MRI Summer Course
Lab 1: Spin Echo T1 & T2 Curves

Experiment 1

Goal: Examine the effect caused by changing TR on image contrast in a simple spin echo sequence and derive T1-curves.

Image Sequence Parameters:

Use a spin echo sequence and vary TR leaving all other parameters fixed.

Base Sequence: Spin Echo

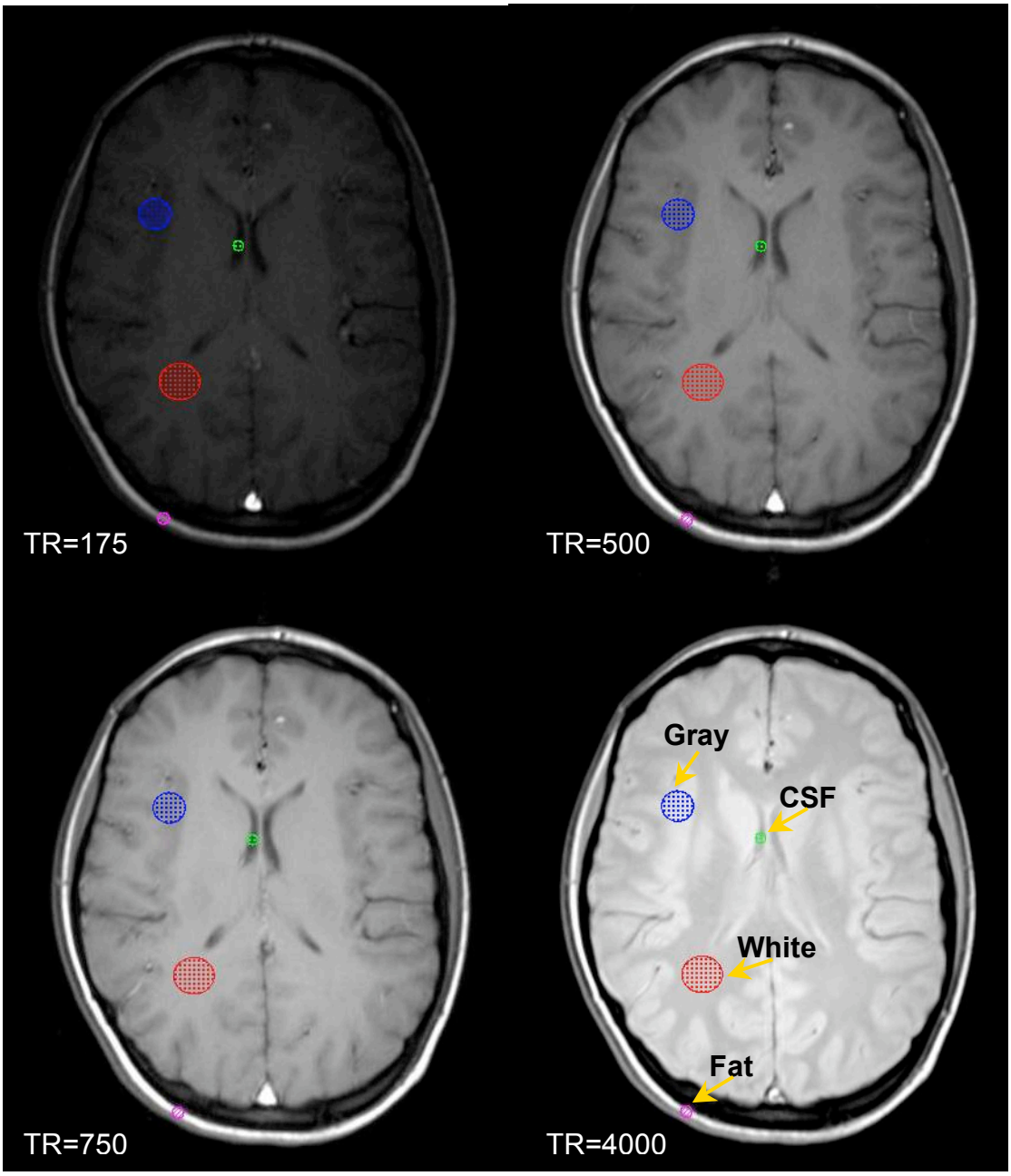
Parameter	Image 1	Image 2	Image 3	Image 4
FOV Read (mm)	256	256	256	256
FOV Phase (mm)	256	256	256	256
Matrix	256x256	256x256	256x256	256x256
Slice Thickness (mm)	5	5	5	5
Distance Factor (%)	30	30	30	30
Number of Slices	5	5	5	5
Resolution (mm^3)	1.0x1.0x6.5	1.0x1.0x6.5	1.0x1.0x6.5	1.0x1.0x6.5
Flip Angle (degrees)	90^o	90^o	90^o	90^o
TR (ms)	***175***	***500***	***750***	***4000***
TE (ms)	6.8	6.8	6.8	6.8
Scan Time (min)	0:37	1:40	2:28	12:54

