

Q355: Neural networks and the Brain

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Week 4: unsupervised learning

Neural plasticity

- Forbes: “With recent neuroscientific findings, meditation as a practice has been shown to literally rewire brain circuits that boost both mind and body health. These benefits of meditation have surfaced alongside the revelation that the brain can be deeply transformed through experience – [a quality known as “neuroplasticity”](#)....eliciting the body’s relaxation response could even affect our genes – in just minutes. They found that meditating (even just once) could dampen the genes involved in the inflammatory response, and promote those genes associated with DNA stability (hello longevity!) Other short-term benefits include reducing [stress](#) and [blood pressure](#) and [improving attention](#). It may even help us [make smarter choices](#).”
- Really? What is this magic neuroplasticity?

Neural plasticity

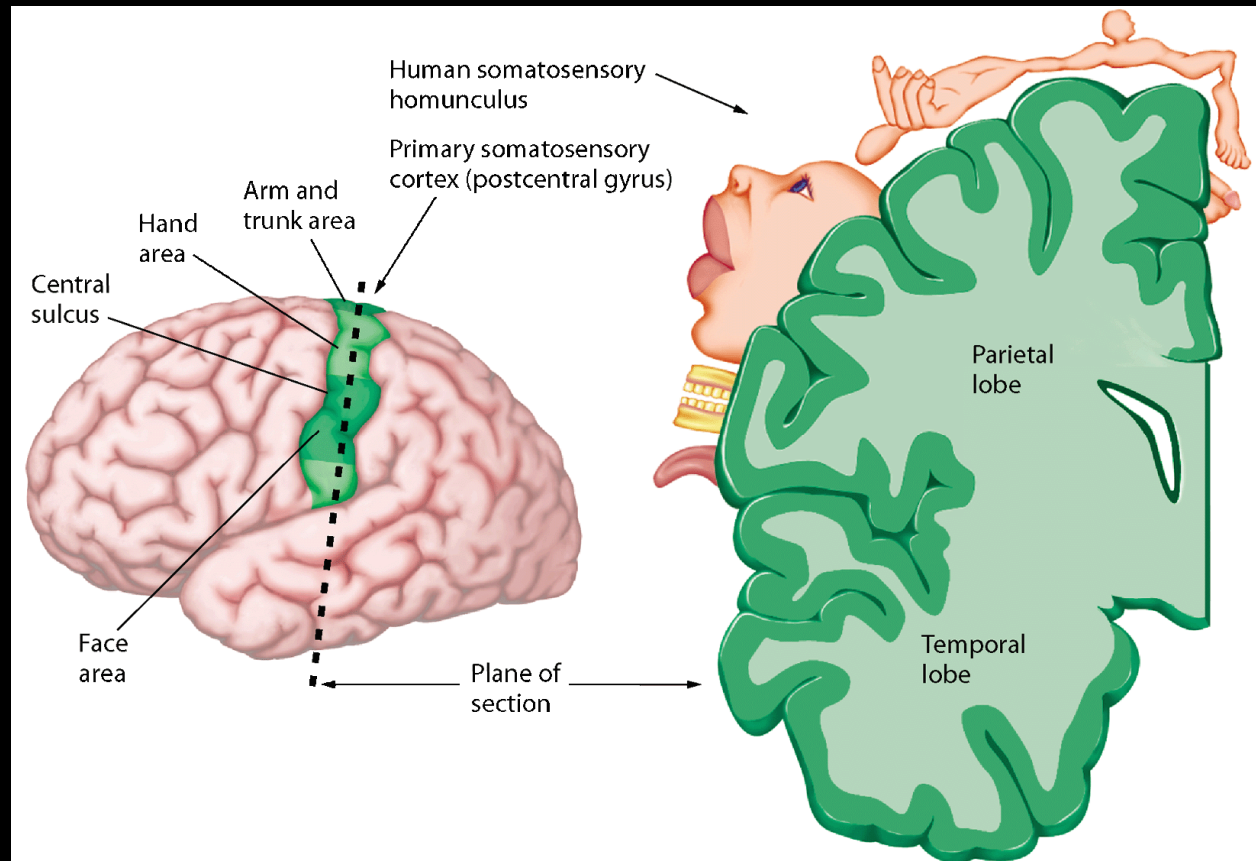
- The brain is remarkably good at rewiring itself, though there are limits
 - Stroke damage
 - Amputation
 - Experience
- How does this rewiring work?
- What is the relationship among neural plasticity, neural computation, and unsupervised learning?

