INTRODUCTION TO BOLD IMAGING

BIG OLE' DATA
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JUST KIDDING

• BOLD = Blood-Oxygen-Level-Dependent imaging
• BOLD is used as a correlate of ‘brain activity’ during fMRI - NOT anatomical or DTI
• BOLD measures the magnetic signal from oxygen in blood in the brain
• Neurons don’t have internal energy reserves of oxygen and sugar
  • The more a neuron fires the more energy it needs
• Blood releases oxygen to active neurons ("for energy")
  • This causes a relative change in deoxygenated & oxygenated blood
• Oxygenated blood is magnetically different than deoxygenated and the MRI can tell you where the oxygen is.
BREAKING DOWN THE BOLD:
TAKING A HIGHLY DIFFICULT CONCEPT AND MAKING IT WAY SIMPLER THAN I PROBABLY SHOULD

1. Blood flow in the brain is highly locally controlled in response to O$_2$ in tissue
   - BOLD is a regional measure
   - It is used to delineate regional activity
2. BOLD measured O$_2$ in BLOOD
   - BOLD DOES NOT measure direct neural activity
3. Increased activity in a region leads to more O$_2$
4. fMRI measures this because of there is a difference in magnetization between oxygenated and deoxygenated blood
EVERYTHING I’VE JUST SAID IS A VAST OVERSIMPLIFICATION OF A COMPLEX CHEMICAL PROCESS WHICH ACTUALLY INVOLVES THE RATE OF MAGNETIC SPIN DEPHASING OF WATER MOLECULES. BUT THINKING BIG PICTURE THIS IS BASICALLY HOW IT WORKS.
A BOLD scan needs to get an ENTIRE scan of the brain very quickly.

- We sacrifice spatial resolution for temporal resolution.
  - It gets blurrier but faster.

- BOLD images are EPI scans.
- Anatomical scans have high spatial resolution but low temporal resolution.
  - Look crisper, only 1 timepoint.
• We sacrifice spatial resolution for temporal resolution
  • Voxel size: 3x3x5mm
  • Get single whole brain scan every 2s

• Anatomical scans have high spatial resolution but low temporal resolution
  • Voxel size: 1x1x1mm
  • Get single anatomical image in an ~7m scan
BOLD ISN’T MUCH ON ITS OWN

- BOLD goes OVER the anatomy.
**IMPORTANT PROS & CONS OF USING THE BOLD SIGNAL**

**PROS**
- It has been shown to be a **VALID NONINVASIVE** measure of regional brain activity
- Produces images that are really high-res, comparatively speaking
- Shows regional activity differences well
- Safe

**CONS**
- **IT IS ONLY AN INDIRECT MEASURE OF BRAIN ACTIVITY**
- One cube of the brain is made up of millions of neurons, **not one**
- Response is slow & laggy – see response 2-6s after stimulus
- Very sensitive to movement

**BUT**

**BUT**

**BUT**

**BUT**
ONE LAST TIME

I'M GIVING 5 TALKS SO I'M GOING TO LET OXFORD SPARKS TAKE IT FROM HERE
ANY QUESTIONS? THIS CAT HATES BOLD IMAGING IF YOUR QUESTIONS ARE ABOUT PHYSICS THERE IS A 50% CHANCE I WILL PRETEND NOT TO UNDERSTAND YOU IN ORDER TO AVOID ANSWERING