

511-2017-10-18-action-I

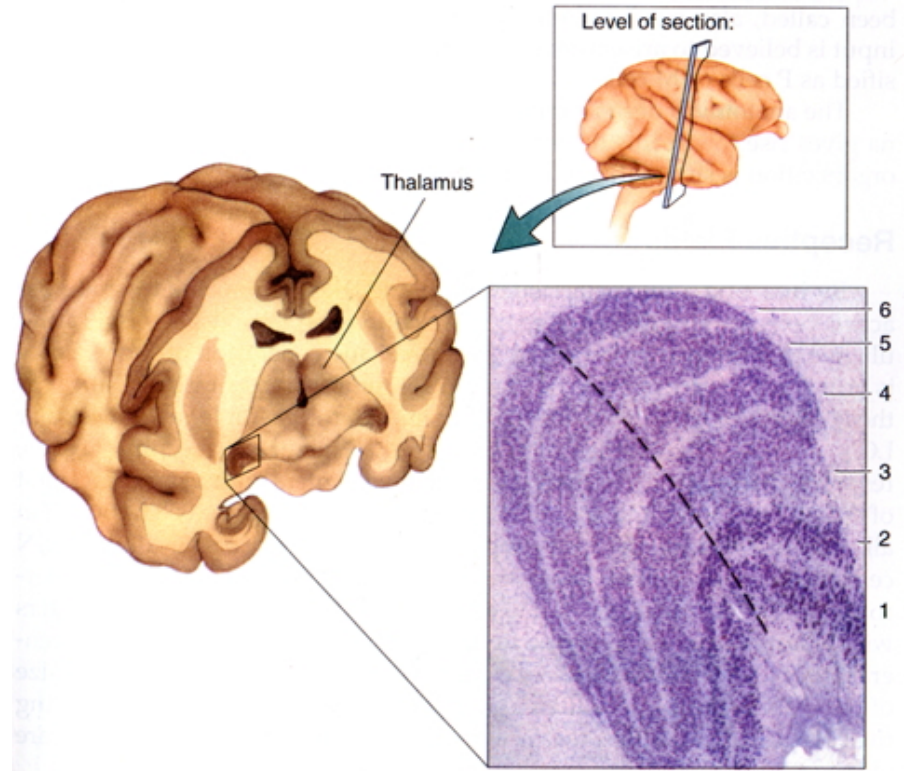
Rick Gilmore

2017-10-18 15:56:14

Today's Topics

- Quiz 2 available now; due by start of class on Wed, 10/25
- Wrap up on vision
- The neuroscience of action

