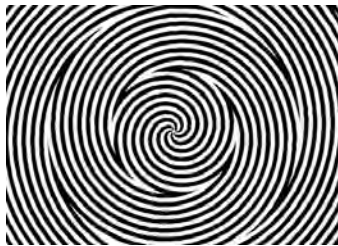


# Neural mechanisms of motion perception

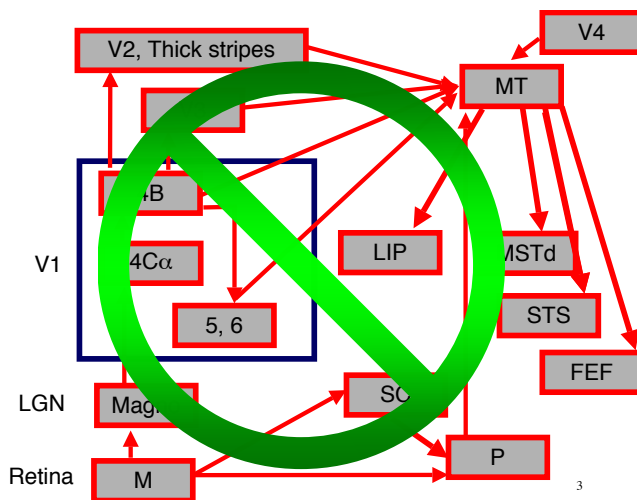


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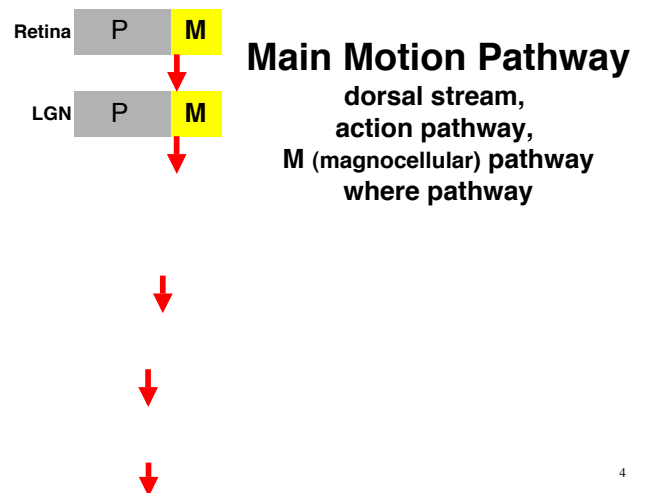
# Announcements

- Exam is on this THURSDAY!
- Review session is:
  - Wednesday, 6:15 - 7:30pm
  - Lattimore 201
- Your journals are due in class on November 17th
  - Type your entries
  - Check instructions posted online (on the syllabus page)

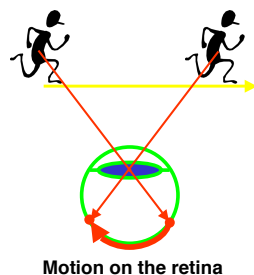
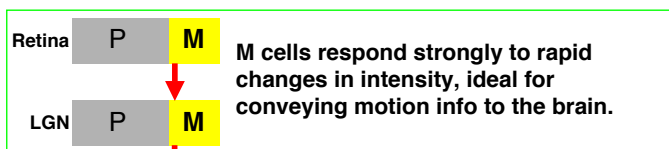
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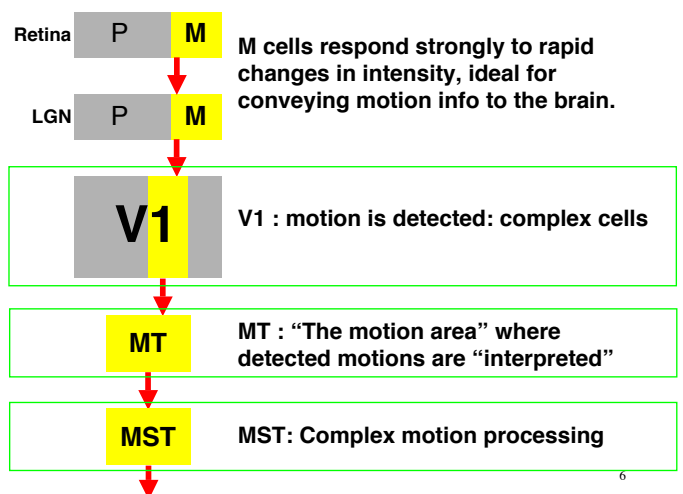
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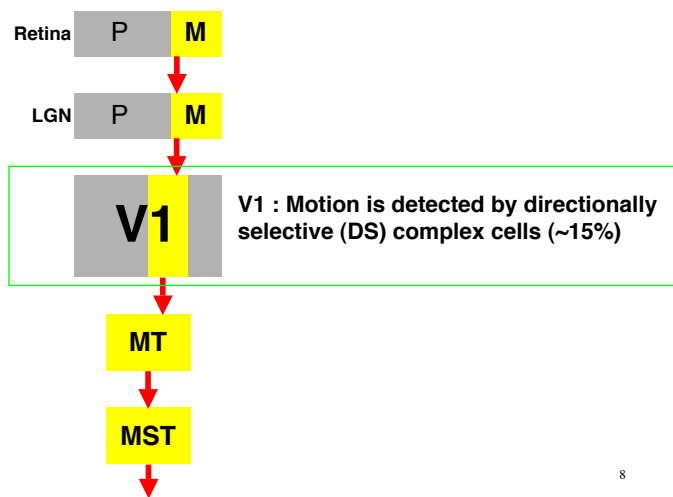
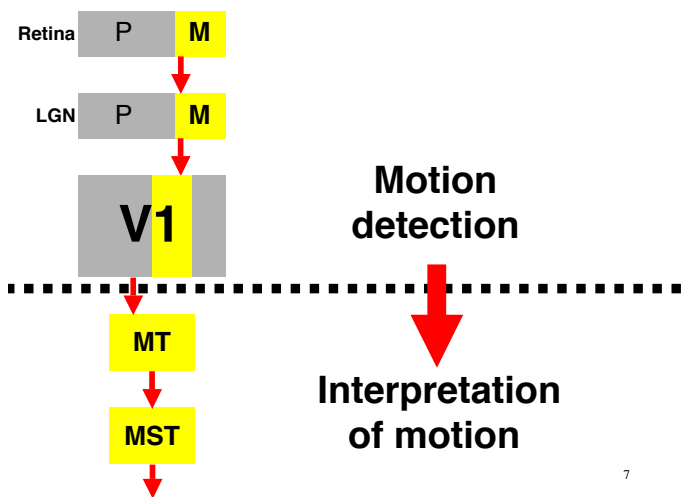
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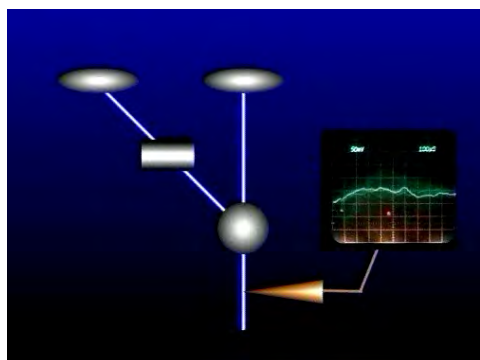
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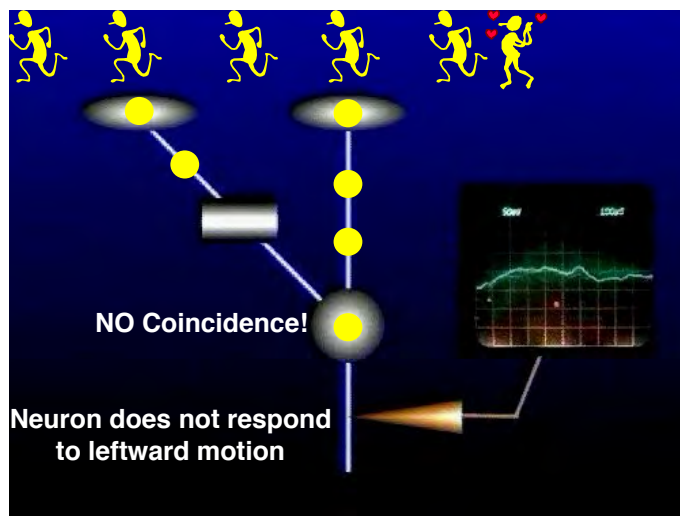
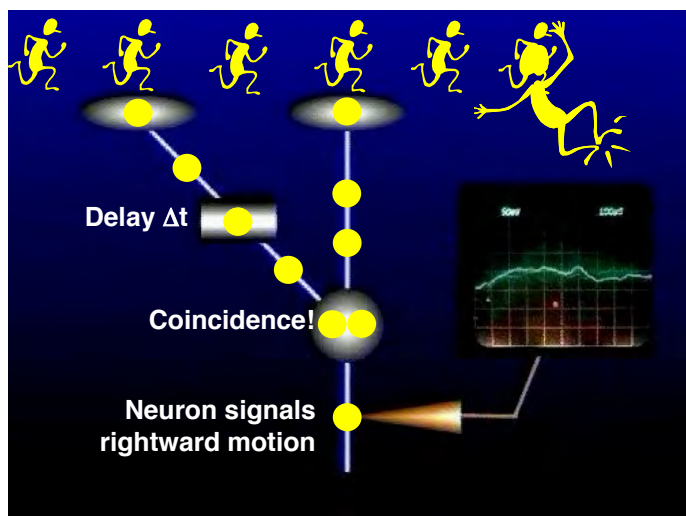
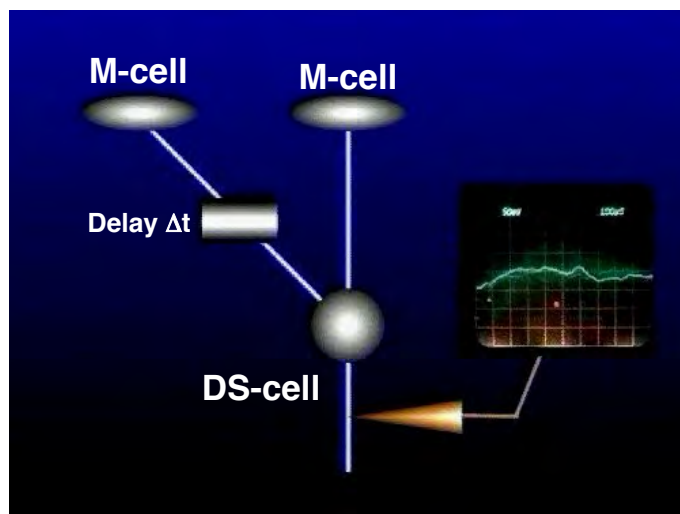
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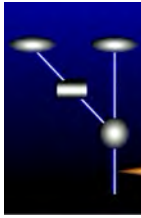


