

# Manual image registration in BrainVoyager QX

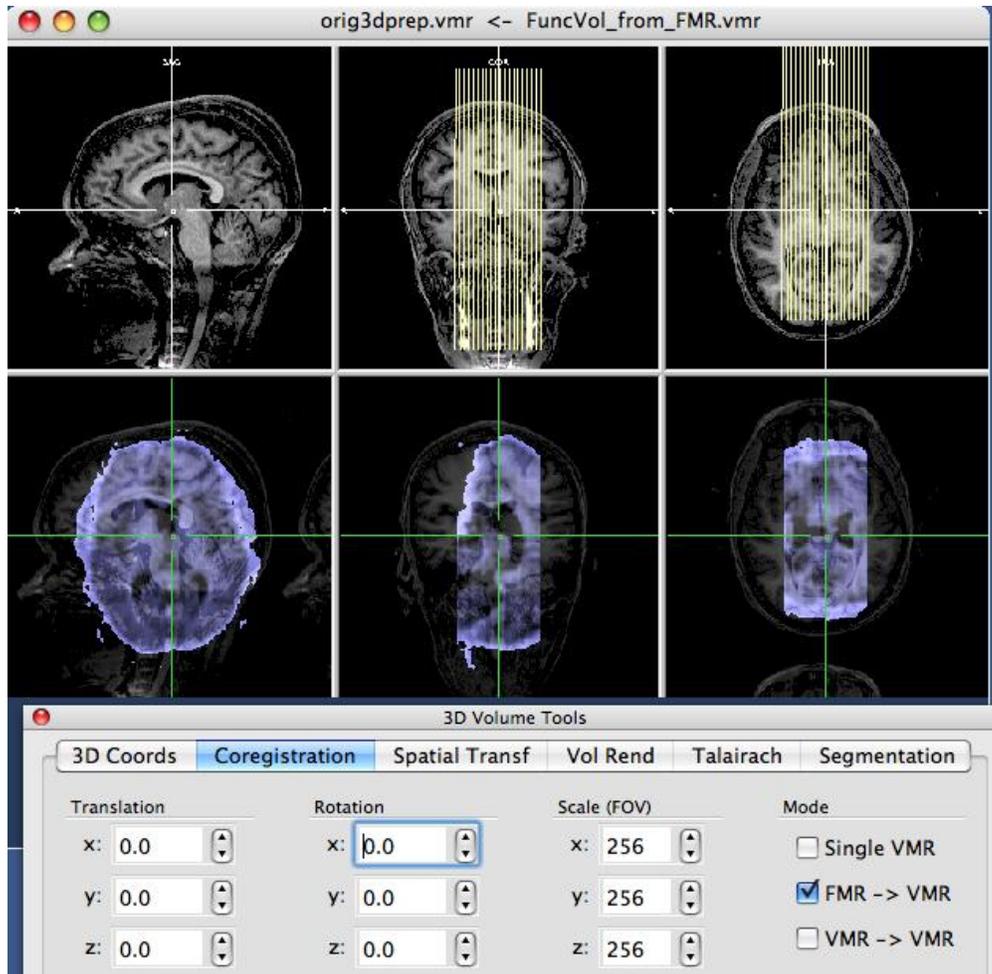
## Table of Contents

Manual image registration in BrainVoyager QX.....	1
Performing manual alignment for functional to anatomical images.....	2
Step 1: preparation.....	2
Step 2: determination of the transformation parameters .....	3
Step 3: apply or save the transformation.....	4
Coregistration of CT and MR images via manual alignment.....	5
Import.....	5
Determine parameters for image registration.....	6
Apply the transformation .....	7
APPENDICES.....	8
Appendix A: image registration.....	8
Appendix B: transformation matrices.....	9