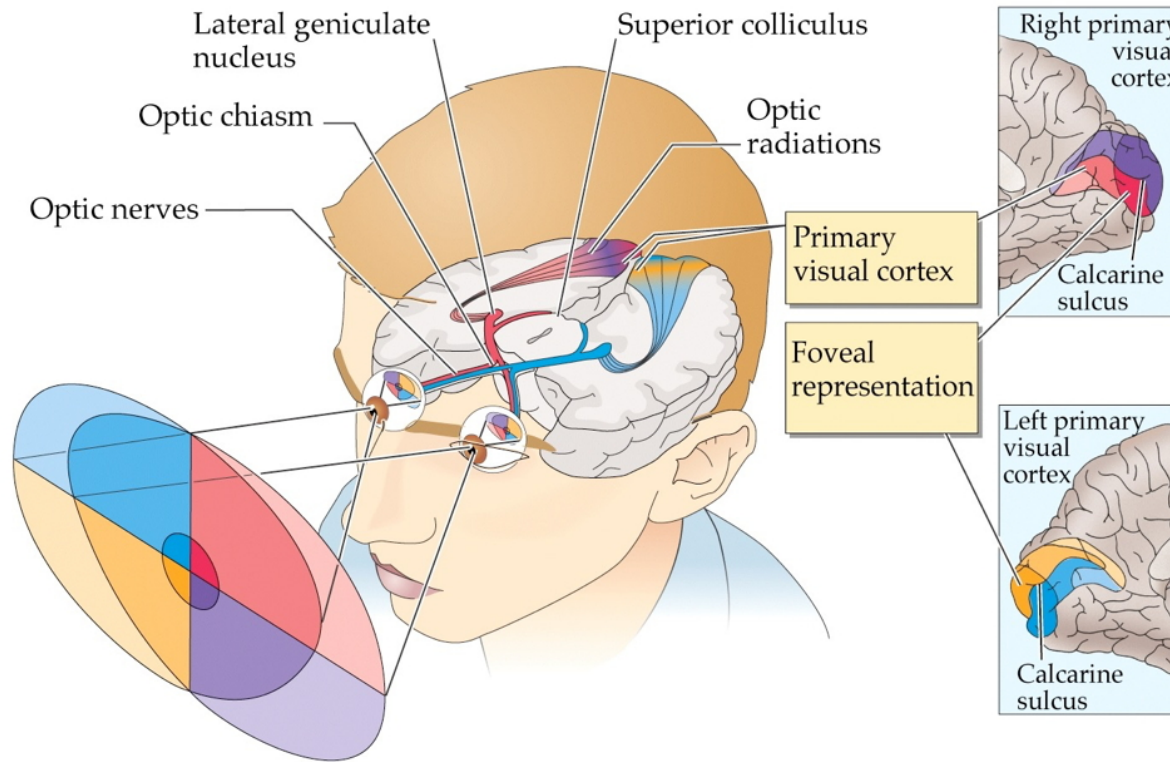
LGN



LGN

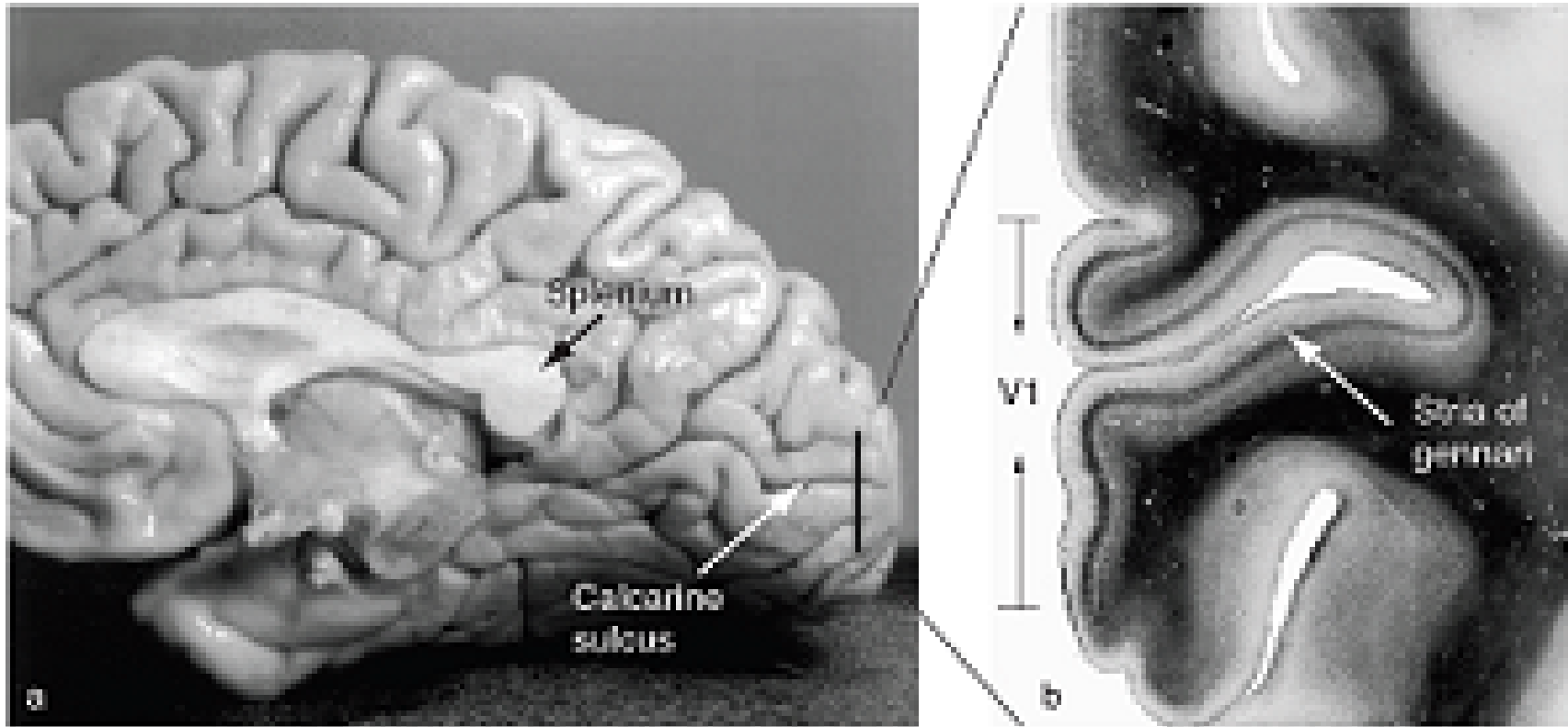
- 6 layers + intralaminar zone
 - Parvocellular (small cells): chromatic
 - Magnocellular (big cells): achromatic
 - Koniocellular (chromatic - short wavelength?)
- Retinotopic map of opposite visual field

From LGN to V1



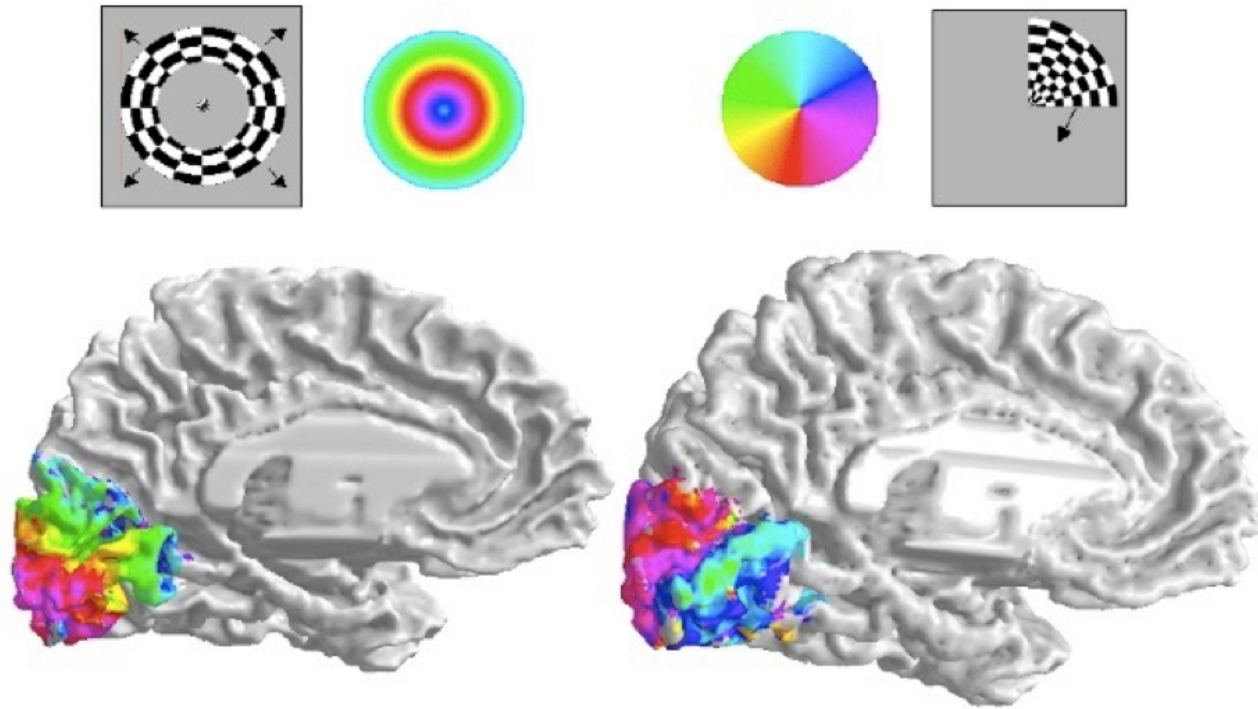
© 2001 Sinauer Associates, Inc.

