Brain Imaging and fMRI

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Contents

How fMRI works

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- fMRI machine emits an energy pulse inside a high magnetic field.
- Small differences in the magnetic field at each point in space cause water at that point to emit a signal.

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- A 3D volume of the head can be collected in 0.5 - 2.0 seconds by collecting 16 individual 64x64 voxel images.
- A voxel becomes slightly brighter or darker in response to changes in deoxygenated iron content in that voxel.
- So the blood itself serves as a contrasting agent, making MRI signal sensitive to brain activation.

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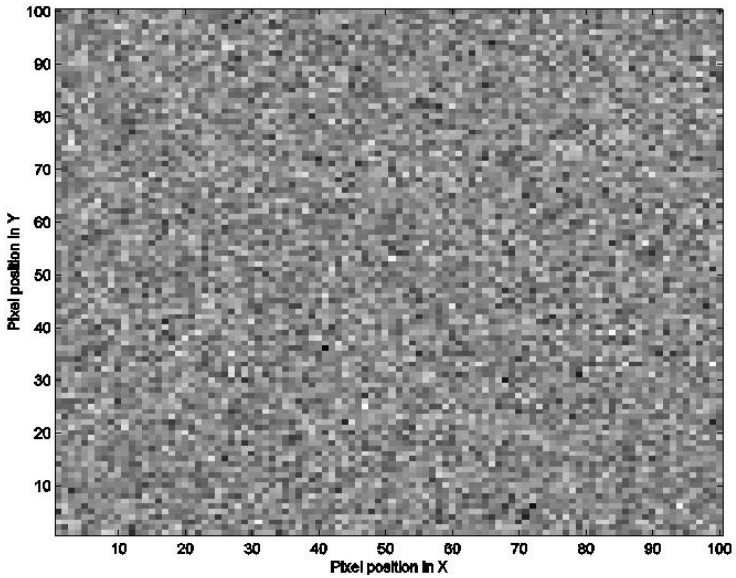
- fMRI cannot detect absolute activity of brain regions.
- The brain is never completely at rest.
- fMRI does not have very good external validity (subject cannot stay perfectly still).

Random Field Theory

- Given an array of voxel values[1]



- To look for an effect we are interested in, we calculate a statistic for each brain voxel that tests for the effect of interest in that voxel.

[1] from Random Field Theory, Will Penny

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- More complicated in functional imaging - many more voxels $\Rightarrow$ many more statistic values.
- Null hypothesis H_0 refers to the whole volume of statistic in the brain. Any evidence against the null hypothesis would mean that the whole observed volume of values is unlikely to have arisen from a null distribution.

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- The family-wise error rate is the probability that one or more values will be greater than A,

$$p^{FWE} = 1 - (1-\alpha)^n.$$

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- Random field theory solves this problem by calculating the expected Euler Characteristic for a smoothed image that has been threshold.

