

# Motion Perception

DT2350 Human Perception for Information  
Technology

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# Literature

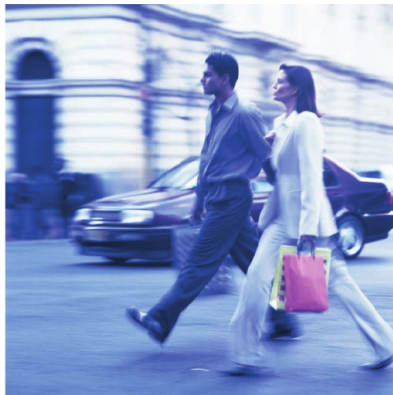
*Goldstein, E.* (2009/2014) **Sensation and Perception**

- ▶ Chapter 8: Motion Perception

*Weinschenk, S.M.* (2011) **100 Things Every Designer Needs to Know About People**

- ▶ surprisingly I could not find any relevant chapter

# Motion Perception



1. stationary observer, moving stimuli
2. moving observer

# Importance of Motion Perception

- ▶ detect danger
- ▶ perceive behaviour
- ▶ disambiguate vision

# Motion Agnosia

Example: 43-years-old woman who suffered a stroke



Time 1



Time 2

Zihl et al. (1983,1991)

# Motion as Attention Capture

The three “F”s

1. Fight

2. Flee

3. Freeze

3. makes it harder to differentiate between the animal and the background

# Explanation

- ▶ bird hard to see because same lines as background
- ▶ movement perceptually organises bird lines into one object

# Important Even Without Camouflage

- ▶ vision is ambiguous
- ▶ pattern recognition more difficult than movement detection
- ▶ research show we perceive shapes more accurately if the object is moving

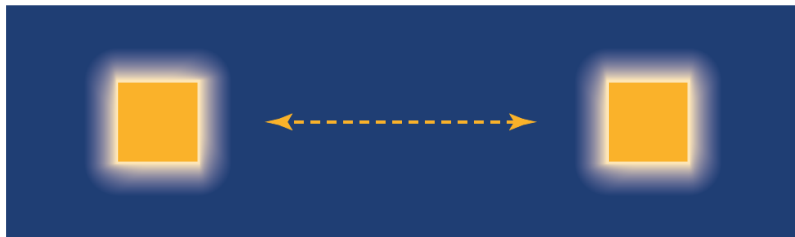


# Real vs Illusory Motion

Illusory motion:

- ▶ apparent motion
- ▶ induced motion
- ▶ motion aftereffects

# Apparent Motion



It is the basis for movies and television

# Induced Motion



# Motion Aftereffects



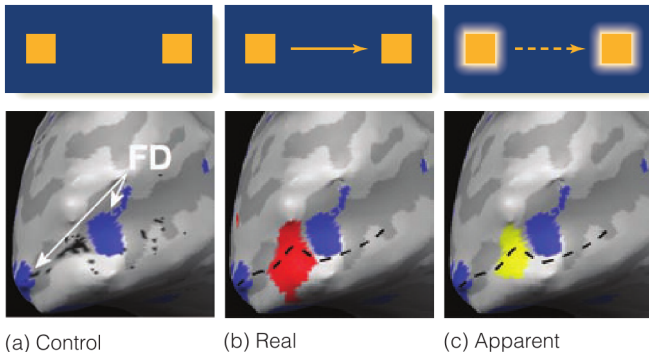
# Demonstration

## Motion Aftereffect Demo (Waterfall)

Steven Cholewiak  
semifluid.com

<http://youtu.be/oNhcp0IQCNs>

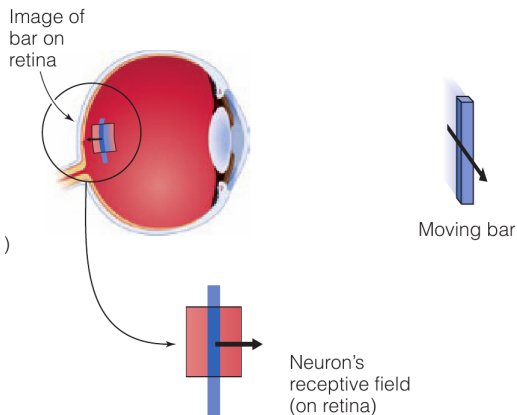
# Are Real and Apparent Motion Different Perceptually?



