COGS 101A: Sensation and Perception

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UCSD

Lecture 12:

Perception and Action

Course Information

- Class web page: http://cogsci.ucsd.edu/ desa/101a/index.html
- Professor: Virginia de Sa
  - ⋆ I'm usually in Chemistry Research Building (CRB) 214 (also office in CSB 164)
  - ⋆ Office Hours: Monday 5-6pm
  - ⋆ email: desa at ucsd
  - ⋆ Research: Perception and Learning in Humans and Machines

For your Assistance

TAS:

- Jelena Jovanovic OH: Wed 2-3pm CSB 225
- Katherine DeLong OH: Thurs noon-1pm CSB 131

IAS:

- Jennifer Becker OH: Fri 10-11am CSB 114
- Lydia Wood OH: Mon 12-1pm CSB 114

Course Goals

- To appreciate the difficulty of sensory perception
- To learn about sensory perception at several levels of analysis
- To see similarities across the sensory modalities
- To become more attuned to multi-sensory interactions

Grading Information

- 25% each for 2 midterms
- 32% comprehensive final
- 3% each for 6 lab reports - due at the end of the lab
- Bonus for participating in a psych or cogsci experiment AND writing a paragraph description of the study (just a few sentences) Deadline to sign up for experiments on Experimetrix is Wednesday of Week 9 (the day before Thanksgiving)
- New lenient midterm policy: If you do better on the final than your worst midterm, we'll downweight that midterm to 10% (and upweight the final); If you do better on the final than your best midterm, we'll downweight that midterm to 15%. There will be no downweighting of the final.

You are responsible for knowing the lecture material and the assigned readings. Read the readings before class and ask questions in class.

Academic Dishonesty

The University policy is linked off the course web page.

You will all have to sign a form

For this class:

- Labs are done in small groups but writeups must be in your own words
- There is no collaboration on midterms and final exam

Midterm results

- Low 20 out of 70
- High 68.5 out of 70
- Mean 70%
- Median 73% exit

Common Mistakes I saw

- receptive field
- contrast sensitivity function
- Mach bands question (off-center cells)
- What do you expect for V2 receptive fields?

Rescheduling Thursday sections and Scheduling Midterm Review (and my office hours)

Last Lecture

Psychophysical and Computational Models of Object Perception

This Class: Consider vision as sensation for action

Perception for Action

In many ways, perception is only important in so far as how it affects are actions (which don't have to be only motor actions)

We don't need to sense differences between things, if we won't act any differently towards them

Ecological approach – concerned with the function of vision (not so much the physiological details) - Founded by J.J. Gibson

Lets look at how the visual system can solve some problems.

Problem: How does an observer navigate in the world?

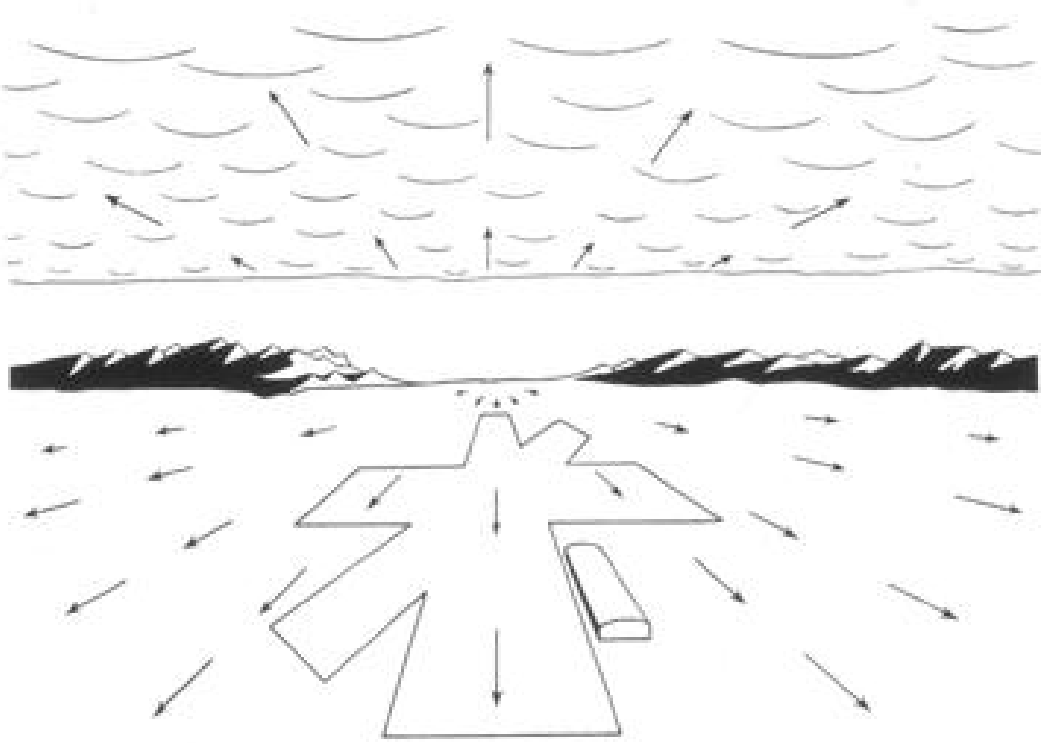
Solution: Use **optic flow** - when observer moves, the visual input streams

Focus of Expansion (FOE) remains constant as you move forward, rest of visual environment expands (and more the farther from the FOE)

Visual environment contracts as you move backwards (least near the FOE, more farther from the FOE)

Optic flow field for a pilot flying over a runway

For pilot landing, the FOE is the point of touchdown



after Gibson 1966 from http://www-psych.stanford.edu/ lera/psych115s/notes/lecture7/figures3.html#optic-flow