## ***Performing manual alignment for functional to anatomical images***

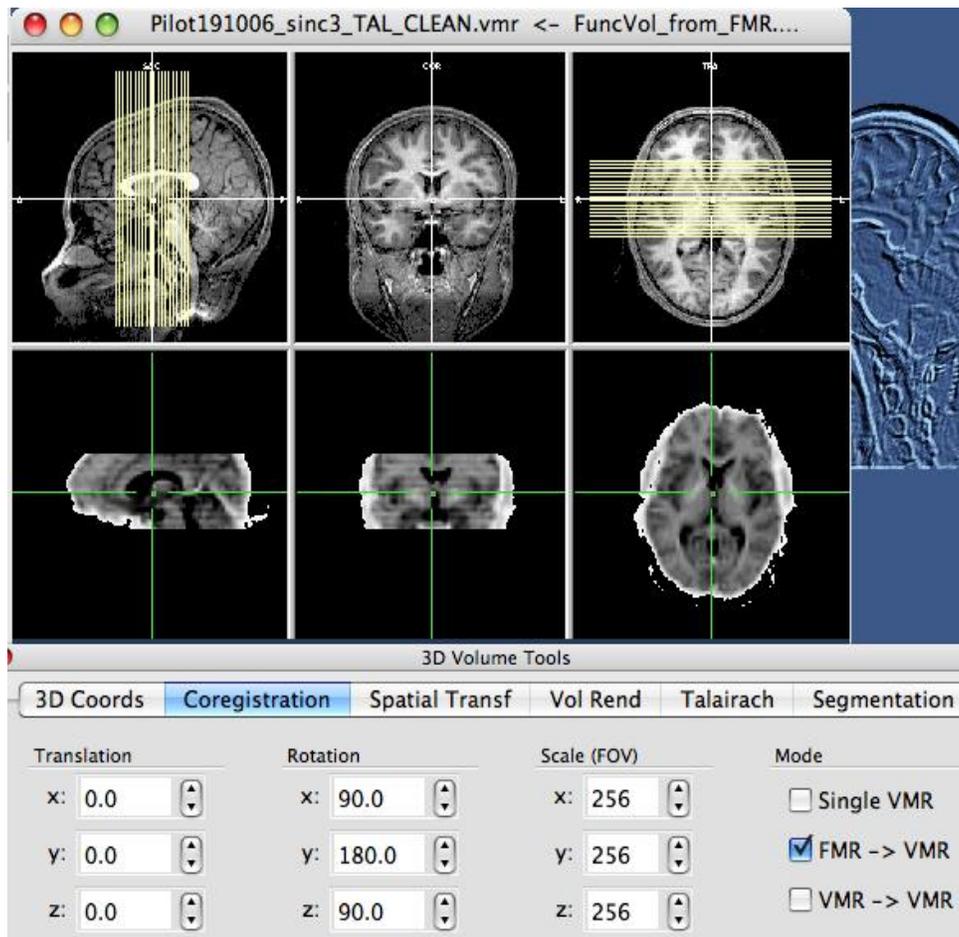
### **Step 1: preparation**

First, open the anatomical image (\*.vmr). Open the 3D Volume Tools (via 'Volumes' > 3D Volume Tools or via the blue cube on the sidebar). Navigate to the 'Coregistration' tab and click the 'Align FMR...' button. Select the functional image (\*.fmr) that should be aligned to the anatomical image (\*.vmr). This start situation is shown in the figure below.



