University of BRISTOL

PSYC10009: Biological Psychology

Vision

Susanne Quadflieg
s.quadflieg@bristol.ac.uk
4D3

From Early Vision To Social Vision In 3 Lessons

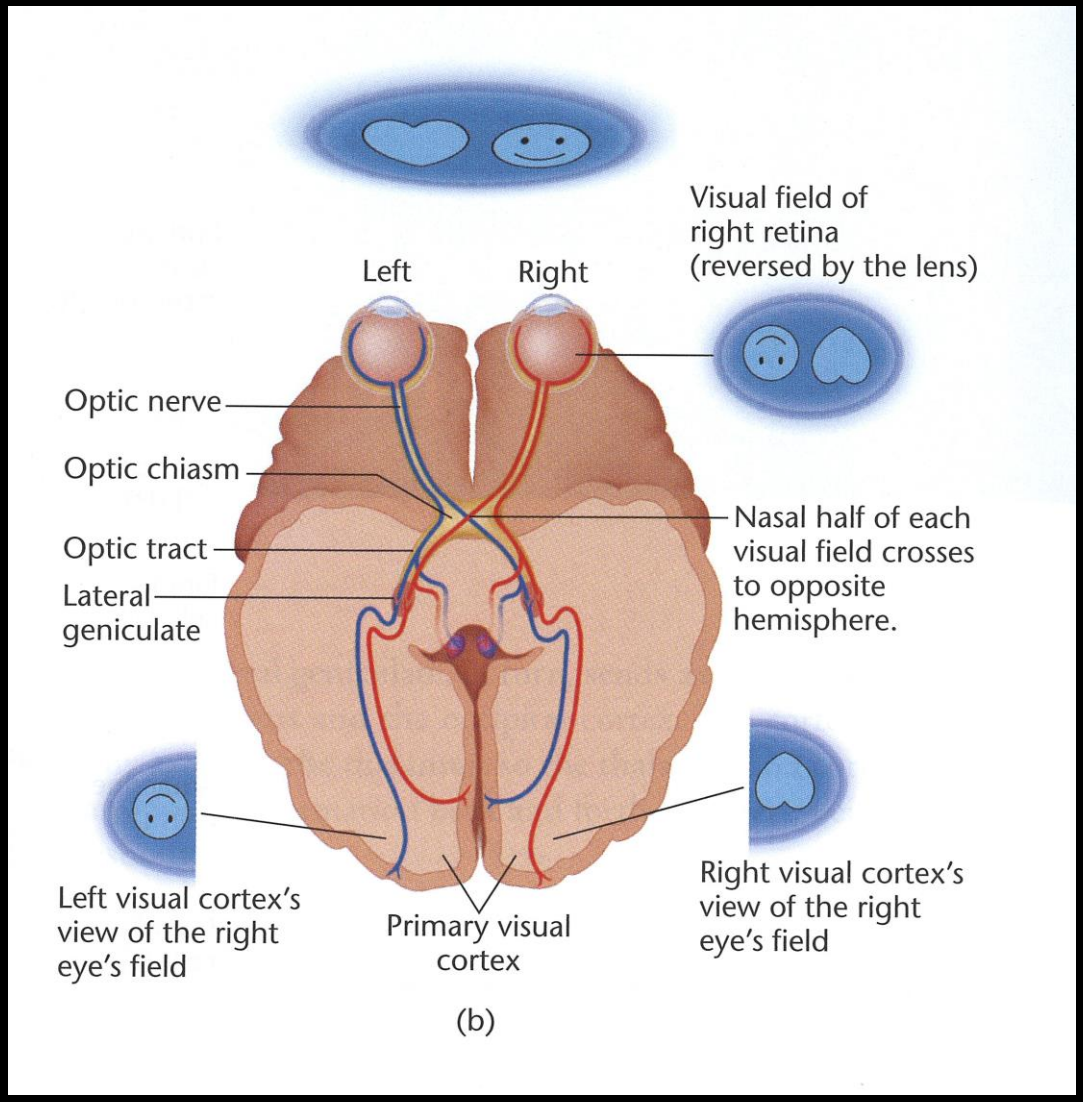
- Lecture 1: Early Vision
  - Retinal processing
  - Early cortical visual processing
- Lecture 2: Higher-Level Vision
  - Beyond V1: colour, motion, form, objects
  - Feature binding
- Lecture 3: Social Vision
  - Perceiving People
  - Perceiving Minds

