ACT-R/S Coordinating Spatial Representations

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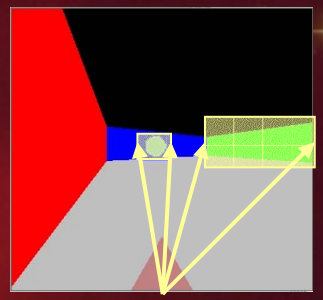
ACT-R/Spatial

Two spatial components, in addition to /PM

- Configural
  - Represents spatial extents of objects that are updated during self-locomotion
  - Supports navigation, path-computation, object avoidance

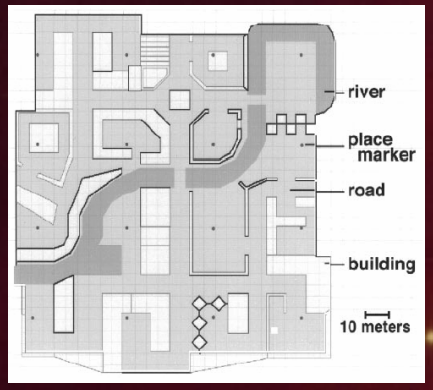


- Manipulative
  - Represents metric spatial bounds of an object
  - Supports spatial transformations of representations (rotation, translation, deformation, etc.)

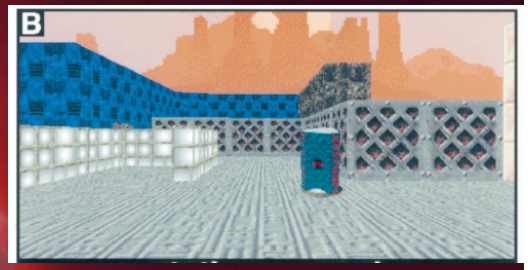
Representational Coordination

- Rat model (ICCM, 2003) could navigate in an open environment using only the *configural* system.
- Many spatial tasks (at least the ones we find interesting) require multiple spatial representations

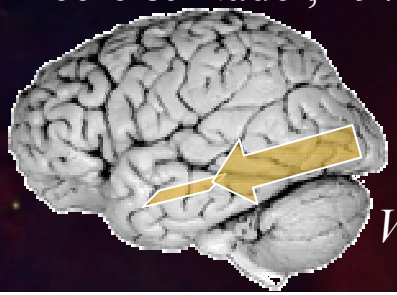
- Is there support for the multiple spatial representation hypothesis?
- What does this coordination entail?



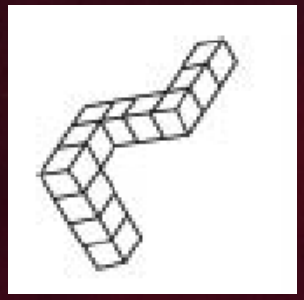
Navigation Studies



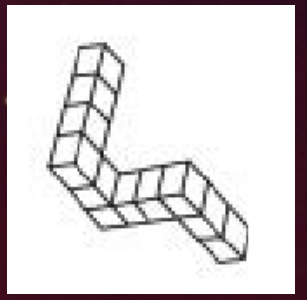
- Navigation from one landmark to another in a semi-closed, complex environment
  - Most landmarks are local
  - Large, distal, constantly viewable landmarks are common
- Neurologically primarily taps ventral visual stream, with task related activation strongest in hippocampal regions
  - fMRI (e.g. Maguire, Frackowiak, Firth, 1997)
  - PET (e.g. Maguire, et al. 1998)
  - Single-cell (e.g. O'Keefe & Nadel, 1978)



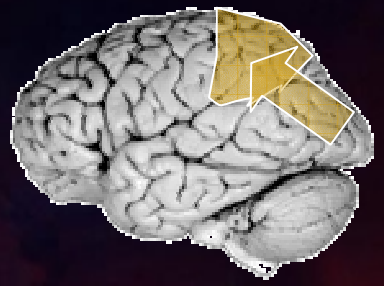
Ventral Stream



Spatial Transformations



- Mental spatial transformations (rotation, scaling, translation, deformation)
- Consistently recruits dorasl visual stream, with greatest task related activation in parietal regions.
  - fMRI (e.g. Jordan, Hiinze, Lutz, Kanowski, & Jancke, 2001)
  - PET (e.g. Alivisatos & Petrides, 1997)