## Step 2: determination of the transformation parameters

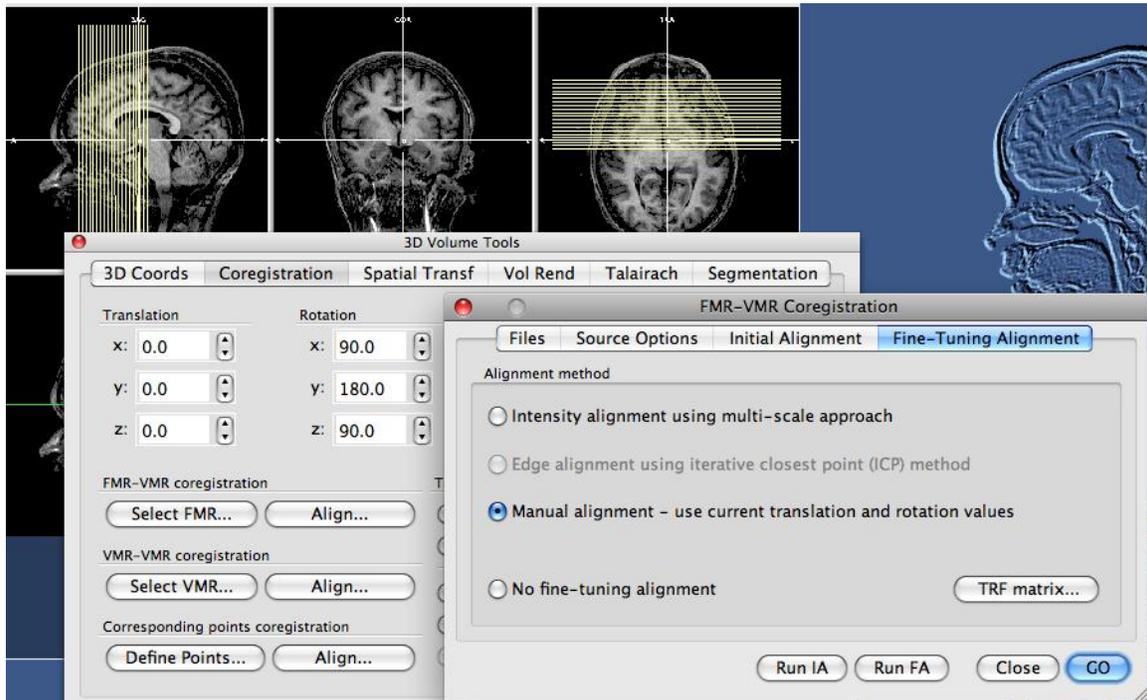
Change the Translation, Rotation and/or Scaling parameters. In the current example the x-axis of the image is rotated by 90 degrees, the y-axis by 180 degrees and the z-axis by 90 degrees. The effective transformation is immediately shown in the lower window.



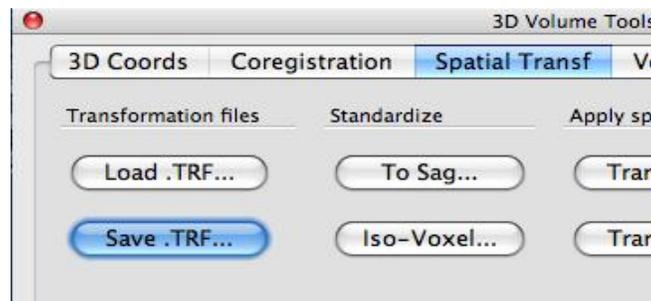
### Step 3: apply or save the transformation

In this step, the transformation can be saved to a transformation file (\*.trf) or applied immediately.

To apply the transformation, go to the Fine-Tune Alignment tab of the FMR-VMR Coregistration dialog (via the 'Align...' button). To apply the transformation, select the option 'Manual alignment – use current translation and rotation values' and click 'Run FA' (see figure below).



To save the transformation in order to apply it later, go to the 'Spatial Transf' tab of the 3D Volume Tools and click the 'Save .TRF...' button. The transformation is now saved in a 4 x 4 transformation matrix in a BrainVoyager QX transformation file (\*.trf) and can be used for creation of a volume time course file (\*.vtc) (in the initial alignment or fine alignment field).



