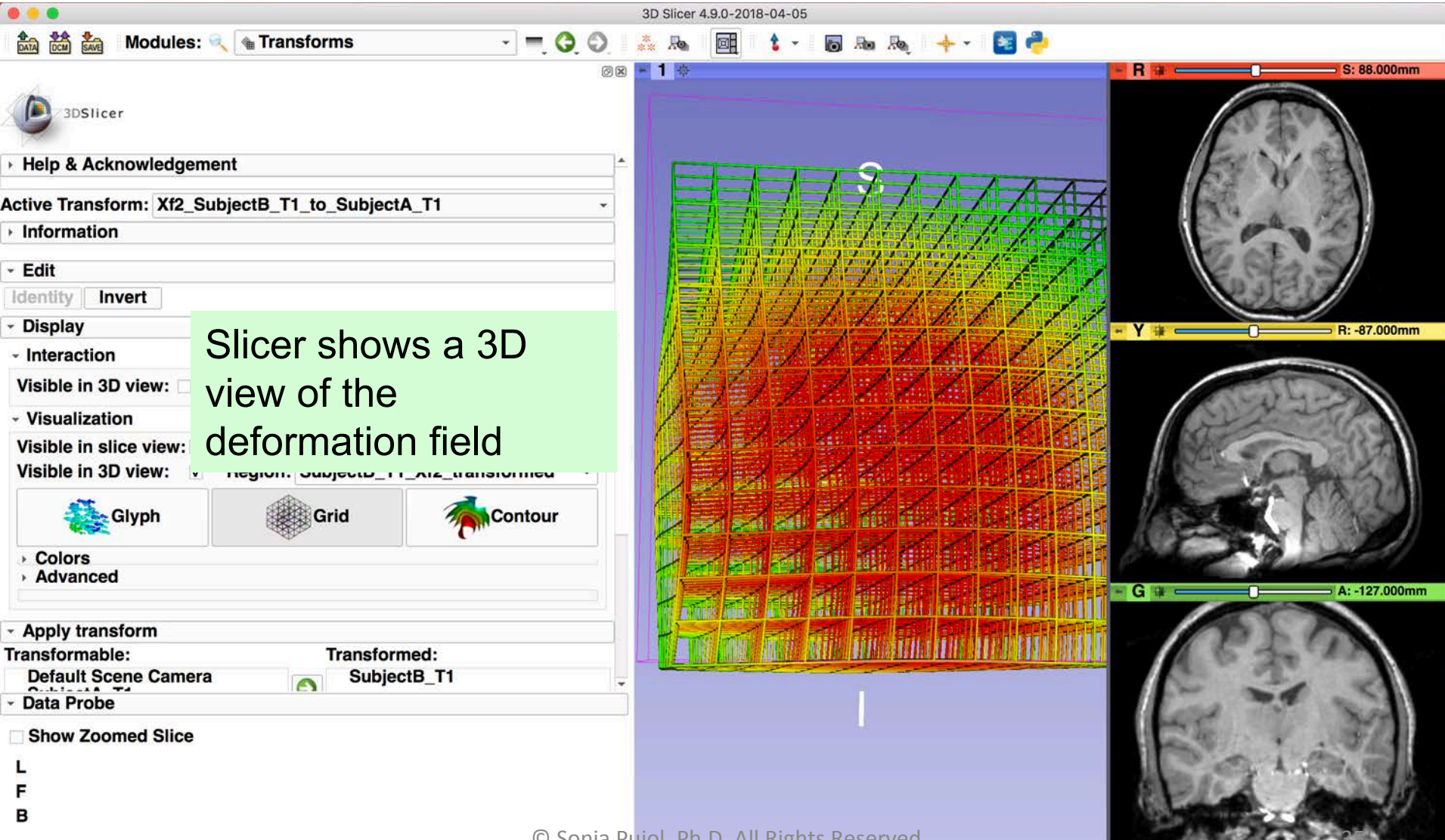
Select **Visible in 3D view**



Visualizing the transform



Visualizing the transform



Acknowledgments



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NIH U54EB005149



- Neuroimage Analysis Center (NAC)

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