### How to detect motion?

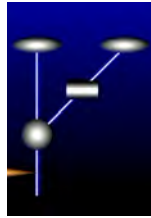


Motion Detector ~ Reichardt detector





Responds to rightward motion



Responds to leftward motion

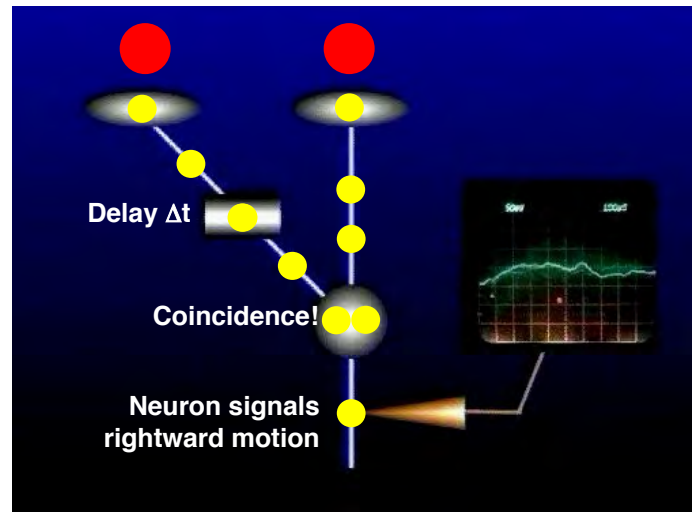
# Apparent Motion



13

14

# Apparent Motion



15

How is speed of motion encoded?

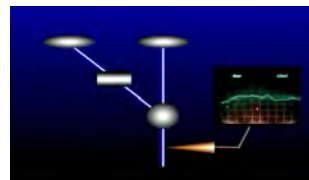


Fast motion

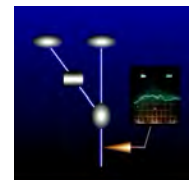


Slow motion

How is speed of motion encoded?



