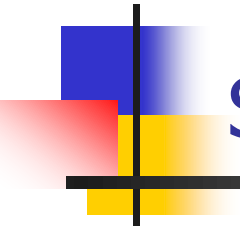


Spatial Knowledge and Visual Memory

Spatial Knowledge

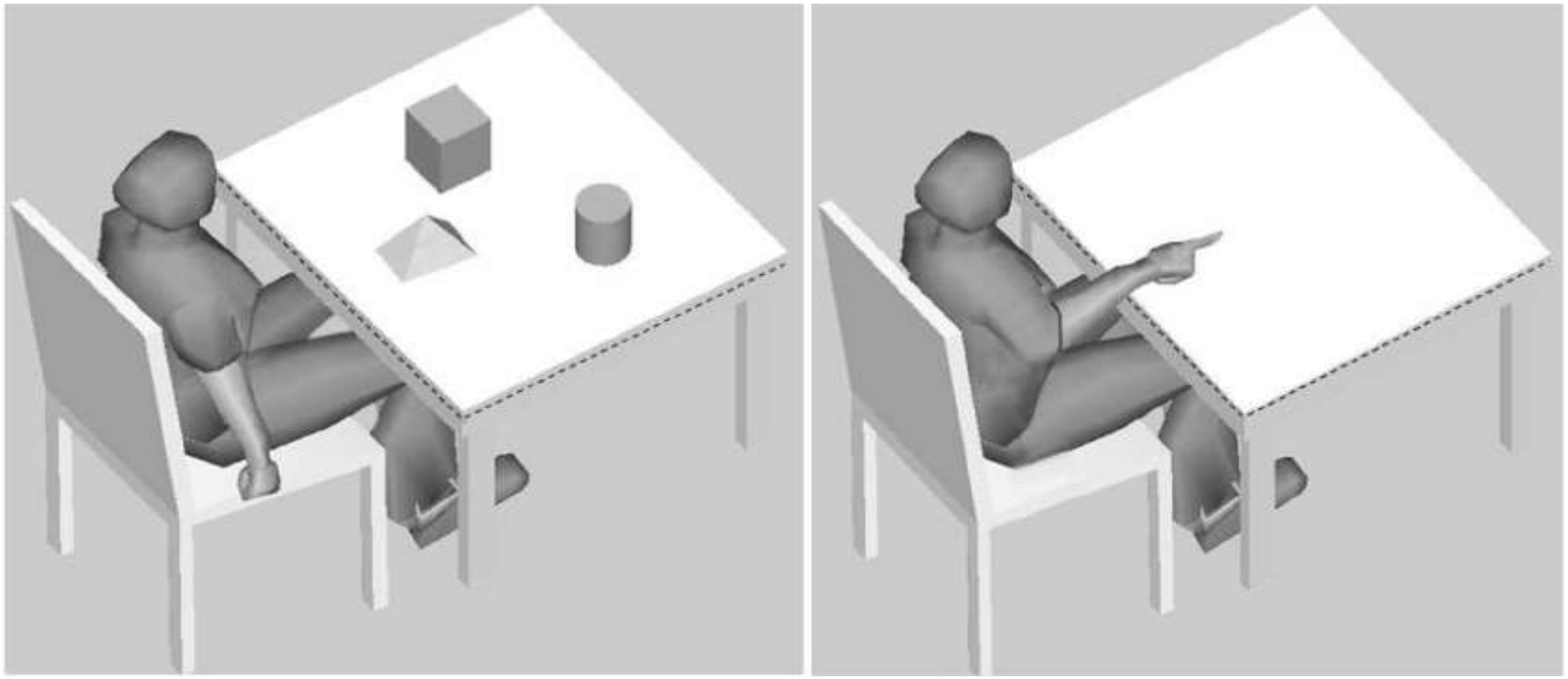
- **How do we use it?**
  - Cognitive maps, reference points, path integration
  - Spatial iconicity and triangulation
- **Why use some forms over others?**
  - Perceptual salience/relevance
  - Functional significance
  - Distinctiveness

Spatial Knowledge

- **Developmental Topographical Disorientation Disorder**

  - Inability to spatially navigate environment or generate mental representations (cognitive maps) of familiar settings

  - Occurs independently of neurological disorders or brain damage



(1) Participants memorize 3 objects and positions presented, then close their eyes while the triad is removed.

