# *Cerebral perfusion imaging using EIT*

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EIT 2017
June 21–24, Dartmouth College
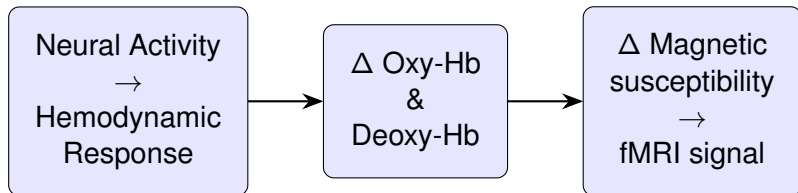Hanover, New Hampshire, USA

Hemodynamic Reponse
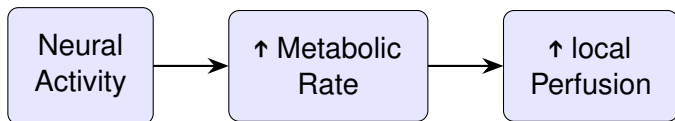
- ↑ blood flow to deliver O_2 and glucose to stressed tissues
- mechanism: dilation of smooth muscle when NO released from endothelial cells
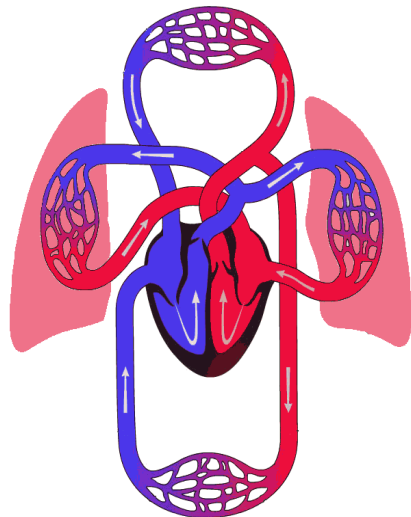
fMRI BOLD response

Cerebral imaging using fMRI plays an important role in functional studies of the brain.

BOLD ≜ Blood-oxygen-level dependent contrast imaging

Question: perfusion with EIT?

Thoracic/lung perfusion imaged
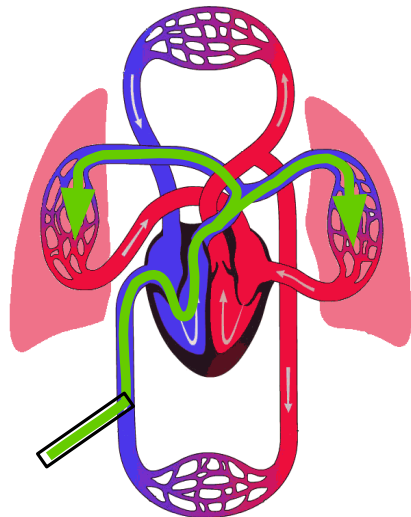using injection of a bolus of
hypertonic saline[1].

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[1] I Frerichs, *et al*, *IEEE T Med Imag* 21:646, 2002.
[2] Image modified from: Urgo Medical, www.urgomedical.com

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Injection into femoral vein

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Question: detect **brain** perfusion with EIT?

Pilot Experiments in a rat

- Scousetom EIT system[2]
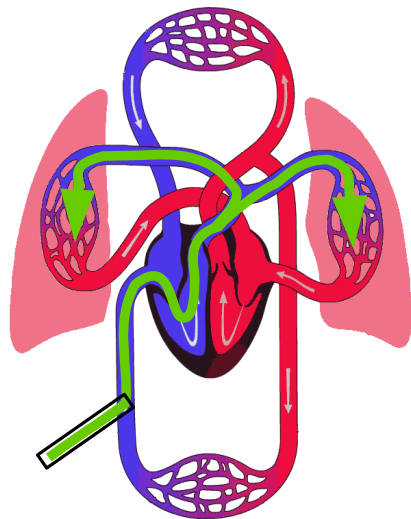- 57 electrodes on cortical surface
- 5 frames/sec, 50 μA at 2 kHz

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[2]J Avery, T Dowrick, M Faulkner, N Goren, D Holder. *Sensors*, 17:280, 2017