Relevant Readings

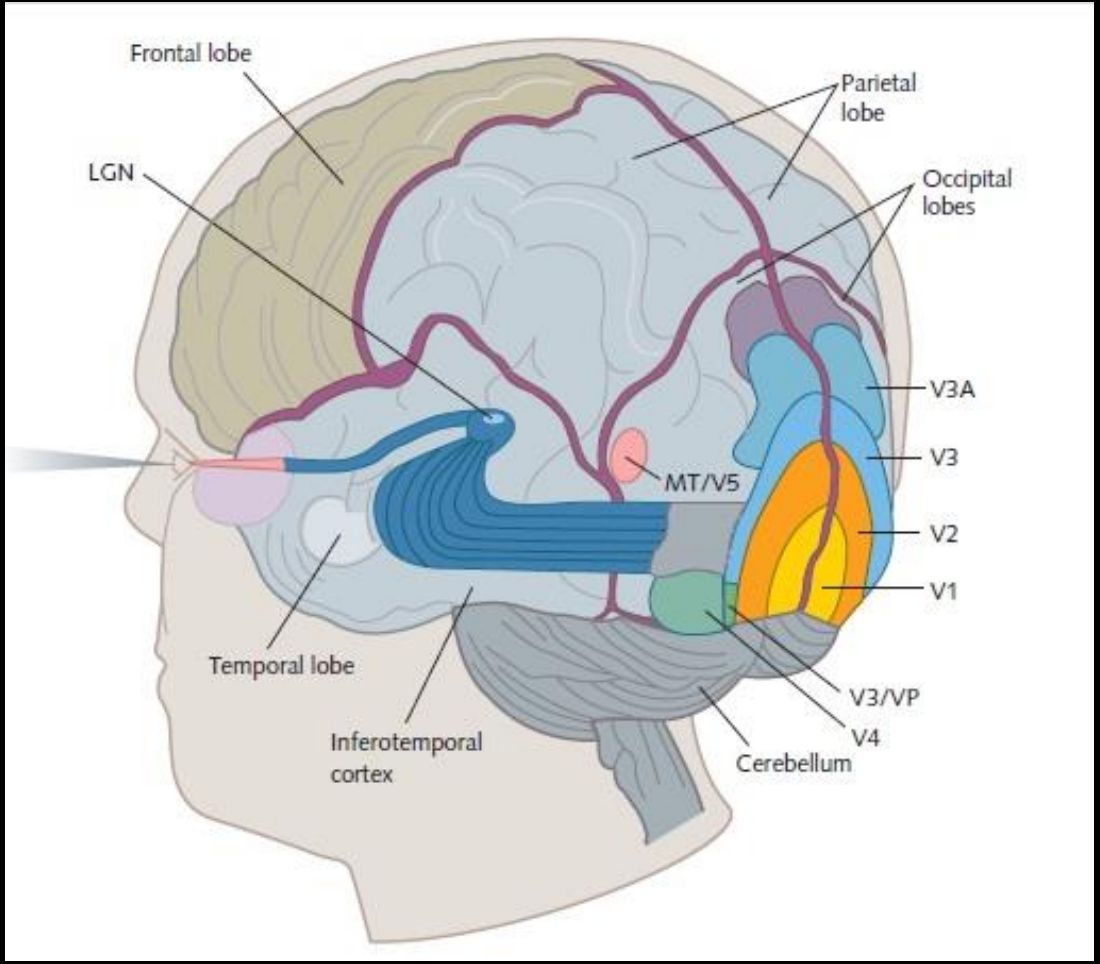
Schacter, D., Gilbert, D, & Wegner, D. (2012). Psychology. New York: Palgrave MacMillan. (Chapter 4, pp. 130 – 147)

Kalat, J. W. (2013). Biological Psychology. Wadsworth Cengage Learning. (Chapter 6, pp. 151 – 187).