(2) Participants then asked, “Which object was closest (or farthest) from you?” and “Which object was closest (or farthest) to a target object (e.g., cylinder)?”

Spatial Knowledge

- **Developmental Topographical Disorientation Disorder**

  (a) Egocentric disorientation

  - Inability to represent the location of objects with respect to the self

  - Can recognize and accurately name objects near them

  - Can not reach for objects when prompted by auditory or visual cues

Spatial Knowledge

- **Developmental Topographical Disorientation Disorder**

  (b) Landmark agnosia

  - Inability to recognize salient environmental cues

  - Can distinguish structures (e.g., house vs. tower) but can't identify specific buildings (e.g., their own house, office, or famous landmarks)

  - Navigate by semantics, such as house number or fence type/color

Spatial Knowledge

- **Developmental Topographical Disorientation Disorder**

  (c) Heading disorientation

  - Inability to represent direction spatially

  - Can identify familiar buildings and landscapes but unable to conclude which direction required to proceed to target destination

Spatial Knowledge

- **Developmental Topographical Disorientation Disorder**

  (d) Anterograde disorientation

  - Inability to orient in "new(er)" environments

  - Can identify and navigate through familiar past locations (e.g., spatial knowledge of hometown) and well-learned environments

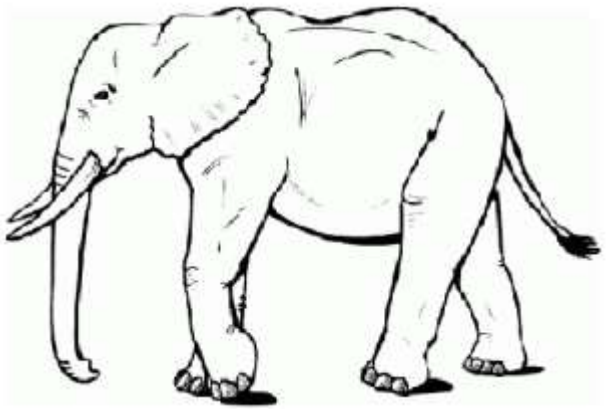
  - Largely unable to cognitively map frequently visited grocery store, current neighborhood, etc.