Optic flow for action

Using optic flow you can

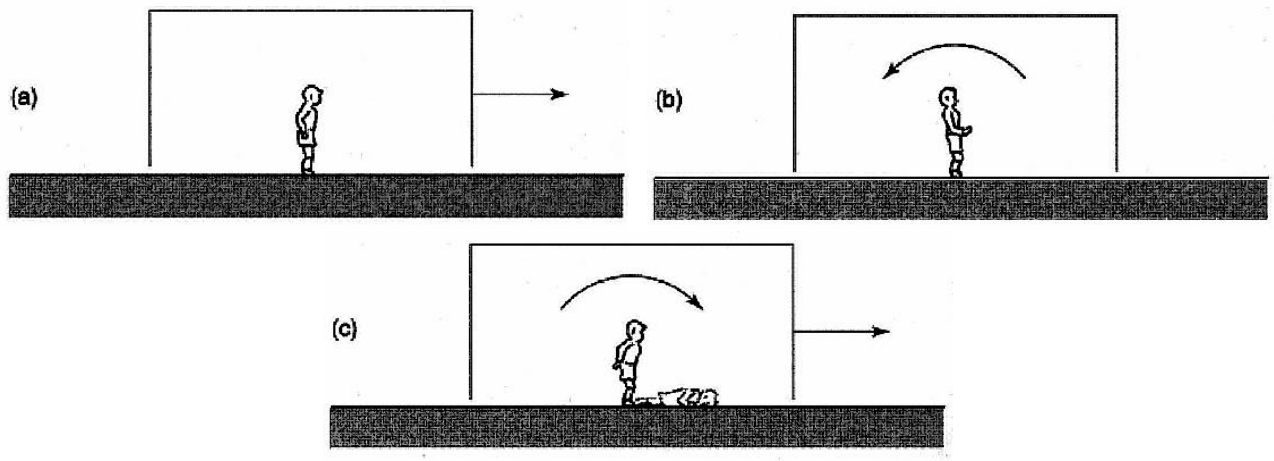
- get to a destination by moving so that the destination is the FOE
- judge relative distances by relative rates of expansion/contraction
- judge your speed by the rates of expansion/contraction
- maintain balance

Optic flow important for balance: Swinging Room

Lee and Aronson put toddlers in a swinging room (stationary floor but moveable walls and ceiling).

[Lee & Aronson 1974]
http://www.pc.rhul.ac.uk/zanker/teach/PS3060/L3/PS3060_3.htm

Optic flow important for balance: Swinging Room



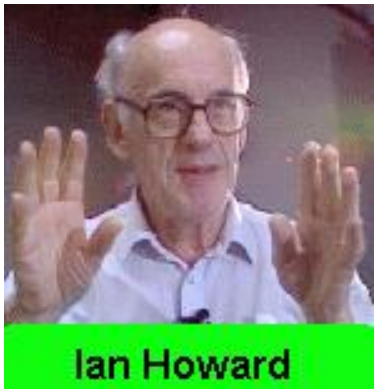
[Lee & Aronson 1974]

When they moved the walls and ceiling forward, toddlers compensated as if they had swayed backwards and fell forwards

Adults also would sway to compensate for perceived motion

Thus vision is an important part of maintaining posture

Ian Howard has taken the idea that vision can influence are sense of orientation even further



http://www.tomorrowtoday.com/fmindex.html?scripts/tumble.htm&1

In the tumbling room, the chair (and you) remain stationary as the room spins. You feel like you're spinning in space (very cool!).

