

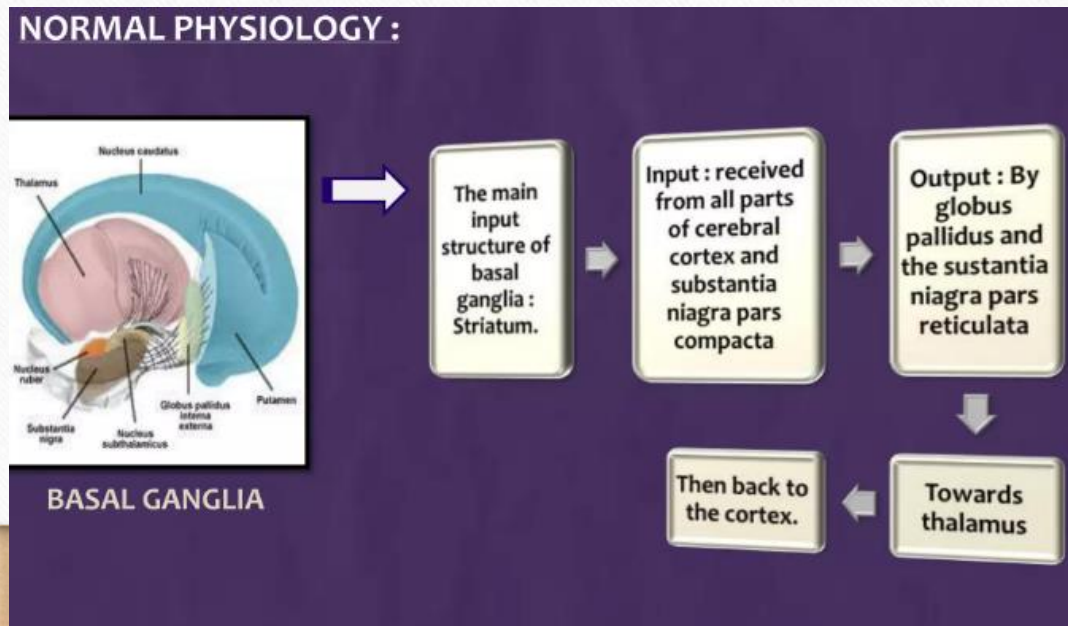
Physics and application of QSM in PD

Ahmad Mohammadbeigi

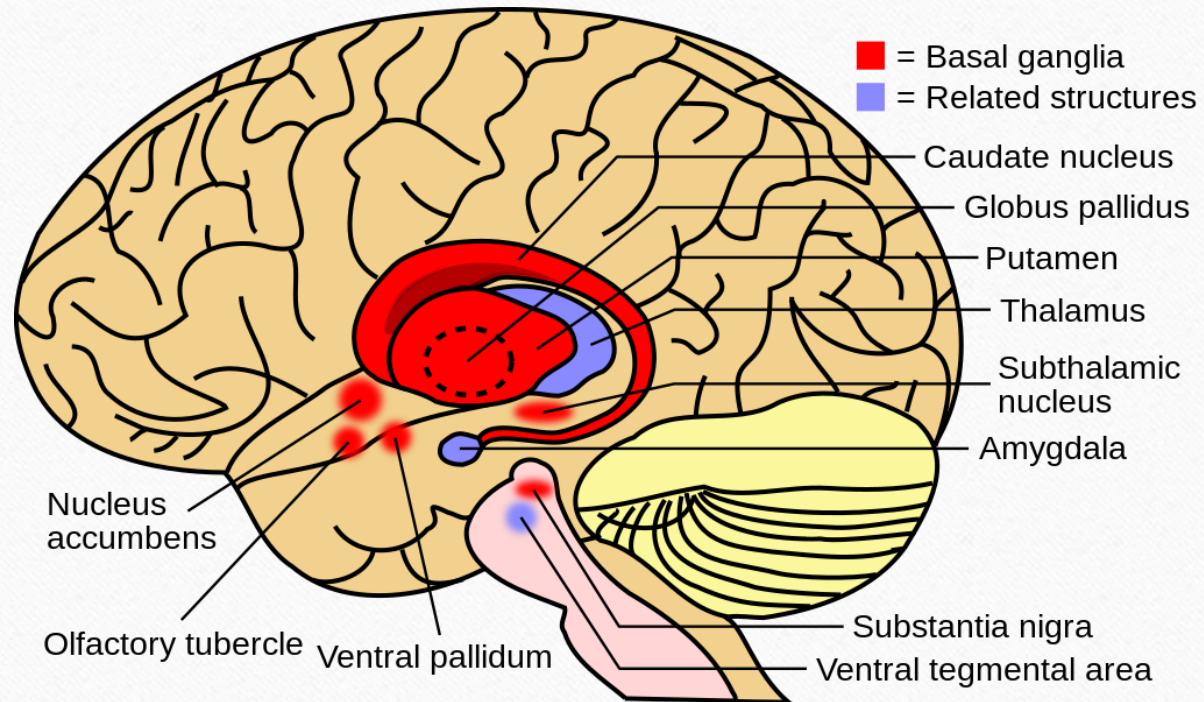
Faculty member of Semnan University of
Medical Sciences

