By:

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Introduction to fMRI

CAN 5 (Cognitive Neuroscience Methods)
24. October 2014

Structure

Quiz

Evaluation & award presentation

Safety

Discussion

Feedback

Quiz

Question №.1:

fMRI

A	
B	
C	
D	

Quiz

Question №.1:

fMRI

Which is the right order for a typical fMRI session?	
A	Introduce gradients → introduce a static magnetic field → introduce radiofrequency → produce pictures from the collected signal
B	Introduce radiofrequency → introduce a static magnetic field → introduce gradients → produce pictures from the collected signal
C	Introduce a static magnetic field → introduce radiofrequency → introduce gradients → produce pictures from the collected signal
D	Introduce a static magnetic field → introduce gradients → introduce radiofrequency → produce pictures from the collected signal

Quiz

Question №.2:

fMRI

What is the purpose of the static magnetic field?	
A	To receive the MR signal
B	To align the hydrogen protons of the human body to the z-axis (either parallel or anti-parallel)
C	To analyze the complexity of the MR signal
D	To align the oxygen protons of the human body to the z-axis (either parallel or anti-parallel)

Quiz

Question №.3:

fMRI

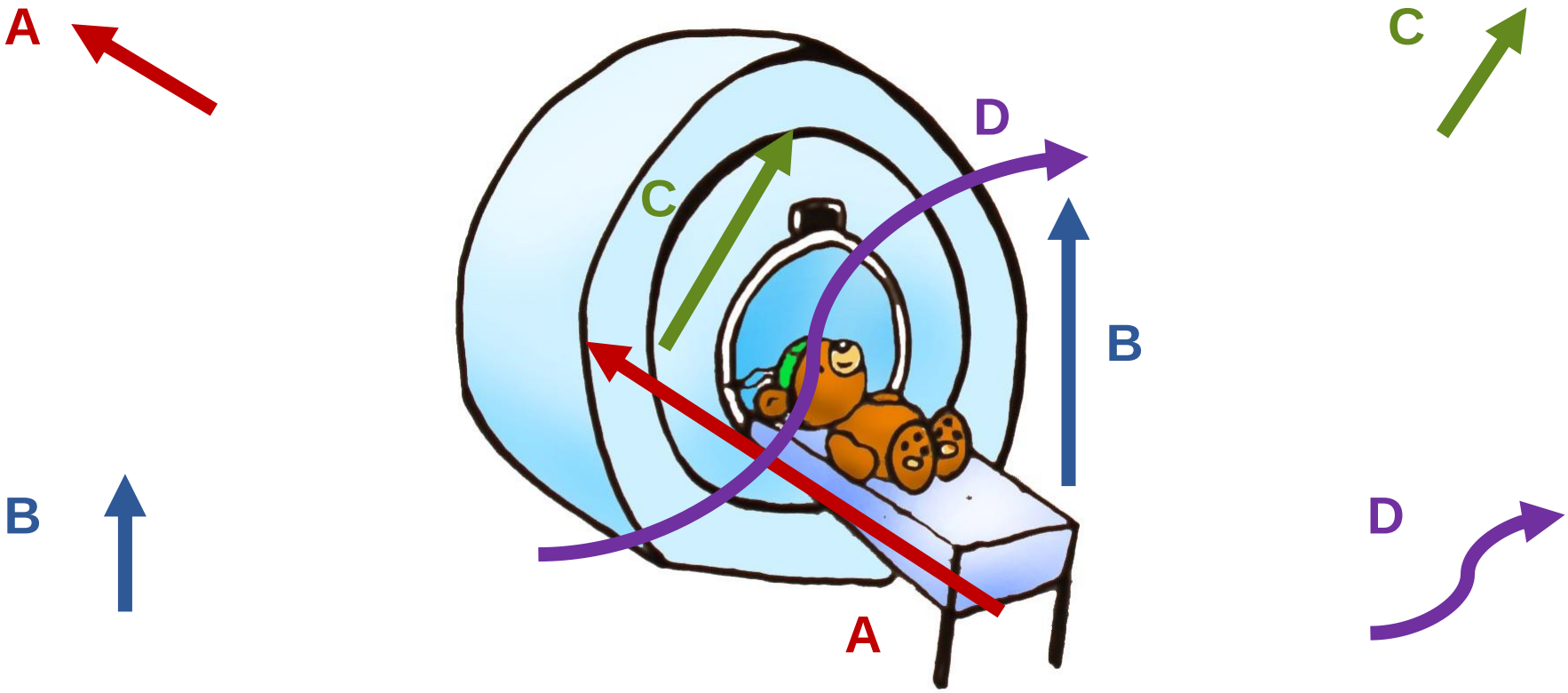
How is the strong static magnetic field induced?	
A	With a superconducting coil
B	With a cooled Large-Hadron-Collider (LHC)
C	With a titanium-curium coil
D	With a dynamo

Quiz

Question №.4:

fMRI

In which direction is the static magnetic field induced?



