Action and perception

PSY 310

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Lecture 26

How does he know where to go?

Perception

If you asked a physicist or engineer how perception guides action they would likely say that you do something like:

- Identify object properties in the world
  - Color
  - Shape
  - Position
  - Motion
- And then use that information to predict what would happen next
  - If you do something
  - Where the objects will be

Getting the information

With this approach, you have to get a lot of information

- Speed, velocity, position
- This can be difficult
  - e.g., to find the Focus Of Expansion

Crossing the street

Suppose you want to cross a busy street

- You have to be able to judge whether a car is going to hit you before you cross
  - And leave room for errors!
  - Softball video

Time To Collision

To estimate the Time To Collision (TTC), you might think you have to work with physics

- Suppose a truck is 100 yards away and moving at 45 mph (22 yards per second)
- Then, the TTC is distance divided by velocity
  - TTC = 100 yd / 22 yd/s = 4.54 seconds

So from the perspective of physics you have to figure out properties of objects in the world

- Distance of the object (difficult). 100 yards is too far for disparity
- How fast it is moving (difficult)
- All before everything changes and you get squashed
It turns out that you can get the same estimate from the flow field and you don't have to compute the distance of the object or the speed of its forward movement. All you have to know are the properties of patterns on the retina.

You can work entirely with visual angle.

\[ \tan \left( \frac{\theta}{2} \right) = \frac{s}{d} \]

If the angle is small enough (the object is small or far away), the tangent is almost the same value as the angle.

\[ \frac{\theta}{2} \approx \tan \left( \frac{\theta}{2} \right) = \frac{s}{d} \]

Move things around a bit with algebra.

\[ s = \frac{\theta}{2} d \]

Now take the derivative (calculus) to see how things change over time (use the chain rule).

\[ 0 = \frac{1}{2} \left( \theta d' + \theta' d \right) \]

Get rid of the 1/2.

\[ \frac{d}{d'} = -\frac{\theta}{\theta'} \]

d' is the forward velocity of the object.

Solve for d/d' (Time To Collision).

This estimate is called Tau.
**Time To Collision**

- The visual angle and its change can all be estimated on the retina.
- One never has to estimate the object’s actual size or velocity!

\[ \frac{d}{d'} = \frac{\theta}{\theta'} \]

**Ecological Psychology**

- This analysis is an example of a branch of perception called ecological psychology (J. J. Gibson).
- It claims that you can find simple calculations from the visual scene (and flow fields) that correspond to important information for a person.
- Note, the claim is that the calculation is simple for the visual system, not that it is easy to find them or to prove why they work.
- Tau could be used to estimate Time To Collision, but is it actually used?

**Virtual Braking**

- Use a virtual reality setup to explore how people brake to stop just in front of a (virtual) target.
- Control the perceived speed and size of the target.

**Virtual braking**

- Manipulate the perceived size of the target (shrink or grow in size)
  - This should change the tau estimate of needed stopping time
  - It shouldn’t do anything to perceived distance of the target

**Virtual braking**

- Subjects adjusted stopping distance (when they first brake) to be larger with faster velocities.

**Reaching objects**

- You can do similar analyses for getting to an object that is moving.
- How do you catch a baseball?
  - You might think that you have to know the baseball’s speed, acceleration, and trajectory and aspects of wind.
  - But you do not.
  - There is a simple optical strategy.
To catch a ball, run in a way so that the ball appears to be on a straight path.

You can prove it mathematically, but we won’t.

There are other strategies as well.

We perceive, in large part, to determine what kinds of actions we will perform.

The perceptual system (or judgments based on the perceptual system) appear to be modified by our intended action.

Judging the steepness of a hill.

Demonstration.

In general, people are not good at reporting the slant (steepness) of a hill.

Even when viewed from the side.

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Even when viewed from the side.
Interestingly, the effect is only for visual judgments or verbal reports.

If asked to adjust the angle of the hand to match the angle of the hill, there is pretty good agreement.

Slant estimates of hills depend on:
- Fatigue (more steep when fatigued)
- Wearing a heavy backpack (more steep)
- Poor physical condition (more steep)
- Difficulty of walking on the hill
  - For a particularly steep hill (30 degrees), you can climb up, but not climb down.
  - Subjects on top of a hill judge the hill as being more steep.
  - Subjects at bottom of the hill judge the hill as being less steep.
- Fear (stand on a skateboard at top of hill vs. stand on box at top of hill)
- Does it really change the perception of the hill?
  - Or is it just the interpretation of the perception that changes?
  - And what does this question mean?

You can get the same effect with virtual environments.

People use flow fields to maintain balance:
- Changes in the flow indicate self-movement
- Can even compensate for other cues for balance (inner-ear)
- Construct a swinging room
- Move the outside walls only
- The floor does not move

The movement of the walls and ceiling lead to a flow field that indicates movement:
- 26% of toddlers sway
- 23% stagger
- 33% fall over
- Adults behave similarly
- So do children too young to stand.
Conclusions

- Action and perception are closely linked
- There are fairly simple ways to use the retinal optics to guide action behavior
  - Time to contact
  - Catching a baseball
  - Balance
- The visual system is not always as smart as it seems!
  - Do not need to know everything about the environment if the end goal is to drive behavior

Next time

- Some other relations between perception and action
- Simon effect CogLab due
- Applying perceptual psychology to the design of various devices