Human V1



<http://www.scholarpedia.org/w/images/3/3a/03-Human-V1.png>

Measuring retinotopy in V1

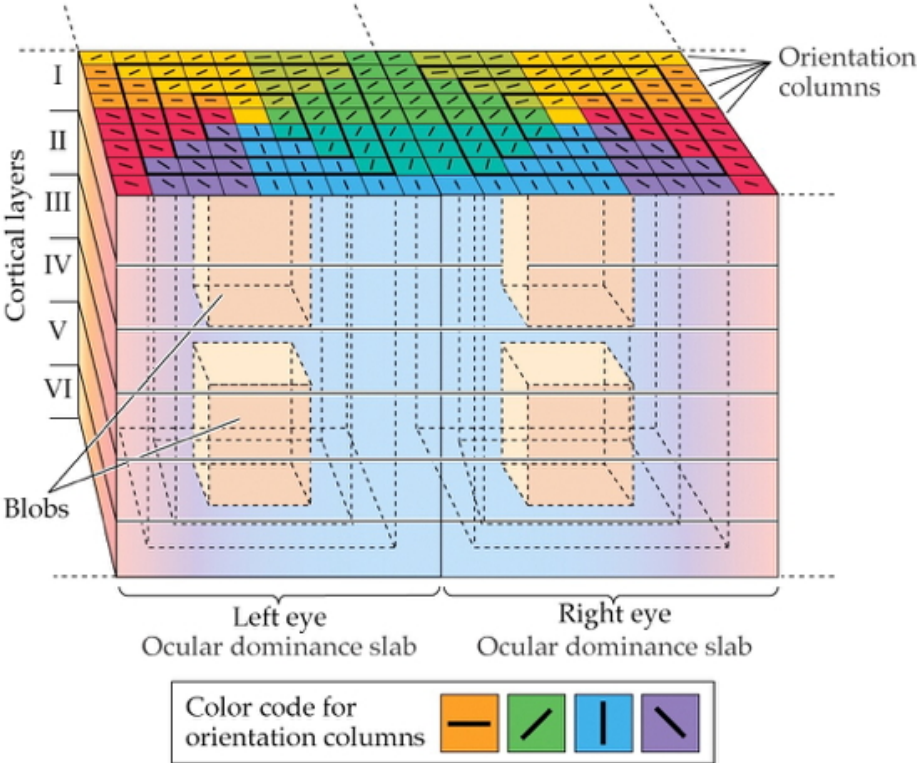


(Dougherty et al. 2003)

Retinotopy in V1

- Fovea overrepresented
 - Analogous to somatosensation
 - High acuity in fovea vs. lower outside it
- Upper visual field/lower (ventral) V1 and

V1 has laminar, columnar organization



© 2001 Sinauer Associates, Inc.

V1 has laminar, columnar organization

- 6 laminae (layers)
 - Input: Layer 4 (remember stria of Gennari?)
 - Output: Layers 2-3 (to cortex), 5 (to brainstem), 6 (to LGN)

V1 has laminar, columnar organization

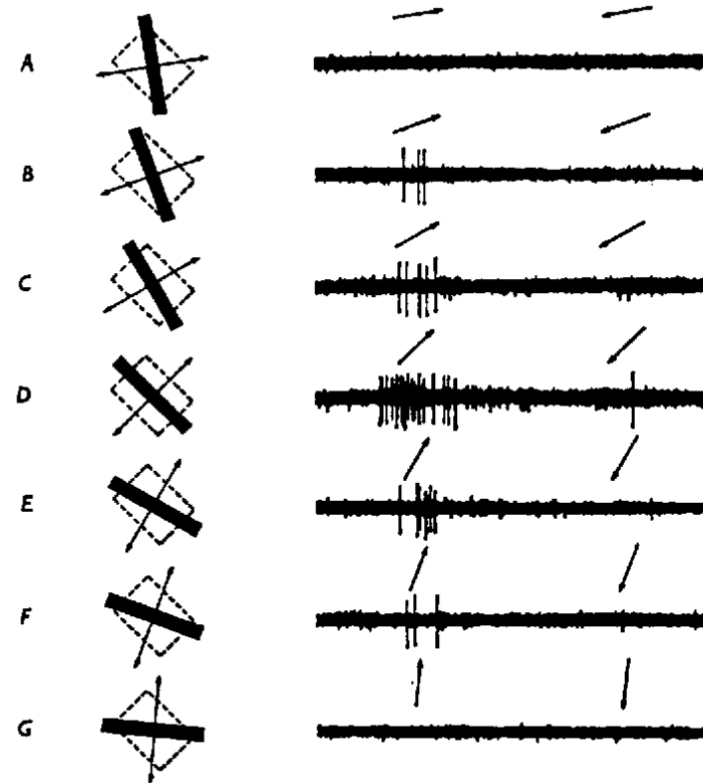
- Columns
 - Orientation/angle
 - Spatial frequency

