Reading list:
- Goldstein, Chps 4 & 5
- Amedi et al. (2001) *Nature Neuroscience*

Lecture overview

- Functional properties of V1
- Multisensory interactions in V1
- Modularity in higher visual areas
- Multisensory interactions in higher visual areas

1. Primary visual cortex
Organisational structure of V1
• Hubel & Wiesel (1981)

Edge detection in V1

• Ocular dominance columns

• Hypercolumns
  - location specific

2. Multisensory interactions in V1
• Cortical recruitment of V1 with sensory loss...
  – functional relevance to cortical plasticity in V1 with sensory loss
    • TMS studies

  – Perceptual benefits associated with cortical plasticity in V1
    • Task performance in blind versus sighted individuals

3. Modularity of human visual areas
Projections from midbrain to cortex

• Connections between visual areas in macaque
  – Felleman and van Essen (1991)

Role of V1 in higher level vision in humans
Destruction of V1 leads to cortical blindness

Some evidence of visual function but without awareness
   “blindsight”

Other functional routes to visual areas
   – Emotional faces can be discriminated without primary visual cortices
   – Amygdala activation
   • Pegna et al. (2005) Nature Neuroscience

Functional properties of higher visual areas
V3- dynamic form
V4 - colour perception
(damage to V4 results in achromatopsia)
V5/ MT - motion
(damage to MT results in motion agnosia)

Two visual pathways
Dorsal pathway
- Parietal cortex

Ventral pathway
- Inferotemporal cortex

Ungerleider and Mishkin, 1982
Goodale and Milner, 1995

Two visual pathways:
Recognition and Action pathways
Damage to inferotemporal lobe results in object agnosia and/or prosopagnosia
Damage to parietal lobe results in spatial deficits and prehension movements

Evidence for dissociation
- Patient DF
Milner and Goodale, 1995

Neural coding in Parietal Cortex: action
Area AIP
(anterior intraparietal area)
active during grasping of objects
Binkofski et al. (1998)
*Culham & Kanwisher, (2001)
Neural coding in dorsal pathway: motion
• Implied visual motion in static images activates area MT
  – Kourtzi & Kanwisher (2000)

Multisensory perception in area MT
– Implied motion in static images of objects previously learned through touch activates area MT
  – Learned moving object shapes
    • Haptic or visual
  – Tested on recognition of static visual images
    • MRI scanner

Area MT was activated to implied visual and haptic motion
Chan, J. et al. (2009)
- Area MT is multisensory

Neural selectivity in temporal cortex: objects and faces
Area called the lateral occipital cortex (LOC) active during visual object recognition
*Grill-Spector et al. (2001)

Human Fusiform Gyrus active for face recognition
Kanwisher et al., 1997

Face and object recognition visual areas
View-selective tuning for objects in IT neurons shaped by experience
Logothetis, Pauls and Sheinberg, 1995

View-selective tuning for faces in STS neurons
Perrett et al. 1992

4. Multisensory interactions in visual areas
• Activation in area LOC to visual and haptic recognition of familiar objects
  • Amedi et al. Nat Neuro 2001

• Auditory shapes activate area LOC
  • Amedi et al. Nat Neuro 2007

• Functional relevance?
  – Damage to occipital cortex results in impaired haptic object recognition
    • (Saetti et al. ’99)

Auditory object recognition
• The vOICe system
Recodes visual information in an image into sounds. Used for sensory substitution in persons who are blind.

**Visuo-tactile interactions in face recognition**

- Visual self-recognition compared to haptic self-recognition
- Poor haptic recognition relative to visual recognition
- Improved haptic recognition with haptic pre-exposure to own face
  - Casey & Newell, EBR 2005

**Multisensory enhancement in perception**

- Vision and touch use similar processes for object recognition
  - Both viewpoint dependent
  - Vision recognizes front views of objects best whereas haptics recognizes back views of objects best.
  - Both systems may complement each other for object recognition

**Multisensory enhancement in perception**

Benefit for multisensory vs. uni-modal learning on object recognition

Ernst & Newell, 2008

4. **Multisensory interactions in face areas**

- Learned associations between faces and voices
  - Facilitates voice recognition
  - Activates FFA
  - (von Kriegstein et al. JoCN, '05)

- Functional associations
  - Prosopagnosic SO
    - Poor at familiar voice recognition
    - Reduced activation in FFA
    - Normal crossmodal activations in FFA
    - Normal crossmodal activations with voice regions
  - Cross-sensory binding not dependent on top-down influences
    - (von Kriegstein et al. Cerebral Cortex, 2006)

**Audio-visual interactions in face recognition**

- Distinctiveness effects in one modality affect perception in another

**Summary**

Visual brain thought to be both functionally and structurally modular

- Different functional properties of visual areas
- Two parallel pathways from primary visual cortex
  - Recognition and spatial pathways

Dorsal pathway
  - Evidence for multisensory interactions in motion areas

Ventral pathway
Evidence for multisensory interactions in object and face areas

Evidence for modularity of visual areas breaking down - these areas are now seen are more multisensory than visual