Fast motion

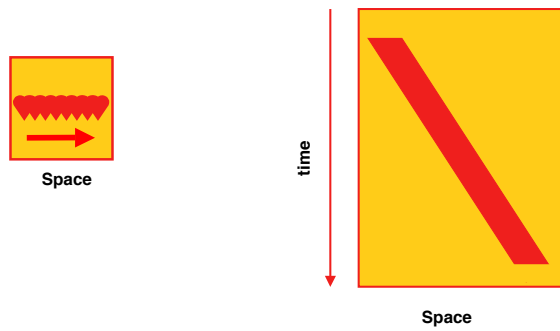


Slow motion

17

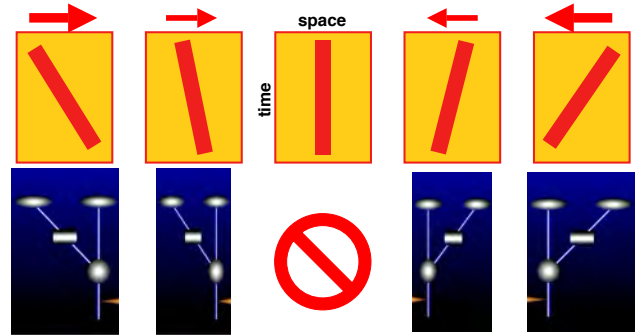
18

# Space/time Plot

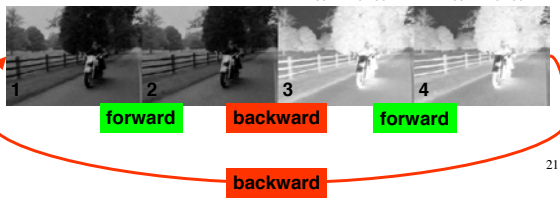


19

# How Can the Visual System Detect the "Orientation" of Motion Energy in Space/Time?

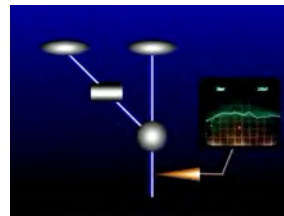


# Can we fool our motion detectors?



21

# Motion Detector ~ Reichardt detector

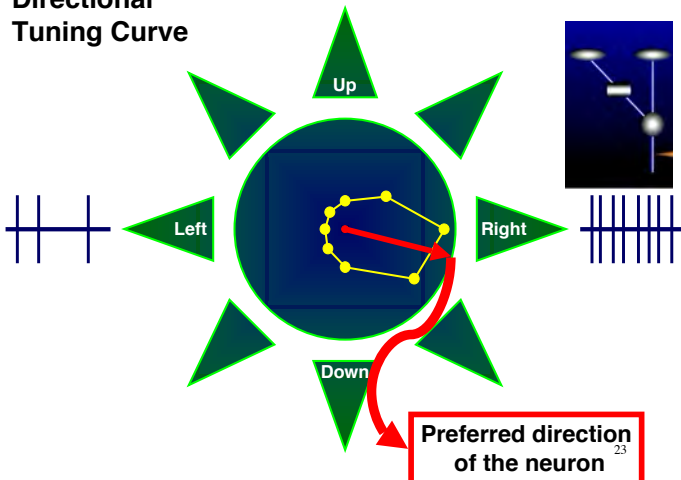


Good response to rightward motion,  
+  
Poor response to leftward motion  
but,  
How about vertical?

What happens if the direction of motion is slightly different from preferred direction?