Last Session: From The Retina To V1



Beyond V1: Visual Association Cortices



From V1 to V2 and V3

- V1 has reciprocal connections with secondary visual cortex (V2), V2 has reciprocal connections with V3
- in V2 and V3 contain many complex and hypercomplex cells, but also cells that respond to even more complex patterns (e.g., circles, lines that meet at a right angle etc.)
- from V2/3 visual information passed on to several regions across the occipital cortex
- visual properties such as color, shape, motion, location processed in different brain regions

V4: Colour Processing

- important for color processing
- damage results in ‘cerebral achromatopsia’:
- patients have intact colour naming from memory but impaired colour naming for objects in environment
- patients describe their surroundings as being darkly coloured, as in an unlit room at twilight
- intact shape and motion processing and intact achromatic discrimination (i.e., different grey levels)

V4: Remember The Color Constancy Challenge?

- apparent color of object does not only depend on the light it reflects but also on how it compares to objects around it
- responses of cells in V4 correspond to the apparent/perceived colour of an object

V5 (MT): Motion Processing

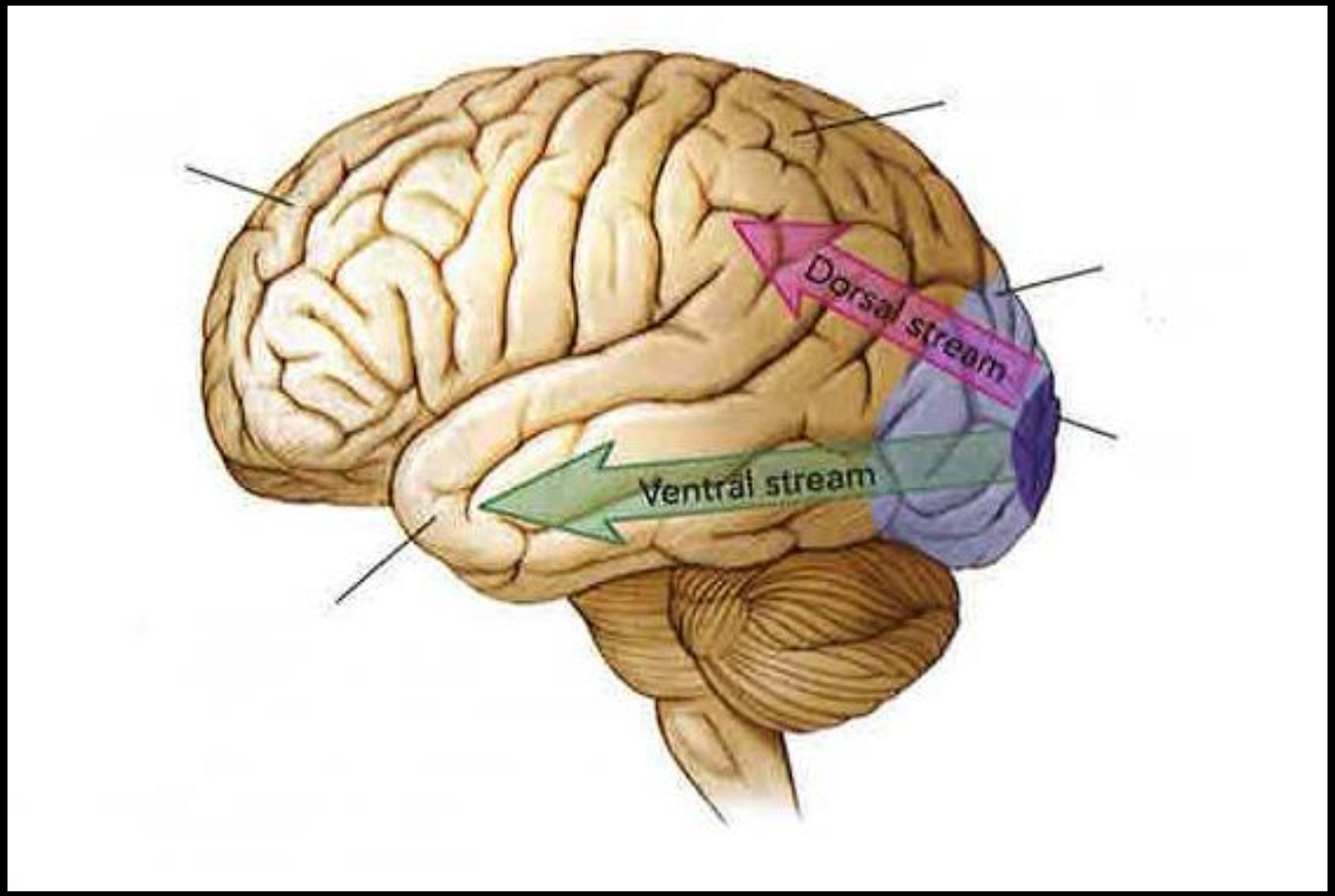
- **damage results in 'cerebral akinetopsia':**