Visual cortex  
Larsen et al. (2006)

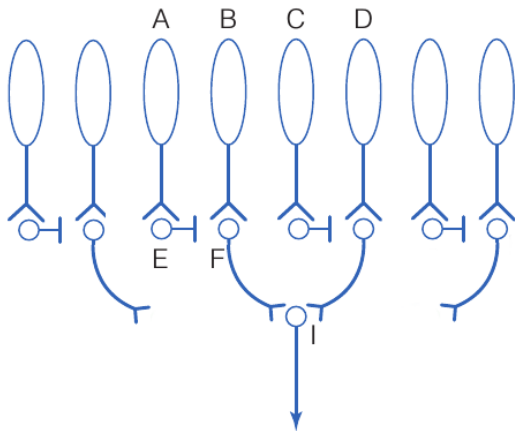
# Neural Explanation of Motion Perception

## Reichardt detector



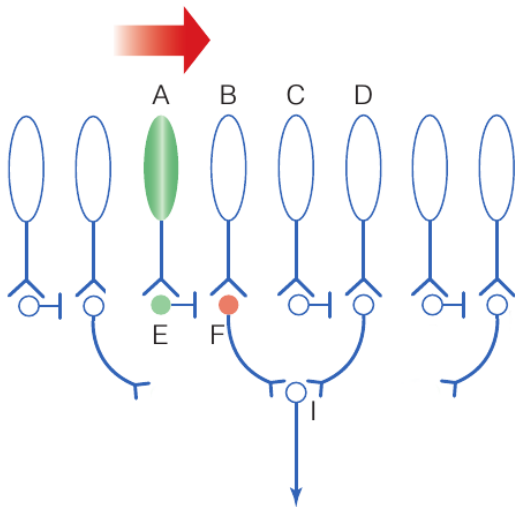
Werner Richardt (1969)

# Reichardt detector (1969)



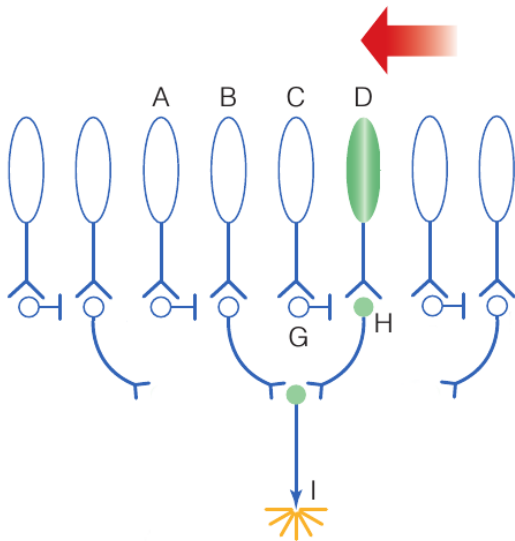


# Reichardt detector (1969)

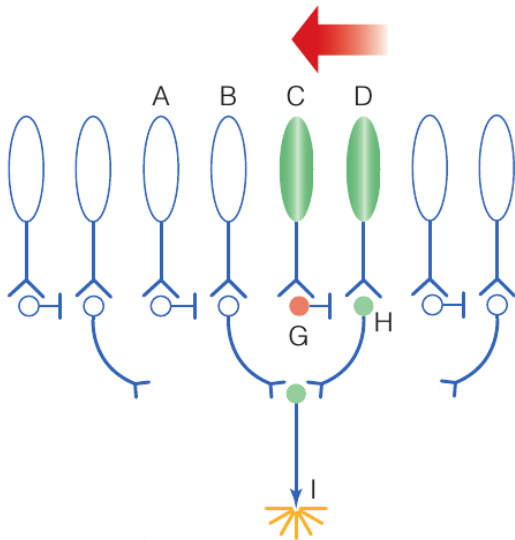




# Reichardt detector (1969)



# Reichardt detector (1969)



# Motion Perception Cannot Be Explained with the Retina



(a) Jeremy walks past Maria; Maria's eyes are stationary  
(creates local disturbance in optic array)