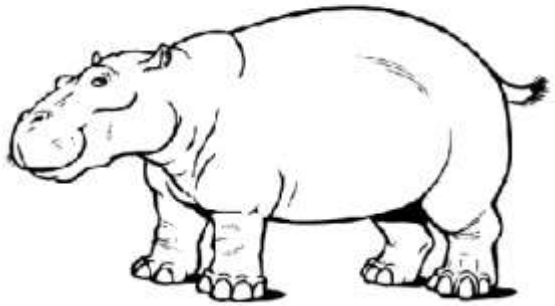
Spatial Knowledge

- Other factors

  - Semantic congruity effect

  (a) Preference to select the larger (or smaller) of two large animals



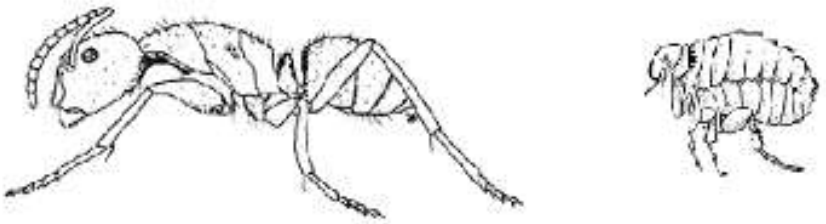


Spatial Knowledge

- Other factors

  - Semantic congruity effect

  (b) Preference to select the larger (or smaller) of two small animals

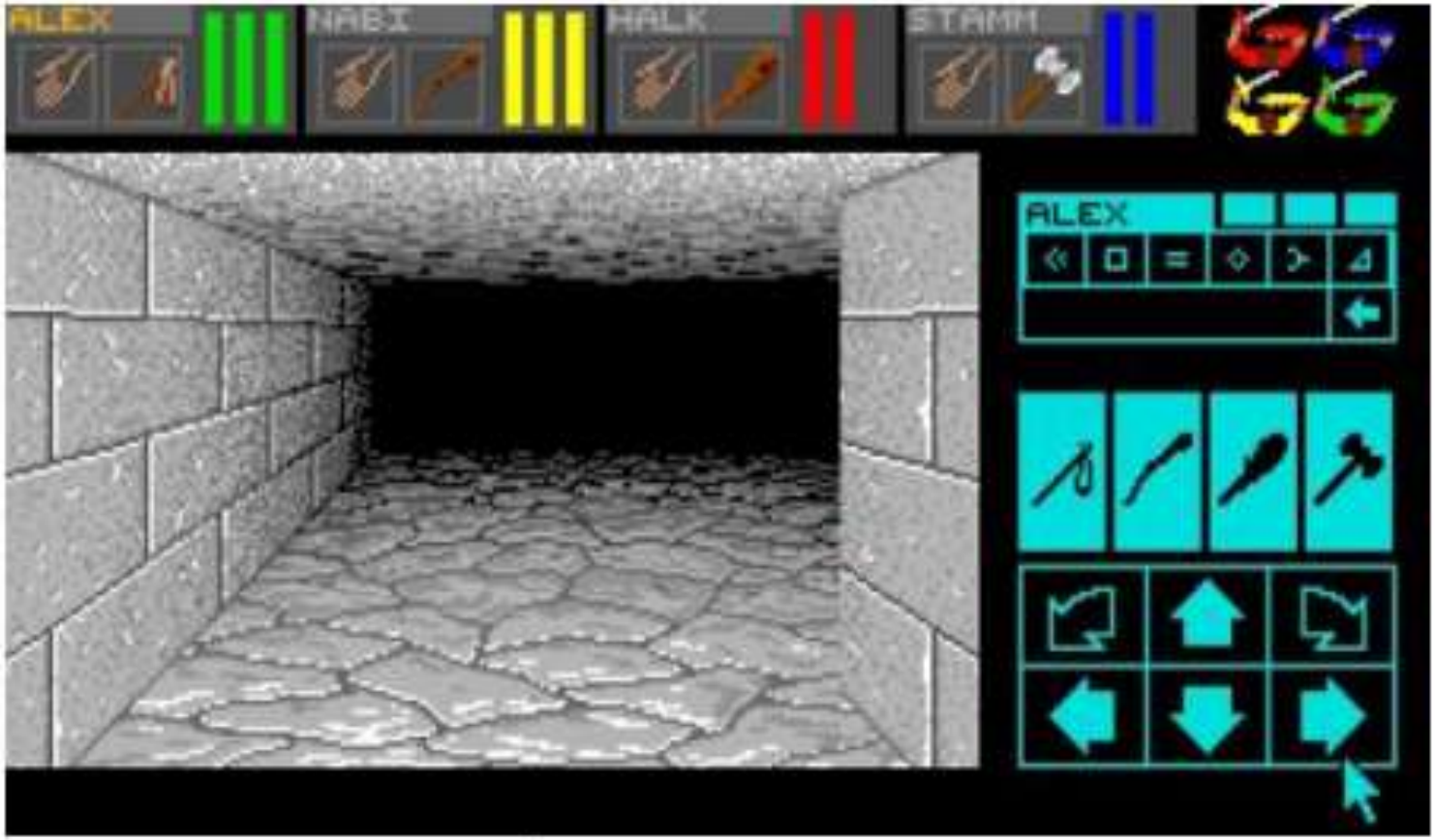


Spatial Knowledge

- Other factors

  - Learning from Exploration vs. Maps

  - Subjects asked to learn a 2-building structure (Thorndyke & Hayes-Roth, 1982)
  - More accurate and faster landmark recall for subjects allowed to explore vs. subjects who studied map



Dungeon Master

Metroid Prime


Shadow Isles
Freljord
Kaladown
Filtover
Ionia
Serpentine River
Zaun
Lyonspike Mountains
Bubbling Bog
Conqueror's Sea
Demacia
Noxus
The Institute of War
Guardian's Sea
The Great Barrier
Tempest Flats
Icathia
Blue Flame Island
Urtistan
Shurima Desert
Voodoo Lands
Bilgewater
Tyrone Flats
Kumungu
Bandle City
Yordle Land
N
Plague Jungles