The visual disorder complained of by the patient was a loss of movement vision in all three dimensions. She had difficulty, for example, in pouring tea or coffee into a cup because the fluid appeared to be frozen, like a glacier. In addition, she could not stop pouring at the right time since she was unable to perceive the movement in the cup (or a pot) when the fluid rose. Furthermore the patient complained of difficulties in following a dialogue because she could not see the movements of the face and, especially, the mouth of the speaker."
(Zihl et al., 1983, *Brain*)

V5: Illustration Motion Blindness

https://www.youtube.com/watch?v=tYFhDzQ1rYU

Processing Beyond The Visual Association Cortices



Two Major Visual Processing Streams

Processing along temporal cortex (ventral stream): WHAT pathway

Processing along parietal cortex (dorsal stream): WHERE/HOW pathway

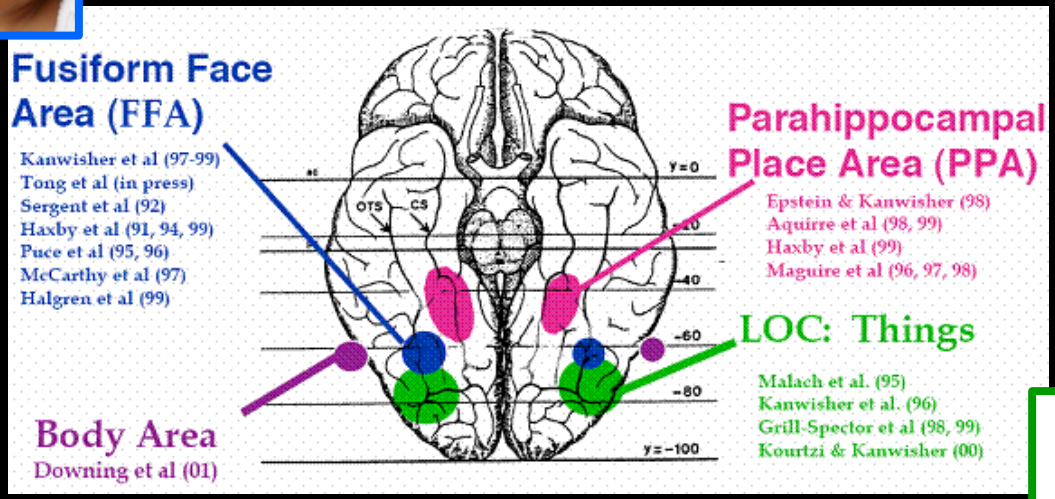
Pathways exchange information but it is currently poorly understood how.