The "accidental" discovery of oriented receptive fields in V1

Hubel and Wiesel Cat Experiment

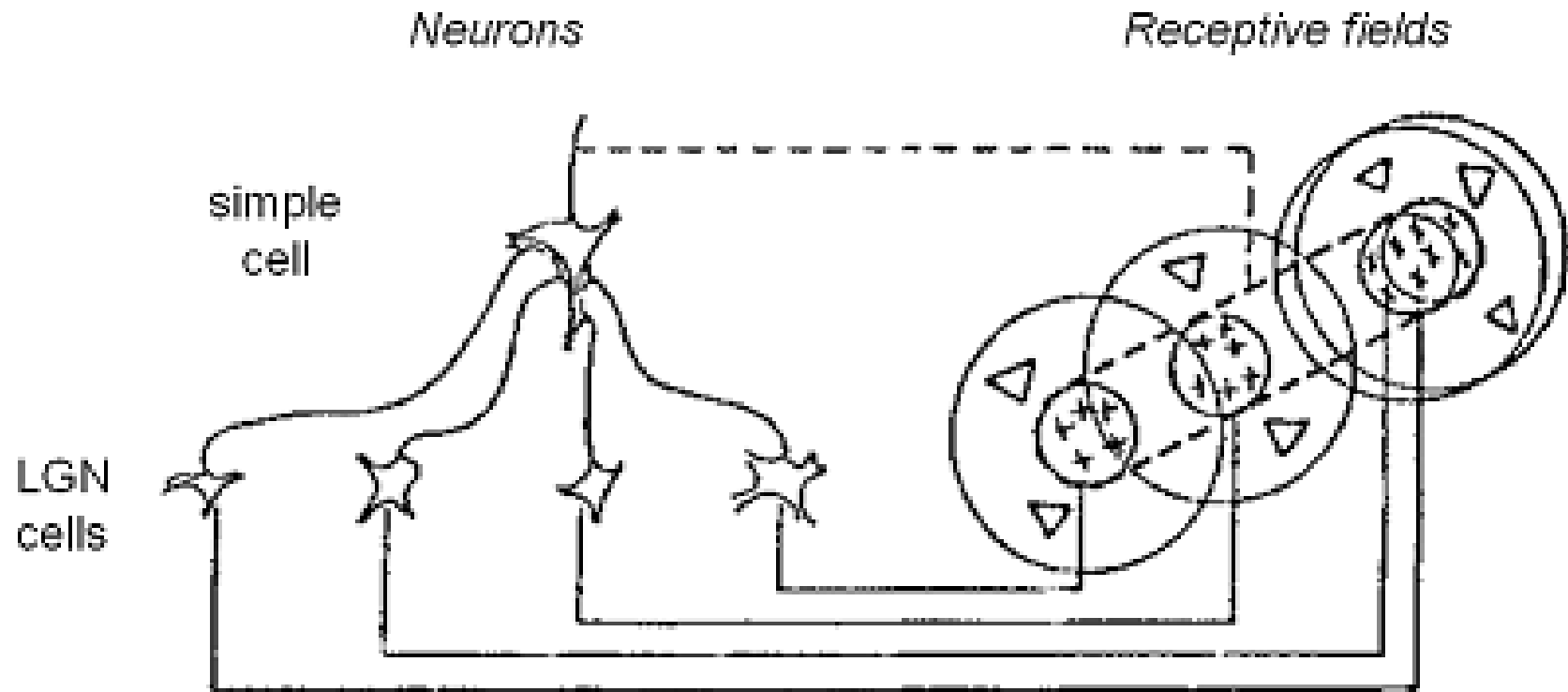


Orientation/angle tuning



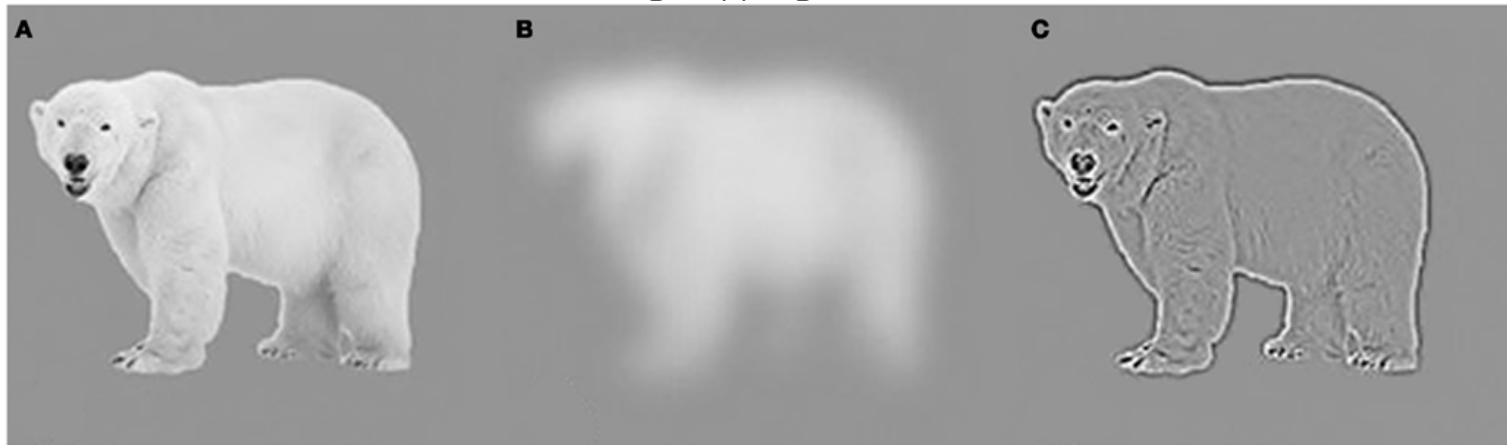
<https://foundationsofvision.stanford.edu/wp-content/uploads/2012/02/dir.selective.png>

