Motion perception

PSY 310

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Lecture 23

Where would you grab this branch?

Motion and survival

- Almost all animals with vision are very sensitive to motion
- Motion contributes to object perception and figure-ground identification
  - Camouflaged objects become visible with motion (Hidden item)
  - Small details in motion dramatically change figure-ground relationships (Moving rings)
  - Object properties vary with motion (Teapot)
- Like everything else in sensation and perception
  - Our percepts of motion generally track some important characteristics of things in the real world
  - However, the percepts are based on certain computations of visual information and do not always correspond to true motion
Types of motion

- Our textbook describes four ways of producing a motion percept
  - There are actually many more
- Real movement
- Apparent movement
- Induced movement
- Motion aftereffect

Real motion

- For a physical object to get from one place to another, it must cover some path in between
- We do not detect all movements
- Some things move too fast
  - Light
  - Blurs
- Some things move too slow
  - Hour hand of a clock
Apparent Motion

- When objects move, there is a continuous path of motion
  - But, continuous paths are not necessary for motion to be seen
- Motion in movies, TV, computers is all apparent motion

Korte’s laws

- Apparent motion was highly studied at the turn of the 20th century
  - Korte (1915) noted that to get good motion, you needed to increase the ISI between the stimuli as the distance between them increased
- ISI just right
Korte’s laws

- Apparent motion was highly studied at the turn of the 20th century
  - Korte (1915) noted that to get good motion, you needed to increase the ISI between the stimuli as the distance between them increased
- ISI too brief (simultaneity)
Korte's laws

- Compare to CogLab data (68 subjects)

Induced movement

- A non-moving object can appear to be moving if objects around it are moving
- Sometimes with the flow of motion
  - Example from textbook
- Sometimes the opposite direction
  - Nearby car or train moves, but it feels like you have moved
  - Moon-in-the-clouds illusion
- Hard to demo because they work best in isolated conditions
  - Motion dominates the field of view, while the induced object is isolated within the field
Movement aftereffect

- competition between opposite directions of motion
  - Left-right
  - Up-down
- habituating gate
- offset of one direction leads to rebound in other
- Motion aftereffect

Detecting motion

- Just like depth, brightness, color, and many other aspects of perception
  - We do not have direct awareness of motion
- Instead, the visual system computes motion based on patterns on the retina
  - Both space and time
  - And using information about movement of our bodies / eyes
- Your textbook gives a description of a simple circuit to detection motion
  - It is not a good model of motion detection
  - Although it could be elaborated to work properly
It’s instructive to discuss the problem with the textbook model because it highlights some aspects of motion perception.

Here’s a little diagram of the model:

- Suppose a dot moves from left to right.
Textbook model

- When the dot is here it activates these cells

Textbook model

- Which inhibits the other cell
- Meanwhile the dot is moving
When the dot hits here, the cell may still be inhibited, even though the receptor is excited.

No motion detected.

Suppose a dot moves from right to left.
When the dot is here it activates these cells

The signal continues even while the dot moves
When the dot reaches the other receptor, that receptor responds and inhibits the other cell, but it is too late to stop the motion signal.
Textbook model

- What’s the problem?
- A motion detector should not respond to a stationary dot
  - But this circuit does

Reichardt detector

- A better model looks similar, but has different calculations
- Here the signals from the two receptors multiply
- The signal on the left is delayed relative to the one on the right
Suppose a dot moves from right to left. Here it activates the receptor. There is no motion signal because the x-cell needs input from both sources.

The dot moves.

Reichardt detector

- Suppose a dot moves from right to left
- Here it activates the receptor
- There is no motion signal because the x-cell needs input from both sources

Reichardt detector

- The dot moves
Reichardt detector

- The dot moves and the first receptor signal fades

Reichardt detector

- When the dot is here, the receptor responds
Reichardt detector

- When the dot is here, the receptor responds
- There is a delay before the signal goes to the x-cell, but only one source, so no motion signal

Reichardt detector

- Consider left-to-right motion

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Reichardt detector

- When the dot is here the receptor responds

Reichardt detector

- When the dot is here the receptor responds
- There is a delay, and the dot moves on
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Reichardt detector

- When the dot is here, the other receptor responds
- And the x-cell receives inputs from two sources, so there is a motion signal

![Diagram of Reichardt detector with movement and inputs](image1)

Reichardt detector

- A non-moving dot generates only one source to the x-cell
- No motion signal

![Diagram of Reichardt detector without movement](image2)

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Detecting Motion

- Here’s a fancier version of the same thing

Detecting Motion

- Detecting motion properties is sometimes difficult
  - Speed
  - Direction
- Any detector (e.g., neuron) sees only part of the visual scene
  - Elements in the scene may produce ambiguous motion or non-ambiguous motion depending on their shape and their motion
Aperture problem

- A detector that only sees part of a scene cannot precisely identify the motion direction or speed of an edge

The same thing is true for whole gratings

- It's a property of physics, not of the brain
  - Everything is the same inside the aperture
Aperture problem

- The aperture problem has a big impact on how the visual system represents and computes motion percepts
  - Two squares demo
- We'll address this more next time

Conclusions

- Motion perception
- Ways of creating a motion percept
- Apparent motion
- Reichardt detector
- Aperture problem
Next time

- Organization of motion signals to produce a motion percept
- Eye movements versus stimulus movements