## Coregistration of CT and MR images via manual alignment

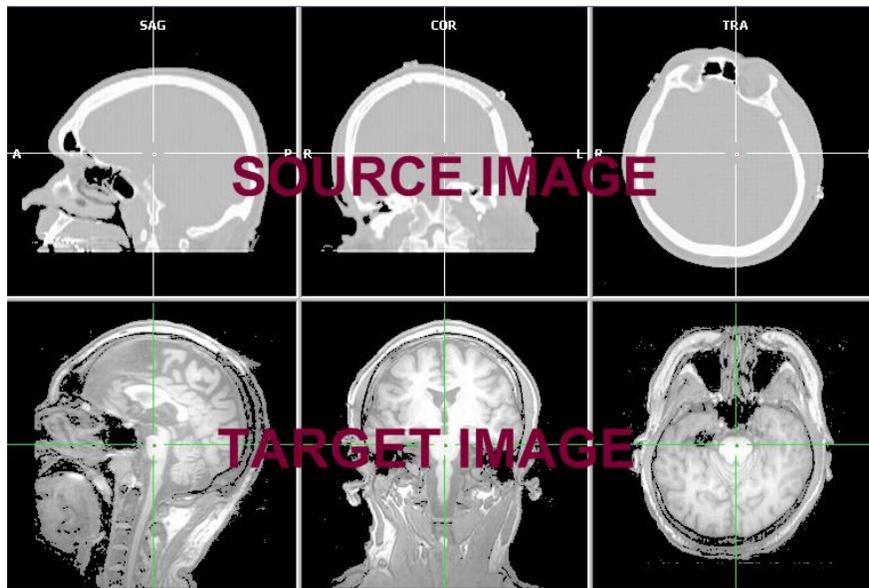
### Import

Import the CT and MR image via 'File' > 'Create new project'. In case of Analyze 7.5 images, use file type 'ANALYZE'.

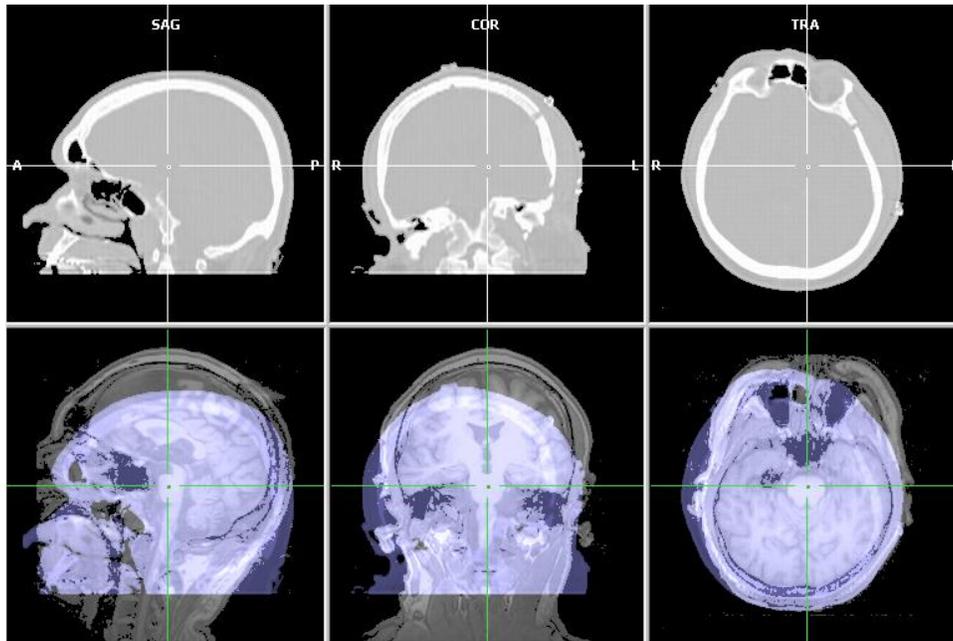
BrainVoyager QX will ask whether the file should be isovoxeled, i.e. transform the voxel resolution to 1 x 1 x 1 mm.

After this has been applied, go to the 'Spatial Transf' tab on the 3D Volume Tools (via 'Volumes > 3D Volume Tools or the blue cube icon on the toolbar). Use the 'To SAG...' button and manipulate the views so that the image is in sagittal orientation. Now, the CT and MR image have the same orientation and same resolution. This means that the transformation is only rigid body; for rigid body transformation we only need to find 6 parameters: translation in x/y/z directions and rotations about the x/y/z axes (see Appendix A for possible search spaces).