From center-surround receptive fields to line detection



Spatial frequency tuning

Low == gist || high == details

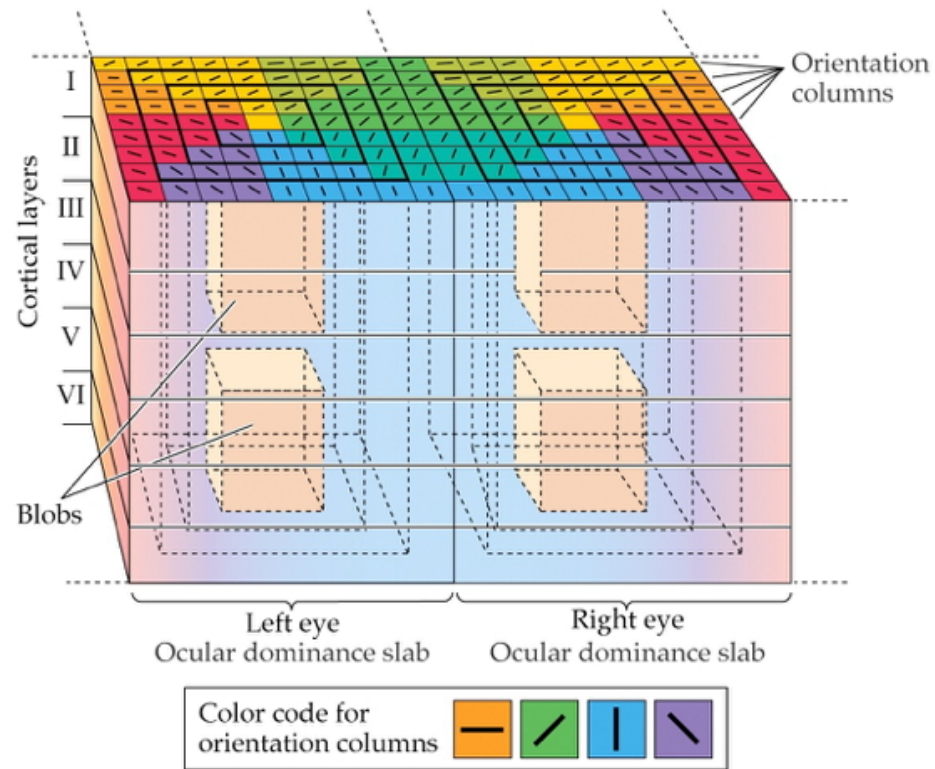


(Panichello, Cheung, and Bar 2013)

V1 has laminar, columnar organization

- Columns
 - Color/wavelength
 - Eye of origin,

Ocular dominance columns



© 2001 Sinauer Associates, Inc.

Ocular dominance signals retinal disparity

Cloudy with a Chance of Meatballs 3D Snippet (yt3d:enable=true)



<http://www.scholarpedia.org/w/images/9/99/11-Hubel-Wiesel-model.png>

Beyond V1

- Larger, more complex receptive fields
- (where/how)
 - Toward parietal lobe
- (what)

What is vision for?

- What is it? (form perception)
- Where is it? (space perception)
- How do I get from here to there (action control)
- What time (or time of year) is it?

The Real Reason for Brains

Daniel Wolpert
The real reason for brains

The neuroscience of action

- What types of actions are there?
- How are they produced?
 - By the muscles
 - By the nervous system

Remember

- Nervous system "output" includes
 - Movements
 - Autonomic responses
 - Endocrine responses

Types of actions

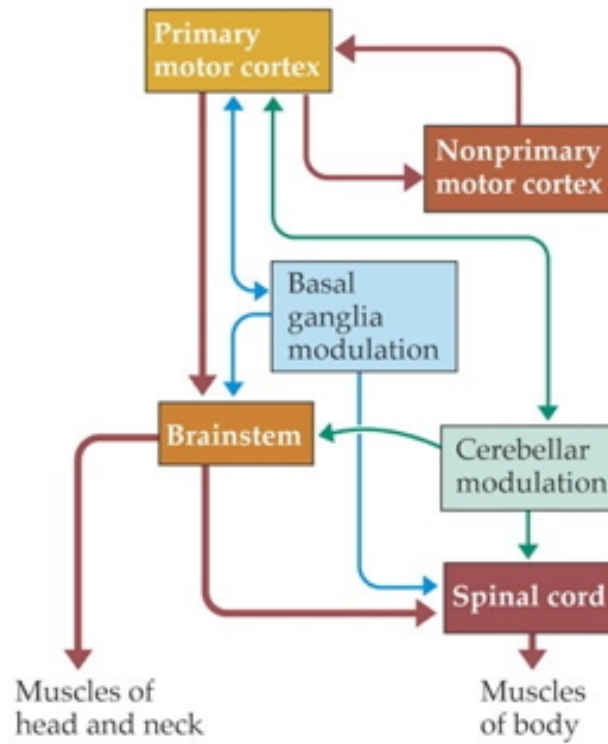


<http://www.kidport.com/reflib/science/humanbody/muscularsys>

Types of actions

- Reflexes
 - Simple, highly stereotyped, unlearned, rapid
- vs. Planned or voluntary actions
 - Complex, flexible, acquired, slower
- Discrete (reaching) vs. rhythmic (walking)
- Ballistic (no feedback) vs. controlled (feedback)

Multiple, parallel controllers



BIOLOGICAL PSYCHOLOGY, Fourth Edition, Figure 11.4 © 2004 Sinauer Associates, Inc.