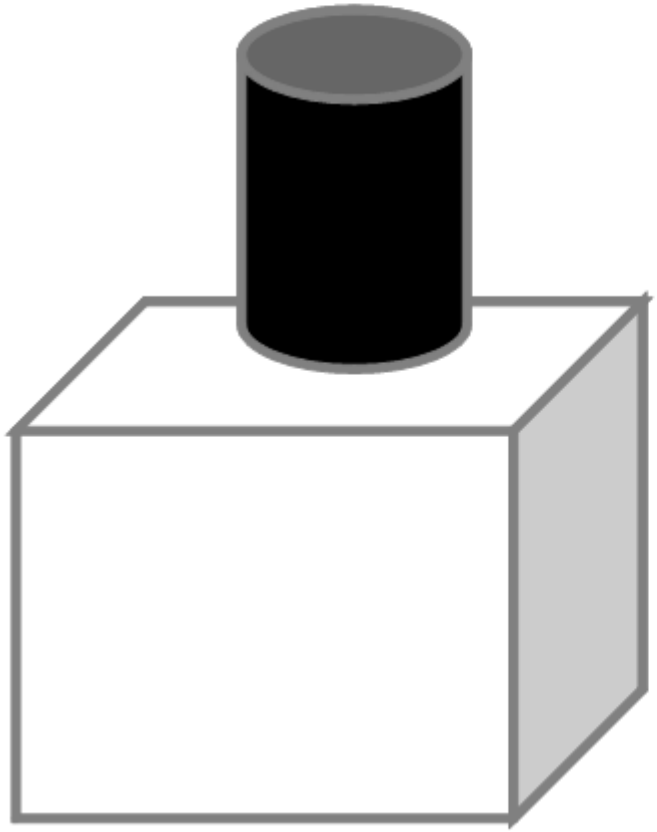
Spatial Knowledge

- **Analog (prototype) representation**
  - Mental representations are *analogous* to structures of represented world
- **Propositional (symbolic) representation**
  - Abstract coding, assertions, and beliefs that may not hold strong resemblance to physical representations

Analog vs. Propositional

Imagine: *The can is on the box. The can is black*

Analog representation



Propositional representation

Symbolic

on(*can*, *box*)

black(*can*)

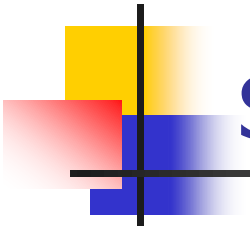
???

Analog Representation	Propositional Representation
	**Example of Propositional Representation:** - window at top of cab - door handle on cab below window - wheel at lower left of cab - wheel at lower right of cab - overly happy dude leaning dangerously far out window...

Depictive vs. Descriptive

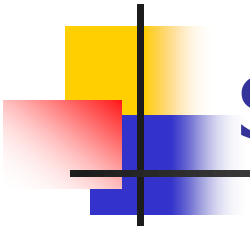
Spatial Knowledge

- **Analog (prototype) representation**
  - Good for configural stimuli and data
  - Accommodation not too difficult
- **Propositional (symbolic) representation**
  - Each individual has subjective/arbitrary perceptions of “X” – one thing has several interpretations



Spatial Knowledge

- **Quick Classroom Challenge**
  - 2-3 students vs. Prof V.
  - Draw your cognitive map of DigiPen's 3rd floor