Method #1: bolus via vein

Contrast:
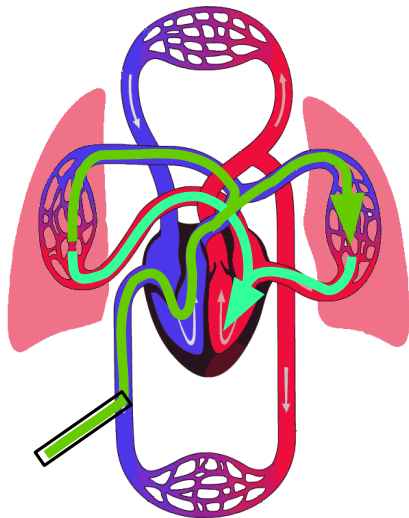   500 μL of 10% NaCl (w/v)

Injection via femoral vein

Method #1: bolus via vein

Contrast:
  500 μL of 10% NaCl (w/v)

Injection via femoral vein

Method #1: bolus via vein

Contrast:
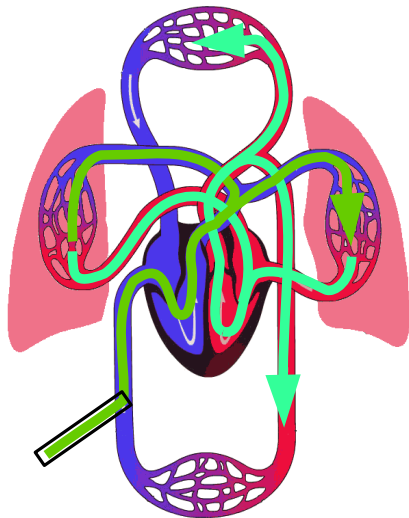   500 μL of 10% NaCl (w/v)

Injection via femoral vein

No signal seen
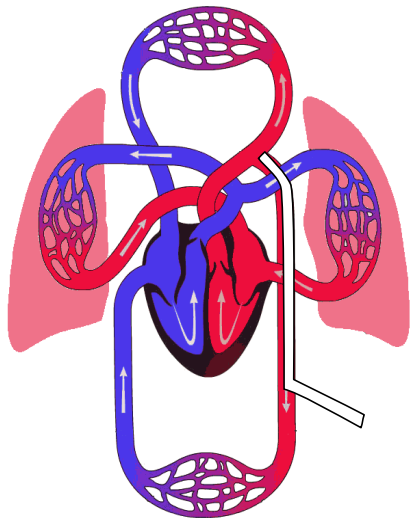
Method #2: bolus at aortic arch

Contrast:
  500 μL of 10% NaCl (w/v)

Catheter into femoral artery to
aortic arch (determined by
pressure waveform)

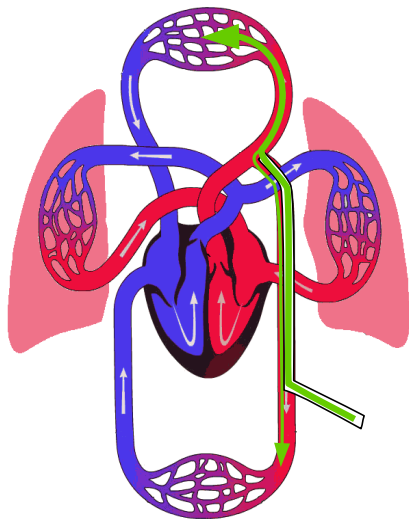# **Method #2**: bolus at aortic arch

Contrast:
    500 μL of 10% NaCl (w/v)

Catheter into femoral artery to
aortic arch (determined by
pressure waveform)
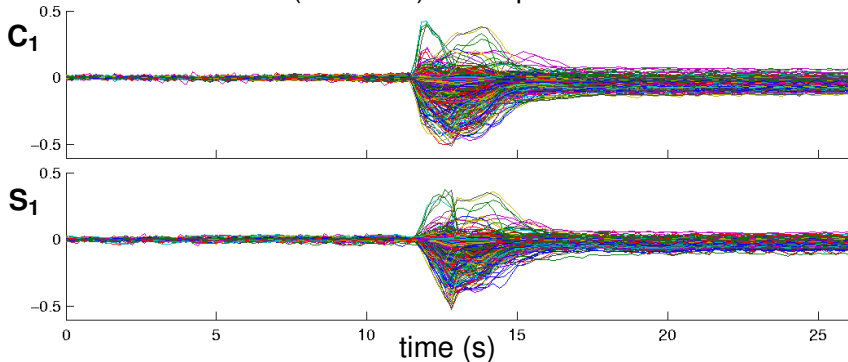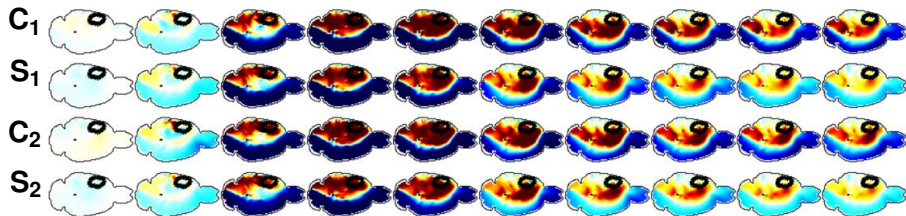
"*It'll only take 5 minutes*"