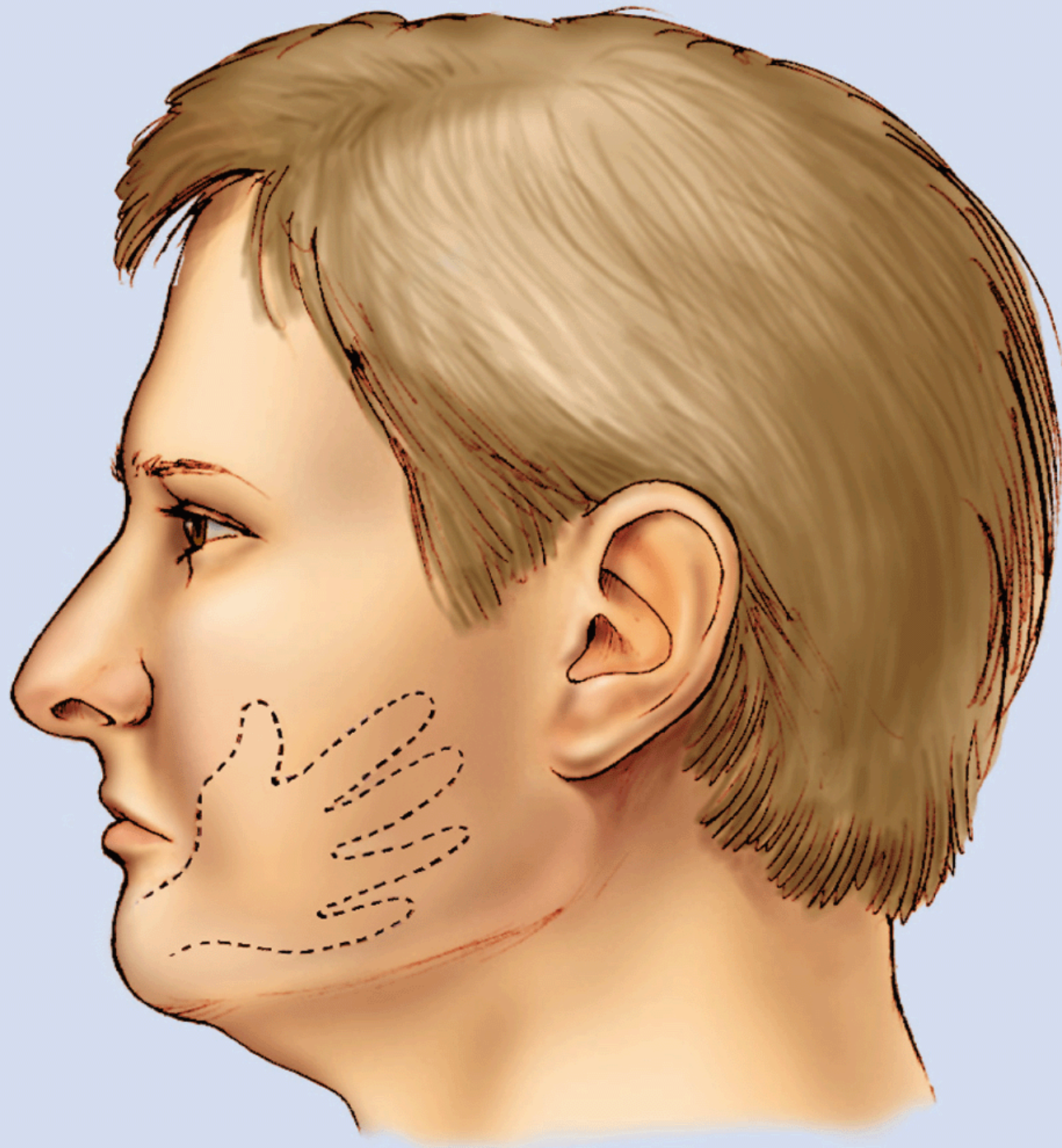


Amputee

The sensory homunculus -- plasticity

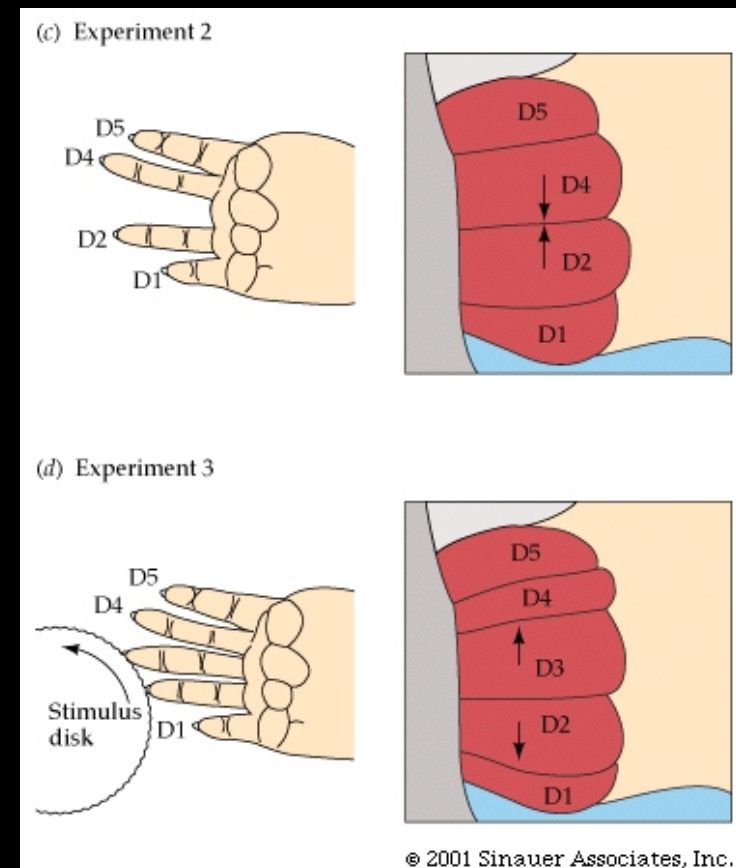
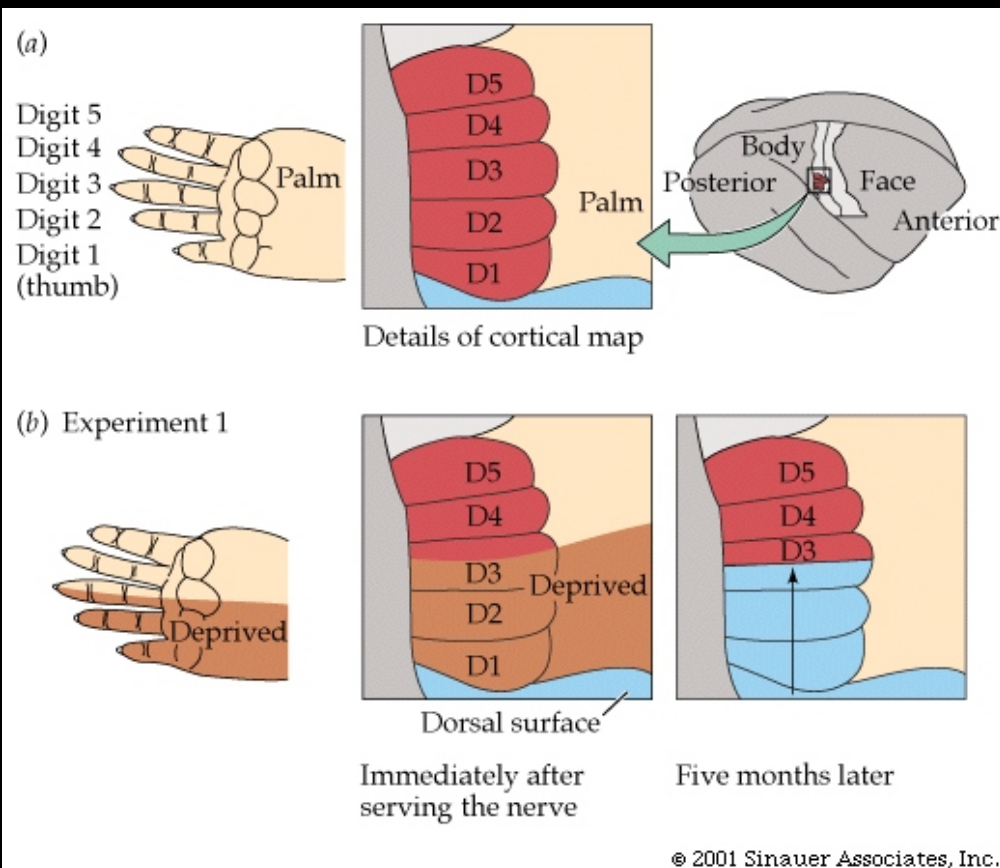
- The face representation is next to the hand representation in primary somatosensory cortex
- Amputation leads to a rewiring of the sensory cortex, so that unused representations become subsumed by their neighboring representations.
- In the case of the amputee, the face area took over representation from the now disused hand area, so that hand sensations could be evoked by touching the face



