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Computational Neuroscience
100 billion neurons

40% gray matter - vision

HOW DOES THE HUMAN BRAIN LEARN TO SEE?

Why is this question important?
- understanding the mature system
- diagnosis + intervene disorders
- machine vision

Approach 1: Studies w/ Infants
Strength: very direct
Constraints: Infants lack comprehension + wakefulness

Approach 2: Adults + Novel Inputs
Strength: Adult comprehension
Constraints: Prior visual experience confounds results

Complementary Approach
Studies w/ children who have sight onset late in life

- children who've been allowed to remain blind for several years even though their disease is treatable.
Less than 20 cases in last 1000 years: virtually non-existent in US/EU.
1 in 100 Indians are blind

Causes of Childhood Blindness:

- Corneal scarring
- Cataracts
- Congenital anomalies like microphthalmos
- Retinal dystrophies
- Optic Atrophy
- Traditional "Remedies"

Nearly 60% are treatable/preventable
<20% actually treated

Project Prakash ("light") - Humanitarian side

Treat blind children, spread treatment awareness in India

have "eye camp" things, where ophthalmologists go to rural villages + screen blind children. Those with residual vision (like ability to see light) are most treatable + studyable.

Bring them to one of their hospitals - treat them.

Scientific Goal

- Pre-Operational Screening
- Treatment
- Study

- week 1 - Acuity 6/36
Motion Sensitivity
- week 2 - Acuity 6/30
Motion Sens.
Shape Matching
- week 3 - Acuity 6/30
Motion
Shape
Color Naming
- week 4 - Acuity 6/24
Motion
Shape
Color
Face detection
- week 40 - Acuity 6/24
Mot.
Sh.
Col.
Face
Object Recognition

It used to be believed that if the brain weren't introduced to visual stimulus in the first months/years, it couldn't develop (raise kitten in dark box). This has been shown false.

Molyneux's letter to Locke:

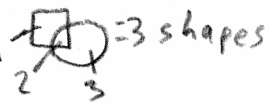
Blind guy can feel the difference between a cube and sphere. If he gains sight, and you show him both, can he tell which is which?

We haven't ever had a chance to answer til now. The answer is no. Not immediately. But within a week, they've learned.

How do we integrate data into distinct regions?

Varying levels of brightness that we can separate into distinct objects.

Newly sighted children/people 4 weeks after treatment, recognize individual shapes, but not overlapping.



Can't recognize pictures of objects easily, because their shadows or bright spots look like separate objects.

If you move the object (A, A') with respect to its background, they can then recognize it as a whole, individual shape/image.

SK was tested on a bunch of pictures of objects. Almost all he recognized were things that moved. Almost all the things that moved, he recognized.

1. Early steps of sight acquisition are accompanied by integrative difficulties

2. Integrative impairments compromise

3. Motion

Given several months, they learn to recognize overlapping shapes + other stuff mentioned.

Infant studies show that motion helps group near regions into single object.

Motion might serve as a key bootstrapping cue for early visual learning

The brain maintains its plasticity for visual learning well into adulthood

"Dylan"
Dynamic learning? (I think...)
Computational model of visual learning