Quiz

Question №.5:

fMRI

What is the purpose of the radiofrequency (RF)?	
A	To make the static magnetic field stronger and more homogenous
B	To produce the MR signal following excitation and reception of electromagnetic energy
C	To provide spatial information in the MR signal with three different gradients (slice selection, phase encoding and frequency encoding)
D	To bring good music into the scanner (mostly from Bach and Mozart… but sometimes even rapmusic like Eminem)

Quiz

Question №.6:

fMRI

What is happening after the induction of the RF with the radiofrequency coils?	
A	Most of the sample protons are relaxed (low-energy state)
B	Most of the protons are ionized (high-energy state)
C	Most of the protons are isotropic (low-energy state)
D	Most of the protons are excited (high-energy state)

Quiz

Question №.7:

fMRI

What is incorrect for the radiofrequency (RF)?	
A	The RF is introduced by special radiofrequency coils
B	The RF provides volume information into the MR signal
C	The RF ist on an equal frequency like the atomic nuclei within the static magnetic field (to excite the atomic nuclei)
D	The RF influences atomic nuclei of the whole brain

Quiz

Question №.8:

fMRI

What is the purpose of the gradient coils?	
A	To produce the MR signal following excitation and reception of electromagnetic energy
B	To make the static magnetic field stronger and more homogenous
C	To provide spatial information in the MR signal with three different gradients (slice selection, phase encoding and frequency encoding)
D	To analyze the k-space images with a fourier transformation to produce images of the brain

Quiz

Question №.9:

fMRI

What is incorrect for the gradient coil sytem?	
A	The power of the coils is half of the power of the static magnetic field
B	To ensure spatial information in the MR signal
C	The slice selection determines the plane which is excited with the larmor-frequency (z-axis)
D	Phase encoding and frequency encoding is used to produce the specific signal from a determinated slice (x-axis, y-axis)