Optic flow fields

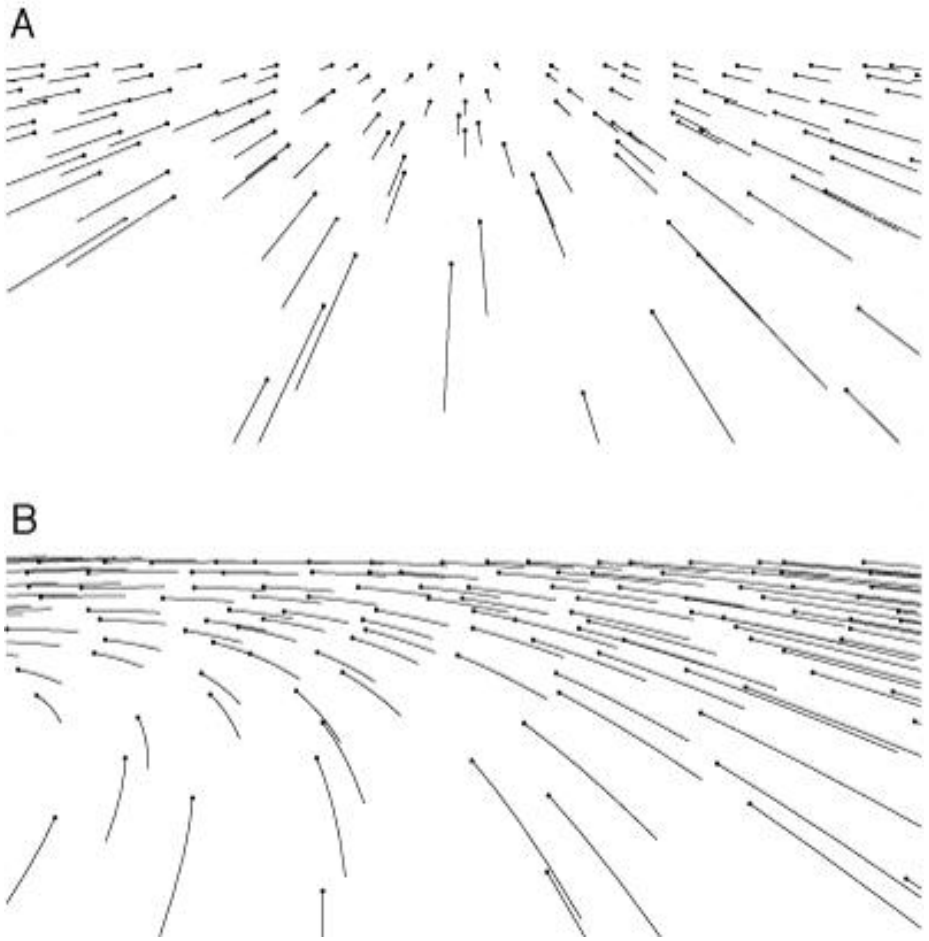
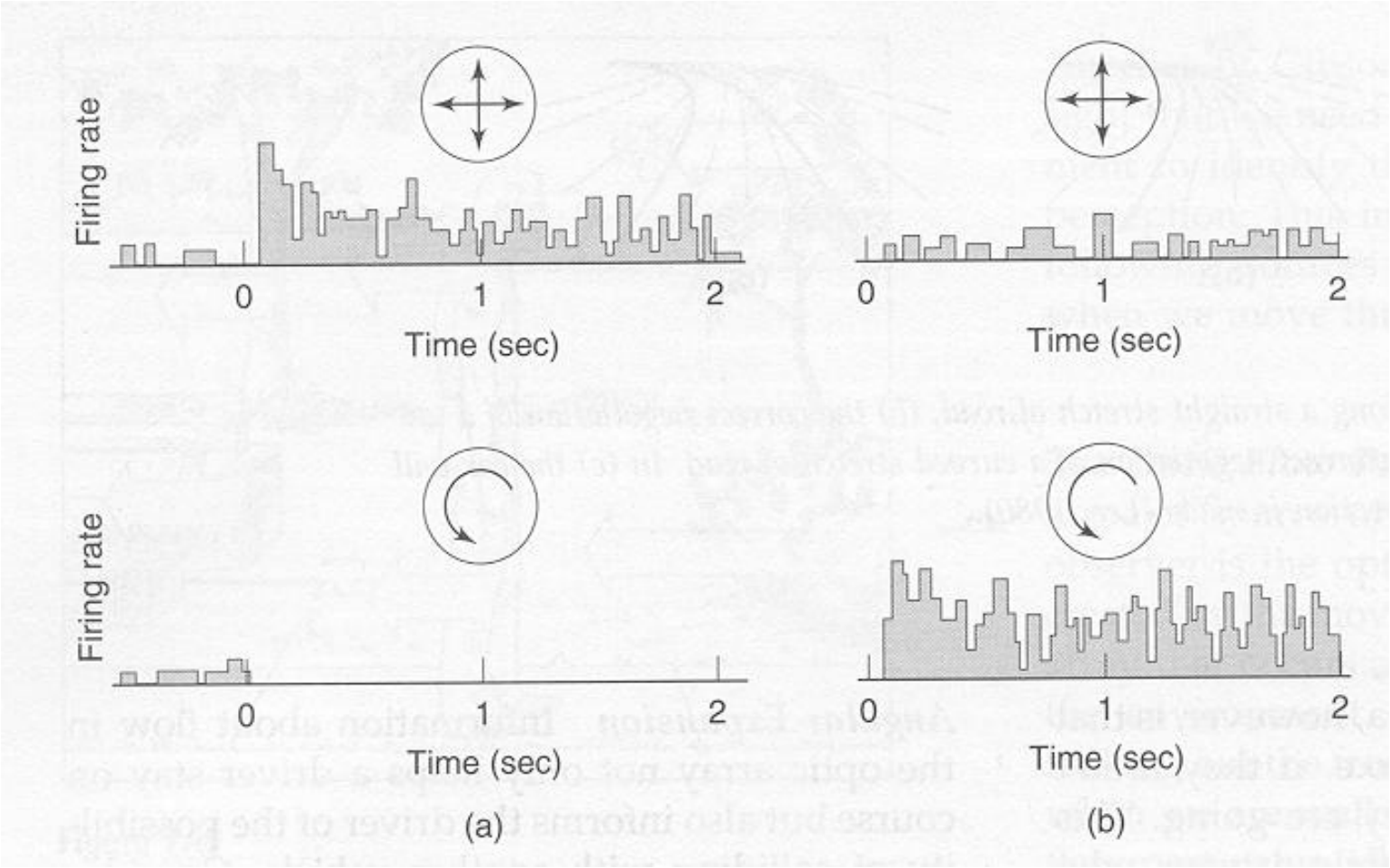


Image supplied by the Journal of Vision, courtesy of Richard M. Wilkie, John P. Wann at the School of Psychology, University of Reading, Reading, UK

Physiological Evidence: MST responses

MST neurons respond to optic flow fields



[Graziano,Andersen&Snowden 1994]

Problem: How do you detect collisions?

Solution: Boats can predict collisions if the bearing of another boat does not change.

Symmetrical expansion indicates a head-on collision course

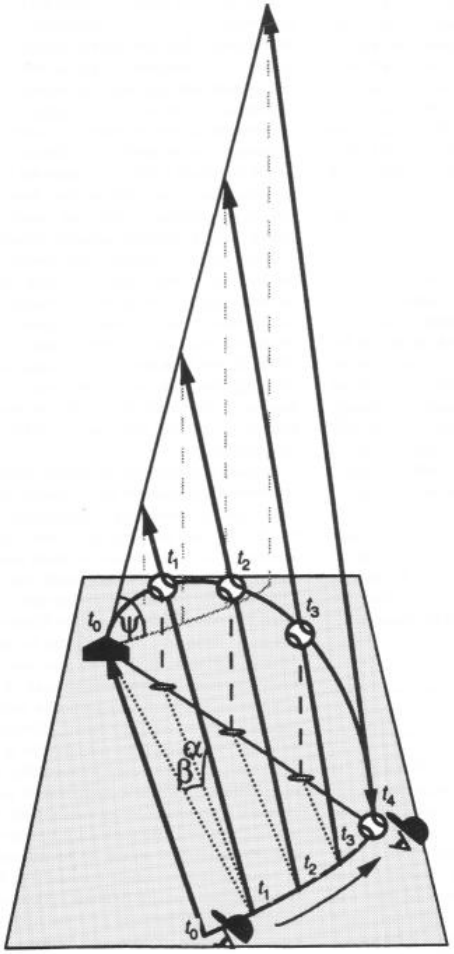
Time to collision can be estimated with **tau**- image size/(rate of expansion) (Don't use the book's definition)

Faster edge expansion means faster time to collision.