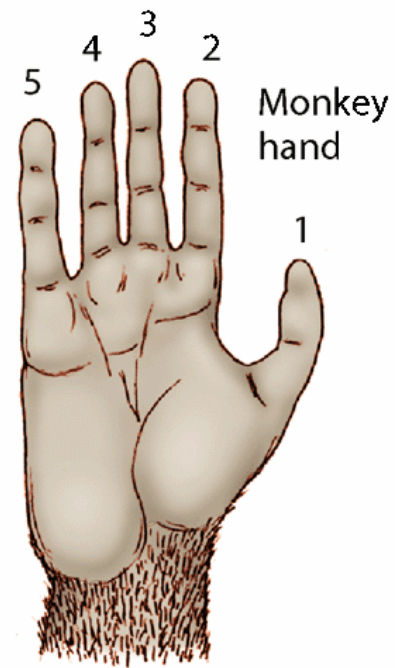
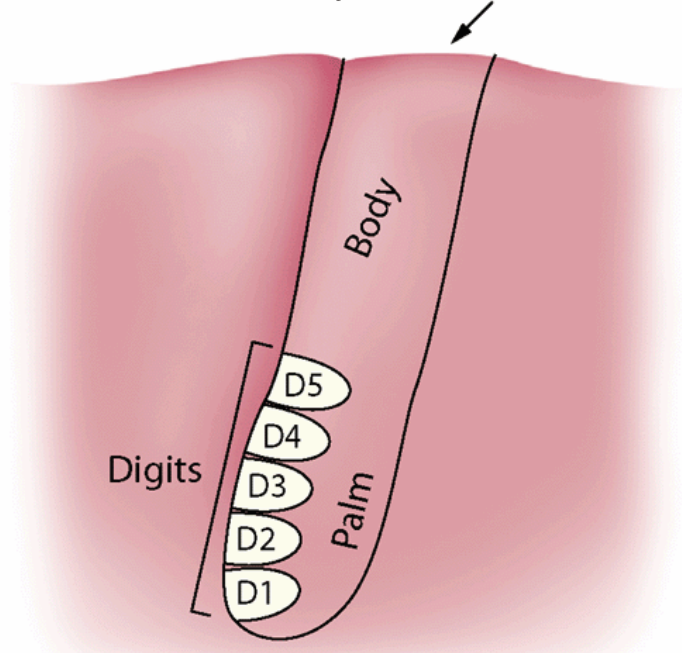