The Ventral Processing Stream I

- detailed analysis of shape
- involved in identifying/recognizing objects
- cells in this processing stream respond to identifiable, familiar objects
- high-level, abstract representations: responses usually consistent regardless of object size, position, angle etc. (= view-independent)

The Ventral Processing Stream II

- some entities of particular importance => responsive cells bundled in certain locations (referred to as modules)



The Ventral Processing Stream III

- **damage in this processing stream leads to visual form agnosia** (i.e., inability to recognize objects by sight despite otherwise satisfactory vision)

https://www.youtube.com/watch?v=rwQpaHQ0hYw

- **not impaired: understanding where things are**
(i.e., people can go for walks without bumping into things, reach out and grab things, shake hands, show normal eye movements etc.)

The Dorsal Processing Stream I

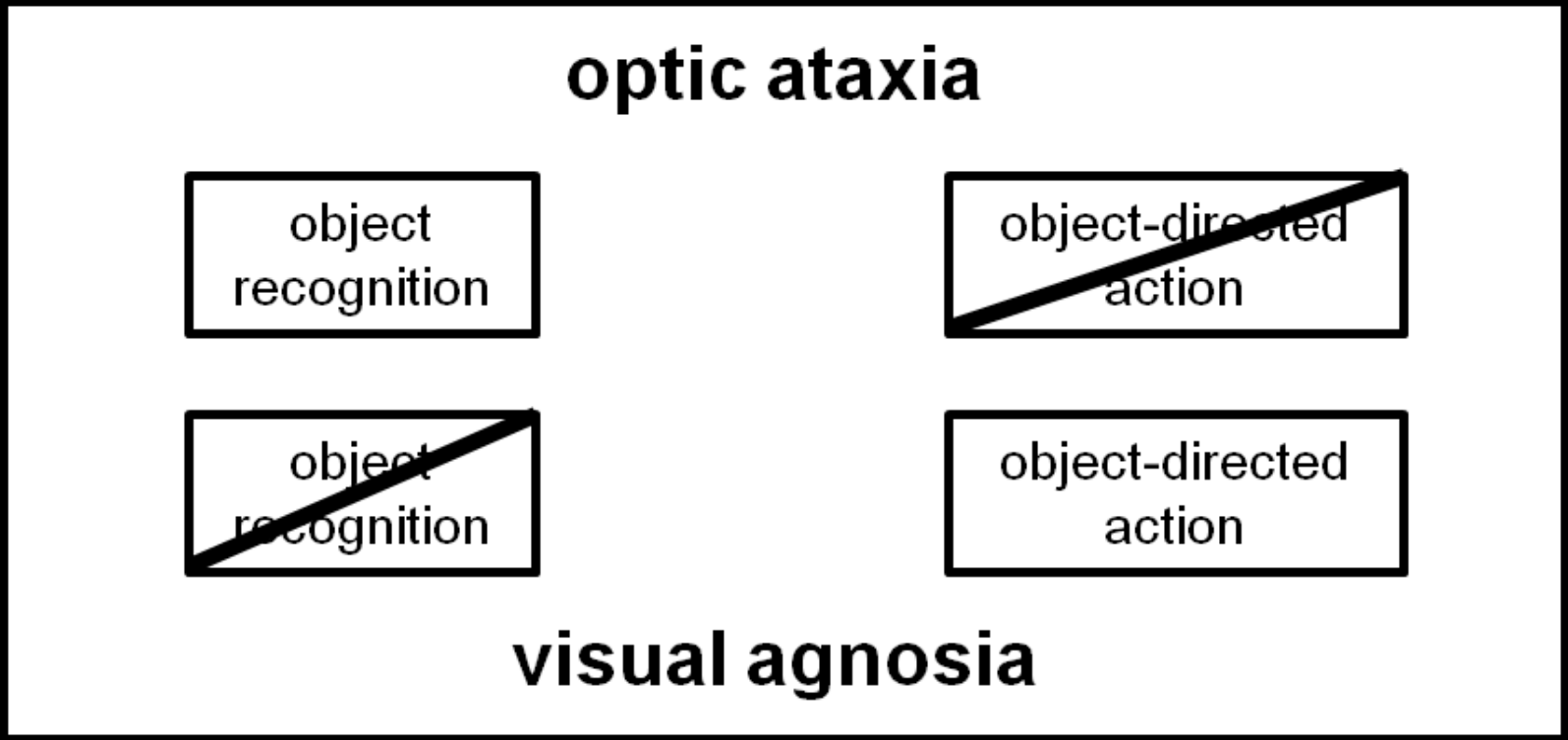
- detailed analysis of the location and motion of an object and spatial relations (WHERE)
- processing in this stream guides human movements such as aiming, reaching, tracking with the eyes, grabbing etc. (HOW)