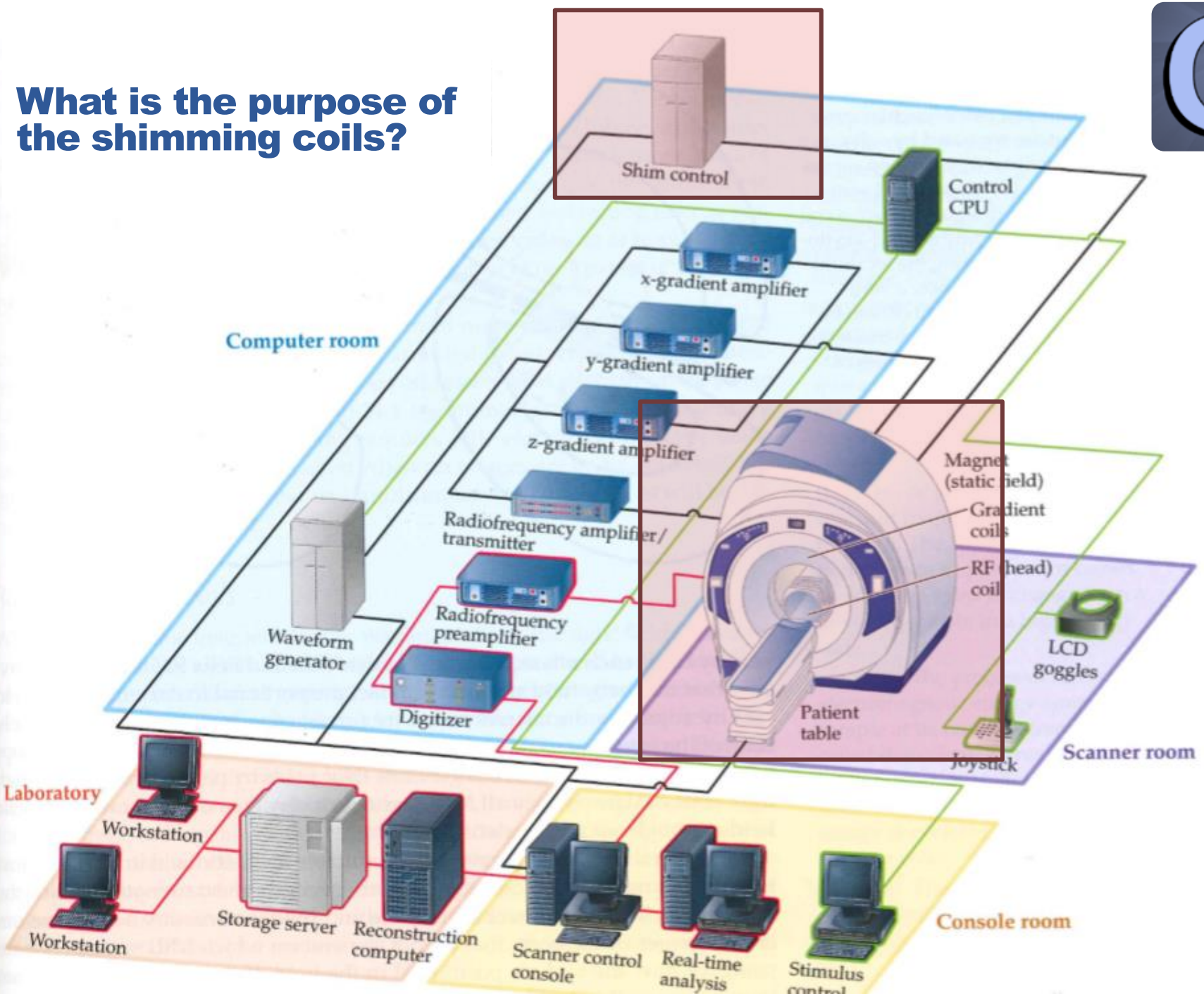
Quiz

Question №.10:

fMRI

What is the purpose of the shimming coils?	
A	
B	
C	
D	

What is the purpose of the shimming coils?



Quiz

Question №.10:

fMRI

What is the purpose of the shimming coils?	
A	To ensure the uniformity (homogeneity) of the static magnetic field
B	To reduce the earth´s magnetic field (by shimming) near to 0
C	To make the static magnetic field stronger (up to 3-7 Tesla)
D	To protect the medical stuff from the force of the magnetic field (projectile effects can occur)

Quiz

Question №.11:

fMRI

Which coils are not part of a fMRI scanner?	
A	Superconducting elelctromagnetic coil (1,5 – 11 Tesla)
B	Radiofrequency coils
C	Gradient coils
D	Larmor coils

