Measuring Ventricular Volume using MEASURE

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GETTING STARTED

Hopefully at this point, you've had the luxury of learning the various facets of MEASURE and are pretty familiar with several of the windows and commands. The ventricular system is also a relatively easy region of interest to measure if you are somewhat familiar with brain anatomy (not required, of course, but some knowledge of neuroanatomy is cool to have around). In the following walkthrough, the names of Menus, Commands and other MEASURE lingo are cheerily presented in FUCHSIA for your viewing ease.

1. After you've located the .csd file of interest, look for its corresponding .hdr or .csh file. Depending on the file you are opening, you will have only either a corresponding .hdr file OR a .csh file.
2. Check either of those files for the field of view and the thickness of the scan you're working with.

If you're using a .hdr file:

1.) After opening the file, look for the entries fov and thk (you can take a shortcut by pressing F3). You'll want to jot down these values so you can enter into the Comments field later.
2.) Make sure you have these settings:

fov=24

thk=1.5

If you're using a .csh file

1.) After opening the file, look for the entries Field of View and Image Thickness and see what numerical values appear by the entries. You'll want to jot down these values so you can enter into the Comments field later.
2.) Make sure you have these settings:

Field of View= 24
Slice Thickness= 1.5

Hey! What if my Slice Thickness setting isn't 1.5? What then?

There are two ways you can go about taking care of this:

1. The quick do-math-in-your-head way
2. The eloquent I prefer-tautological-algebra way

Aha! Remember all those times that folks would tell you that you'd never use algebra again? They were lying!

Pencil and paper ready? In the following equation, put whatever value for Slice Thickness that you found either your .csd or .hdr file into the part that says <Your value for Slice Thickness. Then solve for x. that new value of x is the value you will enter into the Dimensions space under the Image Depth section once you get to the Measure Settings window.

Structure Descriptions: CEREBRAL AQUEDUCT AND THE FOURTH VENTRICLE

The cerebral aqueduct is a thin canal in the brain stem that leads into the Fourth Ventricle. If no grid points appear in the cerebral aqueduct, that is acceptable. If the cerebral aqueduct opens to the rest of the brain, do not mark any

grid points until it closes again. The cerebral aqueduct expands into the Fourth Ventricle-the Fourth Ventricle becomes more and more horseshoe-shaped as you continue inferiorly.

HELP!! When do I stop?

1. When you reach the inferior portions of the fourth ventricle, it is often difficult to find the end of the fourth ventricles. This is because you are skipping three slices between each measurement and the anatomy changes quickly. These two rules seem to work.
    1. Stop measuring when there is no discernable space between the midbrain/spinal cord and the cerebellum (in other words, the ventricle disappears)
    2. Stop measuring when there is no longer tissue surrounding the area that was ventricle in the previous slice. This occurs towards the bottom of the cerebellum.

    The other helpful thing to be doing here is to refer to the Tiled View in MEASURE and check your location in the Axial view with the corresponding locations in the Sagittal and Coronal views. May also be handy as you're getting started to have a Brain Atlas nearby so you can develop a feel for when the ventricles "should" be ending.

    Now you too can have hours fun measuring the sewage system for our brains!

    CEREBRAL AQUEDUCT AND FOURTH VENTRICLE

    Structure Description: LATERAL VENTRICLES

    These are the most superior portions of the ventricles. There is a right and left lateral ventricle. They are butterfly-shaped in the Axial plane and roughly C-shaped in the Sagittal plane.

    Structure Descriptions: THIRD VENTRICLE

    The third ventricle is a singular structure that begins to appear in the medial and inferior portion of the septum (the wall separating the two lateral ventricles). DO NOT MEASURE THIS STRUCTURE. It will begin to appear as a 5^{th} medial compartment while you are still measuring the lateral ventricles. When this happens, check in the sagittal view to establish the boundaries between the third and lateral ventricles.

    Structure Descriptions: TEMPORAL AND OCCIPITAL HORNS OF LATERAL VENTRICLES

    The temporal horns extend rostrally into the temporal lobe and lie beside the hippocampus. The occipital horns extend caudally into the occipital lobe. The horns of the ventricles start to appear at the level of the cerebral aqueduct and end before the Fourth ventricle. These are problematic areas to measure because of their small size and visual disconnection from the lateral ventricles. It is possible to check in the sagittal view to establish that they are actually part of the lateral ventricles. Sometimes moving from the most lateral position of the suspected horn to the spinal cord will help its identification—nonetheless, make sure to measure them in the axial view.