Plasticity in Cortical Maps

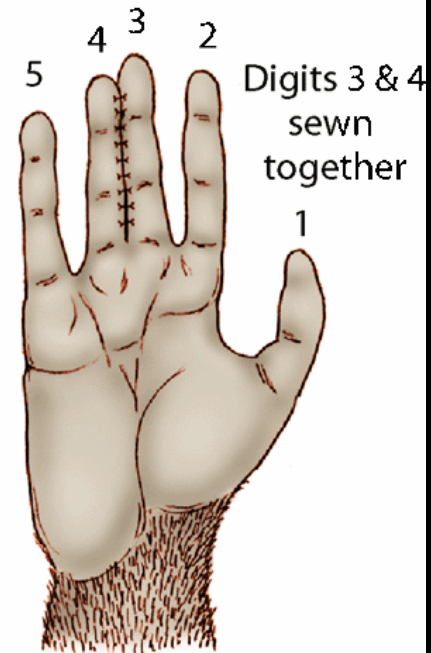
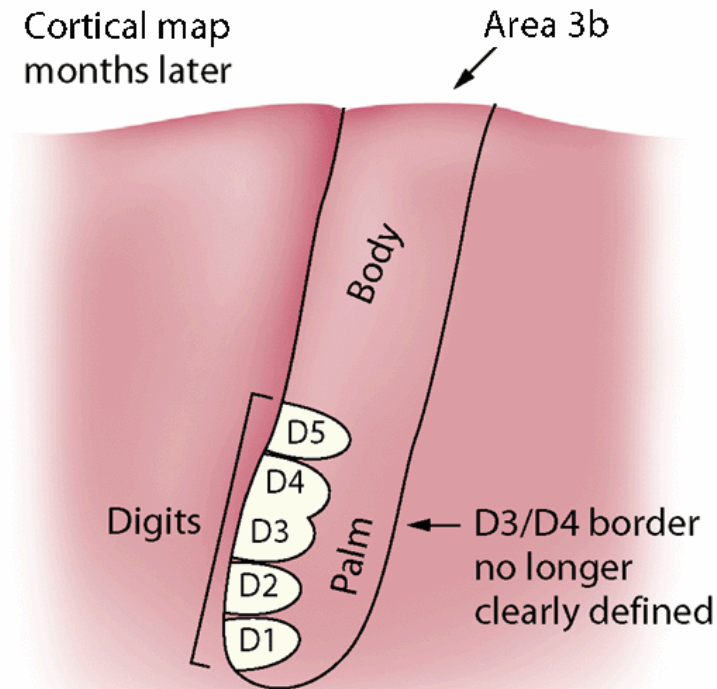
- Experiment with monkey: Initially, all 5 digits represented in cortex
- Experiment 1) If nerves cut, then 5 months later, blue dorsal surface representation expands to fill in inactive representation space.
- Experiment 2) If digit amputated, representations of nearby digits expand to take over unused cortical area
- Experiment 3) If digit overstimulated, representation area in cortex expands

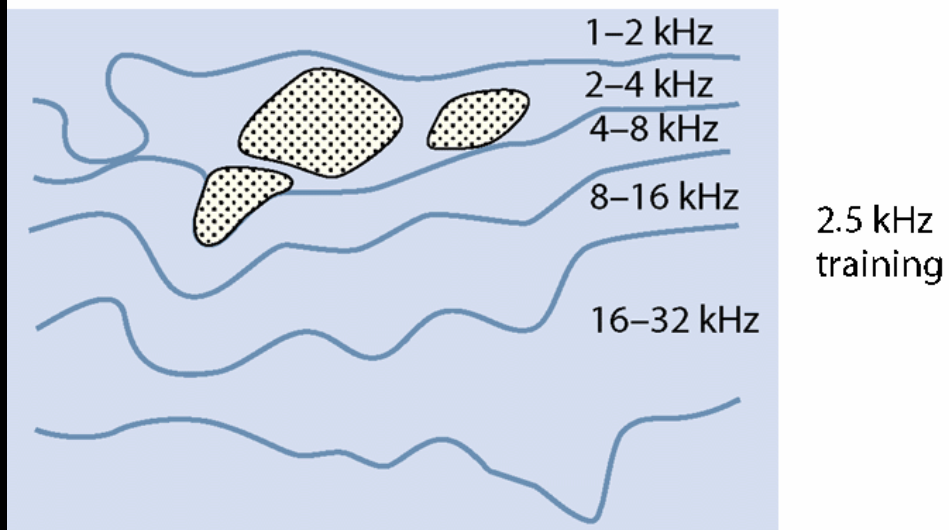
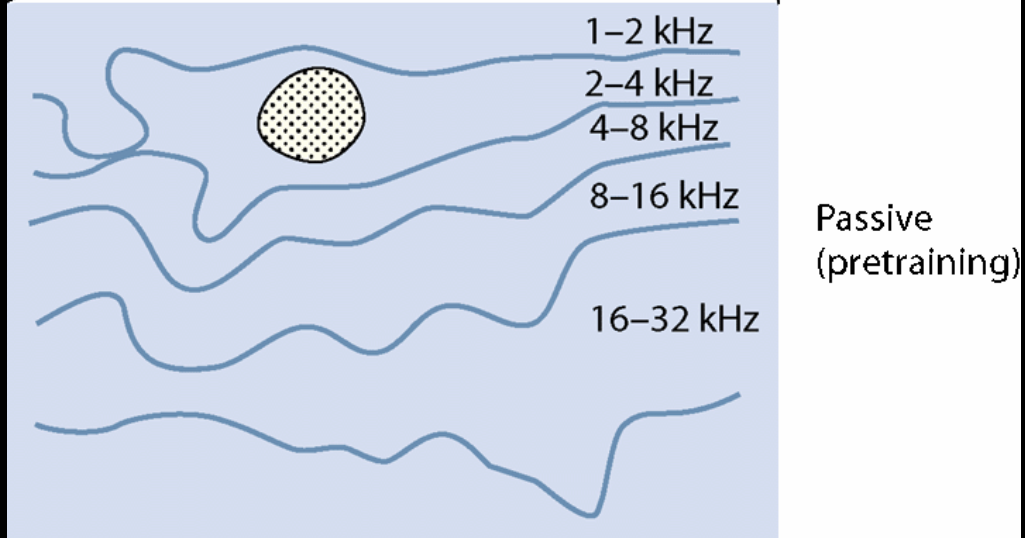
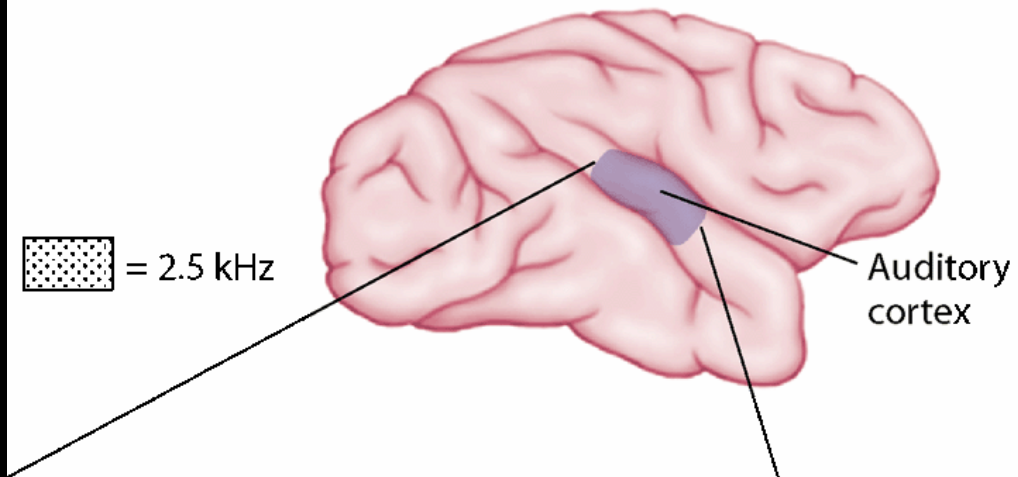