22

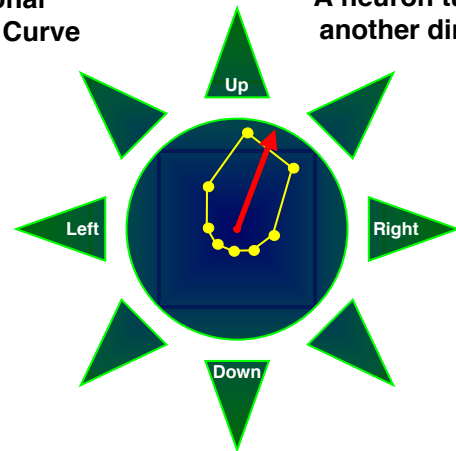
# Directional Tuning Curve



23

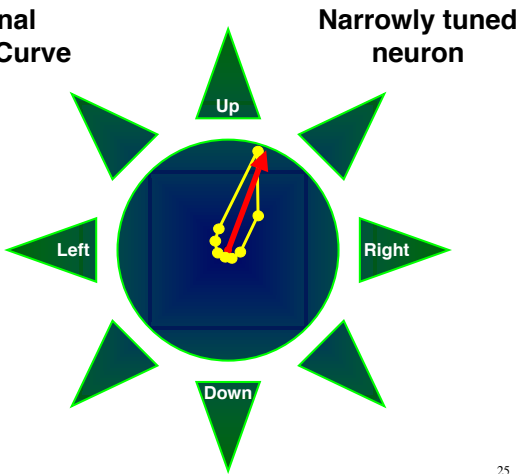
# Directional Tuning Curve

# A neuron tuned to another direction



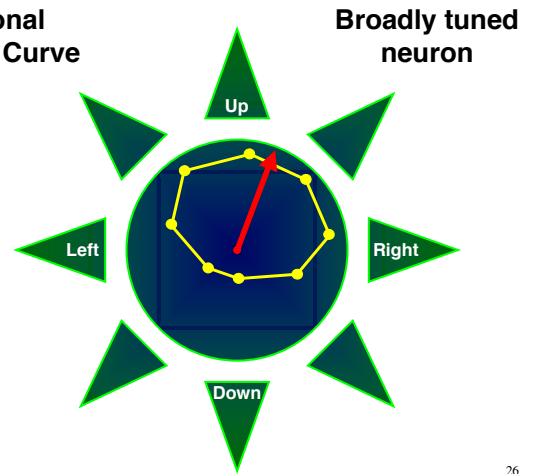
24

**Directional Tuning Curve**



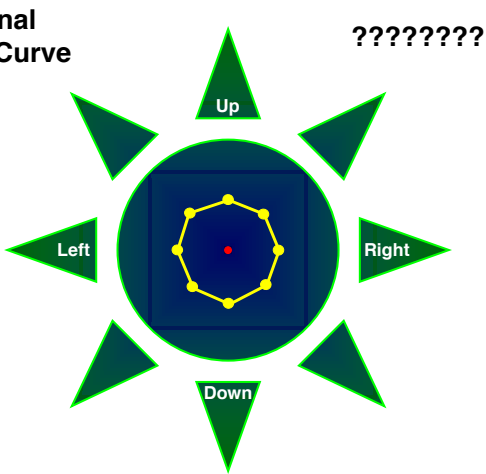
25

**Directional Tuning Curve**

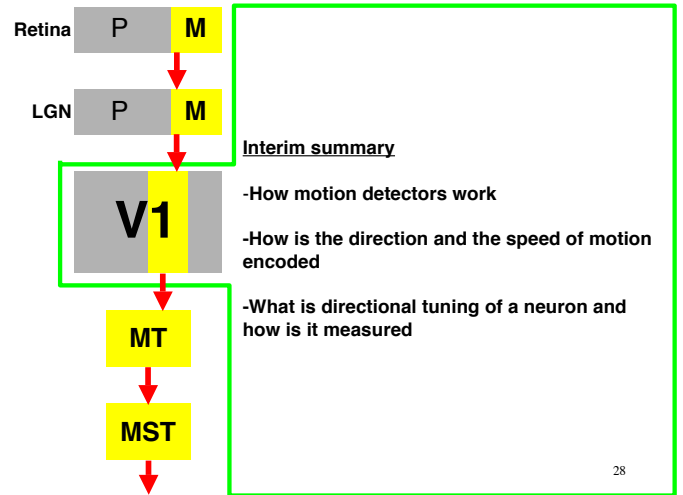


26

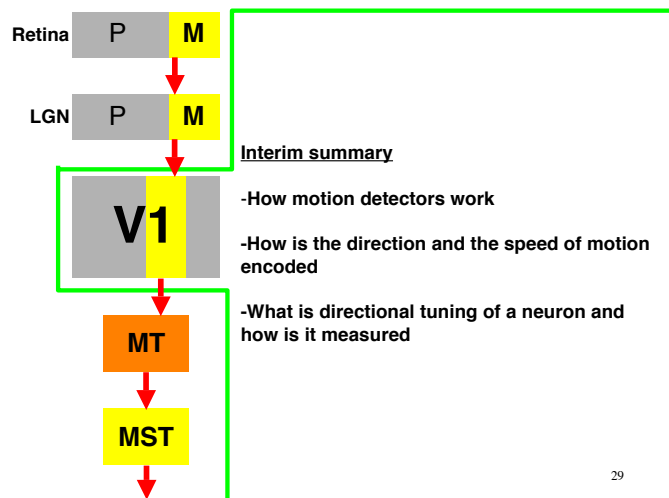
**Directional Tuning Curve**



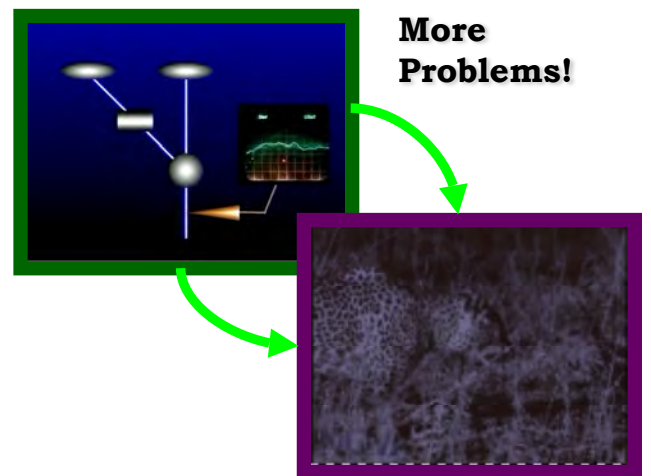
27



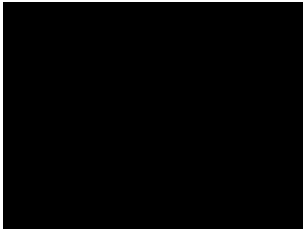
28



29



**More Problems!**



31

**More Problems!**



32

**More Problems!**

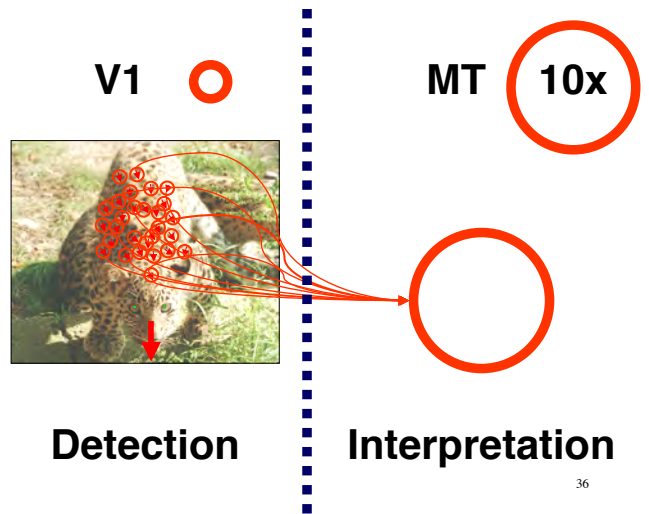
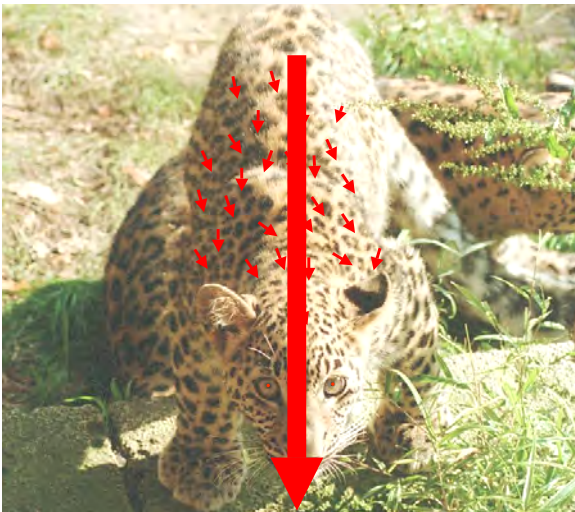


33

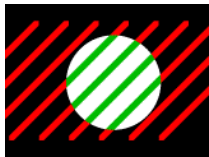
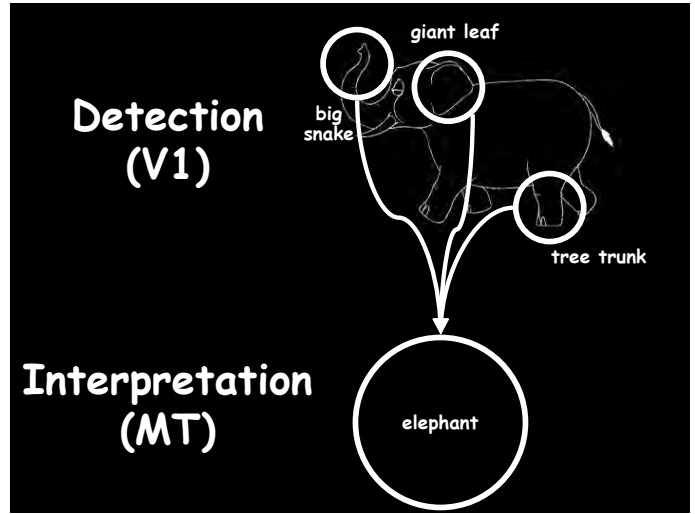
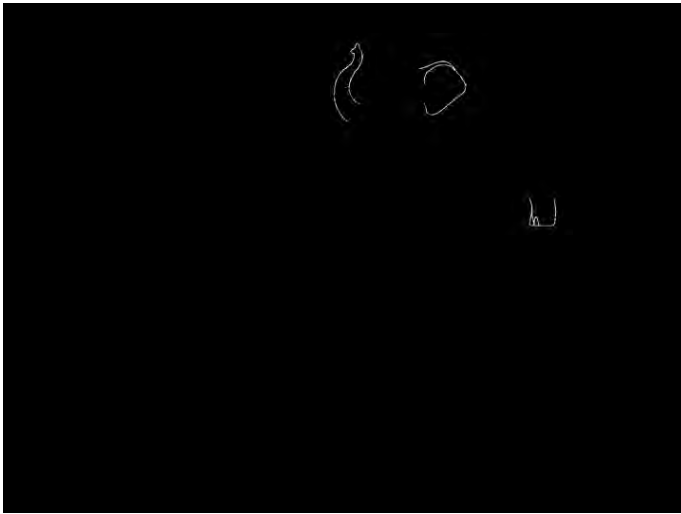
**More Problems!**



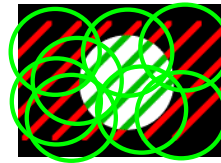
34



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**More Ambiguity!**  
Aperture problem



**More Ambiguity!**  
Aperture problem



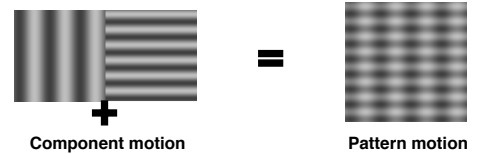
**Moral:**  
The response of one neuron is ambiguous. Combination of outputs among many neurons is necessary to resolve the ambiguity.