First open the source image that should be transformed. To start the registration, click 'Select VMR...' on the 'Coregistration' tab of the 3D Volume Tools. When the CT image should be warped to the MR image, then select the MR image now.

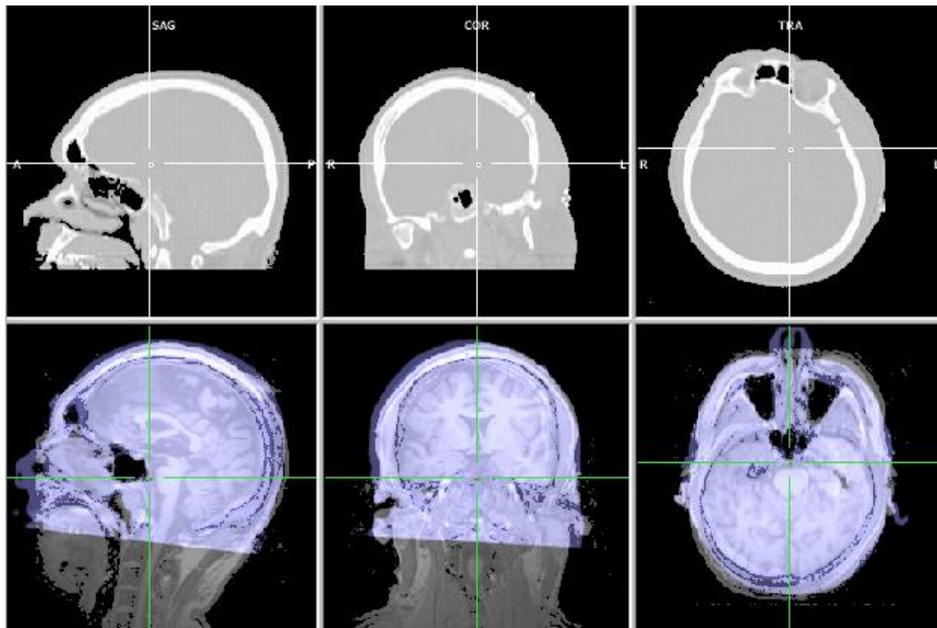


To visualize the distance between the source and target image, click 'Blend: Transparent':



#### Determine parameters for image registration

Determine the rotation and translation parameters to transform one image to the other via the 'Translation' and 'Rotation' boxes on the 'Coregistration' tab of the 3D volume tools (registration via intensity based alignment is less appropriate for the alignment of CT and MR since the intensities of the tissues are different). Manipulate the rotation and translation parameters until the images are overlapping.



Save the transformation in a text file (\*.trf) via the 'Save TRF...' button on the Spatial Transf tab. This results in a transformation file, containing the transformation matrix (see figure below) that

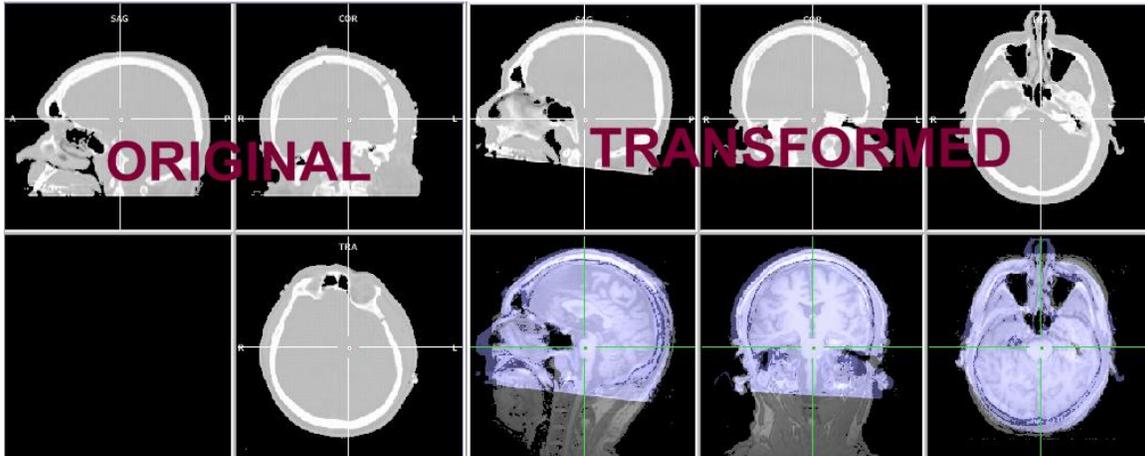
sends each voxel in one image space to space of the other image. Please see appendix B for an explanation of the transformation matrix in a \*.trf file.