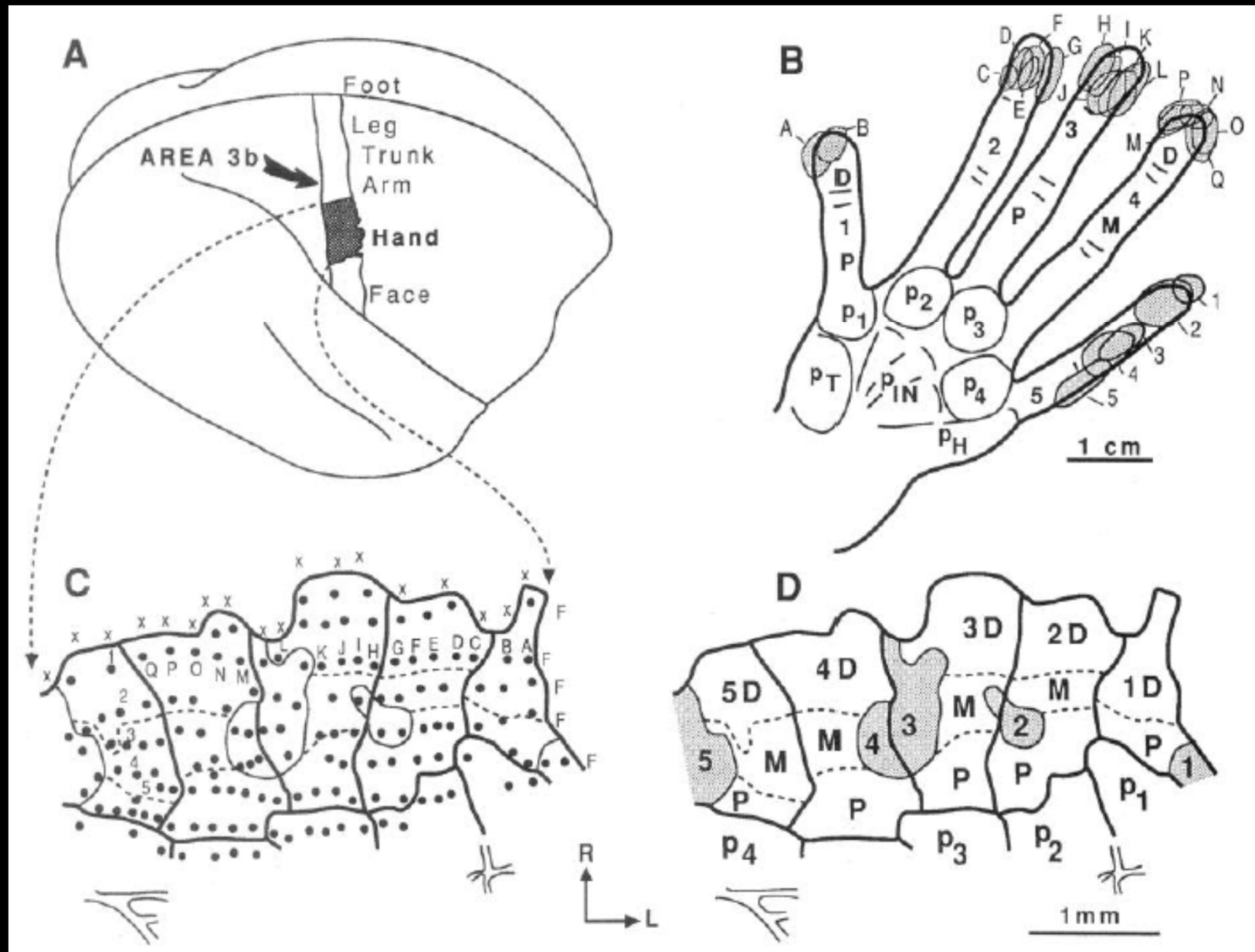
Normal cortical map



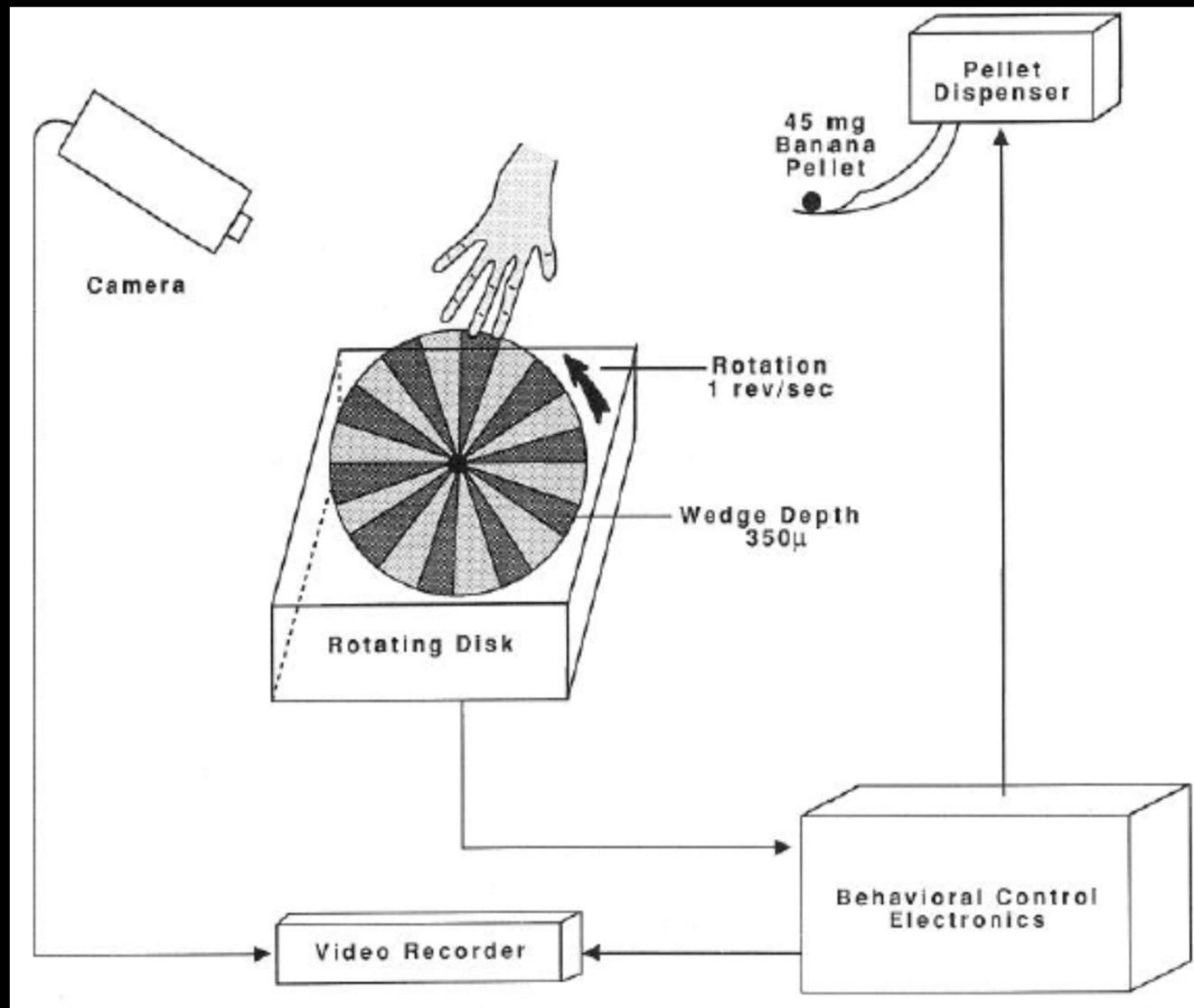
Cortical map months later



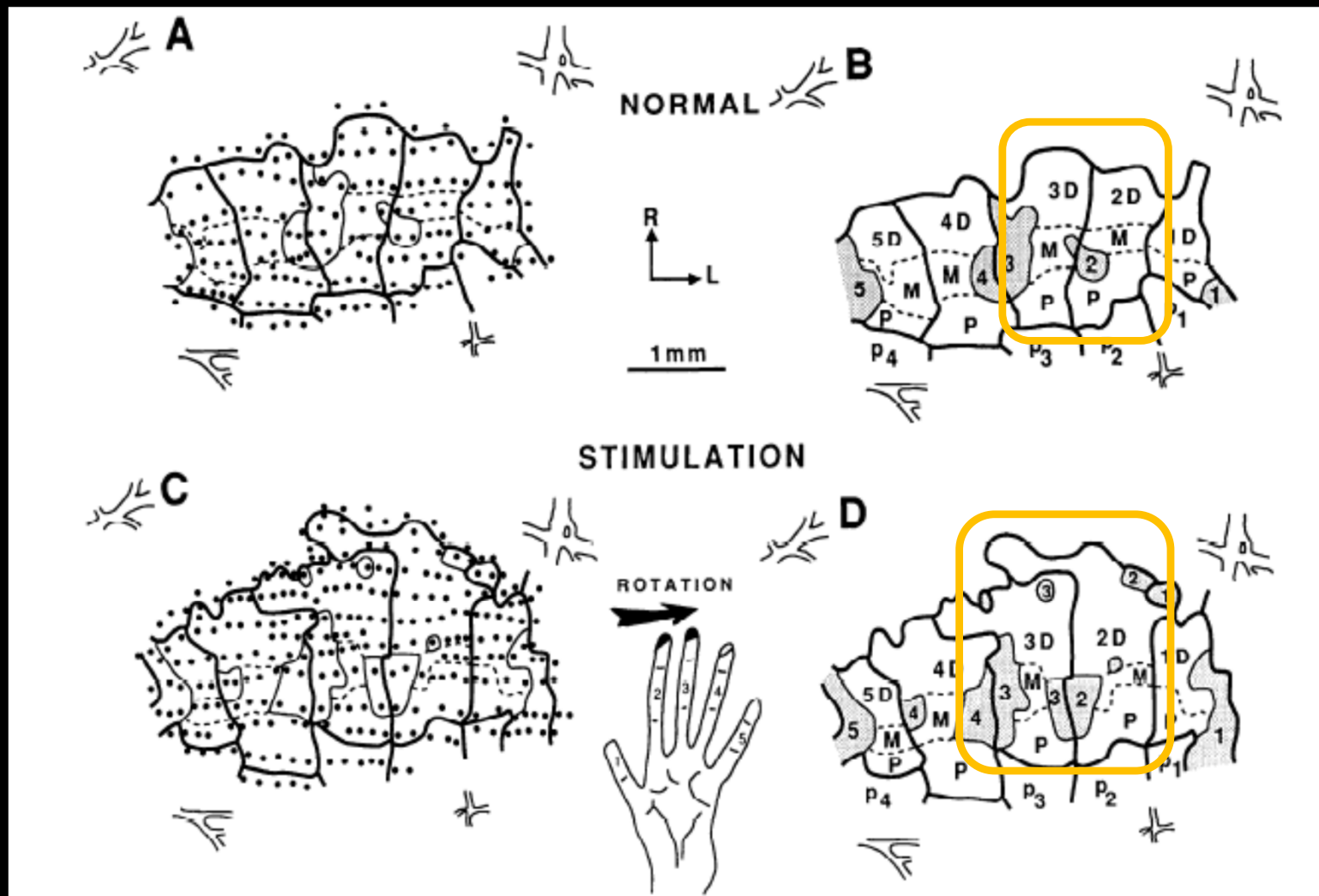