4.Using the left mouse button, now move the scrollbar TOWARDS THE RIGHT until you have rotated exactly 90 degrees (if the degree values are negative, then you're going the wrong way).

Once you've completed these four steps, the Tiled View layout should look like Layout 1 (see above). Once that has been established, you're ready to start the actual measuring.

MEASURING THE VENTRICLES

In MEASURE, under the Edit menu, select Change Grid Settings. Change all the values: Column, Row, and Slice to values of 3. This creates a 3 x 3 x 3 matrix for you to measure the ventricles on.

Basic Measurement Method

1.) Working from the Axial view, find the most superior slice in which the lateral ventricle appears.
2.) Proceeding in an inferior direction, mark each grid point which is partially or totally with the area if the lateral and 4^{th} ventricles, including the cerebral aqueduct. Anything touching black is considered "in" and should be highlighted. (Just like in Brain Stripping, the right mouse button colors in the grid. Holding down the shift-key while pressing the right mouse button erases grids.)

As you work your way down from the top of the brain, you'll run into the many features of the ventricle structures. The following descriptions will help guide you through most all of them as your fascinating descent through the brain continues. The third ventricle, however, is one of the structures that should NOT BE MEASURED (see Structure Descriptions: THIRD VENTRICLE, below).

The following Structure Descriptions are to help you become more familiar with the different ventricular regions as you encounter them:

LATERAL VENTRICLES

THIRD VENTRICLE

TEMPORAL AND OCCIPITAL HORNS

Foreground, f1, when you're measuring ventricles).

Just for reference, the values for Voxels and Dimension under the Image Height and Image Width sections of the MEASURE settings window are 256 and 24, respectively, just like they were for Brain Stripping. Also, don't forget to type in what the Field of View and Slice Thickness values are under the Comment section. When you're done here, be sure to Auto Contrast the image just like in Brain Stripping. Thus should be indicated in the Comment section.

MAKING SURE THE BRAIN IS IN THE RIGHT ORIENTATION

Take a look at the orientation of the brain after you've loaded the .csd file in MEASURE. Make sure that while you're in Tiled View the brain is laid out in the traditional way where the "eyes" of the Axial view are looking up at the coronal view (Layout 1).

Layout 1

If the above layout is what you see, you're ready to MEASURE the ventricles (see next section). Otherwise, in some instances, you may instead see the following layout (Layout 2):

Layout 2

If this is the case, where the Axial "eyes" are looking to the left, you need to re-orient the scan by rotating the Axaial view. You need to rotate the Axial view by:

1. Using the right mouse button, move the crosshairs to the left-most edge of the Axial view.
2. Again using the right mouse button, you'll now want to position the crosshairs such that they're as close to being in the middle of the hemispheres as possible:

3. Hold down the Ctrl key and click the right mouse button again. A window will appear called Rotating Around Bottom Axis.

That's the ONLY number that you need to change. All the other numbers under the Image Height and Image Width sections of the Measure Settings window stay the same.

For example:

Okay, say you're checking the .hdr file and when you find the thk entry, the value 1.7 is shown instead of 1.5. Fear not! Panic not! You take the value of 1.7 and plug that into the space in the above equation where it says < Your like this:

$$1.5/18.6 = 1.7/x$$

Using the handy-dandy calculator (you can find it under Accessories in the Windows 95/98 Start Menu) you find that 1.5/18.6 is around 0.080645 or something disgusting like that. Leave that value on the calculator screen and divide it by 1.7. Next hit the 1/x button on the calculator and voila! The number you get is 20.08. This is the number you type into the Dimension blank under Image Thickness.

Another way you could do this is to take the Total number of slices of your scan (usually this will be 124) and multiply it by the new thickness (1.7 in the previous example). Take this new number and divide it by 10.

$$124 \text{ X } 1.7 = 210.8$$
$$210.8 / 10 = 21.08 \text{ \{ the same as above \}}$$

Okay so that was a little easier—but then you wouldn't be able to use a cool formula or fiddle with the 1/x button on the Microsoft calculator! The ultra-nerdy thing to do would be to do it BOTH ways to make sure you did all that zany math correctly.

Whew! Too much Math. Can we please get back to Neuroimaging, PLEASE?!

Once you've gotten all the correct settings, open up the desired .csd file in MEASURE. After you select New Measure, highlight the option that says Volumes by Cavalieri Method and then click OK. The familiar MEASURE settings window will show up now; enter in the correct numbers into the appropriate spaces and sdjust the contrast settings as if you were setting the f 2 in Brain Stripping (you don't need to set a…