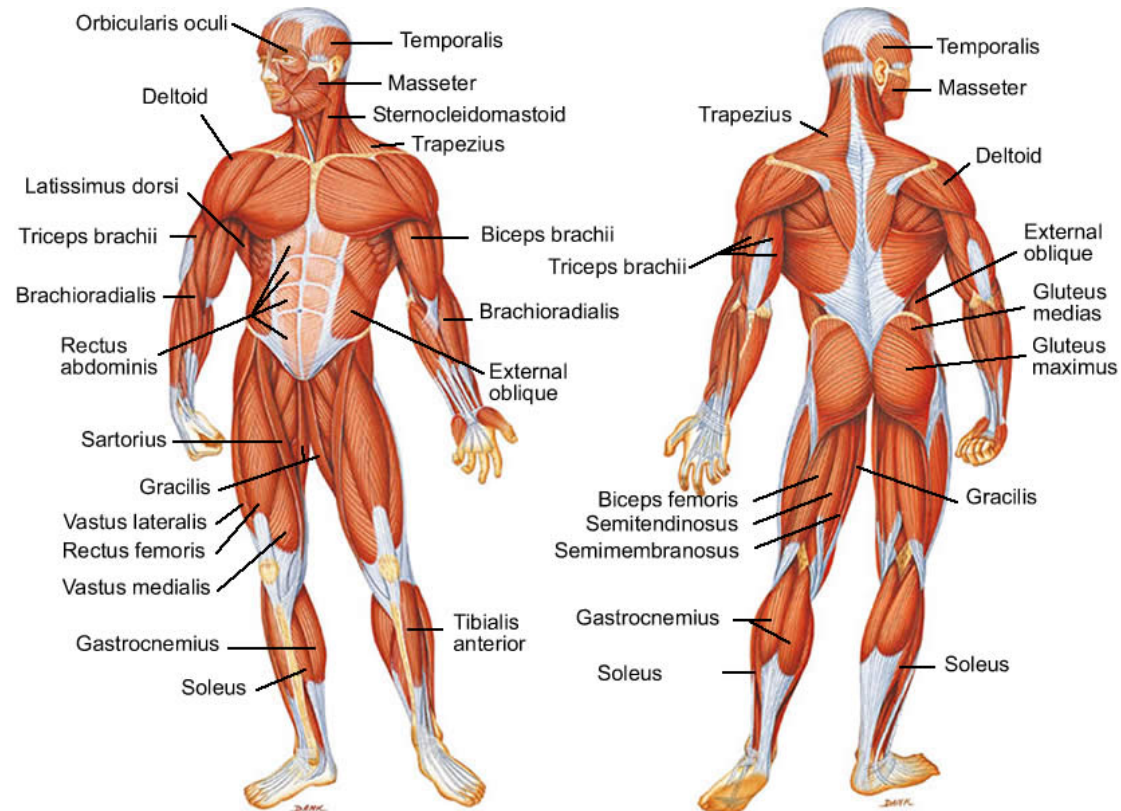
Key "nodes" in network

- Primary motor cortex (M1)
- Non-primary motor cortex
- Basal ganglia
- Brain stem
- Cerebellum
- Spinal cord

Muscle classes

- Axial
 - Trunk, neck, hips
- Proximal
 - Shoulder/elbow, pelvis/knee
- Distal
 - Hands/fingers, feet/toes

Muscles

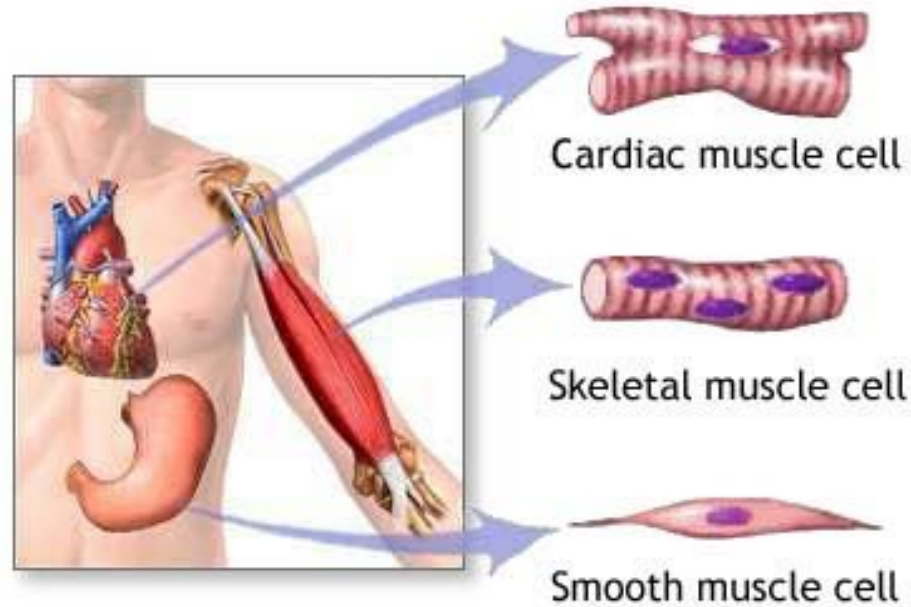


<http://mypages.valdosta.edu/dodrobin/2651/Muscles/Muscles.jp>

Muscle types

- Smooth
 - Arteries, hair follicles, uterus, intestines
 - Regulated by ANS (involuntary)
- Striated (striped)
 - Skeletal
 - Voluntary control, mostly connected to tendons and bones
- Cardiac

Muscle types



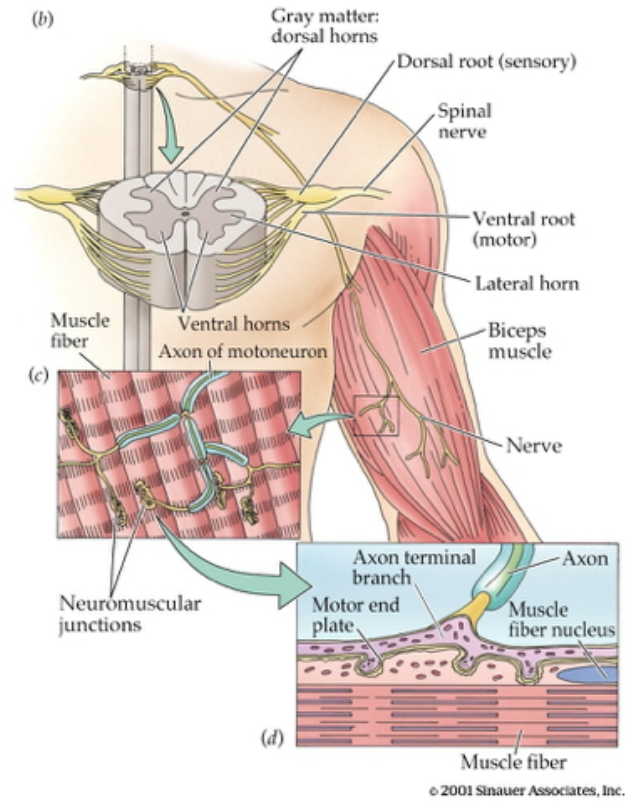
© ADAM, Inc.

<http://graphics8.nytimes.com/images/2007/08/01/health/adam/>

How skeletal muscles contract

- Motoneuron (ventral horn of spinal cord)
- Neuromuscular junction
 - Releases ACh