Notice that the scan time increases as the TR increases.

Deriving T1-Curves:

1. Draw an ROI (region of interest) in each type of tissue (white matter, gray matter, CSF, and Fat). Ensure the ROI is in the same position on the same slice across all 4 of the images used in the experiment.
2. Get the mean intensity in each of these ROI's.
3. Plot the mean intensity in each tissue as a function of the change in TR.
4. Calculate the difference in signal intensity between white matter and gray matter to identify the optimal TR.

Resulting Images:



Notice how the tissue contrast of the image changes as TR changes. Recall that tissue contrast is our ability to distinguish different tissues within an image. In addition to the changes in the tissue contrast, there is an overall ***increase*** in brightness as the TR increases.

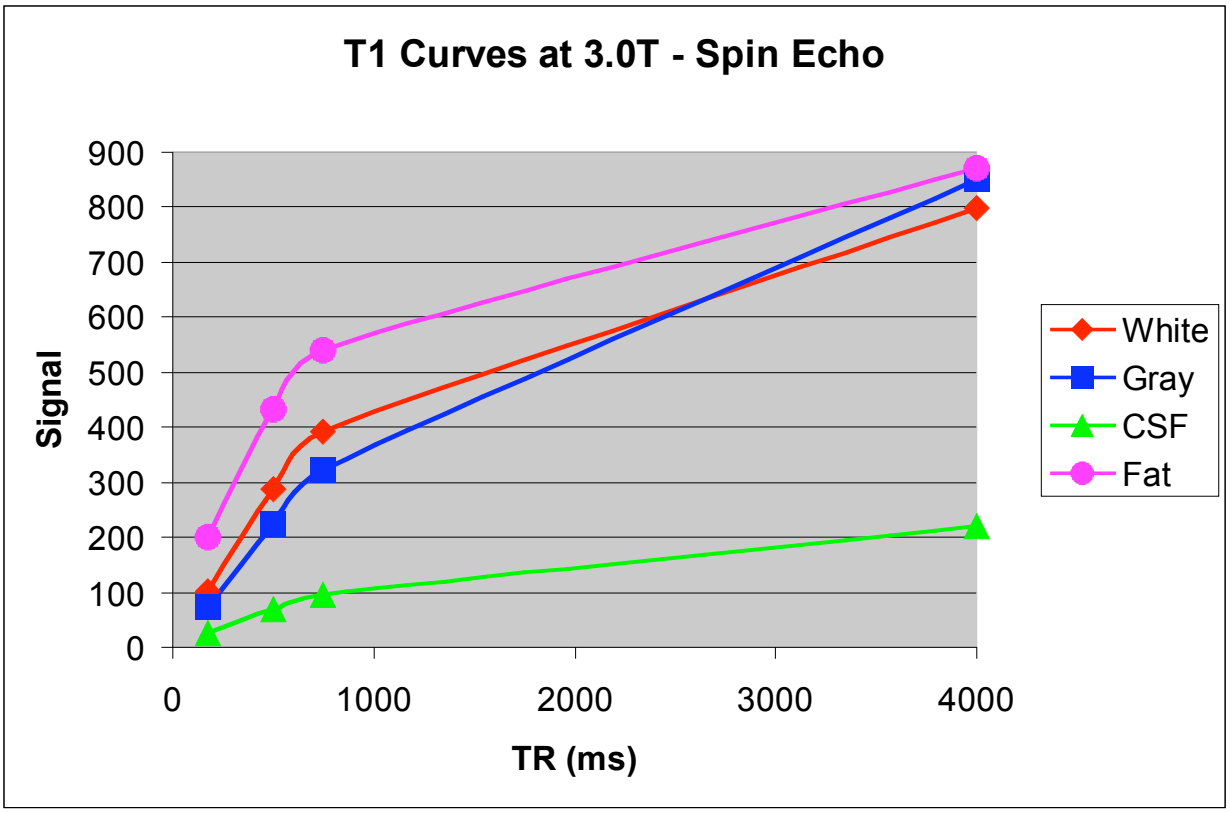
Based on these images it appears that the best T1-weighted tissue contrast is achieved with a TR=750ms.