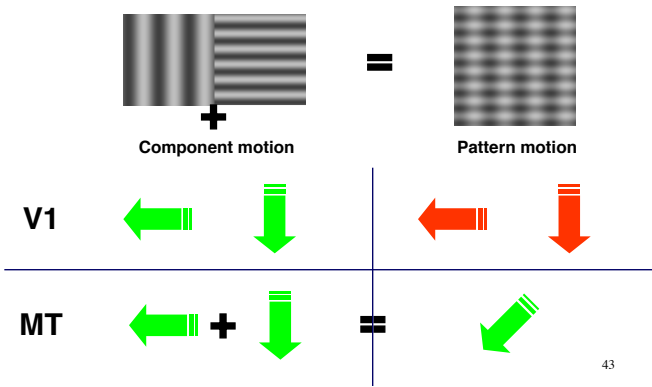
**Moral:**  
The response of one neuron is ambiguous. Combination of outputs among many neurons is necessary to resolve the ambiguity.

Aperture problem	V1	MT

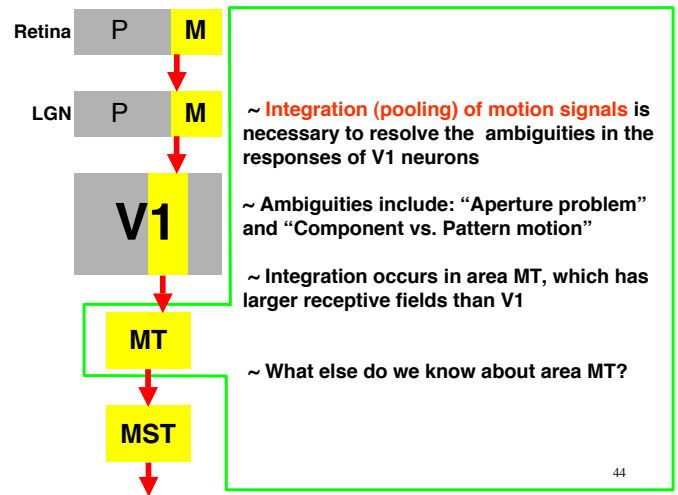
**More Ambiguity!**  
Component vs. Pattern motion



## More Ambiguity! Component vs. Pattern motion



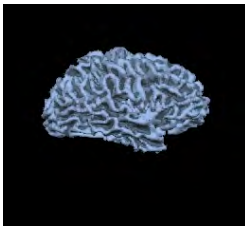
43



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### Where is MT?

Back of the brain  
Occipital Cortex

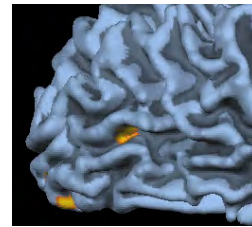


Front of the brain  
Frontal Cortex

45

### Where is MT?

Back of the brain  
Occipital Cortex

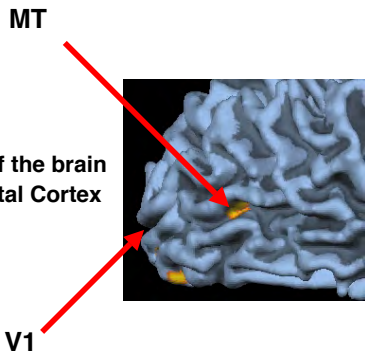


Front of the brain  
Frontal Cortex

46

### Where is MT?

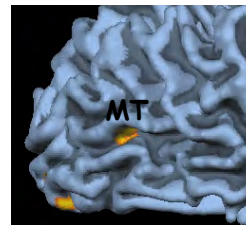
Back of the brain  
Occipital Cortex



V1

47

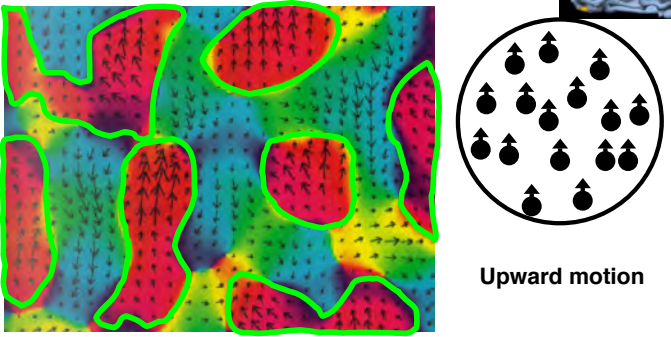
### Area MT is critical for normal motion perception



Akinetopsia  
(inability to perceive motion)

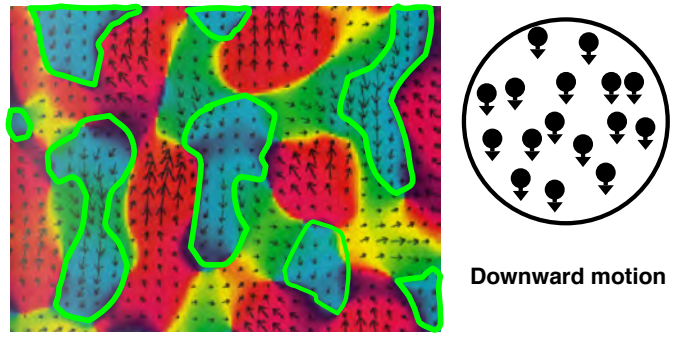
48

Directional maps in MT (using optical imaging)



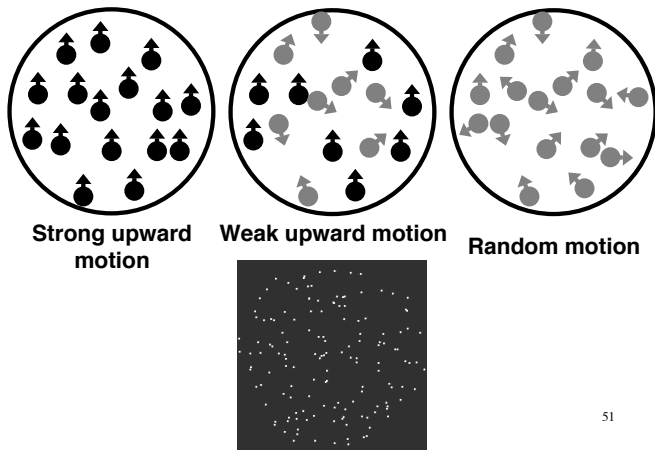
49

Directional maps in MT (using optical imaging)