Physiological support: There are collision detecting neurons in the pigeon brain (nucleus rotundus)

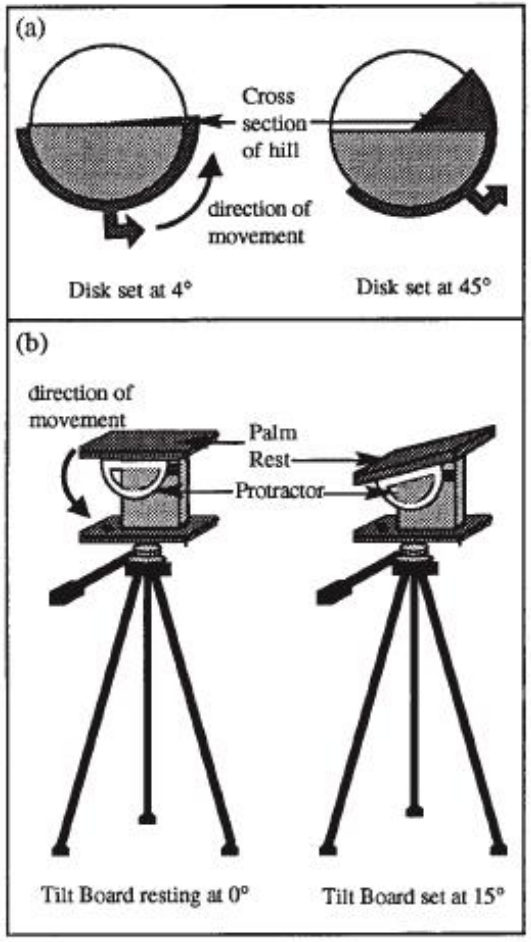
To catch a baseball, move so the ball looks like it's following a straight-line path

This is called the **linear optical trajectory (LOT) strategy**



[McBeath, Shaffer & Kaiser 1995]

Judging Slant

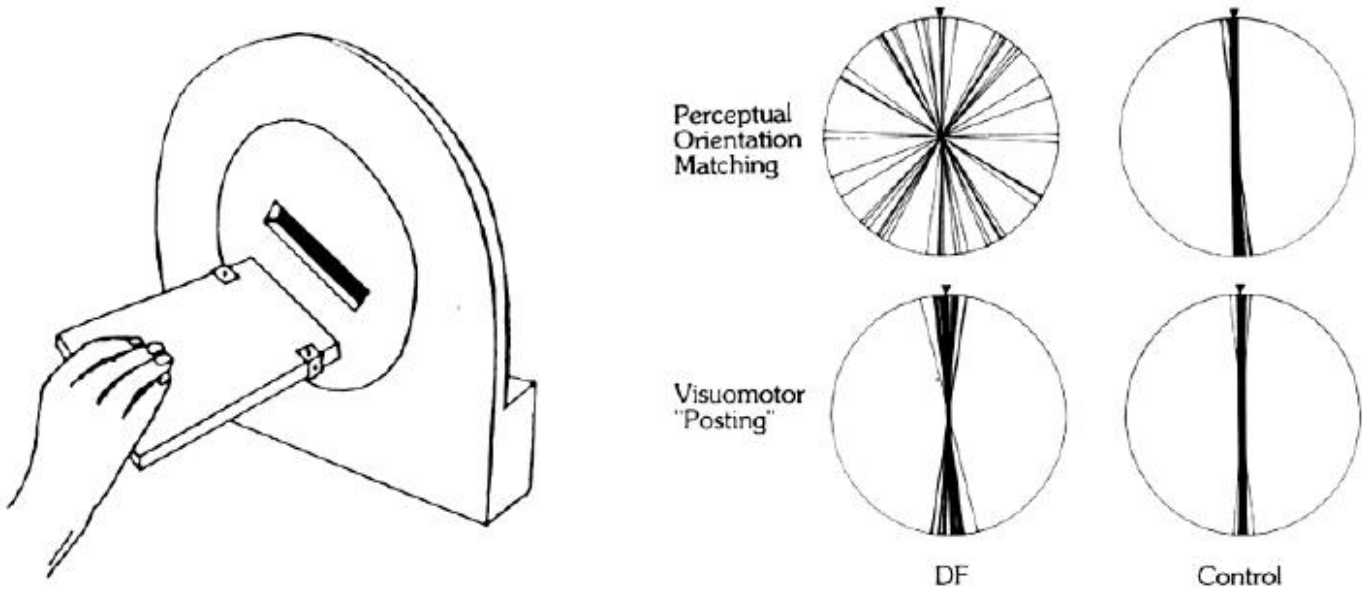


Dennis Proffit et. al. (1995) asked subjects to estimate the slant of a hill verbally (give the angle in degrees), visually (match the angle with disc) and haptically (adjust a plate to the right angle by feel (no visual feedback)).