PD

- Parkinson's disease is a chronic and progressive disease in which dopaminergic cells die in the Substantia nigra (SN) of the brain and body movements become irregular in the absence of dopamine.

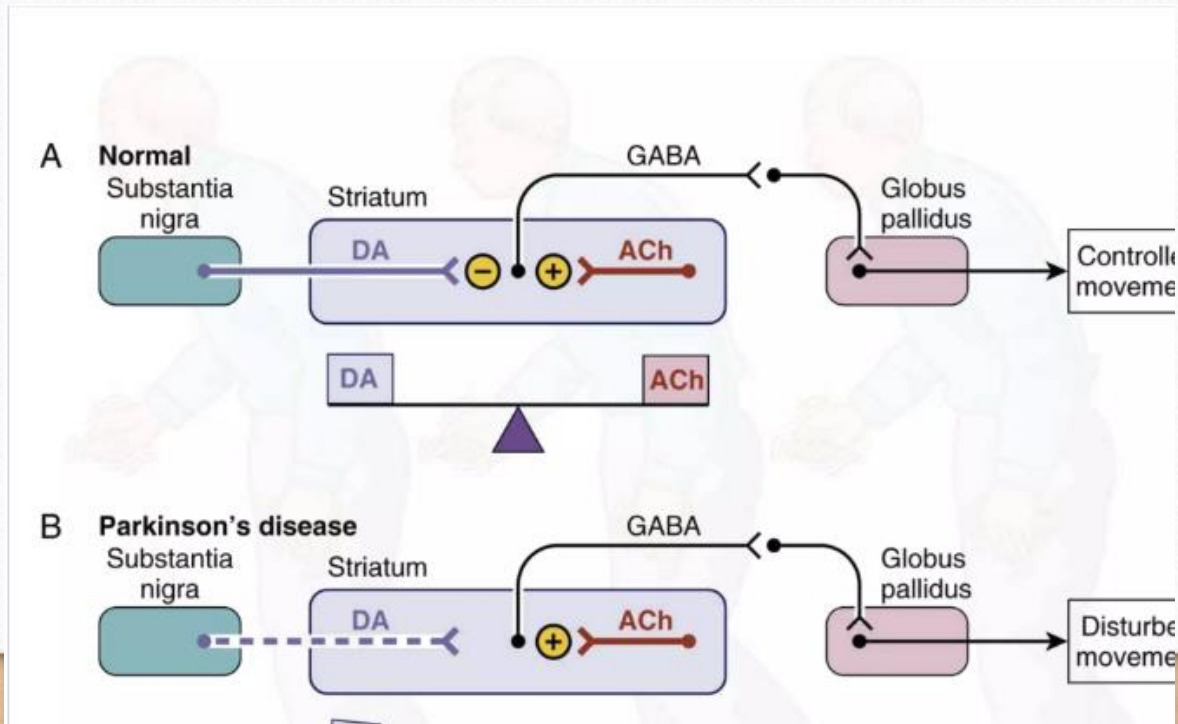


Basal ganglia



PD

- Dopamine works as a neurotransmitter mediator in most of brain regions, especially in the dopaminergic pathway from the SN to the caudate and putamen nuclei



PD

- Measurement the [iron deposition](#) in brain can explain pathophysiological interactions in the patient's brain. Studies have shown that increased amount of iron is associated with diseases such as multiple sclerosis, Alzheimer's disease, and [Parkinson](#).
- Parkinson's disease is the most common malignant neurological disorder after Alzheimer's disease.
- Iron as the most frequent metal among the transmitter metals in the brain plays an important role in many cellular processes of the cell, including oxygen and electron [transport](#), brain metabolism, myelin production, and dopamine production.