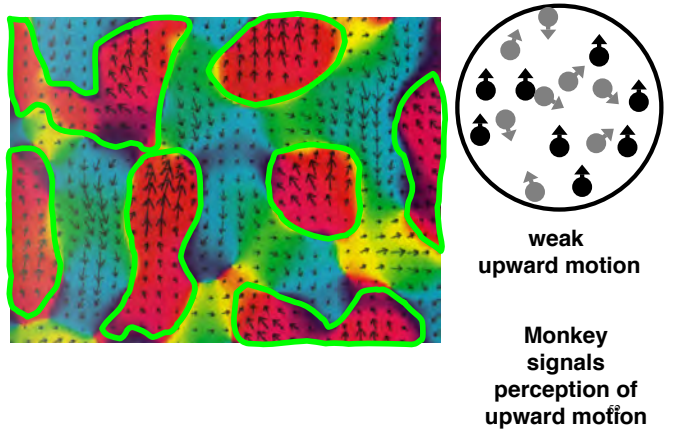
50

A way of manipulating motion strength: correlation

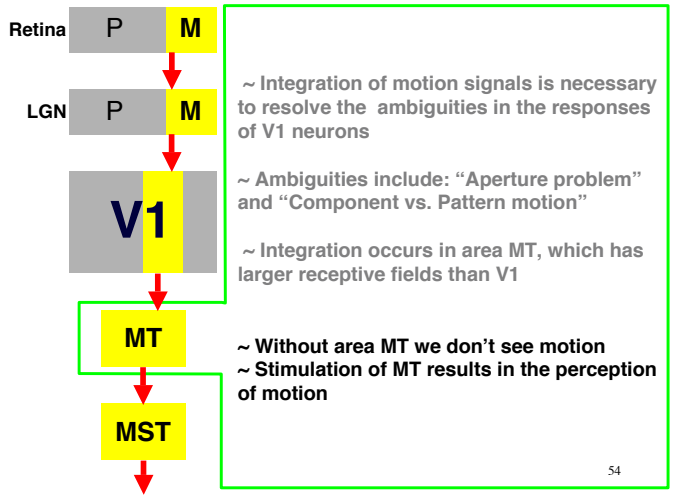
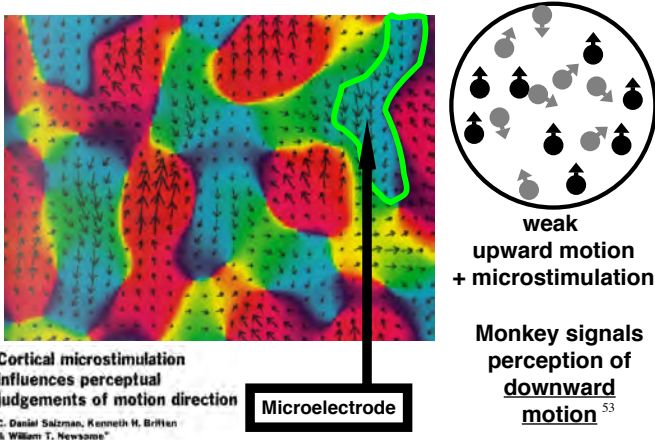


51

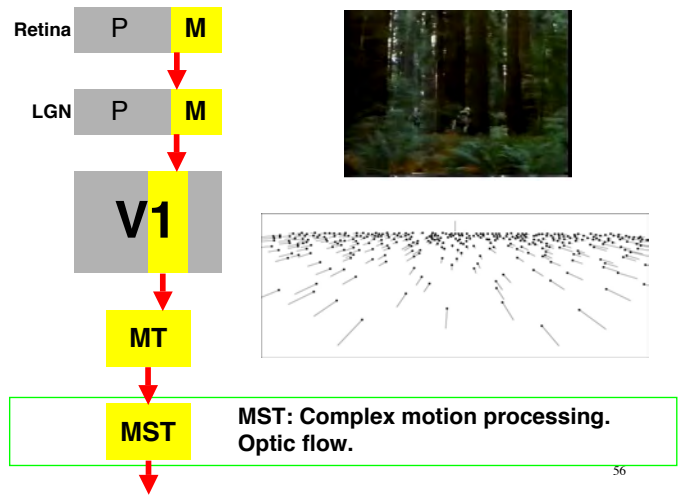
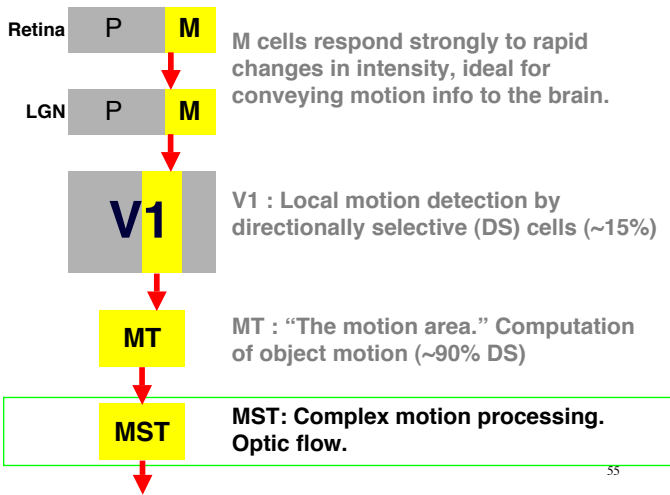
Directional maps in MT (using optical imaging)



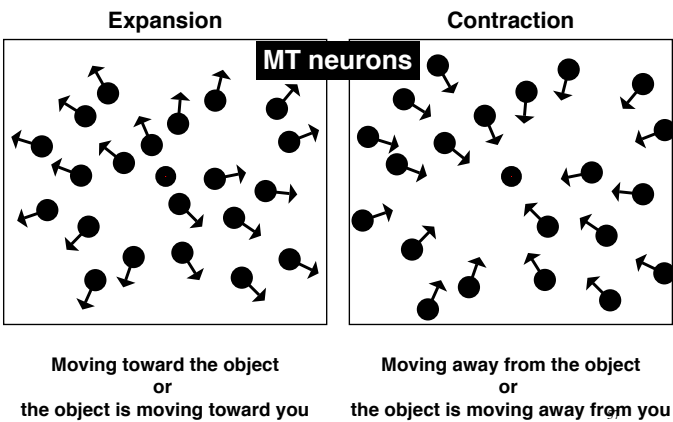
Directional maps in MT (using optical imaging)