- Subjects were much better in the haptic case.
- slant estimates increased after jogging
- slant estimates were greater at the top of very steep hills than at the bottom (the hills were too steep to walk down)
- slant estimates were larger for those in poor physical condition (or weighted down with heavy backpacks)

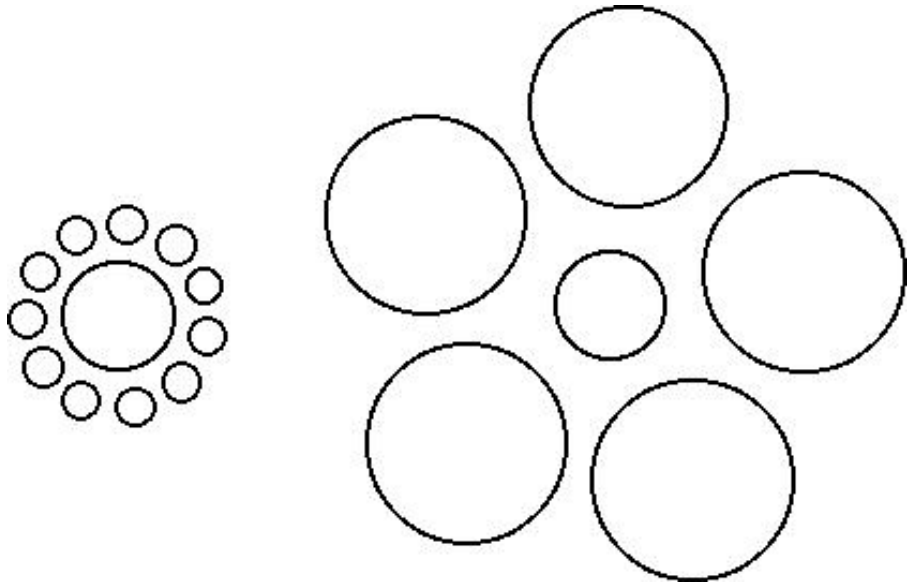
This indicates a separation between our visual perception and our ability to navigate with our knowledge (gained visually)

Remember Patient D.H. had a dissociation between perception and action



Patient D.F is unable to "match orientation" but when posting a letter orients the letter appropriately (even before touching the slot). Her "what" pathway is damaged but her "how" pathway is intact.

Another dissociation -The Ebbinghaus illusion

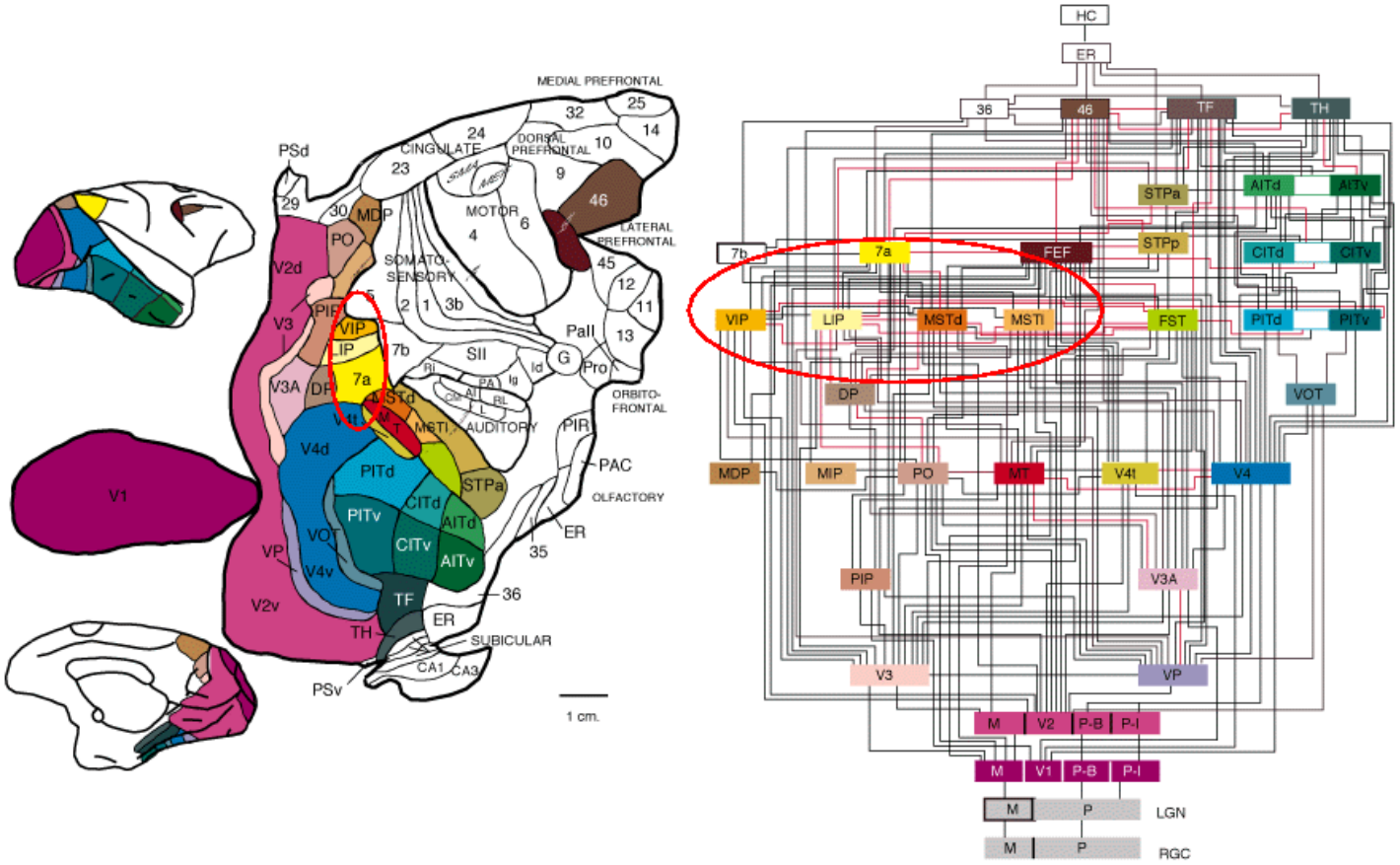


You should have the perception that the circle surrounded by bigger circles looks smaller than the one surrounded by smaller circles

However some experimentalists have found that subjects hand shapes before picking up the object are the same (and others disagree).

Intraparietal areas

Intraparietal areas are important in the use of perception for action



from Felleman, D.J. and Van Essen, D.C. (1991) *Cerebral Cortex* 1:1–47.