DIAGNOSIS

- Diagnosis is based on the clinical features .
- CT scan or MRI of head to rule out secondary cause.
- PET-scan to evaluate levodopa uptake and conversion to Dopamine in the corpus Striatum.

MRI Role

- T-2
- T2* mapping
- R2* mapping
- QSM
- the R2* method is more sensitive than T2-weighted imaging and T2 *; however, it is still not considered as an appropriate sequence due to the dependence to the magnetic field strength, the presence of blooming artifact, and the lack of relationship with iron concentrations

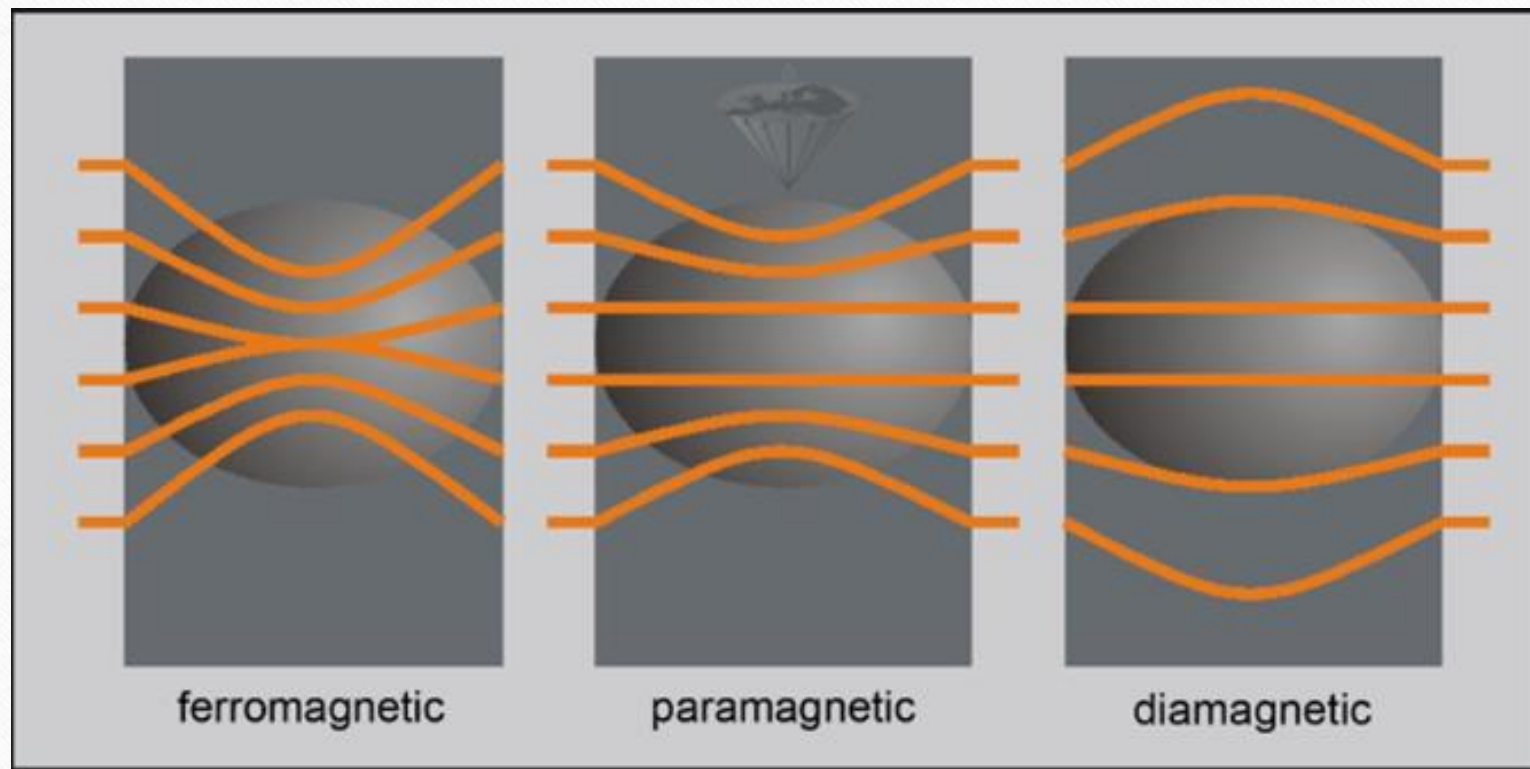
Type of Fe

- Studies have shown that **ferritin** and **hemosiderin** can be detected by MRI techniques among three different iron storage molecules (transferrin, ferritin, and hemosiderin) in the body. However, **transferrin** can't be measured through MRI due to low distribution and low concentrations.

Iron deposition

- Different results have been reported increasing the iron deposition in the Red, Substantia nigra, Caudate, Globus Pallidus, Putamen, and Thalamus nuclei of patients with Parkinson's disease.