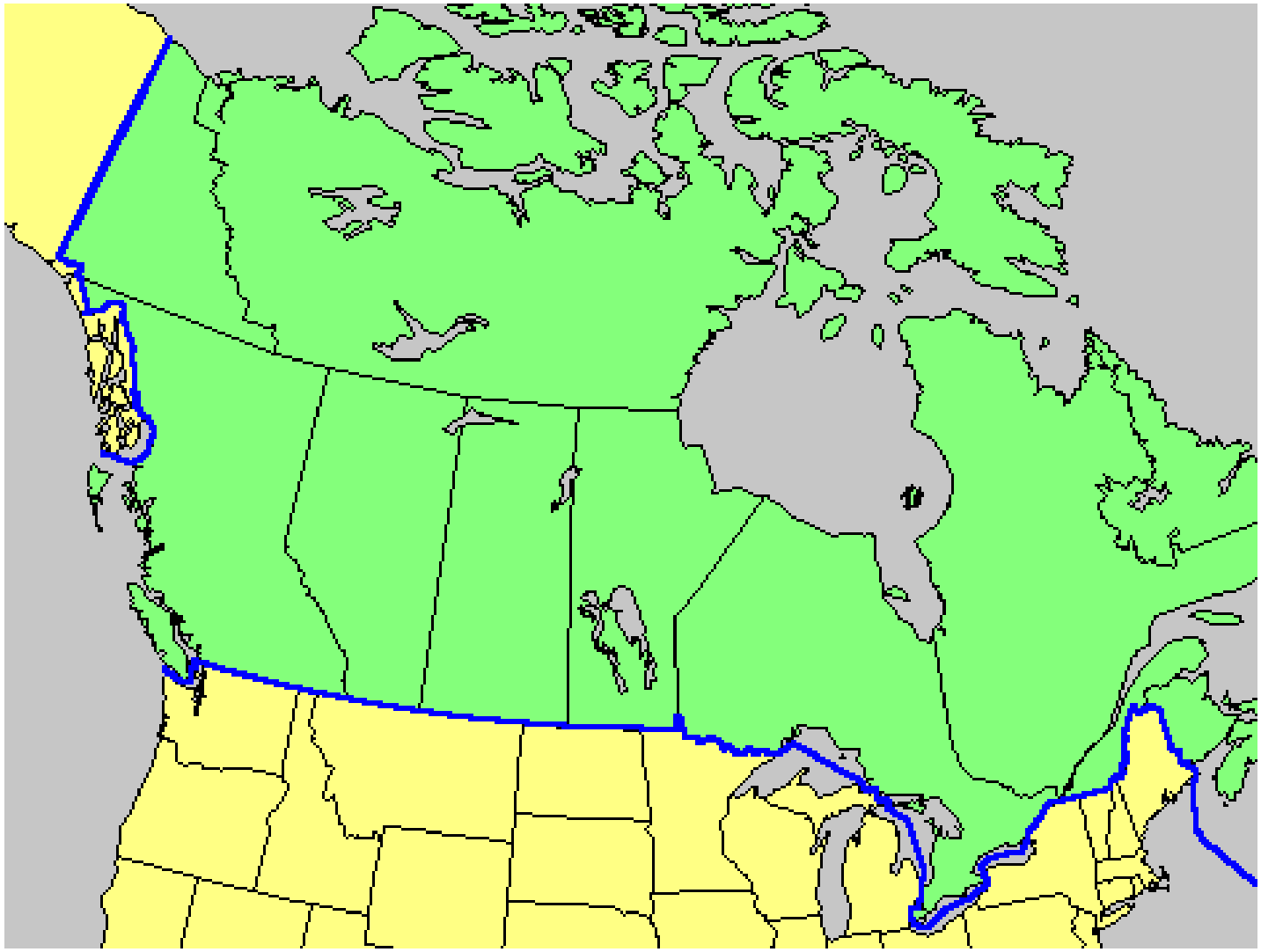


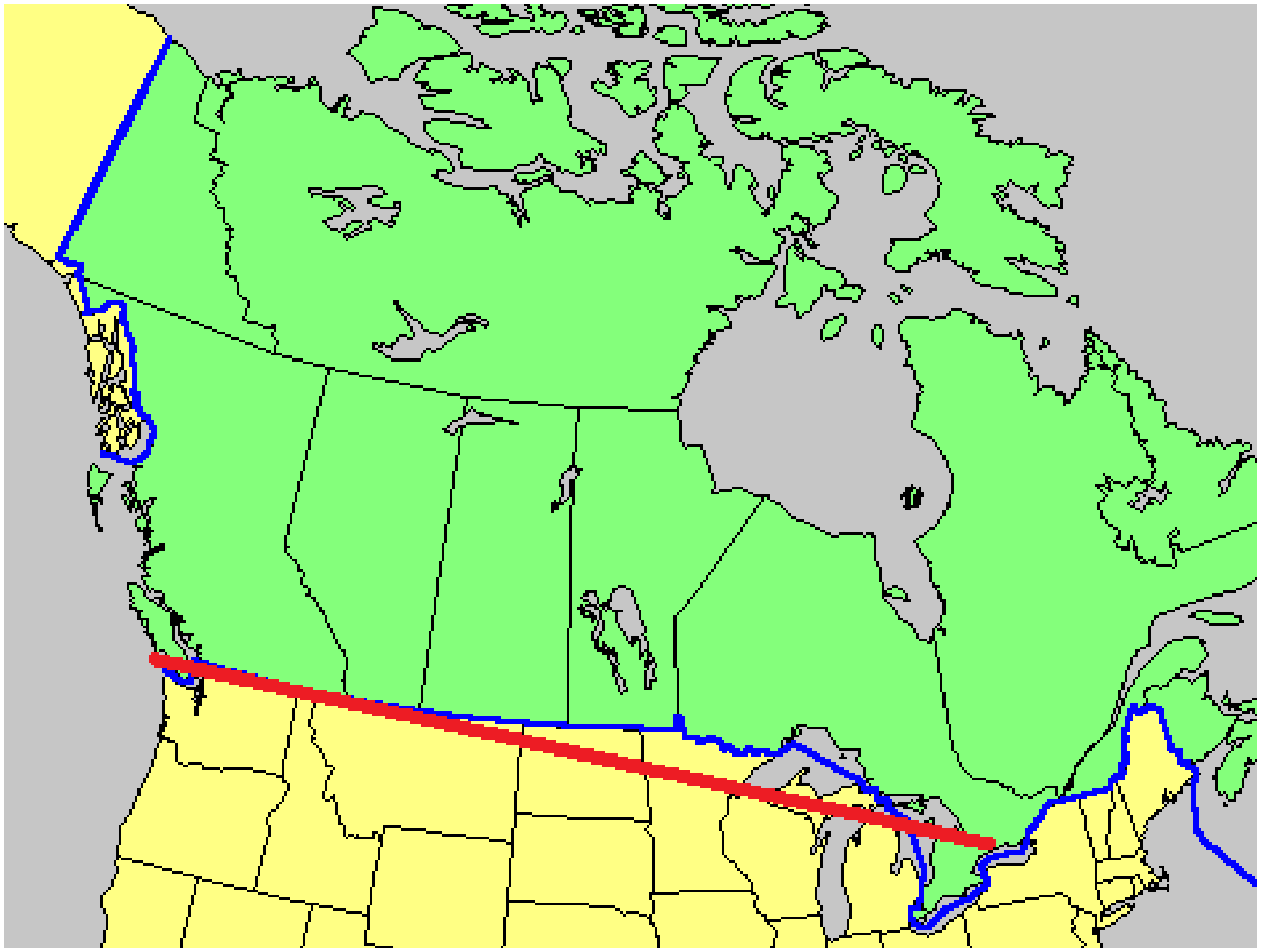
Spatial Knowledge

- **Quick Classroom Challenge**
  - 2-3 students vs. Prof V.
  - Draw your cognitive map of DigiPen's 3rd floor
  - Prof V's spatial knowledge (and xp) of the 3rd floor is likely different

Spatial Memory

- Large scale space ("**spatial iconicity**")
  - Which is farther north:
    - North Korea or Germany?
  - Which is farther south?
    - New Zealand or South Africa?