Tutis Vilis notes for better picture of intraparietal areas

Intraparietal areas

LIP - represents the location of objects you want to look at (responds to visual and auditory input)

MIP - represents the area one can reach to (responds to visual and somatosensory input)

AIP - represents important shape information for grasping objects

VIP - represents the ultra near area important for moving the head,mouth,lips for feeding (responds to visual and tactile input to the face)

Area AIP (Anterior Intraparietal area)

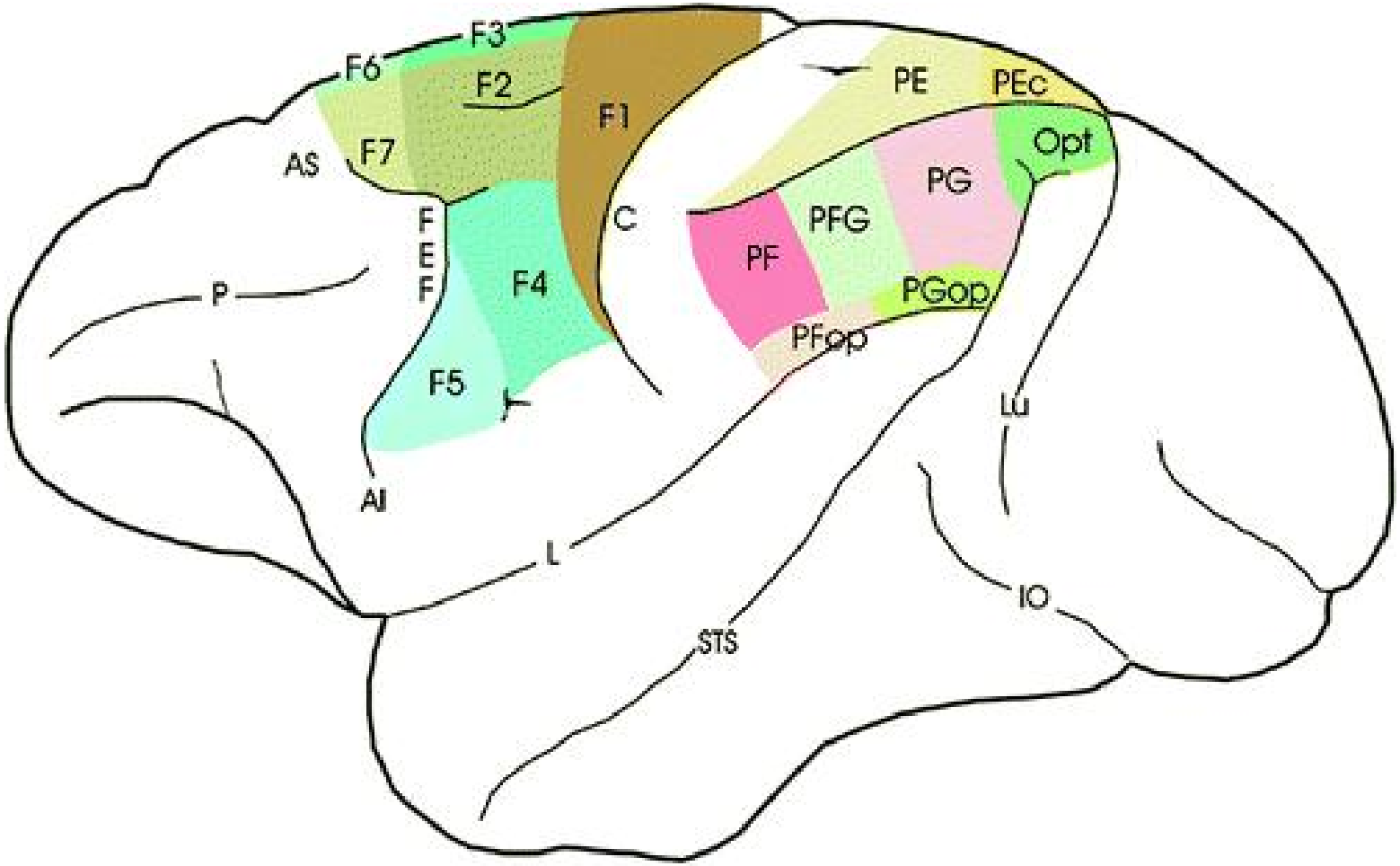
Area AIP is between sensory and motor areas and has neurons that reflect this mapping

- **motor-dominant neurons**- respond when monkey performs an action (in dark or light) but not to seeing visual cue
- **visual-dominant neurons** - respond when monkey performs an action in the light (but not dark) and best to seeing the visual cue
- **visual and motor neurons** - respond to action in light and to a lesser degree to action in dark and visual cue alone