Raw Measurements

Protocol: C_1, S_1, C_2, S_2.

- $C \triangleq$ Control (no stimulation).
- $S \triangleq$ Simulation (electrical) of forepaw

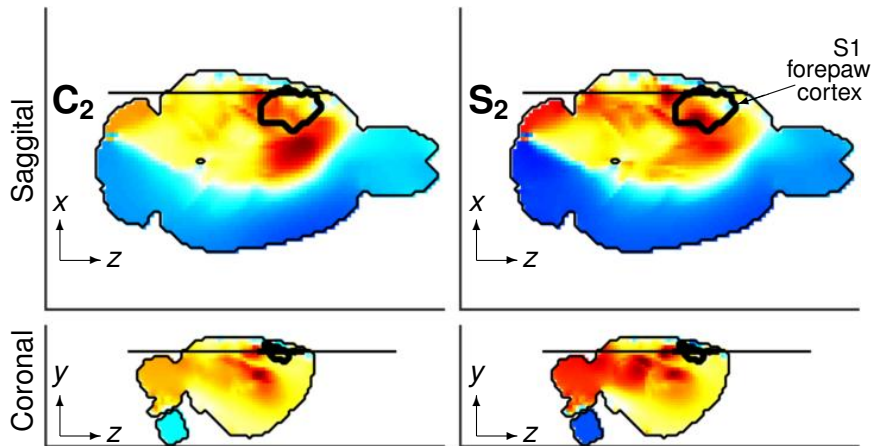Raw EIT recordings C_1, S_1 w.r.t. to baseline ($t = 0$) values.

Raw images

Time sequence of EIT images of a horizontal slice (Red $\uparrow\sigma$, Blue $\downarrow\sigma$), from left to right; images spaced by 600 ms.

- C_1, C_2: control (no stimulation).
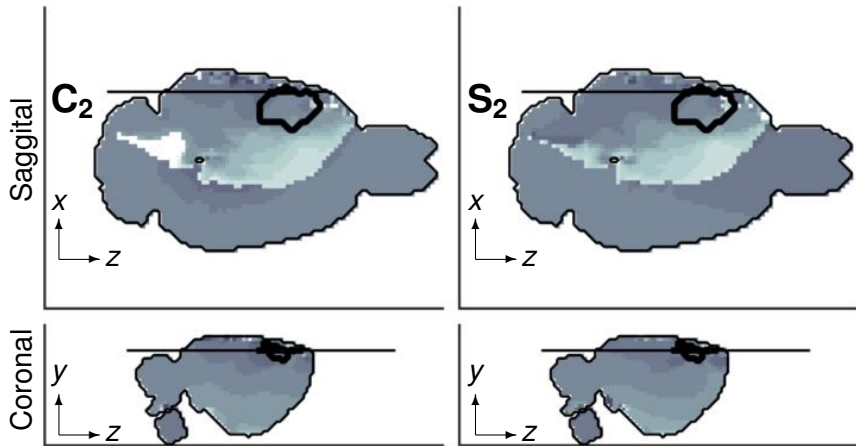- S_1, S_2: with forepaw stimulation.

Maximum images

Images show maximum EIT voxel signed value.

Image: Activation time

Images show time of maximum EIT activation (light=earlier)

Discussion

- Can EIT see brain perfusion?

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- Will EIT replace your $5M MRI machine?

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- Can EIT see functional differences in perfusion? | Maybe |
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What does EIT offer for this application?
- Cheap
- Small
- High temporal resolution
- Invasive
- Low spatial resolution