Jeremy walks, Maria looks straight at the window

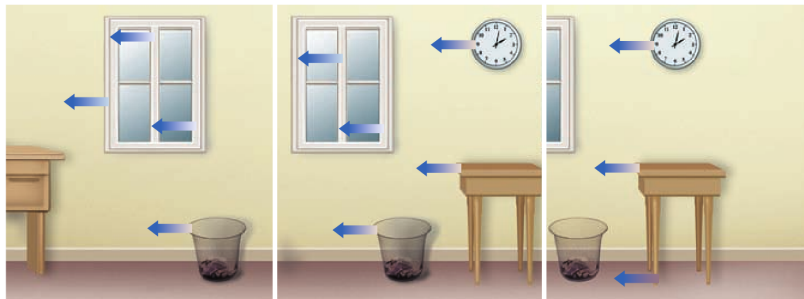
# Motion Perception Cannot Be Explained with the Retina



(b) Jeremy walks past Maria; Maria follows him with her eyes  
(creates local disturbance in optic array)

Jeremy walks, Maria follows him with the eyes

# Motion Perception Cannot Be Explained with the Retina



(c) Maria walks through the scene  
(creates global optic flow)

Maria walks in the room

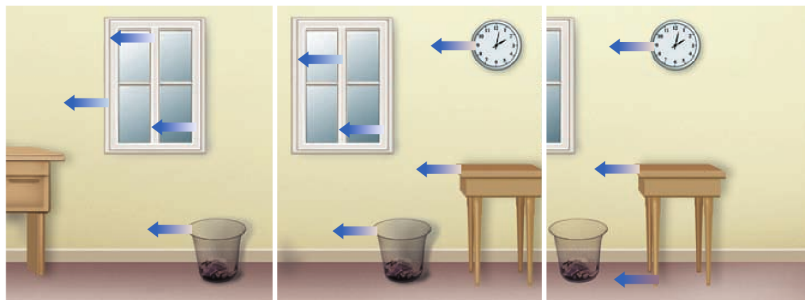
# Information In The Environment

Gibson: disregard the retina

- ▶ Jeremy generates a **local disturbance of the optic array**
- ▶ this happens both if Maria looks straight or follows him
- ▶ when Maria moves it is different: **global optic flow**



# Global Optic Flow



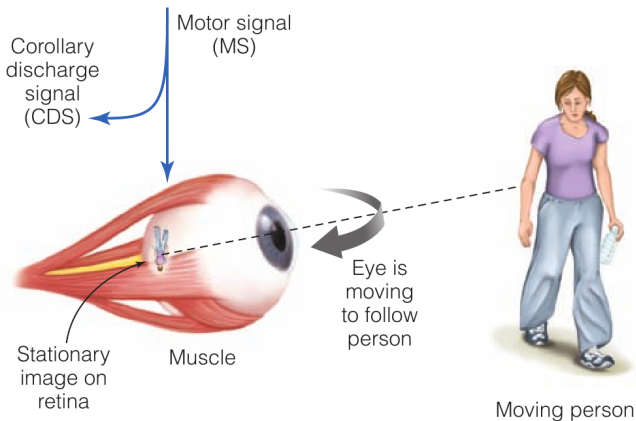
(c) Maria walks through the scene  
(creates global optic flow)

- ▶ in this case everything moves
- ▶ this tells Maria that what she sees is stationary and that she is the one moving

# Problems

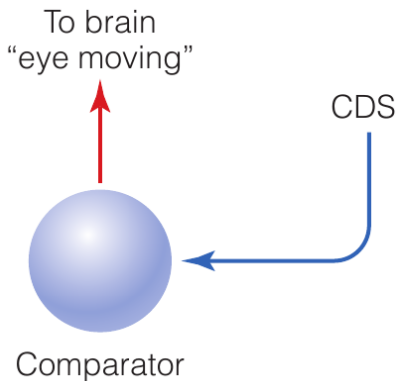
- ▶ Eye motions: Corollary discharge theory
- ▶ Aperture problem (neuron receptive field)