John VanMeter, Ph.D.

Data from ROI's:

TR	White	Gray	CSF	Fat	Δ WM-GM
175.0	101.7	73.9	27.2	199.5	27.8
500.0	286.0	223.9	70.7	433.1	62.1
750.0	391.0	321.6	97.1	539.2	**69.4**
4000.0	797.7	850.3	221.5	872.4	-52.6

Resulting T1-Curves:



Based on these curves the optimal T1-weighted image would be produced when we use a TR=750ms. At this TR the spread between the White matter and Gray matter curves is maximized and the spread between the Fat and White matter curves is still large.

Questions:

1. Why does the scan time increase as the TR increases?
2. What type of relaxation is being measured in this experiment?
3. From the FOV, Matrix size, slice thickness, and distance factor given in the imaging parameters above derive the effective resolution and check your calculations against the resolution listed.
4. Why does the overall brightness in the images increase as the TR increases?

Experiment 2

Goal: Examine the effect caused by changing TE on image contrast in a simple spin echo sequence and derive T2-curves.

Image Sequence Parameters:
Use a spin echo sequence and vary TE leaving all other parameters fixed.

Base Sequence: Spin Echo

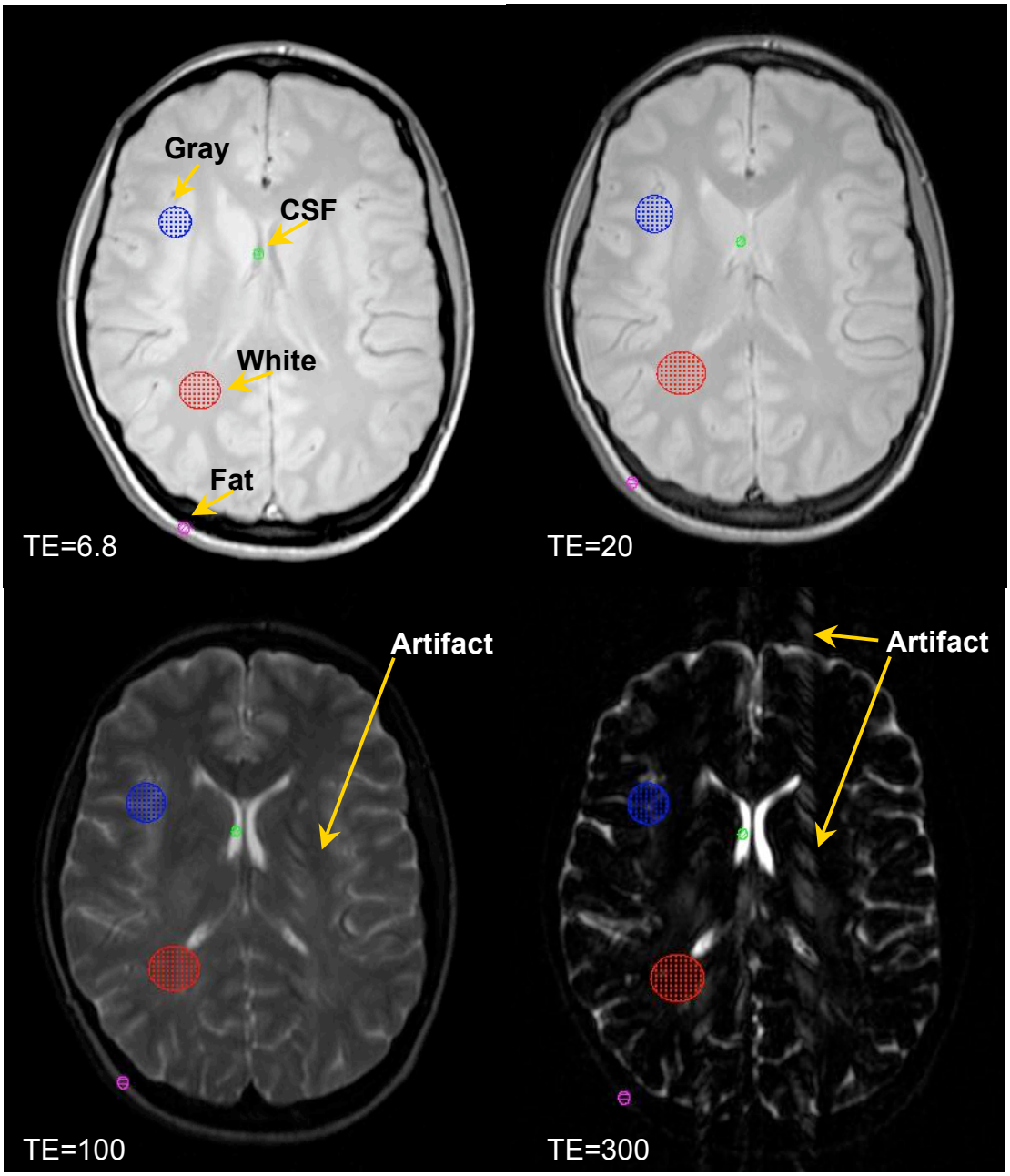
Parameter	Image 1	Image 2	Image 3	Image 4
FOV Read (mm)	256	256	256	256
FOV Phase (mm)	256	256	256	256
Matrix	256x256	256x256	256x256	256x256
Slice Thickness (mm)	5	5	5	5
Distance Factor (%)	30	30	30	30
Number of Slices	5	5	5	5
Resolution (mm^3)	1.0x1.0x6.5	1.0x1.0x6.5	1.0x1.0x6.5	1.0x1.0x6.5
Flip Angle (degrees)	90^o	90^o	90^o	90^o
TR (ms)	4000	4000	4000	4000
TE (ms)	***6.8***	***20***	***100***	***300***
Scan Time (min)	12:54	12:54	12:54	12:54

Notice that the scan time remains unchanged as the TE increases.

Deriving T2-Curves:

1. Draw an ROI (region of interest) in each type of tissue (white matter, gray matter, CSF, and Fat). Ensure the ROI is in the same position on the same slice across all 4 of the images used in the experiment.
2. Get the mean intensity in each of these ROI's.
3. Plot the mean intensity in each tissue as a function of the change in TE.
4. Calculate the difference in signal intensity between CSF and gray matter to identify the optimal TE.