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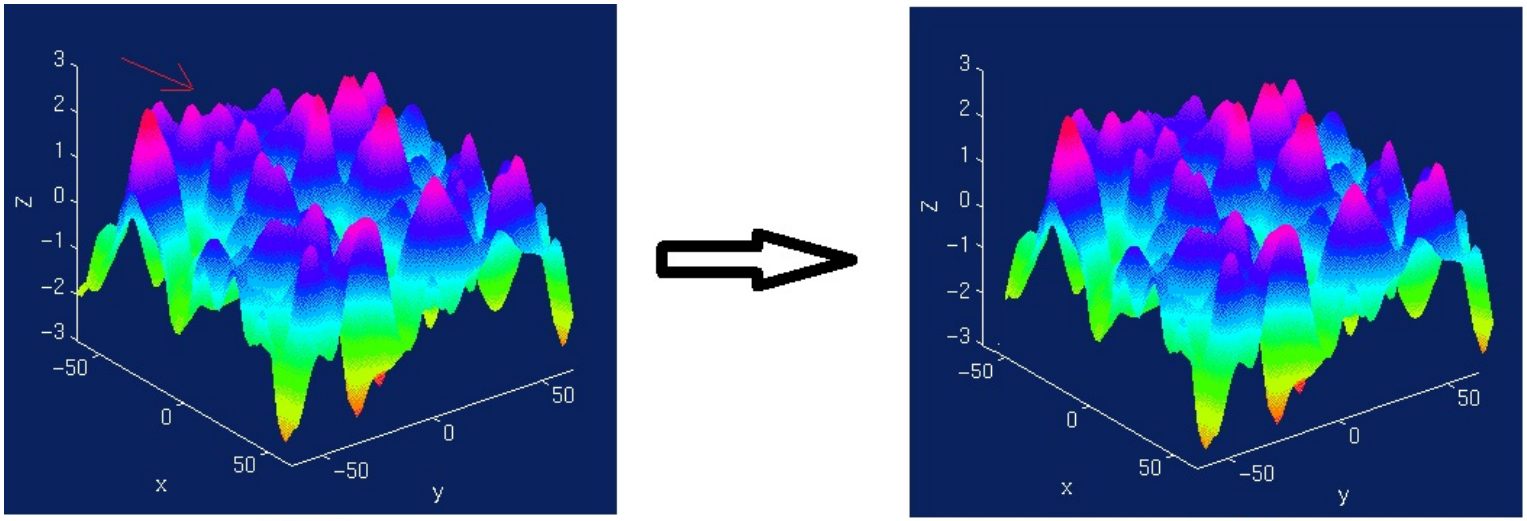
- Translating this into the above setting, we expect to see an evolution of the signal surface.
- We could use this to pinpoint regions of activation and possibly reduce the effects contributed from other regions.

Ideas



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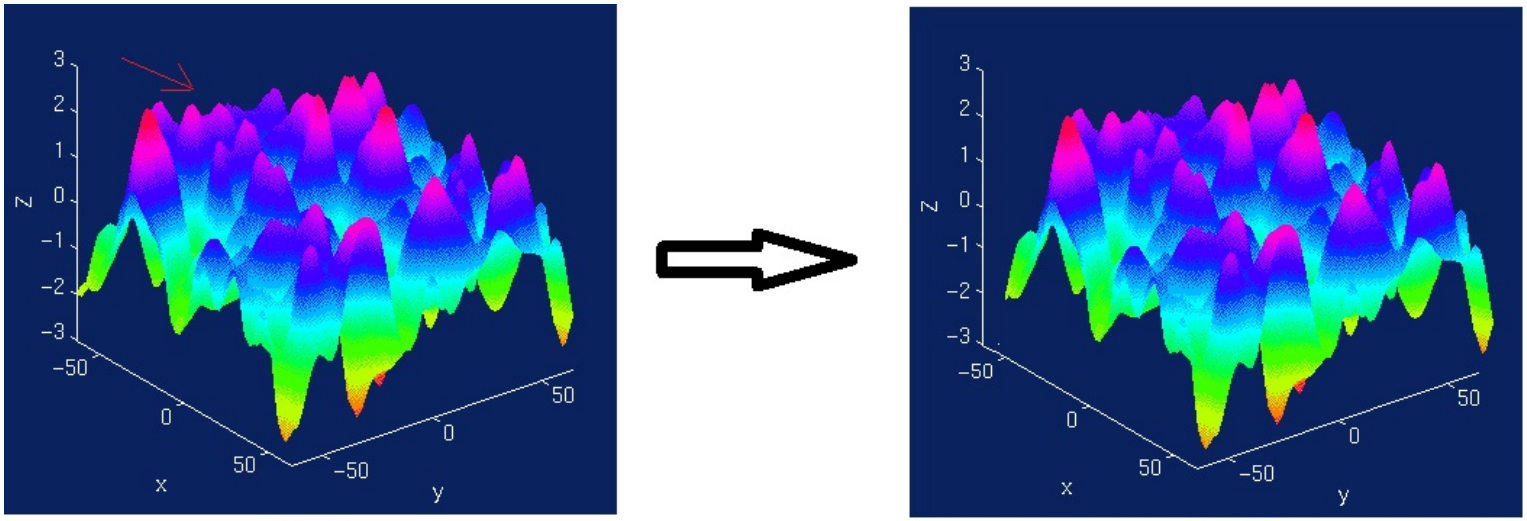
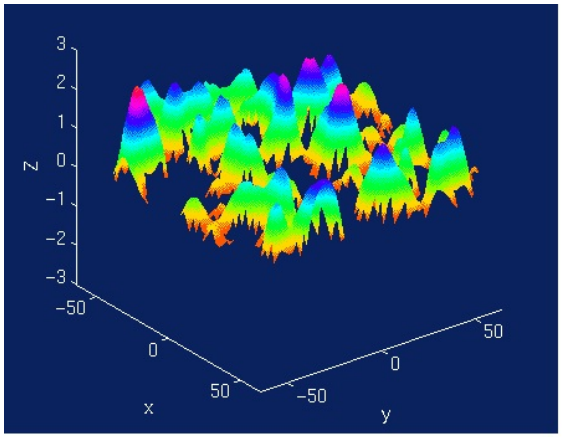