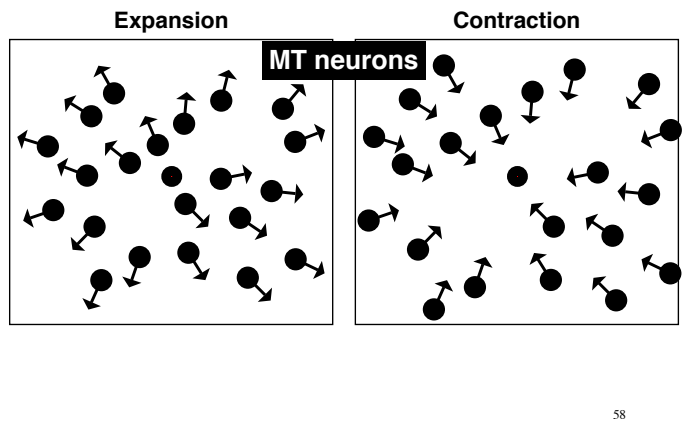
Cortical microstimulation influences perceptual judgements of motion direction  
 C. Daniel Salzman, Kenneth H. Britten & William T. Newsome\*



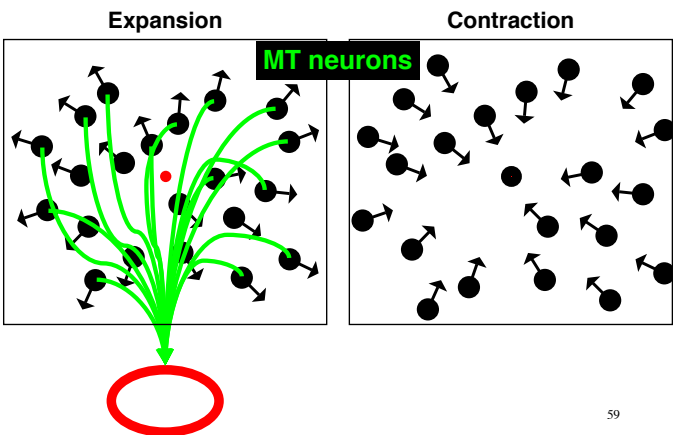
### Optic flow



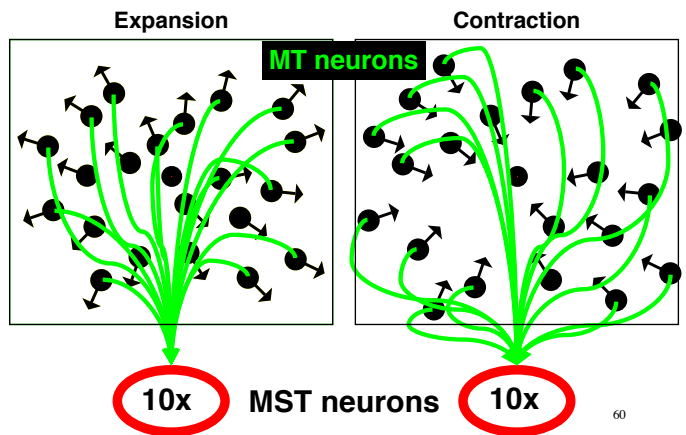
### Optic flow

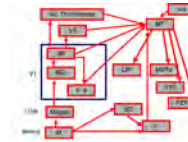
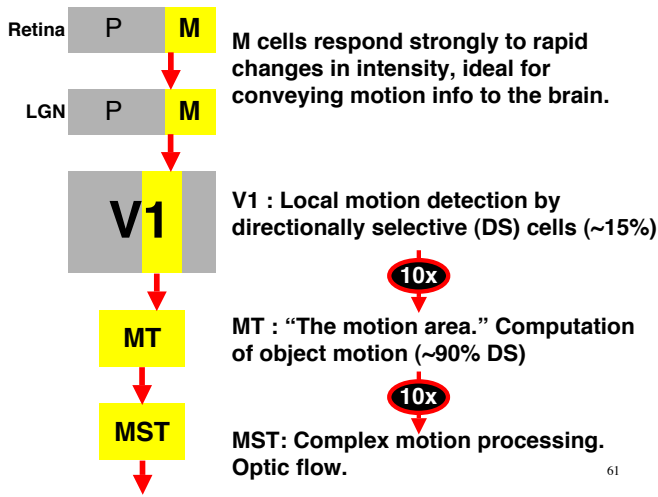


### Area MST & Optic flow

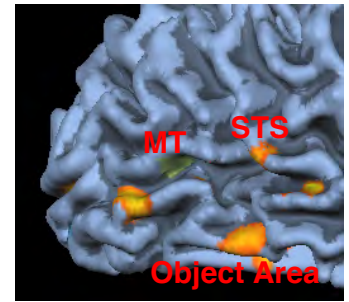
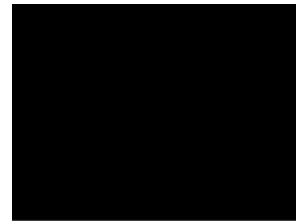


### Area MST & Optic flow

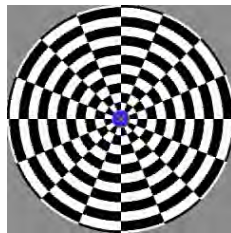




### Other Motion Areas, e.g.: Superior Temporal Sulcus (STS)



### Motion-after effect explanation



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### Brief history of MAE

...when persons turn away from looking at objects in motion, e.g. rivers, and especially those which flow very rapidly, they find that the visual stimulations still present themselves, for the things really at rest are then seen moving...

Aristotle, ca 330 BC

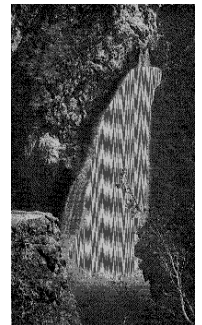
One time I observed a cavalry parade for more than an hour, and then when the parade had passed, the houses directly opposite appeared to me to move in the reversed direction to the parade

Jan Evangelista Purkyně, 1825

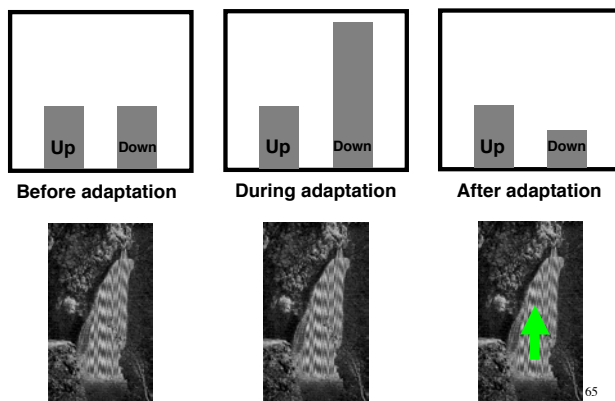
Having steadfastly looked for a few seconds at a particular part of the cascade, admiring the confluence and decussation of the currents forming the liquid drapery of waters, and then suddenly directed my eyes to the left, to observe the face of the sombre ageworn rocks immediately contiguous to the water-fall, I saw the rocky surface as if in motion upwards...

Robert Addams, 1834

1980 ... motion aftereffect ...



### MAE Explanation



### Accepted MAE definitions

The illusory impression, after **prolonged viewing** of movement in one direction, that a stationary object is moving in the opposite direction.

Blake & Sekuler (2006) *Perception*.