Dorsal Stream

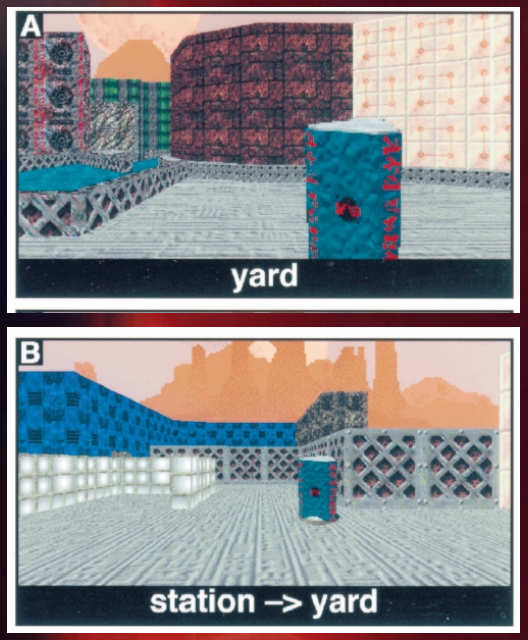
Dual Spatial Systems?

- Virtually all navigation studies also report significant parietal activation
  - Relegated to secondary role
  - Computation of body turns necessary to orient towards the destination, aka. “do I turn left or right?” (Maguire, et al. 1998)
  - Hippocampal region is performing **all** the task-dependent spatial processing

- Can the relative roles be teased apart better?

Navigational Decomposition

- Aguirre & D'Esposito's (1997) fMRI study looking at both systems with different navigation tasks
  - "Where am I?" - Landmark identification and localization.
    - Parahippocampal activation
  - "Where am I going?" - Computing destination location.
    - Parietal activation



- Didn't correlate spatial processing demands with regional activation

Coordinating Multiple Representations?

- Is there support for the multiple spatial representation hypothesis?
  - Yes *(I'll talk about our data in a few minutes)*
- What does this coordination entail?

a thought experiment . . .

Task : get to the post-office from the LRDC

1. "Where am I?"
   - Landmark identification
   - Localization

2. "Where am I going?"
   - Spatial transformations
   - Determine destination location

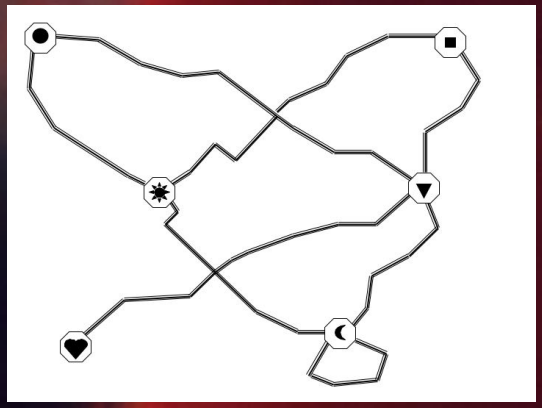
Modeling

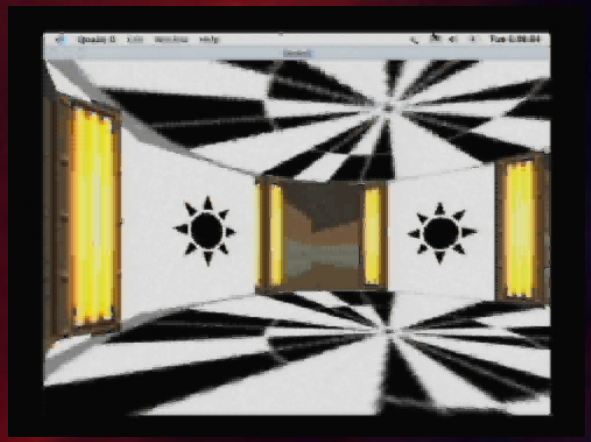
- Extending rat model to utilize both systems (configural & manipulative)

"What data are you actually going to model?"