Mapping out cortical representation of hand in monkey



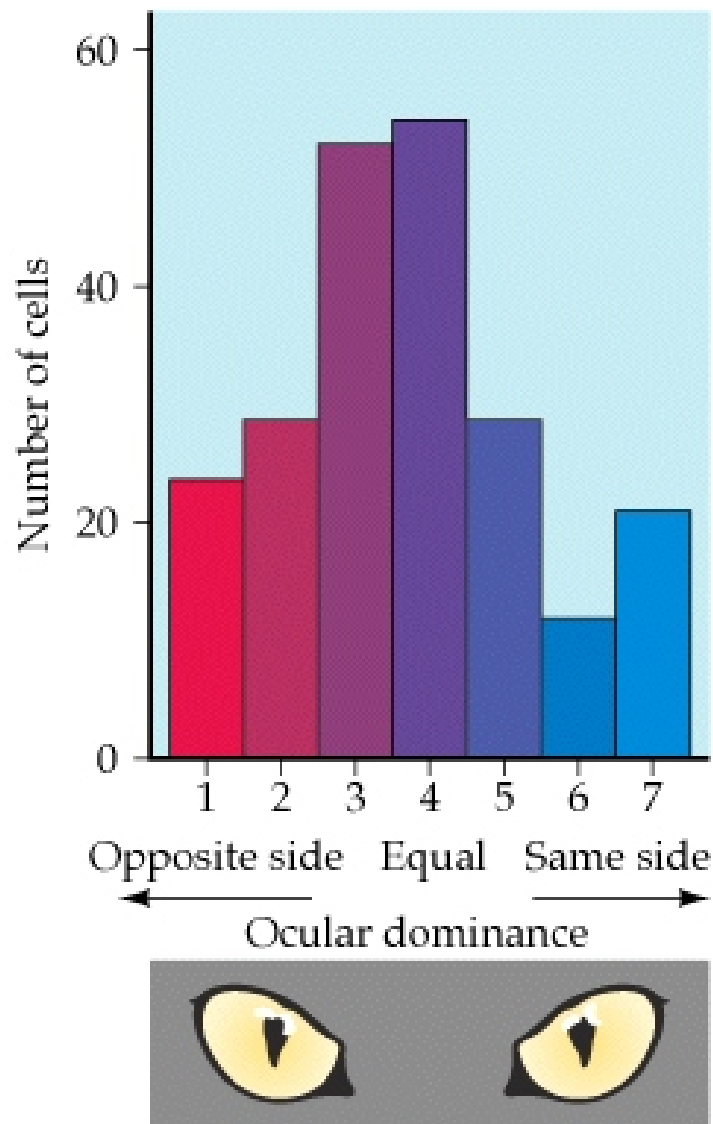
Hand stimulation as monkeys touch roughened, rotating disk