Iron cause to inhomogeneity of magnetic field
and change the phase of protons

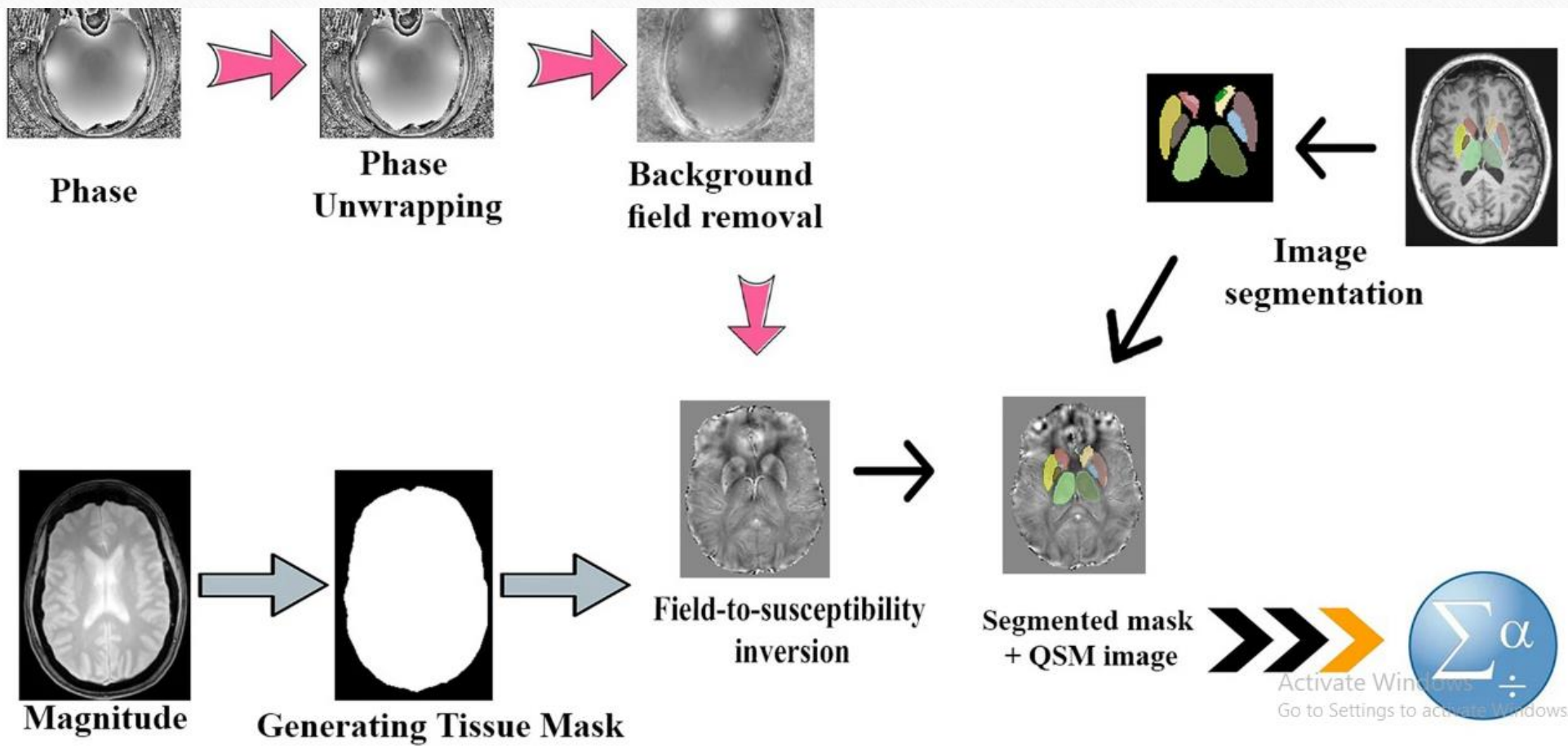


QSM sequence (By Haacke et al.)

- T1-weighted
- 3D gradient-echo
- High resolution
- Flip angle < 20
- TR/TE = 50/25
- Matrix size = 256×256
- Band width = 700 Hz/pixel
- Slice thickness = < 1 mm

Image processing and analysis

- SPIN software
- 1. Skull bone removing
- 2. High pass filter (noise reduction)
- 3. Correction the non-uniformity of voxels
- 4. extract the final QSM images
- 5. Overlaying on MP-RAGE images (increasing the resolution)
- 6. ROI insertion and QSM values measurement