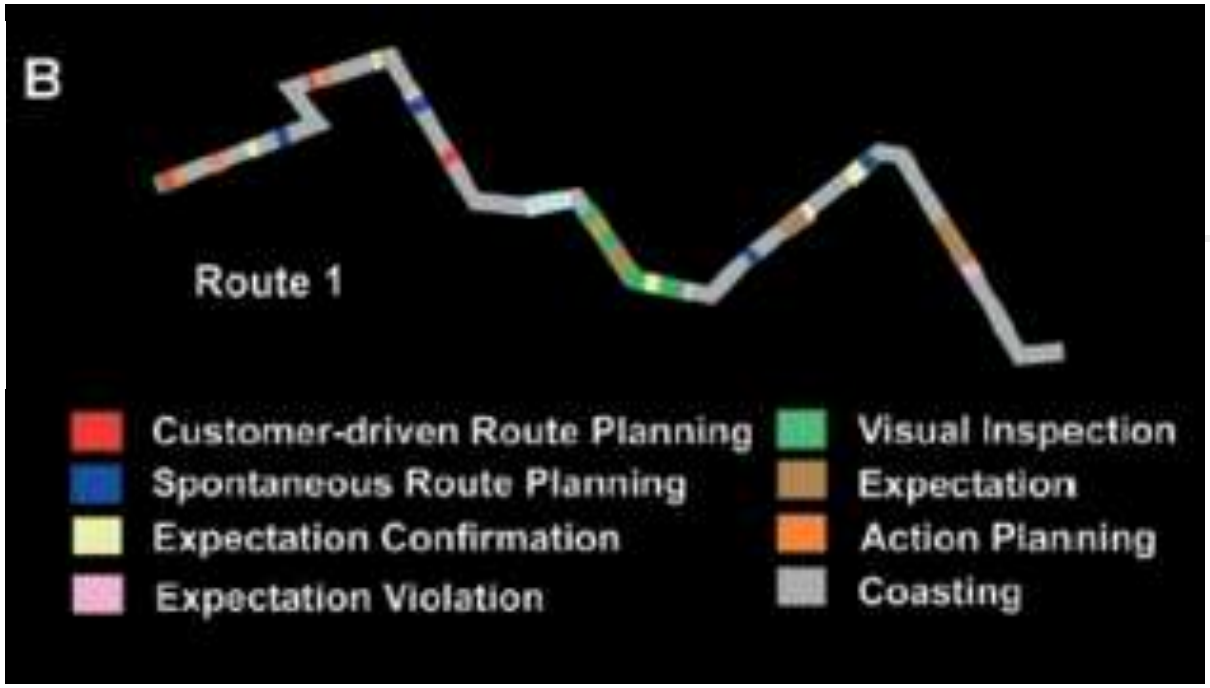
Spatial Memory

- Emerging research
  - Caglio (2012) – VR games improve spatial and verbal memory after traumatic brain injury
  - Maass (2011) – Increases in spatial memory recall post-VG
  - Boot (2008) – Expert gamers better detect changes to objects stored in visual STM

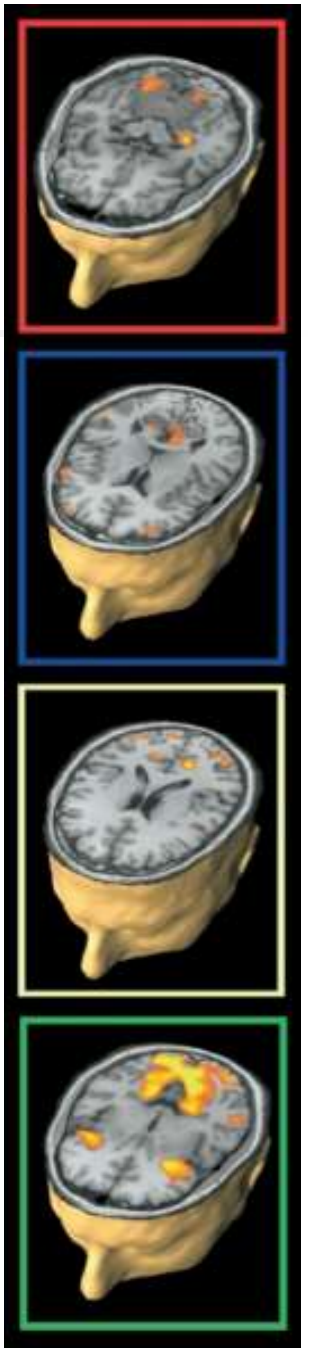
Spiers & Maguire (2005)

Panel A shows areas of London simulated (not all minor streets included)

Panels B and C show example views


B
Route 1
Customer-driven Route Planning
Spontaneous Route Planning
Expectation Confirmation
Expectation Violation
Visual Inspection
Expectation
Action Planning
Coasting