Multiple Representations in Navigation

- Virtual navigation in an environment where there are no distal landmarks
- Hippocampal task-demands:
  - All spatial localization must be done locally
- Parietal:
  - Determining destination location

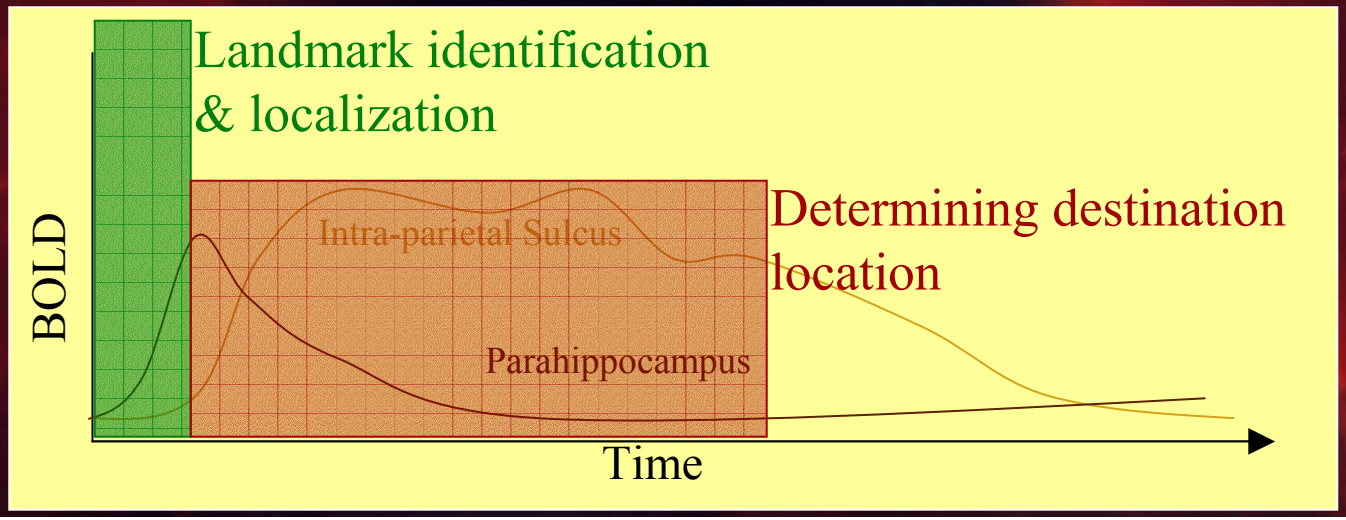




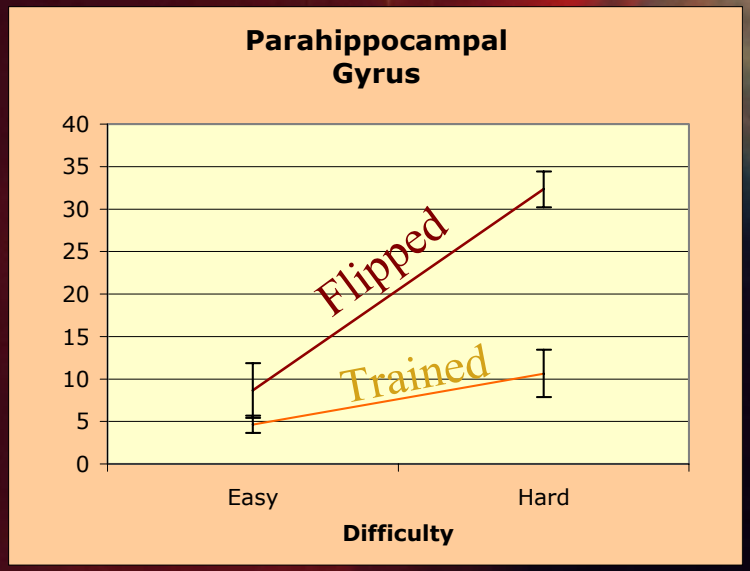
- Two methods of increasing spatial processing demands
  - Difficulty of intersections (# of choices)
  - Reversal of trained path (flipped v. trained)

Predictions

- Should see spatial processing-related activation in both regions
  - In contrast to those theories that would only expect this for hippocampal regions
- Time-course profile showing hippocampal activation early with parietal following.



Early Results



- Both hippocampal and parietal regions show significant, task related activation
- Flipped activation supports egocentric interpretation

Coordinating Multiple Representations?

- Is there support for the multiple spatial representation hypothesis?
  - Yes *(and now we have more support)*
- What does this coordination entail?
  - Analyses pending

ACT-R/S : Configural

- ACT-R/S integrates with *j*ACT-R
  - Lisp version will follow the complete reference impl
- Both are available for Windows/*nix environments
- New beta releases & sample model (rat) will be available next week(ish)

  http://sourceforge.net/projects/jactr/

  http://simon.lrdc.pitt.edu/~harrison/


Questions?