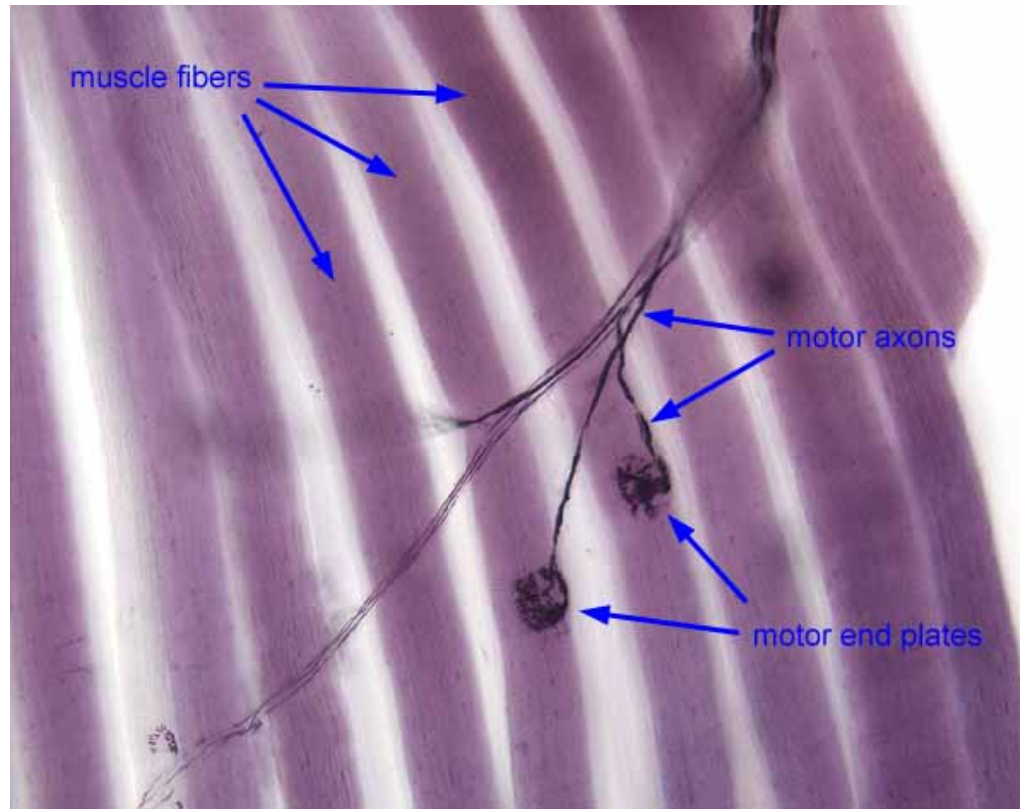
From spinal cord to muscle



How skeletal muscles contract

- Motor endplate
 - Nicotinic ACh receptor
- Excitatory endplate potential
 - Muscle fibers depolarize
 - Depolarization spreads along fibers like an action potential
 - Sarcomeres are segments of fibers
 - Intramuscular stores release Ca^{++}

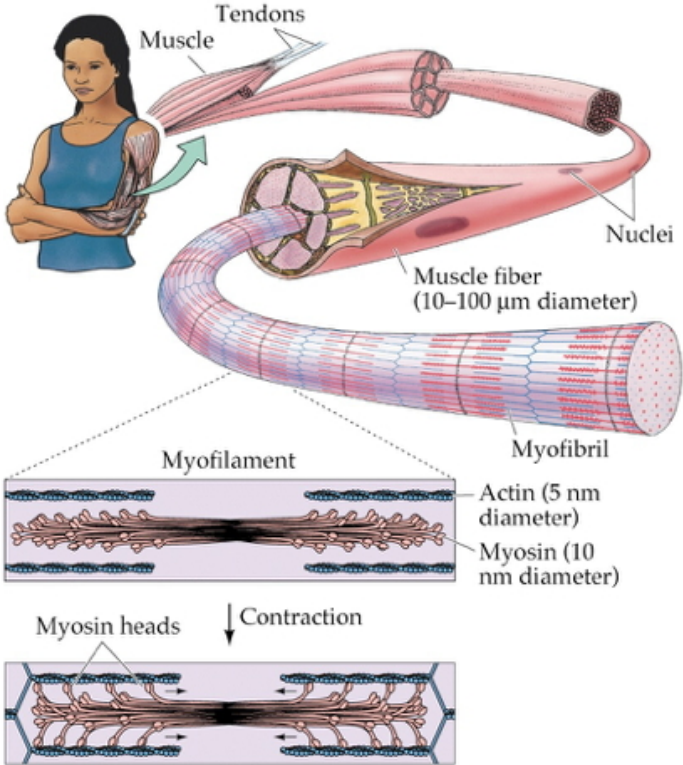
Motor endplate



How skeletal muscles contract

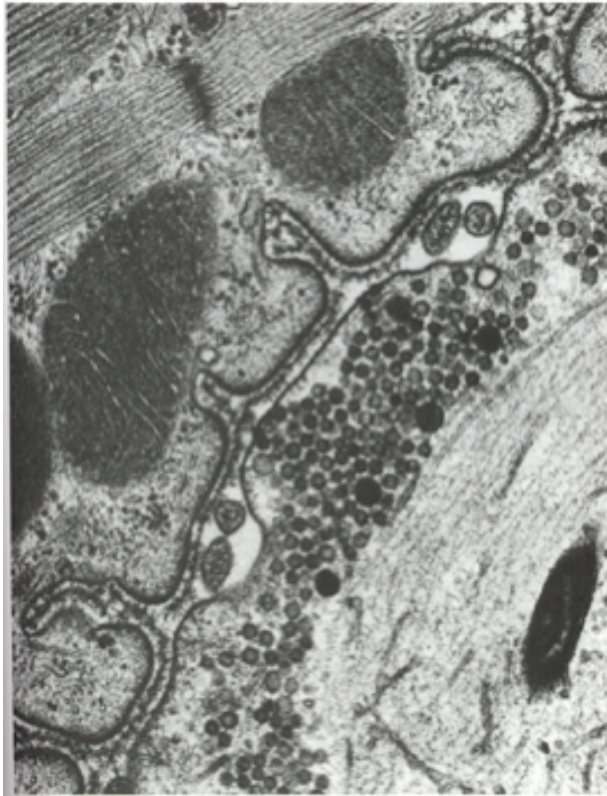
- Myofibrils (w/in sarcomere)
 - Actin & myosin proteins
 - “Molecular gears”
- Bind, move, unbind in presence of Ca^{++} , ATP

Anatomy of muscle fibers



© 2001 Sinauer Associates, Inc.