The Dorsal Processing Stream II

- damage to this stream does not usually impair identification of objects
- but it does impair understanding where things are (i.e., issues to grab things, frequent collisions etc.)
- common consequences of superior parietal lobe damage:
- optic ataxia (i.e., inability to guide reaching movements using visual information) [no spatial localization problem per se: often performance with other limbs unimpaired]
- Balint's syndrome (i.e., optic ataxia, gaze shift impairments, simultanagnosia = inability to see more than one object at a time)

The Dorsal Processing Stream III

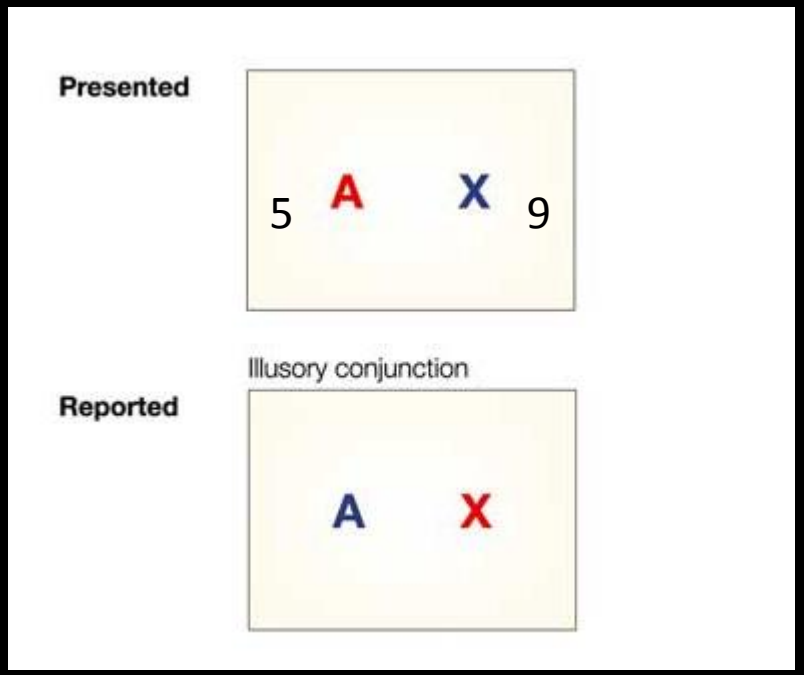
- ‘double dissociation’ suggests functional separation



The Binding Problem

- visual system processes different visual properties/features (e.g., colour, shape, motion, location) in different brain regions
- accurate perception requires putting the right features together
- “binding problem”: question of how various brain regions create a coherent/unified perceptual experience

Feature Binding Requires Attention



Treisman & Schmidt (1982) *Cognitive Psychology*

- **Primary Task: report black digits**
- **Secondary Task: describe coloured letters**
- **approx. 40% illusory conjunctions** (i.e., perceptual mistake where feature from multiple objects are incorrectly combined) **despite high confidence in accuracy**

Feature Integration Theory (Treisman et al., 1980, 1988)

- visual features initially processed separately and pre-attentively
- information gets forwarded to a "master map"
- attention on master map *binds* features