Translation		Rotation		DataFormat:	Matrix
x:	7,5	x:	6,5	0.9934205412864685	0.1131859719753265
y:	-5,5	y:	-3,0	-0.1139555871486664	0.9921067953109741
z:	-33,0	z:	1,0	0.0113918567076325	0.0539724938571453
				0.0000000000000000	0.0000000000000000
				-0.0174524057656527	5.5000000000000000
				-0.0523279868066311	33.0000000000000000
				0.9984774589538574	-7.5000000000000000
				0.0000000000000000	1.0000000000000000

Close all windows.

### Apply the transformation

Open the image that should be transformed and select the transformation file (\*.trf) via the 'Load TRF...' button on the Spatial Transf tab. Apply the transformation by clicking the button 'Transform VMR...' on the Spatial Transf tab. This will open the Spatial Transformation of VMR dialog. Select an interpolation degree (Trilinear and Nearest neighbour are fast, Sinc and Cubic spline are precise) and click 'OK' to transform the image.



The transformed image will open automatically. Load the target MR image via File > Secondary VMR or via the Select VMR... button of the 'Spatial Transf tab'. Select a blend display option to check visually whether the alignment is correct.

Once the CT and MR are registered to each other, the transformation to Talairach space needs only to be performed for one data set, because the resulting transformation files (\*.trf and \*.tal) can also be used for the other data set since they have the same position.

For more information about the registration of anatomical images, chapter 12 of the BrainVoyager QX Getting Started Guide can be consulted. Information about the currently available image registration methods in BrainVoyager QX can be obtained via the chapters 'Coregistration of functional and anatomical data' and 'Spatial Normalization in Volume and Surface Space' of the BrainVoyager QX User's Guide.

For questions, please contact the BrainVoyager support desk via support at brainvoyager.com.