After **prolonged inspection** of a moving 'adapting' stimulus, a static 'test' stimulus appears to move in the opposite direction.

Anstis, Verstraten & Mather (1998) *TICS*

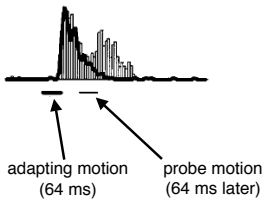
The motion after-effect (MAE) is a visual illusion experienced after viewing a moving visual stimulus **for about a minute** and then looking at stationary stimulus.

Somebody, *Wikipedia 2008*

66

### How does MAE timescale compare to the time-course of neural adaptation?

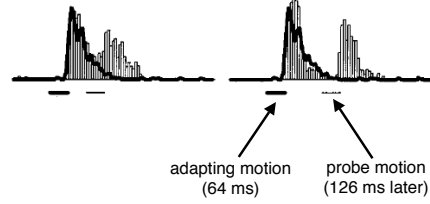
Rapid adaptation in MT  
Priebe et al., 2002, J Neurophysiology



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### How does MAE timescale compare to the time-course of neural adaptation?

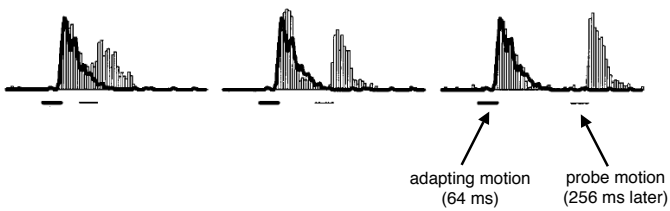
Rapid adaptation in MT  
Priebe et al., 2002, J Neurophysiology



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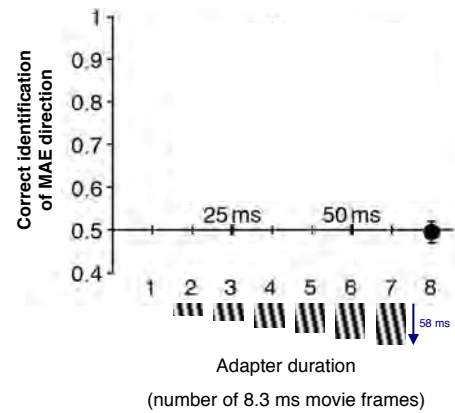
### How does MAE timescale compare to the time-course of neural adaptation?

Rapid adaptation in MT  
Priebe et al., 2002, J Neurophysiology



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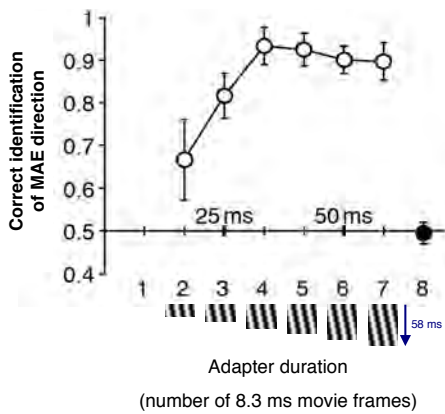
### Rapidly generated MAE



70

Glasser et al., 2011, PNAS

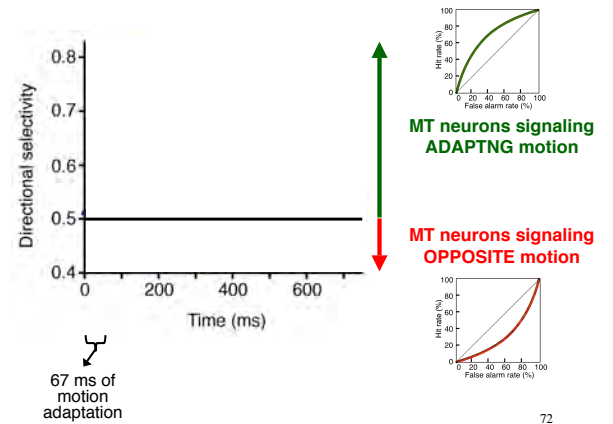
### Rapidly generated MAE



71

Glasser et al., 2011, PNAS

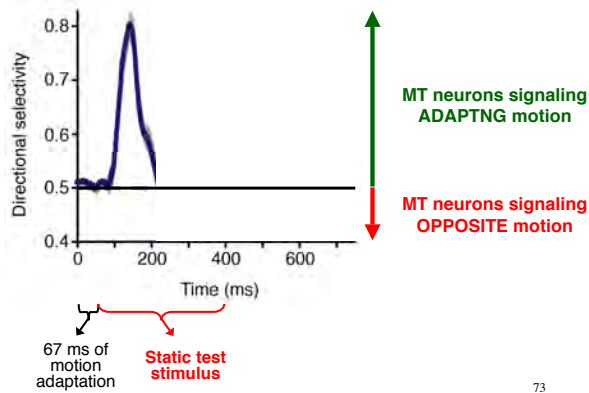
### Motion responses to static stimuli in MT



72

Glasser et al., 2011, PNAS

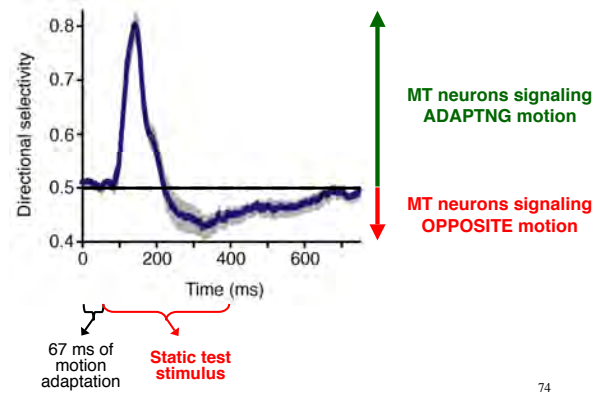
## Motion responses to static stimuli in MT



73

Glasser et al., 2011, PNAS

## Motion responses to static stimuli in MT



74

Glasser et al., 2011, PNAS

## Time to change the MAE definition

The illusory impression, after **prolonged viewing** of movement in one direction, that a stationary object is moving in the opposite direction.

Blake & Sekuler (2006) *Perception*.

After **prolonged inspection** of a moving 'adapting' stimulus, a static 'test' stimulus appears to move in the opposite direction.

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The motion after-effect (MAE) is a visual illusion experienced after viewing a moving visual stimulus **for about a minute** and then looking at stationary stimulus.

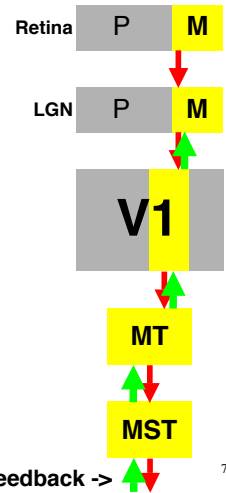
Somebody, *Wikipedia 2008*

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Is this the whole story?



Strong will-power can affect motion perception!



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