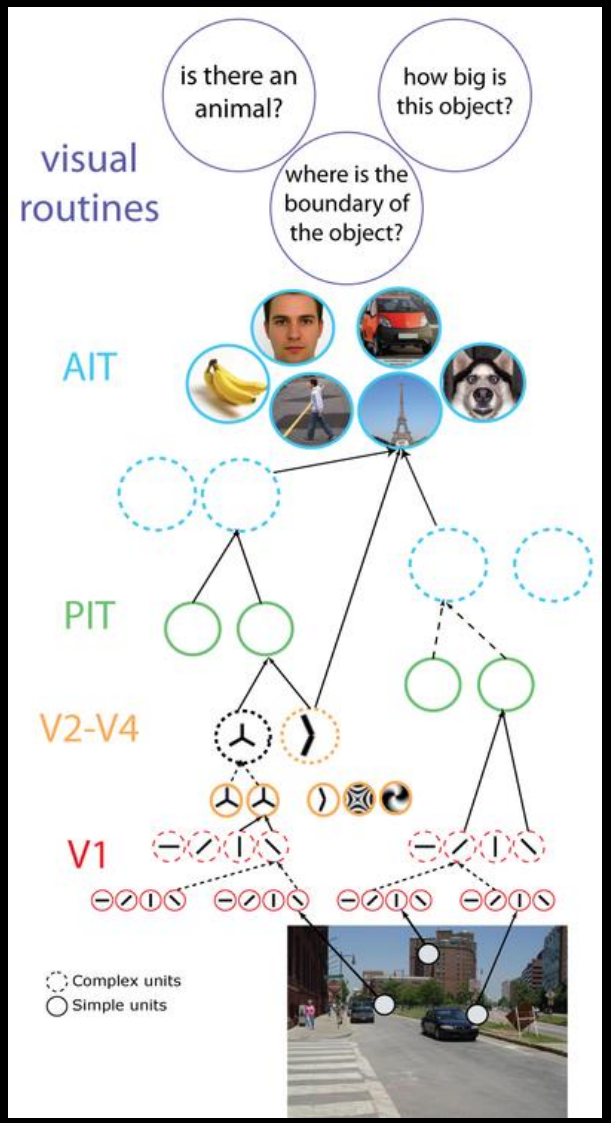
Summary I

- the further down in the visual processing stream cells are, the more they respond to increasingly complex visual properties
- different visual properties (e.g., colour, motion, shape, location) are processed in different brain areas
- 2 major processing streams (ventral vs. dorsal) with functional divergence: conscious object recognition vs. online visual control for object interaction
- this suggests separate 'visual' systems for perception and action

Summary II

- if properties are encoded in separate areas, they need to be bound together: ‘binding problem’
- attention may be the “glue” that is needed for unitary, conscious visual experience
- after localized brain damage, people may be able to process certain visual signals but not others

Summary III


is there an animal?
how big is this object?
where is the boundary of the object?
visual routines
AIT
PIT
V2-V4
V1
Complex units
Simple units
complexity

Example Exam Questions

A) Colors of the visible spectrum in order from shortest to longest wavelength are?

a. purple, blue, green, yellow, orange, red
b. red, orange, yellow, green, blue, purple
c. blue, green, purple, red, yellow, orange
d. orange, blue, green, red, purple, yellow

Example Exam Questions

B) Which of the following sequences correctly follows the visual pathway from the eye through the brain?

a. optic nerve, retina, lateral geniculate nucleus in the thalamus, area V1
b. pupil, lateral geniculate nucleus in the thalamus, retina, area V1
c. pupil, iris, retina, optic nerve, area V1
d. retina, optic nerve, lateral geniculate nucleus in the thalamus, area V1

Example Exam Questions

C) Color perception remains consistent even as aspects of sensory signals change. This principle is called:

a. Color Blindness
b. Visual Reliability
c. Color Constancy
d. Visual Acceptance
e. Magic