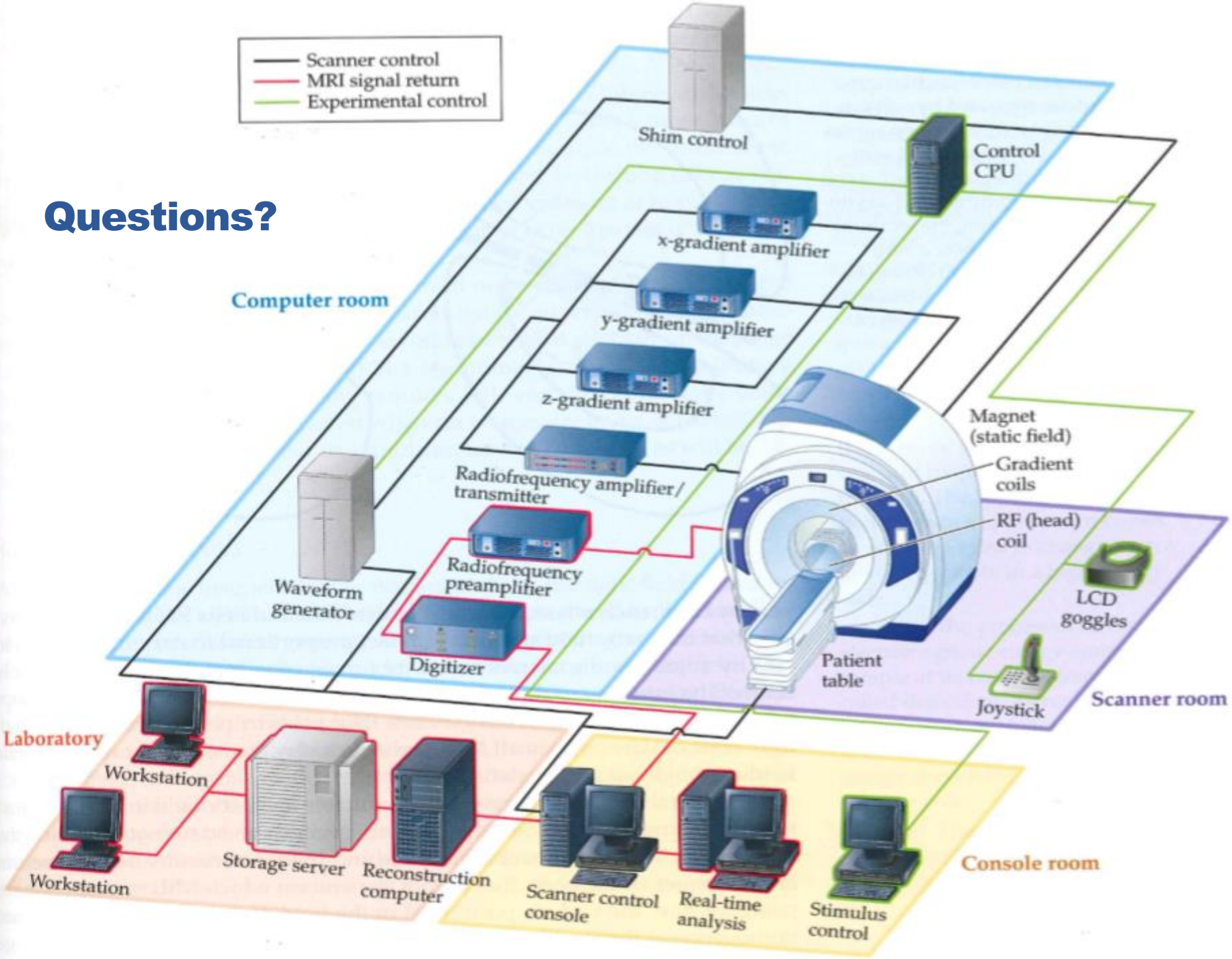
Quiz

Question №.12:

fMRI

Which element doesn´t play an important role in fMRI?	
A	Helium
B	Hydrogen
C	Lithium
D	Titanium

Questions?


Scanner control
MRI signal return
Experimental control
Shim control
Control CPU
x-gradient amplifier
y-gradient amplifier
z-gradient amplifier
Radiofrequency amplifier/ transmitter
Radiofrequency preamplifier
Digitizer
Waveform generator
Computer room
Magnet (static field)
Gradient coils
RF (head) coil
LCD goggles
Patient table
Joystick
Scanner room
Laboratory
Workstation
Workstation
Storage server
Reconstruction computer
Scanner control console
Real-time analysis
Stimulus control
Console room

The correct answers

Question №.1: C
Question №.2: B
Question №.3: A
Question №.4: A
Question №.5: B
Question №.6: D
Question №.7: B
Question №.8: C
Question №.9: A
Question №.10: A
Question №.11: D
Question №.12: C

Evaluation and award presentation

„Congratulations, your good!“

(Mario, 1997)

Safety: Static magnetic field I

Projectile effect (translation): Magnetic Field can lift objects with ferromagnetic properties at a very high velocity

Highly dangerous even at moderate distances

Torsion: Implants/ferromagnetic devices/shrapnells inside the body may rotate towards the net magnitisation vector and cause internal bleeding/swelling and/or irritations

- Every metal containing object should be removed prior to entering the scanner room and be checked thoroughly

Safety: Static magnetic field II

Visual disturbances/metallic taste sensations/headaches may occur due to quick movements of the head

- These should be monitored, but are mostly minor and short-lived

Hair cells of the inner ear may be spun causing nausea, vertigo

Always move the subject at slow speed and restrict head movement

Safety: Gradient magnetic fields

Gradients: very small strength, but change rapidly

Human body is a natural conductor

- Gradient switching can produce small currents
- Nerves/muscles may be stimulated
- Medical devices may be manipulated/disabled

Faster Switching → stronger/more currents

- Skin-to-skin contact should be avoided
- Exclude patients with pacemakers/cochlea implants/other electric/magnetic devices

Acoustic Noises

Safety: Radiofrequency field

Specific absorption rate (SAR)

- RF pulse energy is absorbed by protons, but not fully re-emitted
- Excess energy is dissipated in the form of **heat**

- The SAR depends on the size, geometry and conductivity of the absorbing object, the field strength and the frequency of RF pulses

- Effects: **heating (body, metal devices)**

Safety: Claustrophobia

"OK, Mrs. Dunn. We'll slide you in there, scan your brain, and see if we can find out why you've been having these spells of claustrophobia."