Iron concentration measurement

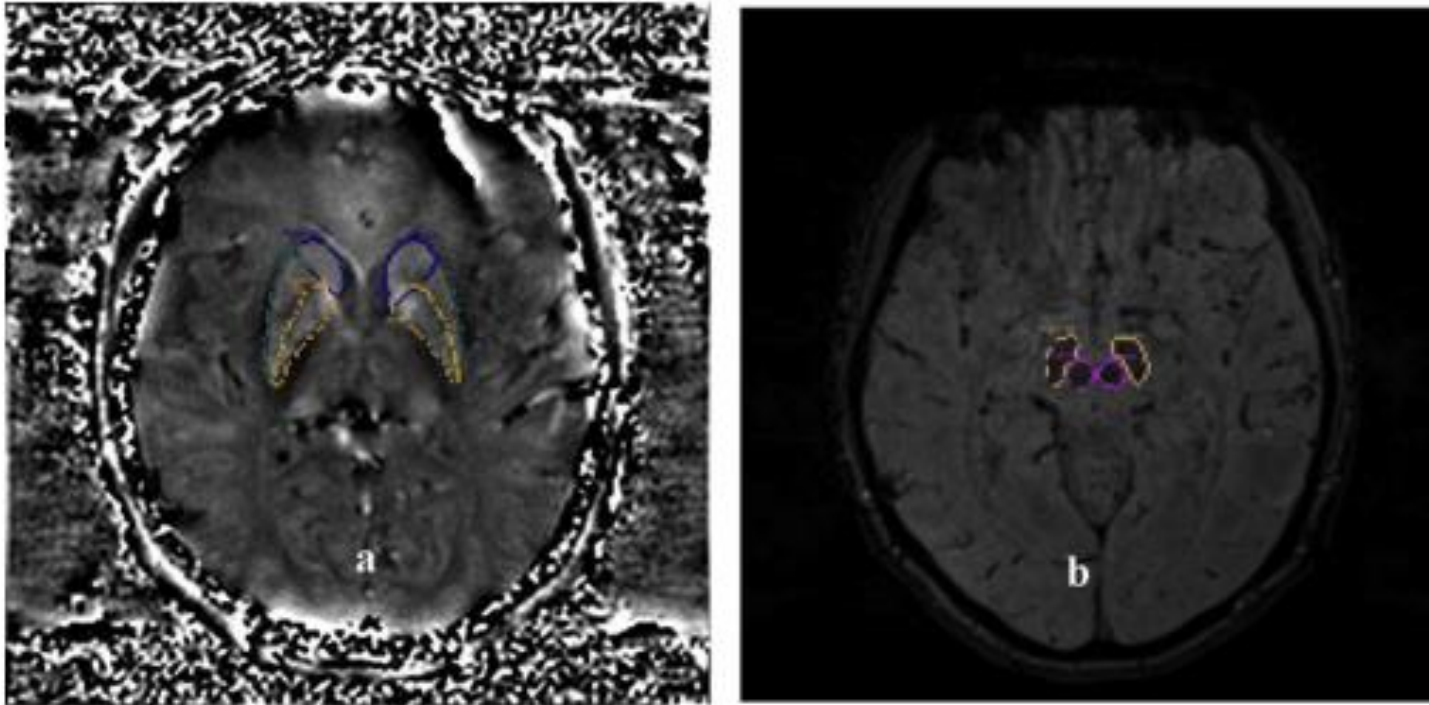


Fig. 1. a) Representative slice show the determined ROI for CN(blue color), PUT(yellow color) and GP(green color), b) the determined ROI for RN(purple color), SN(yellow color) in SPIN software. The ROIs determined manually by the educated radiologic thchnologist.

QSM results

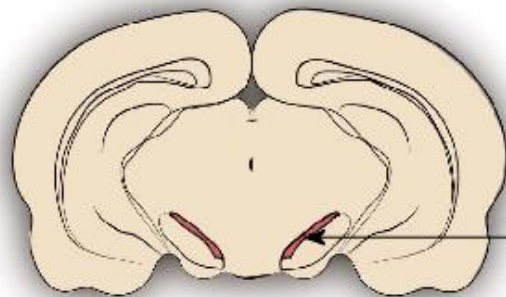