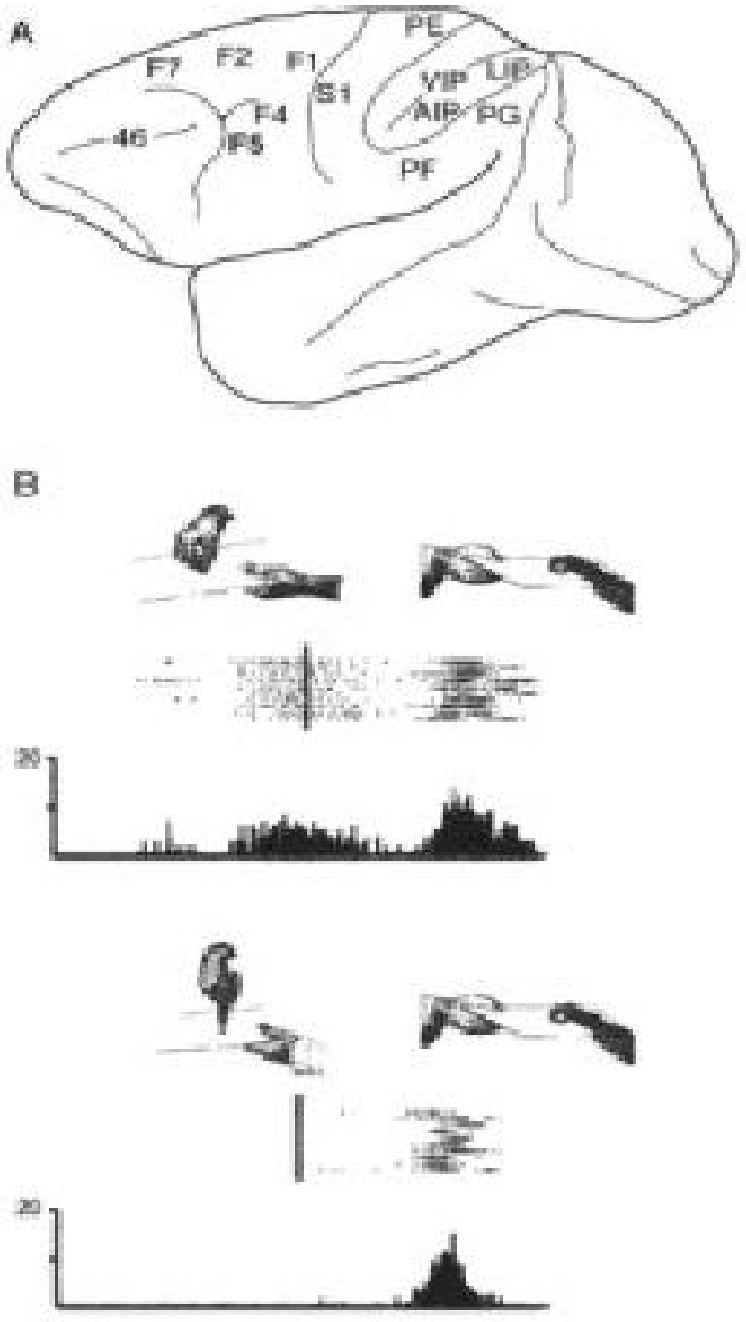
Mirror neurons

AIP neurons send signals to premotor cortex. One of the most interesting types of neurons in premotor cortex are called **mirror neurons**

These neurons in Area F5 respond when a monkey performs an action but also when he sees someone else performing the same action



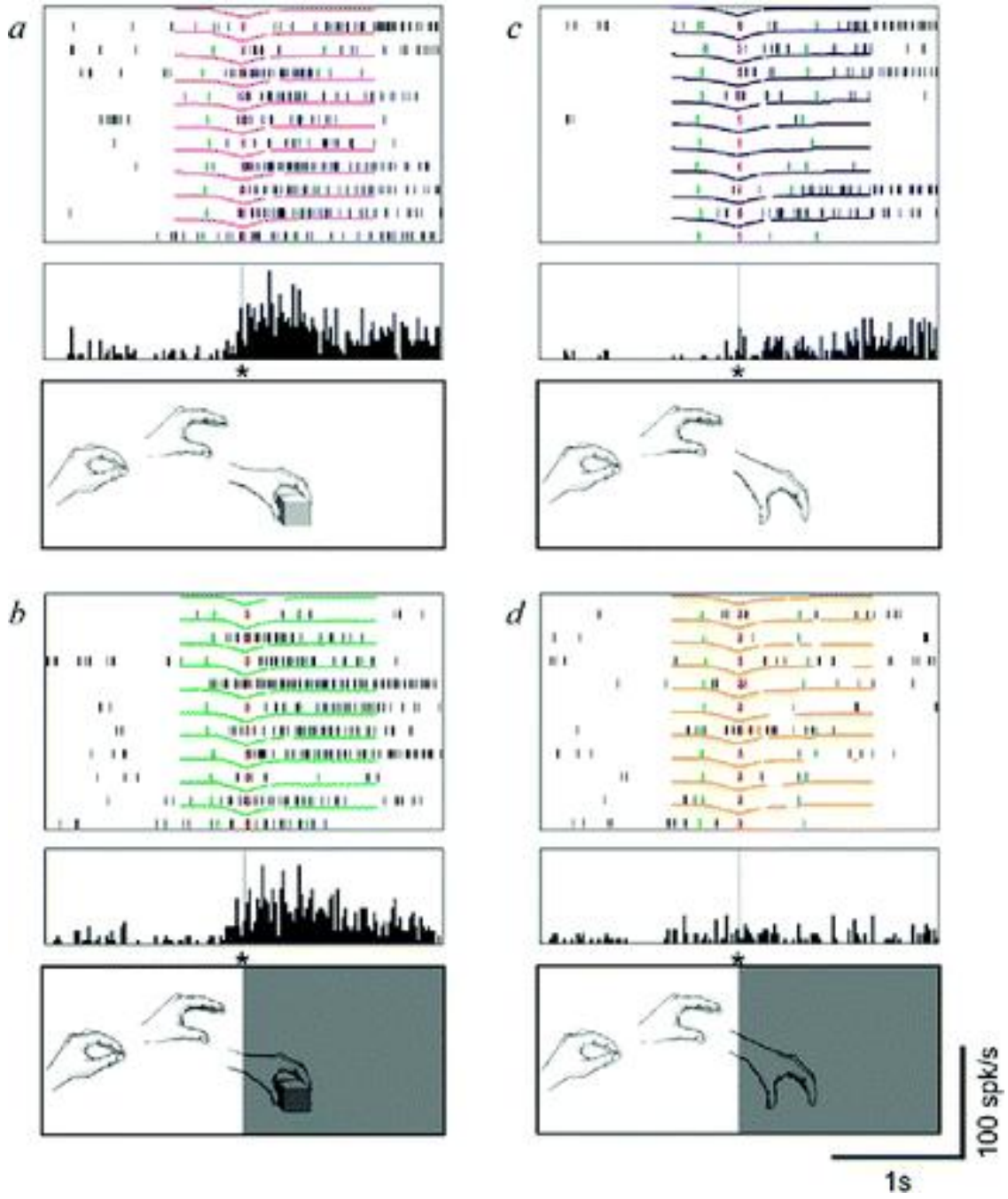
[Rizzolatti & Craighero 2004]



http://www.bcs.rochester.edu/ dlee/bcs245/pmc.htm

Mirror neurons

Many have speculated that these mirror neurons allow us to help understand the actions of others (to have a "theory of mind") and might be damaged in "Autism" a disease where people are socially withdrawn



[Rizzolatti & Craighero 2004] The mirror neurons respond when the monkey

knows there is food behind the barrier, and sees a human hand moving behind the barrier even though he can't see the grasp – It "knows" that a grasp is implied.