# Taking Eye Motions Into Account



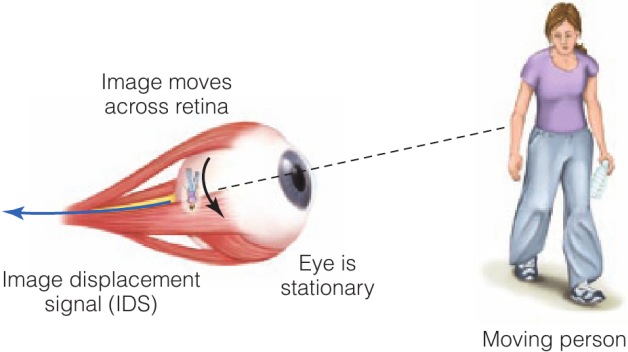
NOTE: the book does not take **head movements** into account

# Corollary Discharge Model

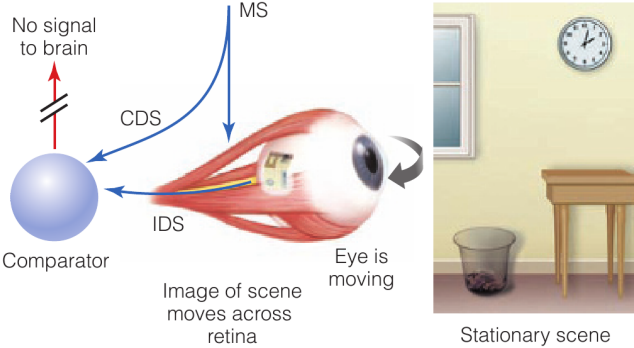


- ▶ corollary discharge signal (CDS)
- ▶ image displacement signal (IDS)

# CDM: Moving Person

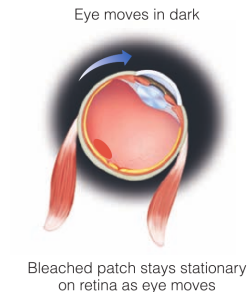


# CDM: Scanning Stationary Scene



# Behavioural Demonstration 1

corollary discharge (**eye movement**) without image displacement



## Behavioural Demonstration 2

corollary discharge (**muscle contraction**) without image displacement





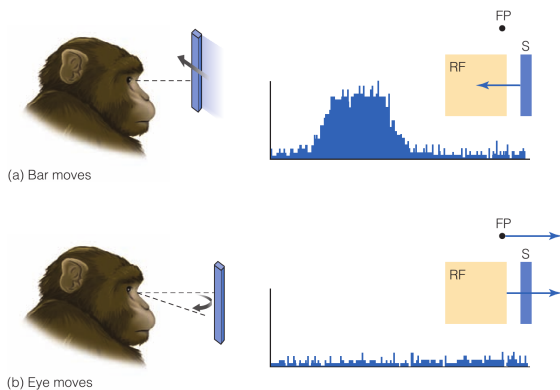
# Physiological Evidence

- ▶ patient with lesions
- ▶ did not receive corollary discharge
- ▶ everything moved around when he moved his eyes

Haarmeier et al. (1997)

# Physiological Evidence in Monkeys

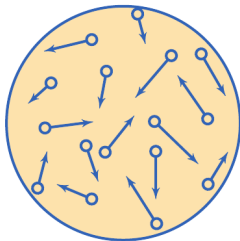
“real motion neuron”



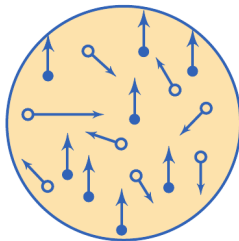
Galletti and Fattori (2003)

# Motion of Arrays of Dots

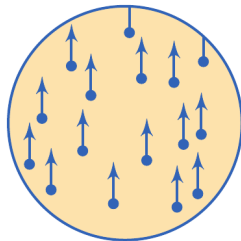
No correlation  
Coherence = 0



50% correlation  
Coherence = 50%



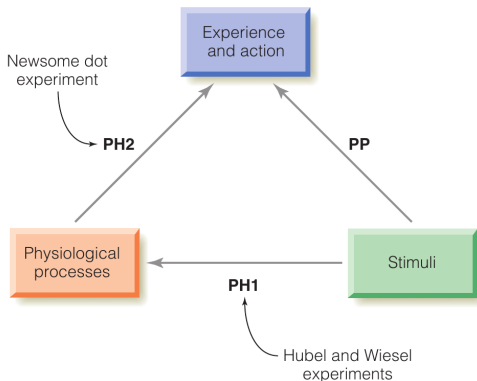
100% correlation  
Coherence = 100%



- ▶ possible to vary difficulty of perception (degree of coherence)
- ▶ monkeys' ability to detect direction
- ▶ response of neuron in Medial Temporal cortex