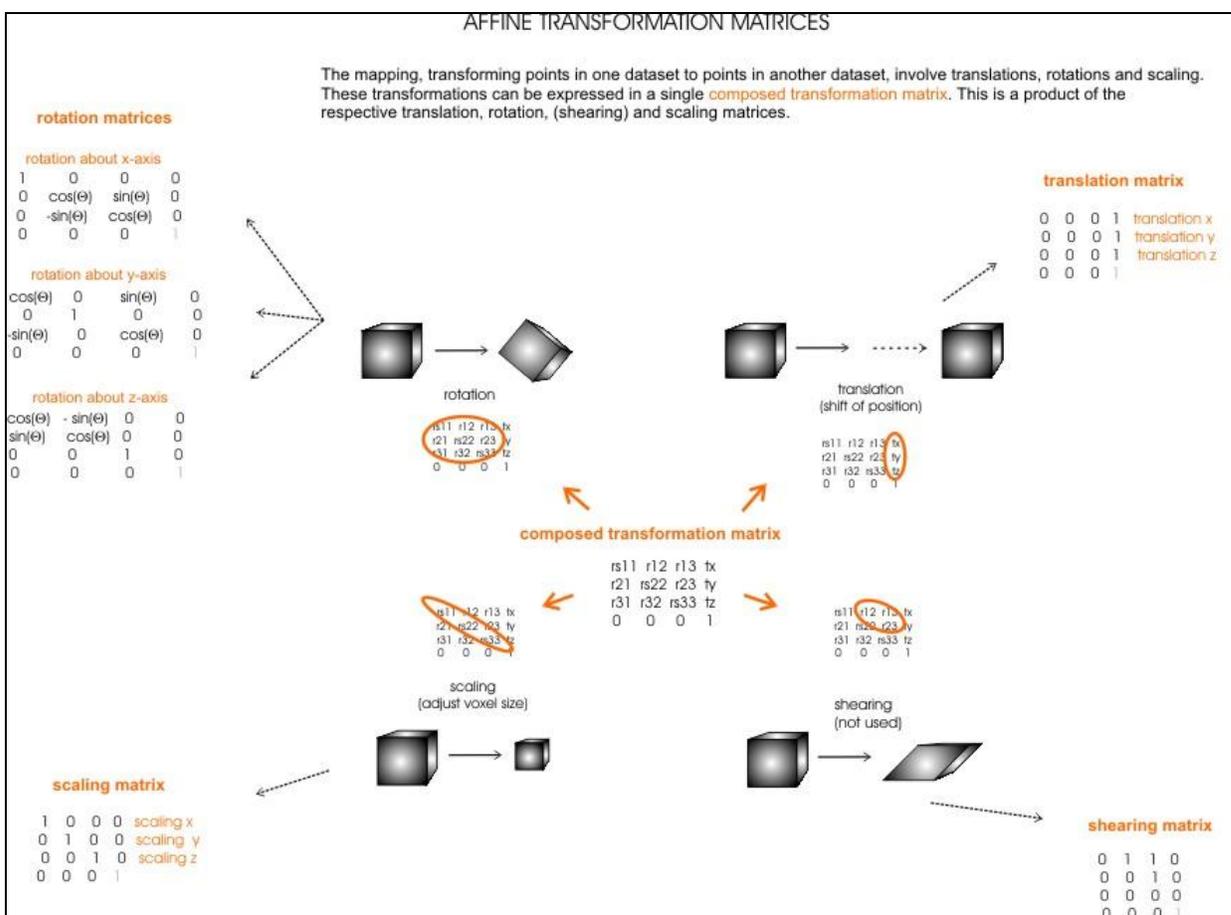
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 Version 0.1: 17-08-07  
 Hester Breman - Brain Innovation B.V.



## Appendix B: transformation matrices

The distance between points in two images can be expressed in several ways, dependent of which properties of the image should be preserved in transforming one point to the other (see 'search space' comment in Appendix A). If we use Euclidean distance and an affine transformation, the distance between the points can be expressed in a 4 x 4 matrix. In BrainVoyager QX, these 4 x 4 matrices can be found in a transformation file (\*.trf). It contains parameters for translation, rotation and scaling for each voxel in an image.

The first three columns contain the coefficients for rotations (see the left upper corner of the image below). The size of the voxels is determined by the scaling parameters and can be found on the diagonal of the matrix (see left lower corner of image below). The amount of motion in space is determined by the translation parameters in the fourth column of the matrix (see upper right corner of image below).



The matrix contains the coefficients for the coordinates; once the coefficients are known, the position of the new x, y and z can be computed using the following equations:

$$\begin{aligned} \text{new } x &= \text{coefficient} * \text{current } x + \text{coefficient} * \text{current } y + \text{coefficient} * \text{current } z + \text{translation of current } x \\ \text{new } y &= \text{coefficient} * \text{current } x + \text{coefficient} * \text{current } y + \text{coefficient} * \text{current } z + \text{translation of current } y \\ \text{new } z &= \text{coefficient} * \text{current } x + \text{coefficient} * \text{current } y + \text{coefficient} * \text{current } z + \text{translation of current } z \end{aligned}$$

To compute the new positions, one multiplies a vector or matrix that contains the current position of the image in the current coordinate system with the 4 x 4 matrix that contains the transformation coefficients.