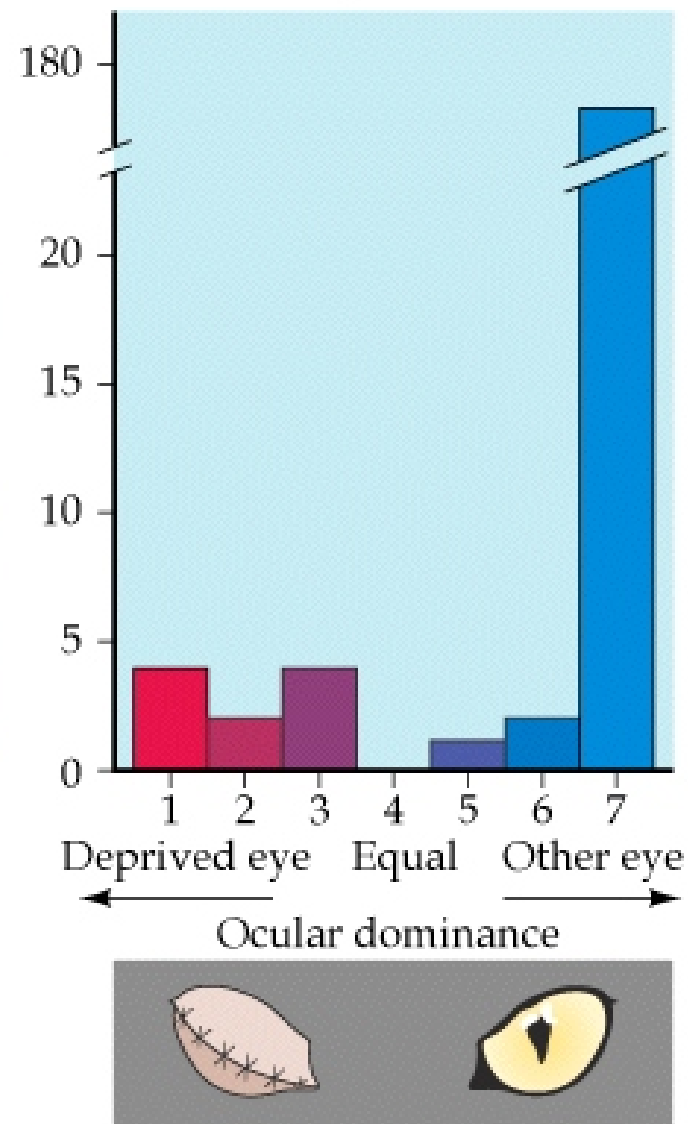
Expanded representation of digits 2 and 3 after stimulation

Plasticity -- Use it or Lose It

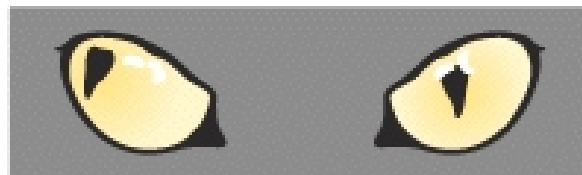
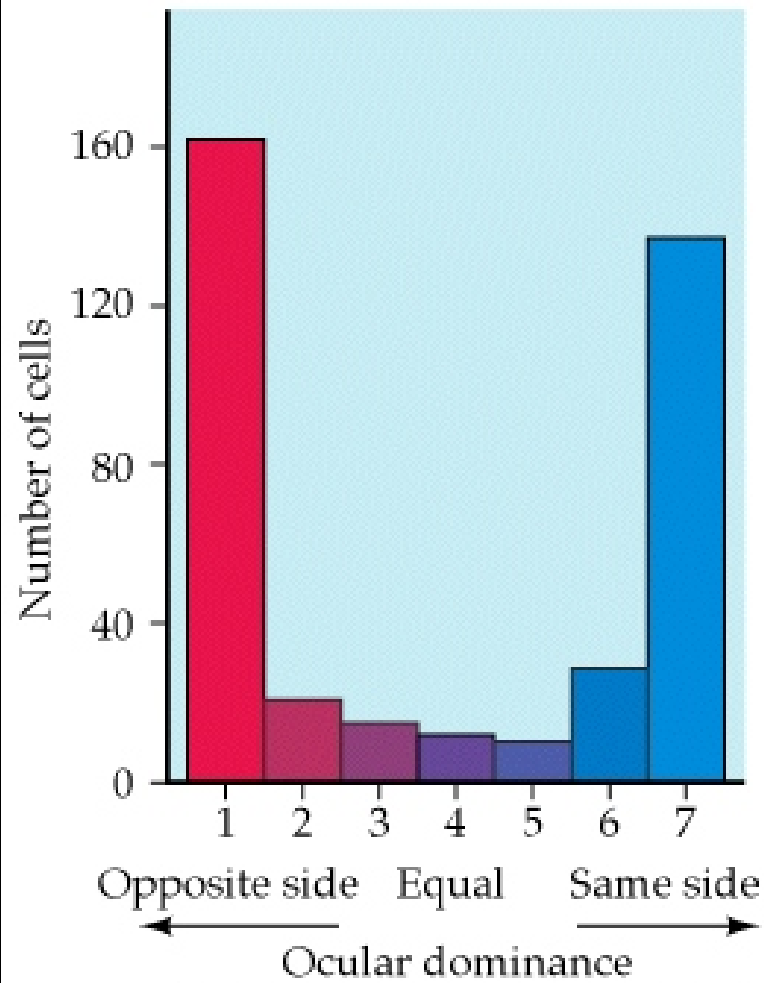
(a) Normal



(b) Monocular deprivation



(c) One eye deviated



(d) Binocular deprivation