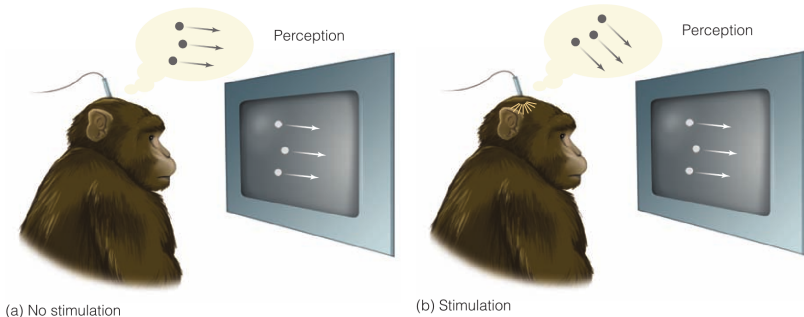
Newsome et al. (1989)

# Relationship to Physiology



(Monkeys must be trained for months to indicate the direction)

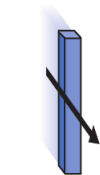
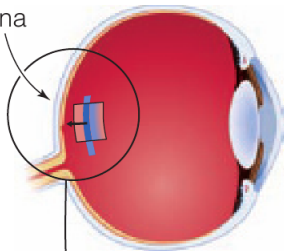
# Effect of Lesioning and Microstimulation



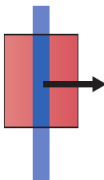
- ▶ without lesioning they detect motion with 1-2% coherence
- ▶ with lesioning they need 10-20% coherence
- ▶ with stimulation can change direction of movement

# Physiology: The Aperture Problem

Image of  
bar on  
retina

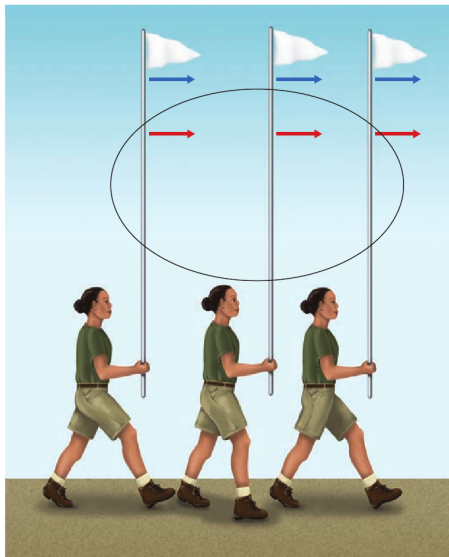


Moving bar

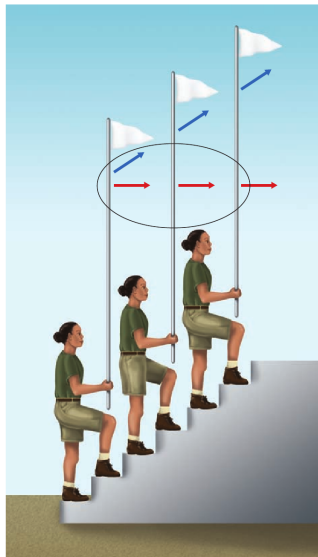


Neuron's  
receptive field  
(on retina)

# Physiology: The Aperture Problem

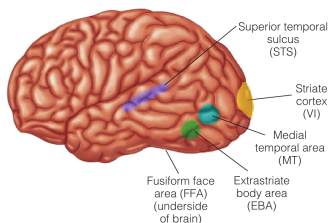


# Physiology: The Aperture Problem





# Medial Temporal Area: Pooling Responses



## Neurons in Medial Temporal Area

- ▶ up to 70msec orientation of the bar
- ▶ after 140msec real movement
- ▶ use object edge detectors in Striate Cortex