And now for some fun (and a little adaptation review)

The next slides are not about perception and action

High-level Adaptation

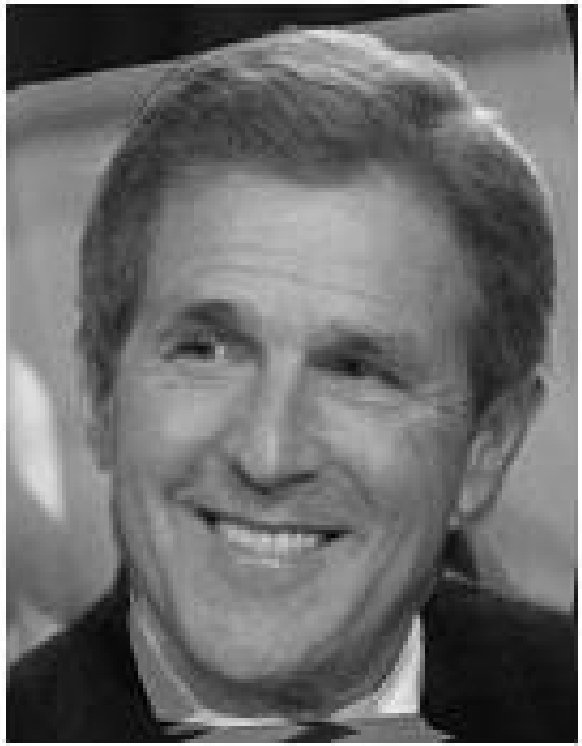
Remember motion adaptation and spatial frequency adaptation? Well, we can have high level adaptation also The middle image should look pretty neutral between Bush and Kerry

Identity Aftereffects

The identity of the middle image is ambiguous, but after looking at Bush the choice is clear.

Image supplied by Michael A. Webster (mwebster@unr.nevada.edu) at the Dept of Psychology, University of Nevada, USA.

Review of Adaptation



This face should look pretty neutral between Bush and Kerry

Review of Adaptation

Now adapt to this figure

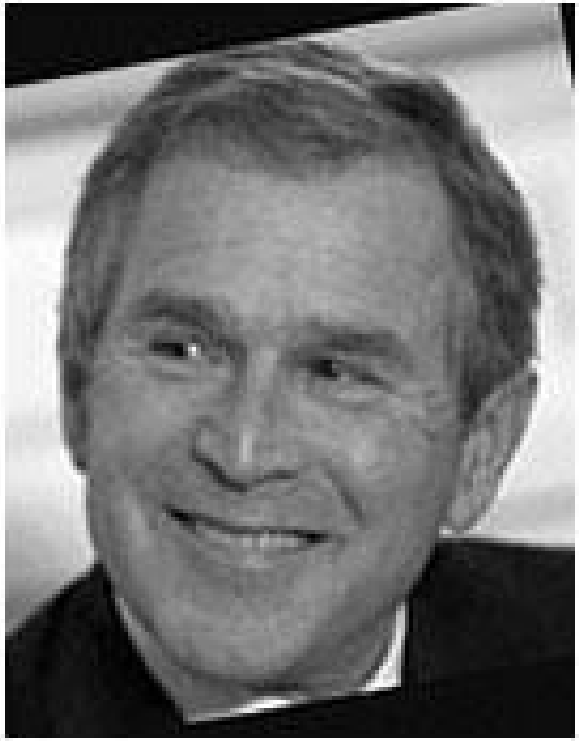
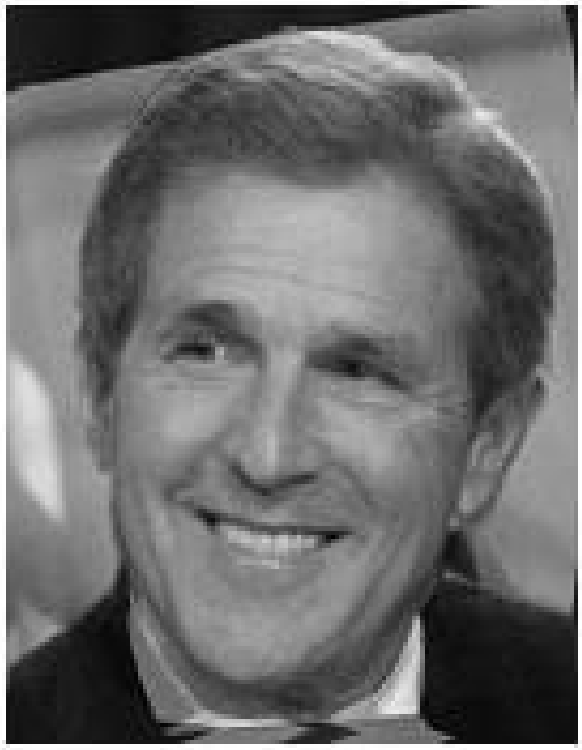


Image supplied by Michael A. Webster (mwebster@unr.nevada.edu) at the Dept of Psychology, University of Nevada, USA.

Review of Adaptation

Now who does this picture look more like?



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Next Class

No class Thursday (Veterans/Remembrance Day)

Midterm 2 on Tuesday!