C
fMRI time-series
Route 1
Rest
Route 2
Rest
Route 3

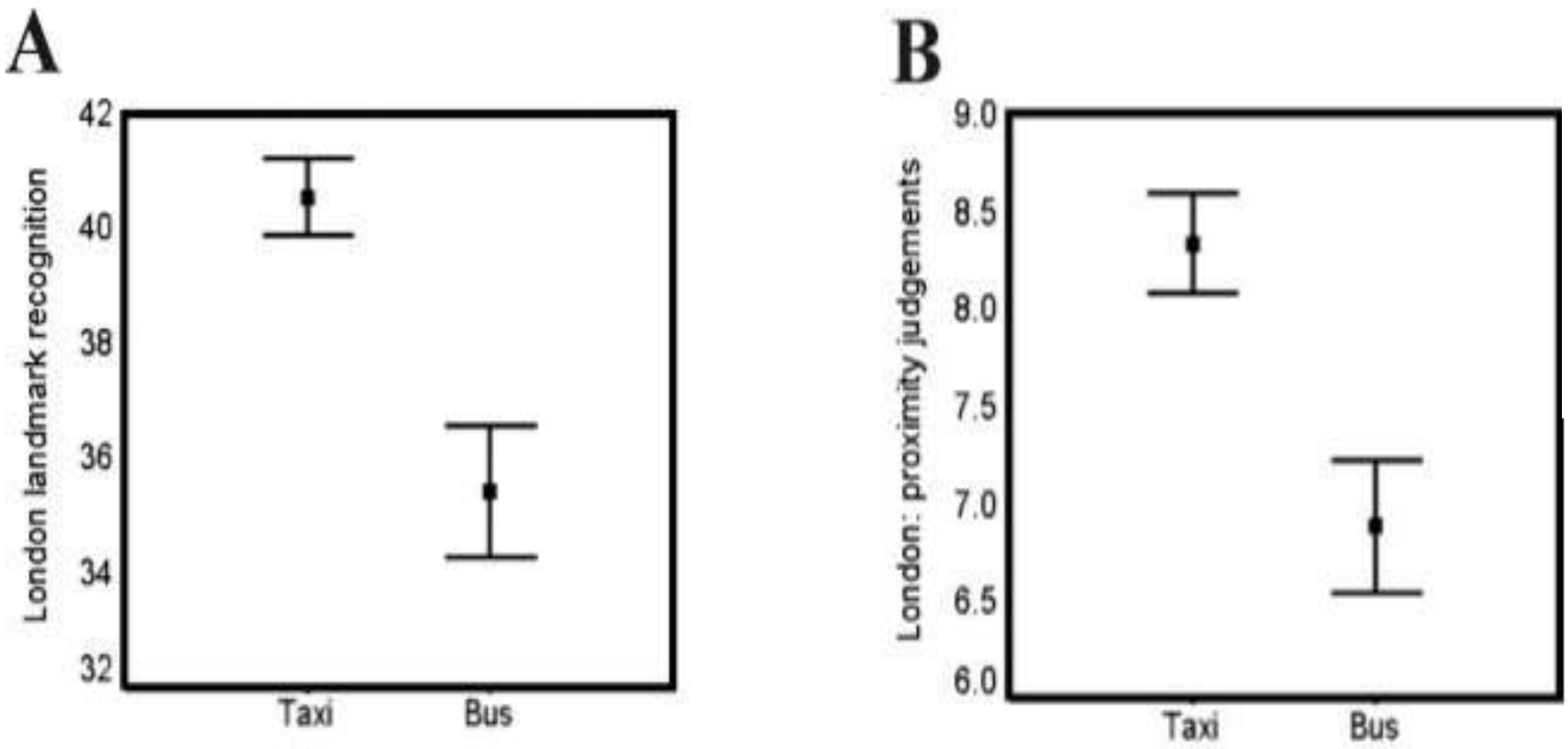


Spatial Memory

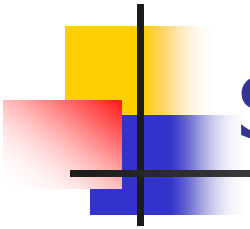
- **Additional research**
  - Maguire et al. (2006)
    - MRI study on hippocampus structure and integrated cognitive mapping
    - Very careful comparisons with London cab vs. bus drivers
    - Matched subjects' training, age (demographics) driving experience, years employed…

Spatial Memory

- **Additional research**
  - Maguire et al. (2006)
    - Taxi drivers show *more* posterior hippocampus grey matter (linked to spatial retrieval) compared to bus drivers
    - Taxi drivers show *less* anterior hippocampus activity (linked to encoding novel stimuli) compared to bus drivers



A: London taxi drivers were significantly better than London bus drivers at identifying London landmarks from among visually similar distractors and B, making judgments about proximal relations between London landmarks.



Spatial Memory

- **Making new images**
  - Imagine a capital letter H and a triangle
  - Rotate the H 90 degrees
  - Place the triangle on top of it
  - What is it?

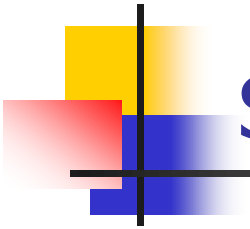
Spatial Memory

- **Making new images**

  - Construct an image of a capital letter M and an image of an inverted capital letter M

  - Align the two images so that the bottom of each (3-point ends) touch

  - What do you have?



Spatial Memory

- **Making new images**

  - Superimpose an image of a capital letter X with an image of a capital letter H

  - What do you have?