Using FreeSurfer to Quantify Cortical Thickness and Surface Area in Young Children

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The FreeSurfer Software

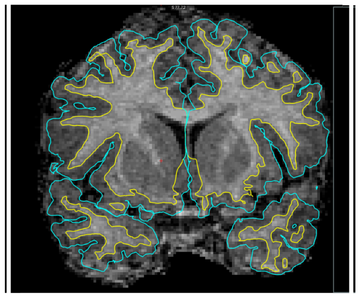
FreeSurfer: neuroimaging data analysis software that can quantify functional, connectional and structural properties of brain images taken by *Magnetic Reasoning Images (MRIs).*

- MRIs - use strong magnetic field to produce images of the brain
  - Measure energy released when protons shift
  - Identify certain types of tissue in the brain, and therefore can depict different parts of the brain

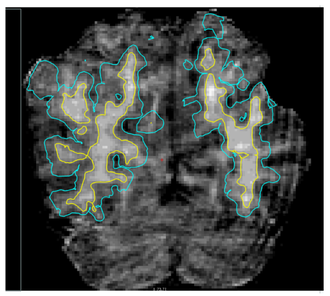
- FreeSurfer **identifies white and gray matter** and uses a template to mark boundaries for those tissues
  - Assign “names” to subcortical and cortical areas.

- How FreeSurfer works: Acquire a T1 weighted image > register T1 into “space” using gross landmarks (skull, ventricles) and affine registration > skull is then stripped > white matter points chosen based on MNI coordinates and intensity > finally, white matter locations are used to “scoot out” until intensity falls out and goes black (CSF).

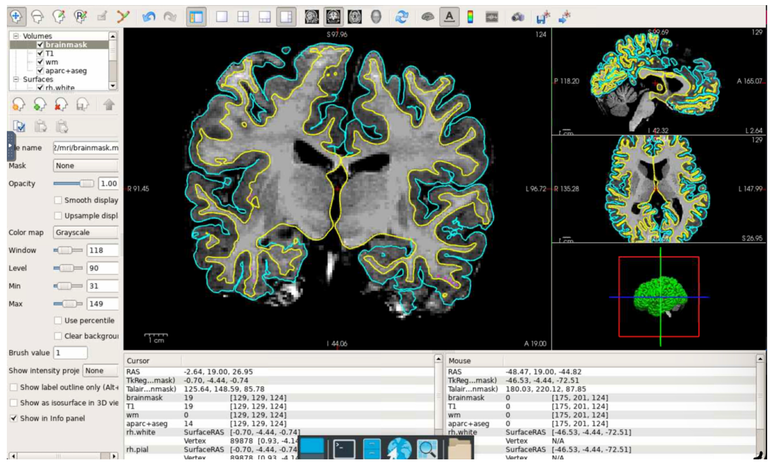
Good Brain



Bad Brain

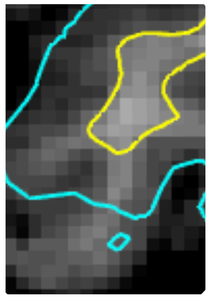


Unusable Brain

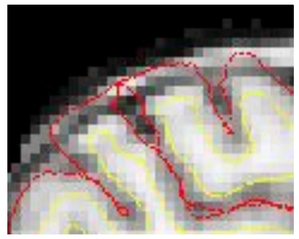


FreeView Application in use while editing a brain with specified settings for optimal viewing of the brain tissue

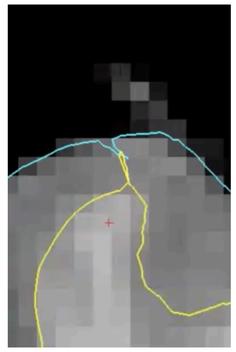
3 different kinds of problem areas to edit:



Extend



Rein In



Adjust

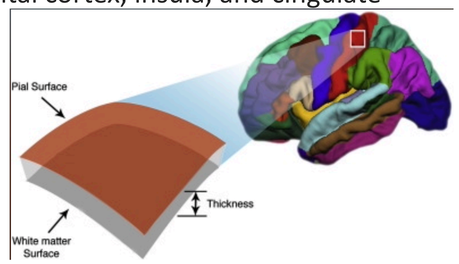
Edits in FreeSurfer

- **Control Points** > expand pial matter boundaries
- **Skull Stripping** > erases excess skull captured as pial matter
- **White Matter** > captures only what is true white matter
  - Maximum of 3 rounds of white matter edits to prevent overloading FreeSurfer with excess information

- <u>Children vs. Adults</u>
  - more edits necessary often in children, due to excess movement during processing of MRI scans
  - Brains are “good brains” if most pial matter is already captured and there are few white matter issues, leading to minimal rounds of edits

Applications of FreeSurfer in Research

- **STARR: Study of Toddler to Teenager Anxiety and Resiliency**
  - A longitudinal follow up to the Duke Preschool Anxiety Study, designed to understand how adolescents (ages 12-18) are influenced by early life experiences
  - Explores how features of early childhood affect a teenager’s emotionality and emotion regulation
- **YES: Youth Emotion Study**
  - Conducted in partnership with UNC Girls Health Study
  - Explores how stressful life experiences affect brain development in adolescence
  - Seeks to identify neural risk markers for self-injurious thoughts and behaviors (STBs)
- **Paper: Distinct Associations of Deprivation and Threat With Alterations in Brain Structure in Early Childhood**
  - Study that tested longitudinal associations between threat and deprivation measured in preschool and brain structure in childhood
  - Threat: associated with widespread decreases in cortical surface area across prefrontal cortex and other regions
  - Deprivation: associated with increased thickness in occipital cortex, insula, and cingulate



References

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