Spot the difference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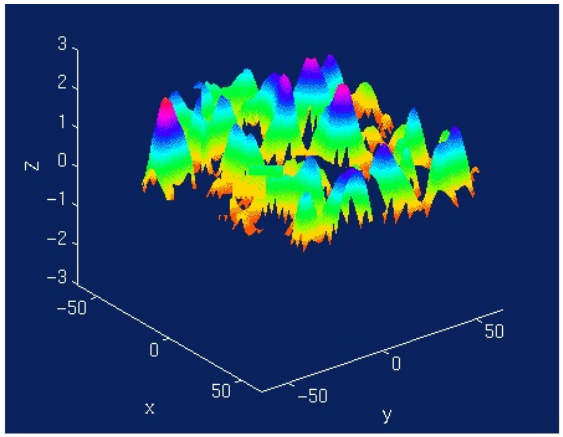
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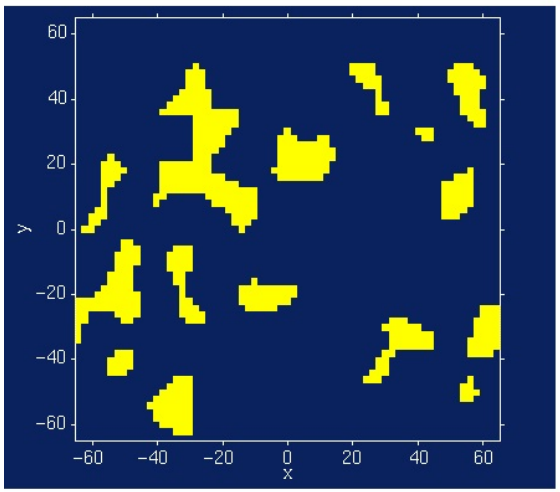
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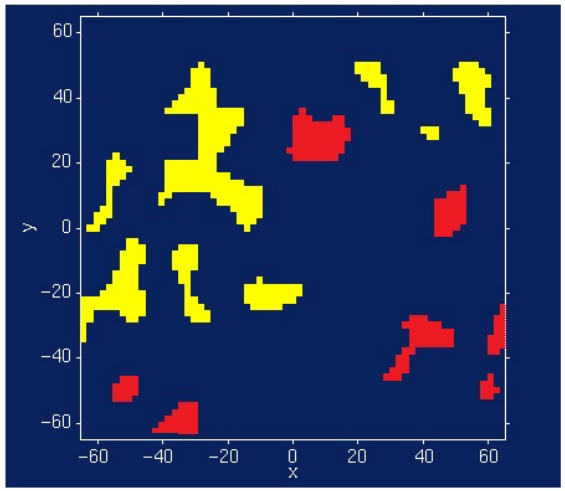
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