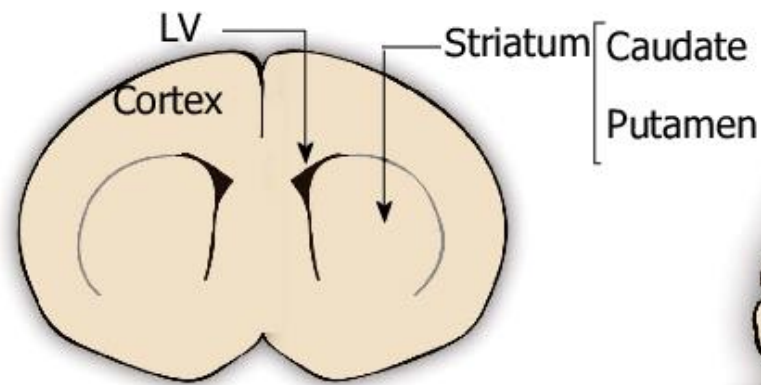
Table 2

Comparison QSM between PD and control group.

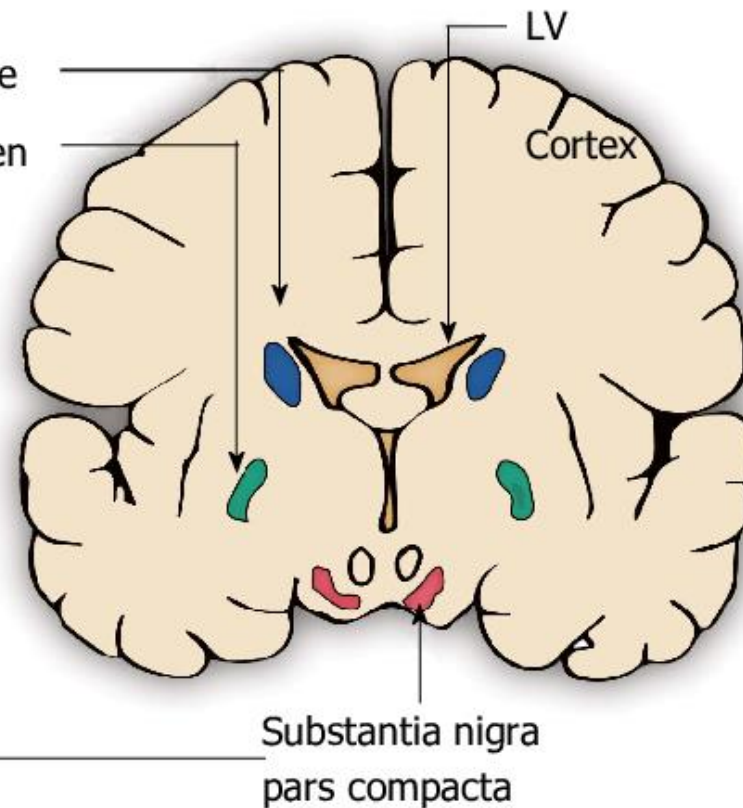
	QSM(ppm)		P
	Control	PD	
SN	0.146 ± 0.026	0.239 ± 0.021	< 0.001
RN	0.173 ± 0.009	0.201 ± 0.018	< 0.001
PN	0.163 ± 0.032	0.152 ± 0.022	0.160
GpN	0.178 ± 0.027	0.247 ± 0.028	< 0.001
ThN	0.108 ± 0.008	0.119 ± 0.012	0.005
CN	0.155 ± 0.011	0.153 ± 0.027	0.193