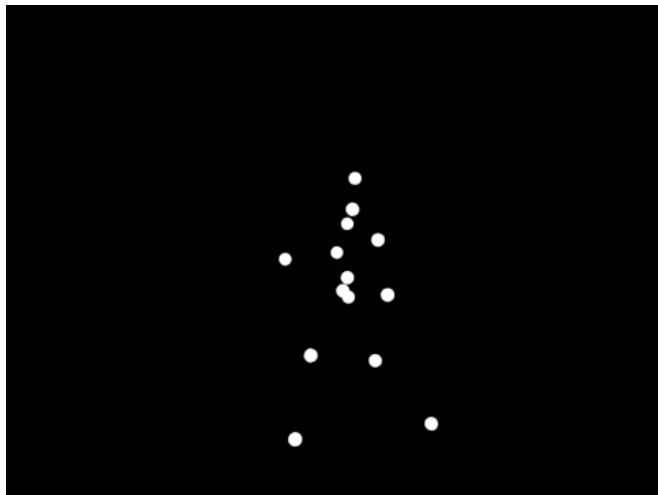
Pack and Born (2001)

# Perceiving Biological Motion

Point-light walker



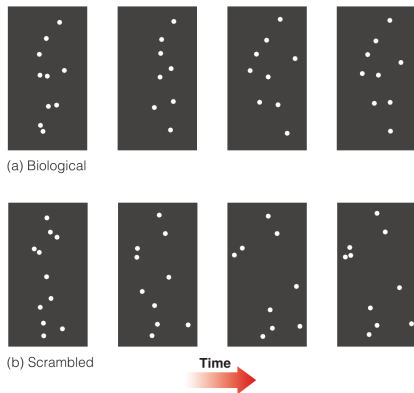
# Point-light Walker Example



<http://youtu.be/r0kLC-pridI>

# Brain Activation to Biological Motion

Stimulating Superior Temporal Sulcus (STS)  
disrupts biological motion perception

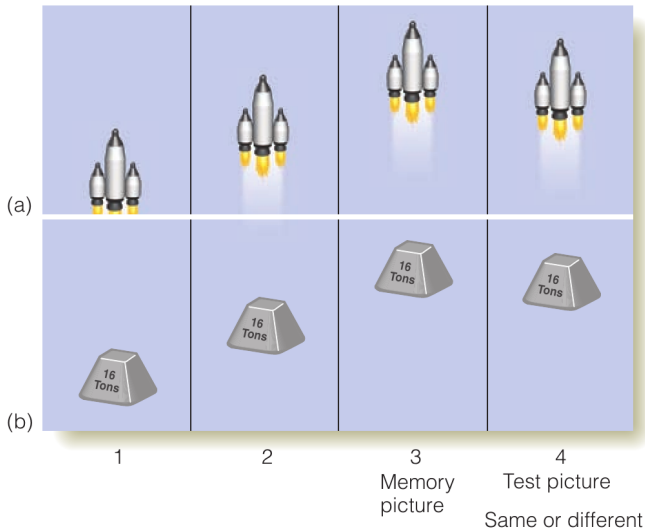


Grossman et al. (2005)

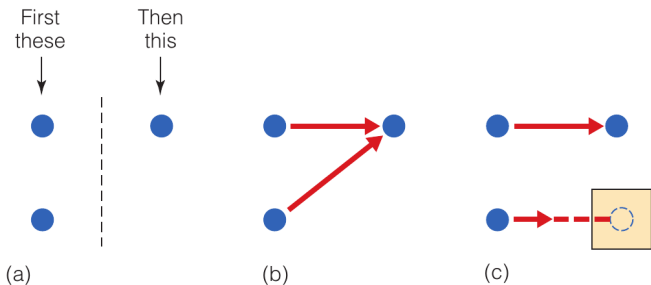
# Beyond the Stimulus: Implied Motion

Knowledge based motion perception

representational momentum (Reed and Vinson, 1996)



# Implied and Apparent Motion



Ramachandran and Anstis (1986)