Resulting Images:



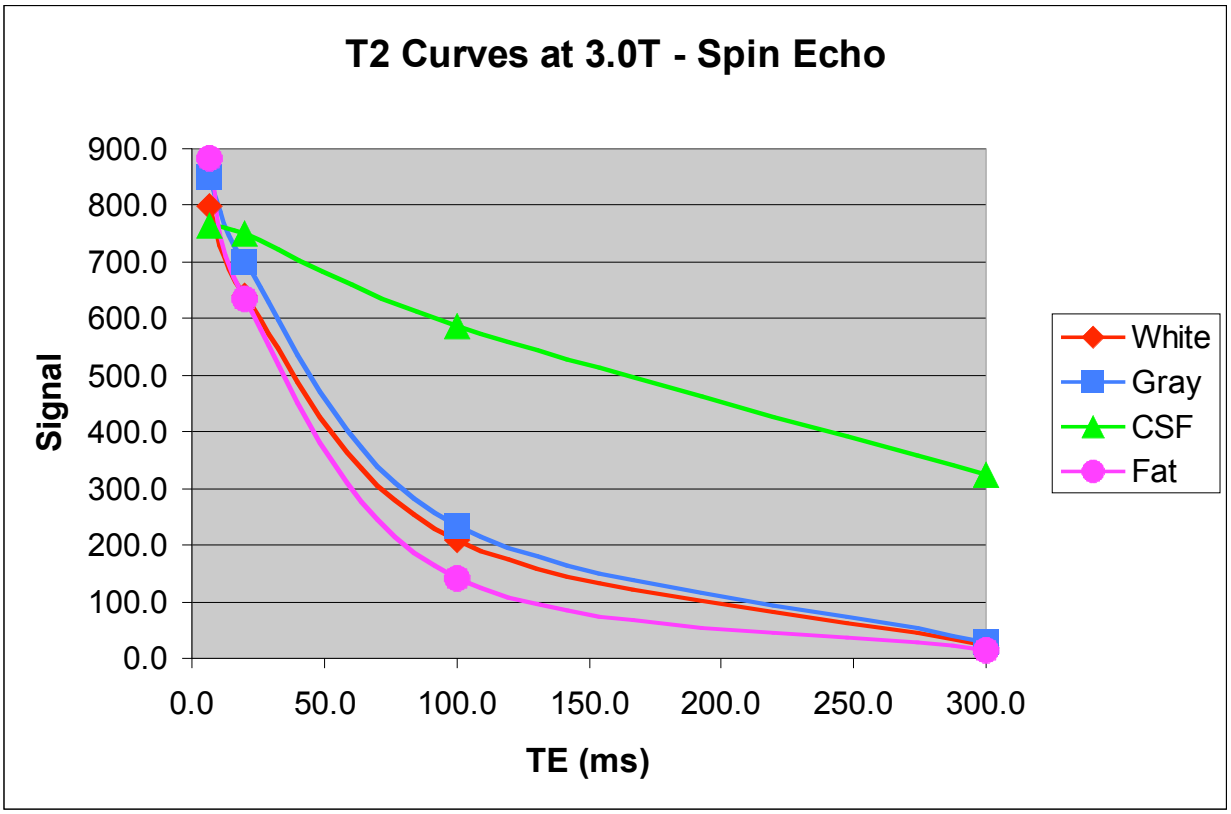
Notice how the tissue contrast of the image changes as TE changes. Recall that tissue contrast is our ability to distinguish different tissues within an image. In addition to the changes in the tissue contrast, there is an overall ***decrease*** in brightness as the TE increases. The other point of interest is the artifact that is fairly prominent in the TE=300 image but also somewhat noticeable in the TE=100 image.

Based on these images it appears that the best T1-weighted tissue contrast is achieved with a TE=100ms.

Data from ROI's:

TE	White	Gray	CSF	Fat	Δ CSF-GM
6.8	797.7	850.3	765.0	882.1	-85.3
20.0	641.2	700.7	749.8	633.5	49.1
100.0	209.8	233.3	588.0	141.3	**354.7**
300.0	23.5	29.0	324.8	14.4	295.8

Resulting T2-Curves:



Based on these curves the optimal T2-weighted image would be produced when we use a TE=100ms. At this TE the spread between the CSF and Gray matter curves is maximized and the spread between the White matter and Fat curves is still large.