New studies are based on Substantia nigra assessment

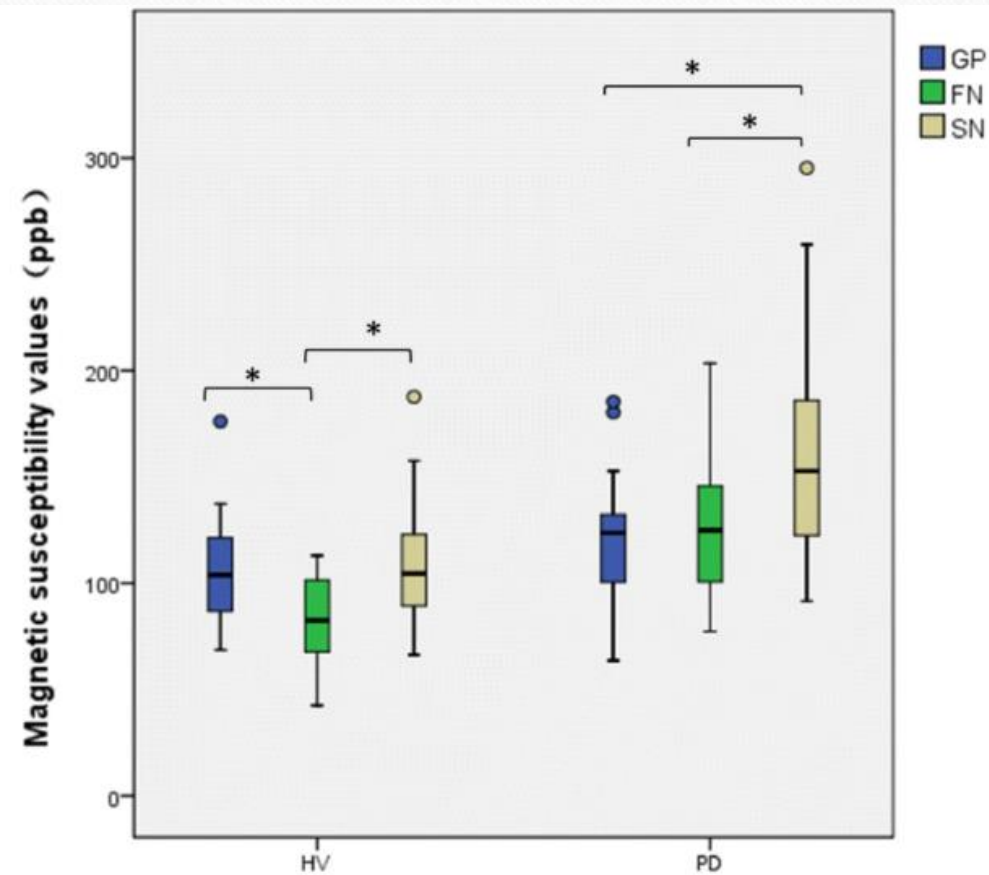
Rat brain



Human brain



Chen et al. (BMC Neuroscience)



Magnetic susceptibility values of GP-FN-SN pathway. Asterisk statistical significance ($P < 0.05$)



Thank you