Motion Perception

Motion Perception (motion induced blindness)

Motion is critical for visual perception

• Without motion there is no vision!
• Motion breaks even perfect camouflage
  • Distinguishing objects from their backgrounds (figure-ground segregation)
• Perception of 3D layout of objects in the world
• Judging heading as we move through the environment, and perceiving “time to collision”
• Perceiving actions and intentions of other biological creatures
• Guiding balance and posture
• Oh yeah, perception of moving objects

30+ Motion-responsive regions of the human brain

Some of motion-responsive regions of the human brain

- V2, Thick stripes
- V3
- MT
- V4
- 4B
- 4Cα
- 5, 6
- LIP
- MSTd
- STS
- FEF
- SC
- P
- V1
- Magno
- LGN
- Retina

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Without motion there is no vision!

Keep staring at the black dot. After a while the gray haze around it will appear to shrink.

If retinal image is stabilized, vision fades away in seconds!

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Retinal image is constantly moving or jittering:
- sacades & microsacades

retinal image stabilization
Motion breaks even perfect camouflage

Where is the bird?

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Relative Motion Breaks Camouflage
from Regan (2000) Human Perception of Objects
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Optic flow
Flow pattern for level flight over the ground in a forward direction

Flow pattern for level flight over the ground in a lateral direction

Flow pattern during airplane landing

The optic flow pattern can be used to negotiate curves while steering a car.

Movement along a straight stretch of road. Correct negotiation of a curved stretch of road. Incorrect negotiation of a curved stretch of road. The car will go off the road unless a steering correction is made.
Motion can provide “time to contact” information

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Perceiving actions and intentions of other biological creatures

http://www.biomotionlab.ca/Demos/BMLwalker.html
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- Guiding balance and posture
  - Together with the vestibular system
- Oh yeah, perception of moving objects

Basic issues in motion perception

- What is motion?
- Apparent motion
- Contextual effects in motion perception
- Representing motion in space-time plots
- Eye-movements & motion perception
- In-class MAE experiment

The optic flow pattern is used to maintain balance while standing upright.

https://www.youtube.com/watch?v=52N5Amkz5KI
What is motion?

Aristotle: Motion is a property independent from "location" and "time."

Democritus: Motion is a nothing more than presence of objects in certain "locations" at certain "times."

What is motion in physics?

Sir Isaac Newton: Motion is a change in position over time. It seems that Democritus’ idea won in physics!

What is motion in perception?

- There are several conditions that we perceive motion without any change in location!
- There are pathological conditions in which the patient can perceive locations but cannot perceive motion!

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Producing motion perception from successively exposed static images: Apparent Motion

"Oh, I really couldn’t tell you whether it was good or bad, but I think it’s worth the price of admission just to see the illusion of motion created by what is actually a sequence of rapidly projected still pictures."

Apparent Motion
Apparent Motion

Apparent Motion: two possible paths

Apparent Motion: ambiguous motion paths

Sampling real motion to produce apparent motion

Imagine taking a series of photographs of a smoothly rotating object
**Sampling** is a discrete observation or measurement, while **Aliasing** is an illusion, appearance of something that is NOT, due to shortcomings of sampling.

**Sampling real motion:**

Wagon wheel illusion

Sampling is a discrete observation or measurement, while Aliasing is an illusion, appearance of something that is NOT, due to shortcomings of sampling.

The wagon wheel illusion

If these frames were played in succession, which way would the wheel appear to be rotating: clockwise or anticlockwise?

This quote from the NPR story is wrong:

In essence the camera in our brains can’t keep up with the spinning spokes so it appears to us that the spokes are moving backwards.

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**Motion perception depends on context:**

the “aperture” problem

No aperture

aperture

Barber pole illusion

http://www.purveslab.net/seeforyourself/
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A simple way to think about motion: The space/time plot

Apparent motion

The space/time plot

Real motion

The space/time plot

Space
Basic issues in motion perception

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How can the visual system detect the “Orientation” of notion energy in space/time?

Does this remind you of another aspect of neural processing that the visual system accomplishes?

“eye” movements a problem for motion perception

Our eyes (and bodies) are inconstant motion. Consequently, the presence of motion on the retina does not require that motion actually occurred in the real world.

How does the brain sort out real motion signals from “fake” motion signals?
One way of addressing this problem is to exploit information from neural signals to the eye muscles. These signals produce a *corollary discharge* that is compared with the outputs of motion detectors. If the retinal motion is as expected due to eye movements, then NO motion is perceived.

Analogous to “CC” in emails.

This system can be fooled if the eyes are moved manually with a finger or if the eye muscles are paralyzed so that intended motor commands have no effect.

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**MAE experiment**

Adapt + Test