Navigation 3: Representing places
Kid & Brain Evidence

So far
Core System 1: Path Integration
   Ants
   Bees
   Baby Goose
   Gerbil
   Infants, with active locomotion
   Adults, when engaged

Core System 2: Scene Recognition
   Bees, as a view-dependent snapshot
   Rats
   Adults, 2 versions:
      1) view-dependent, like a bee
      2) view-independent, that can be integrated with vector information from path integration

Core System 2: Scene recognition in children, Piaget’s three-mountain task

Piaget’s three-mountain task: findings
At 5 years, children are egocentric: choose the picture with the view that matches their own.
At c. 7 years, children start to choose the other picture.
Interpreting Piaget’s findings

Piaget:
• Young children fail to represent Euclidean spatial relationships (distance, direction)
• Young children are “egocentric”: fail to take account of changes in perspective
• Spatial representations are constructed over middle childhood, through active processes of coordinating different perspectives on a scene.

An alternative interpretation: children have the same basic systems of spatial representation as adults: view-dependent representations of scenes, updated by path integration.

Core System 2 (scene recognition) is important for recognizing the world from where YOU are, not for imagining what the world might be like if you were someplace else.

Testing the two interpretations

5 year olds (Huttenlocher & Presson, Rieser)

Conditions:
1: scene is covered, child moves to other side & chooses picture.
2: scene is covered, table moves.
3: scene is covered, child imagines moving to the other side (Piaget’s expl.)

Children’s scene representations: Conclusion

Young children, like adults & bees, construct view-dependent representations of scenes.

Young children, like adults, update these representations by path integration during travel.

Children’s spatial representations are encapsulated leading to a failure in the perspective-taking version of the task (not readily accessible to conscious thought & problem-solving).

This limit is overcome with development (7 year olds pass the 3-mountain task)

Core System 2: Scene Recognition in the brain

How does the brain recognize where you are?

Our Friend: The Hippocampus
An animal model: The rat

- Hippocampal anatomy is very similar in rats and humans.
- Rats and humans show similar deficits from hippocampal lesions.
- 2g
- 150 million neurons

Where is the hippocampus?
Homologous structure to human hippocampus

Major Substructures of the Hippocampus

Cellular Level
(don’t need to know this)
Place Cells in Rats

- Go To Flash
- In the rat, evidence that single cells respond preferentially when a rat is in a particular place.
- Somewhat an open question whether these cells are view-dependent or view-independent

Core System 2: Scene Recognition in the human brain

But, in humans we have behavioral evidence for 2 kinds of scene representation: view dependent (bees) & view independent

View dependent = like picture matching
View independent = like a geometric map of a space

Can we find evidence from single-cell recording in the human brain for 2 kinds of cells?

Scene Recognition in human adults: Neuroimaging Studies

Our Friend: The Hippocampus
Scene Recognition in human adults: Neuroimaging Studies

The hippocampal region in more detail

Ekstrom et al: Place cells in humans

- Patients suffering from epilepsy
- Before surgery on the brain, patients play a computer navigation game while doctors record from individual neurons (≈ 300)
- The game: pick up passengers and take them to particular shops

Ekstrom et al: Place cells in humans

- Shops looked like this
- Spatial layout of the board looked like this
Ekstrom et al: Place cells in humans

• But while people played it was in 3-D like this

Ekstrom et al: Place cells in humans

• A place cell in humans (go to pdf)
• Many cells in the parahippocampal cortex are view independent cells that represented the position of a particular shop regardless of view (unlike bees)
• A few cells, dispersed throughout the temporal lobes are view dependent cells that represented a particular shop viewed only from a particular position (like bees)

Scene Recognition in human adults: Neuroimaging Studies

The hippocampal region in more detail

- Perirhinal Cortex: Recognizes individual objects as familiar
- Hippocampus: Represents the spatial relationships between known objects
- Parahippocampal Cortex: Represents a view independent layout of the geometry of scenes

Next Time: Core System 3, Reorientation Module. May also rely on Parahippocampal Cortex.