Berlin Center for Advanced Neuroimaging (BCAN)

Unmittelbar vor der Untersuchung müssen Sie sämtliche Taschen Ihrer Kleidung entleeren und alle metallhaltigen Gegenstände ablegen. Das betrifft insbesondere:

- Münzen und Geldscheine
- Brille
- Schlüssel
- Schmuck (Piercings, Ringe, Ohrringe, Ketten)
- Uhr
- Gürtel
- Handy
- EC- und Kreditkarte (Magnetstreifen werden gelöscht!)
- Kugelschreiber, Stifte
- Haarspange und Zopfgummi
- Bügel-BH
- herausnehmbarer Zahnersatz / herausnehmbare Zahnspange
- Büroklammern
- Hörgerät
- Taschenmesser
- Nikotinpflaster
- Augen-Make-up
- andere Metallteile

Des Weiteren dürfen bestimmte Personen gar nicht oder nur nach Absprache mit dem Studienleiter untersucht werden. Bitte lesen Sie sich die folgende Aufzählung genau durch und kreuzen Sie an, was auf Sie zutrifft! Ich habe / trage:

- einen Herzschrittmacher ❍ Ja ❍ Nein
- Metallimplantate (z. B. Knochenplatten, Gelenkprothesen, künstlicher Darmausgang mit Magnetverschluss, Gefäßclips, künstliche Herzklappen, Stents, Cava-Filter) ❍ Ja ❍ Nein
- Metallsplitter (z. B. nach Unfällen beim Arbeiten mit Metall oder durch Kriegsverletzungen) ❍ Ja ❍ Nein
- eine feste Zahnspange ❍ Ja ❍ Nein
- eine Tätowierung (manche Tatoofarben enthalten Metallpartikel) ❍ Ja ❍ Nein
- Permanent-Make-up ❍ Ja ❍ Nein
- eine Spirale zur Empfängnisverhütung (Intrauterinpessar) ❍ Ja ❍ Nein
- ein Cochlea-Implantat (Hörprothese) ❍ Ja ❍ Nein
- eine Medikamentenpumpe ❍ Ja ❍ Nein
- Akupunkturnadeln ❍ Ja ❍ Nein
- anderes Metall oder Elektronik im oder am Körper? ❍ Ja ❍ Nein
- Ich bin schwanger oder könnte evtl. schwanger sein ❍ Ja ❍ Nein
- Ich hatte schon einmal eine Operation am Gehirn ❍ Ja ❍ Nein
- Ich hatte schon einmal eine Operation am Herzen ❍ Ja ❍ Nein

Unproblematisch sind in der Regel metallhaltige Zahnfüllungen sowie Reißverschlüsse, Knöpfe und Nieten an Hosen.

Discussion

The End

References

Literature:

- Huettel, S. A., McCarthy, G., & Song, A. W. (2004). *Functional magnetic resonance imaging*. Sunderland (Mass.): Sinauer associates.
- Mario, S. (1997). *Mario Kart 64.* Kyoto: Nintendo. ☺

Video:

- Siemens. (2014.10.23).*Siemens 3T Magnetom Trio Tim Security Instructions*. Retrieved from http://www.Berlin-can.De/scanning-calendar [24.10.2014]

Pictures:

- fMRI picture: http://images.iop.org/objects/med/news/8/2/27/pic1.jpg [24.10.2014]
- Quizduell logo: http://www.netzdurchblick.de/typo3temp/pics/2849f4dc35.png [24.10.2014]
- Bear in scanner : http://images.iop.org/objects/med/news/8/2/27/pic1.jpg [24.10.2014]
- CL-trophy: http://fanshop.kicker.de/media/catalog/product/cache/1/image/700x/9df78eab33525d08d6e5fb8d27136e95/m/f/mfb06670.jpg [24.10.2014]

References

Pictures:

- Safety first sign: http://www.internetbillboards.net/wp-content/uploads/Safety-First.jpg [24.10.2014]
- Comic claustrophobia: http://www.psychologypage.nl/functional_magnetic_resonance_imaging_fmri_cartoon.jpg [24.10.2014]
- Berlin Center of Advanced Neuroimaging (2014). Informationsblatt für gesunde Probanden. BCAN Informationsblatt, 3. Retrieved from http://www.Berlin-can.de/scanning-forms [24.10.2014]
- Discussion pic: http://www.diesseits.de/image/diskussion [24.10.2014]
- Feedback: http://b-i.forbesimg.com/joefolkman/files/2013/12/feedback-heads1.png [24.10.2014]