Questions:

1. What type of relaxation is being measured in this experiment?
2. Based on the artifact in the TE=300 image, which is the phase encode direction in these images?
3. What might be the cause of this artifact?
4. Why does the overall brightness in the images decrease as the TE increases?

Experiment 3

Goal: Examine the effect on image contrast in a simple spin echo sequence if we attempt to mix T1 and T2 contrast in the same image.

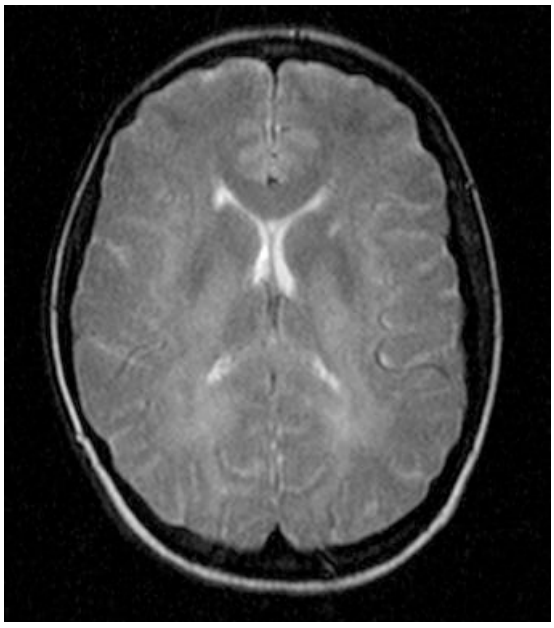
Image Sequence Parameters:

Use a spin echo sequence and choose a TR that would produce the best T1-weighted image and a TE that would produce the best T2-weighted image.

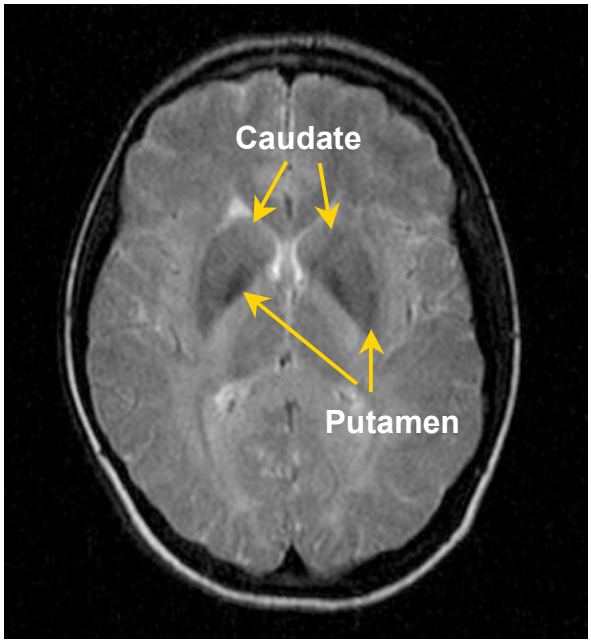
Base Sequence: Spin Echo

Parameter	Image 1
FOV Read (mm)	256
FOV Phase (mm)	256
Matrix	256x256
Slice Thickness (mm)	5
Distance Factor (%)	30
Number of Slices	5
Resolution (mm^3)	1.0x1.0x6.5
Flip Angle (degrees)	90^o
TR (ms)	***750***
TE (ms)	***100***
Scan Time (min)	4:54

Resulting Images:



Notice the very poor tissue contrast in this image. It is nearly impossible to distinguish gray matter from white matter. Even the CSF contrast is relatively poor especially in the sulci.



However, in a slice just below we noticed an interesting affect in that the contrast in the putamen and caudate is much different (darker) than that of the surrounding tissue. This was unexpected and might be useful if one were interested in these structures.