Anatomy of motor endplate

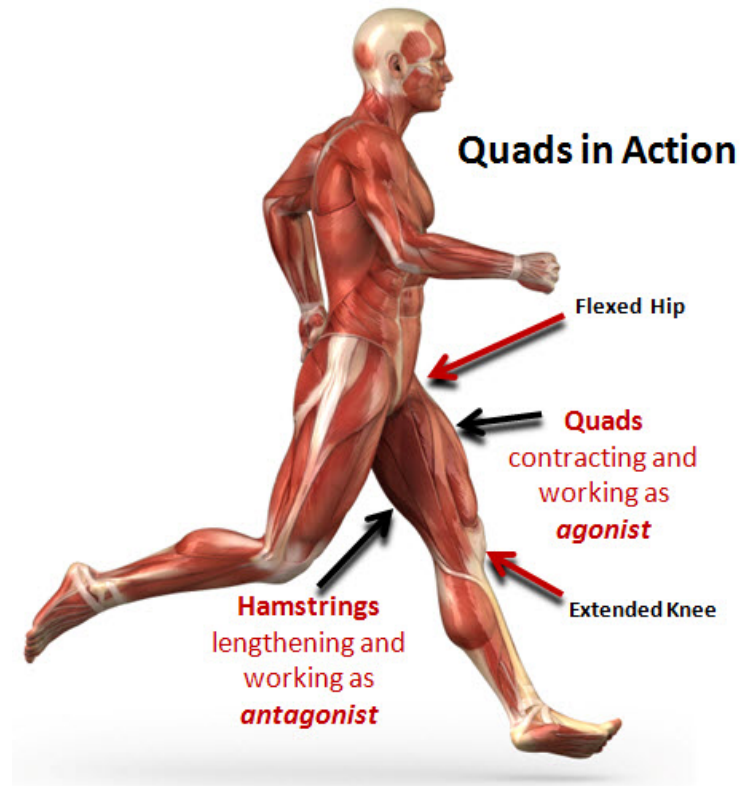


Muscle contraction

Muscle Contraction Process [HD Animation]



Agonist/antagonist muscle pairs



http://2.bp.blogspot.com/-TpOC4my_NBc/T0J-MhEv29I/AAAAAAAAAF88/dYLv7QzFwmg/s1600/Hamstring-Quad4.jpg

Meat preference?



Muscle fiber types

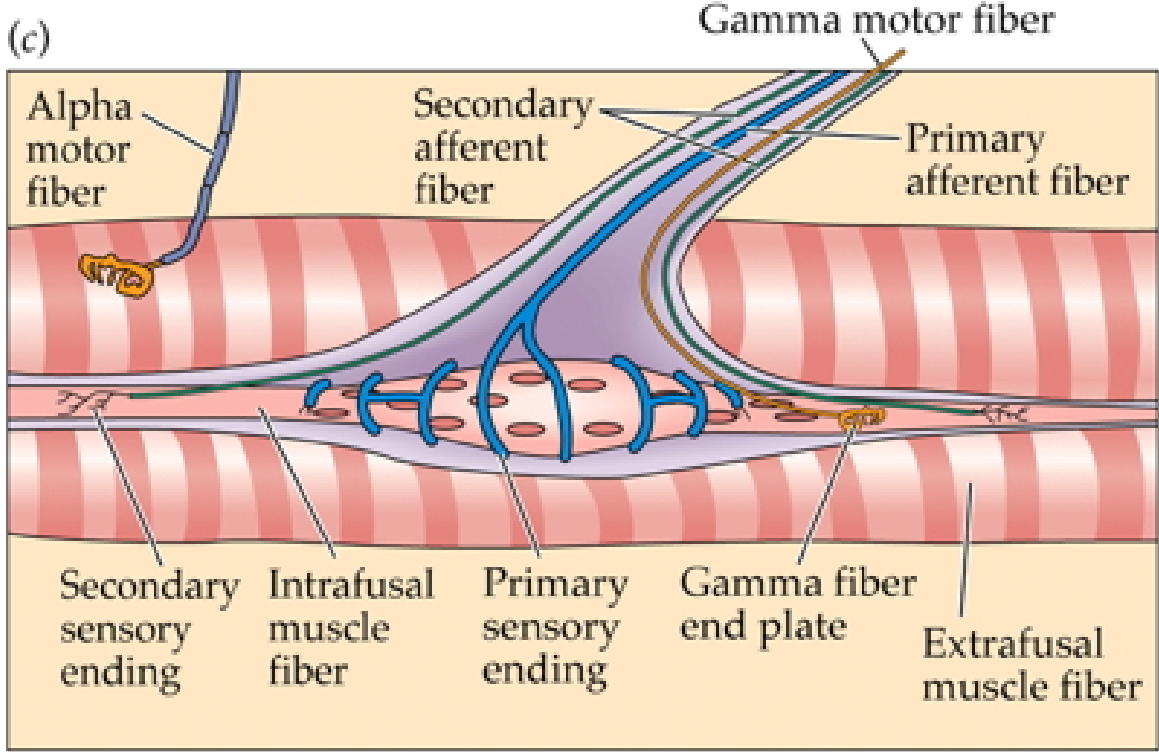
- Fast twitch/fatiguing
 - Type II
 - White meat
- Slow twitch/fatiguing
 - Type I
 - Red meat

Muscles are sensory organs, too!



© Can Stock Photo

Two muscle fiber types



© 2001 Saunders Associates, Inc.

Two muscle fiber types

- Intrafusal fibers
 - Sense length/tension
 - Contain muscle spindles linked to Ia afferents
 - enervated by gamma (γ) motor neurons
- Extrafusal fibers
 - Generate force
 - enervated by alpha (α) motor neurons

Next time...

- More on action

References

Dougherty, R. F., V. M. Koch, A. A. Brewer, B. Fischer, J. Modersitzki, and B. A. Wandell. 2003. "Visual Field Representations and Locations of Visual Areas V1/2/3 in Human Visual Cortex." *Journal of Vision* 3 (10): 1–1. doi:[10.1167/3.10.1](https://doi.org/10.1167/3.10.1).

Panichello, Matthew F., Olivia S. Cheung, and Moshe Bar. 2013. "Predictive Feedback and Conscious Visual Experience." *Journal of Vision* 3: 620. doi:[10.3389/fpsyg.2012.00620](https://doi.org/10.3389/fpsyg.2012.00620).