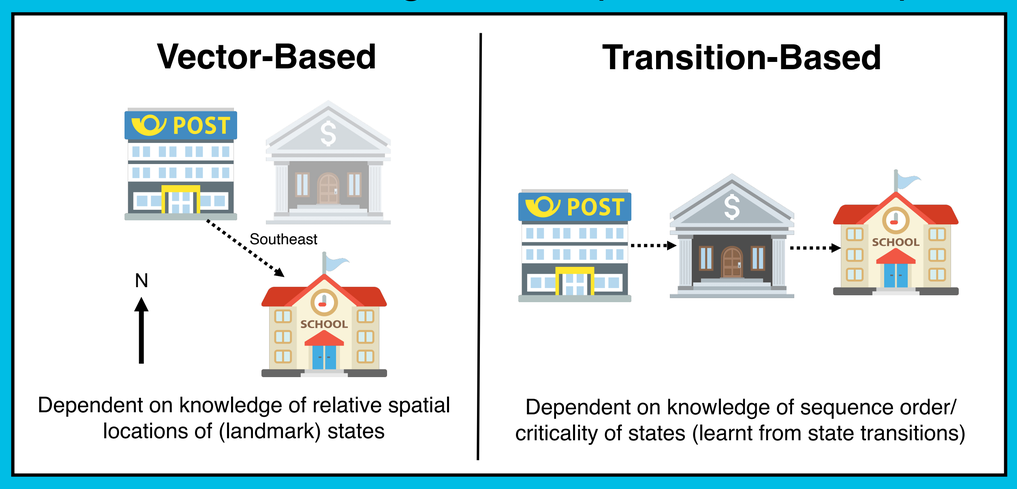
Use of Vector- and Transition-based Strategies is Modulated by Knowledge of the Environment in Human Spatial Planning

Denis C. L. Lan, Laurence T. Hunt*, Christopher Summerfield*
Department of Experimental Psychology, University of Oxford
(* Contributed equally as senior authors)

Introduction

- Two ideas about how cognitive maps are used for planning:

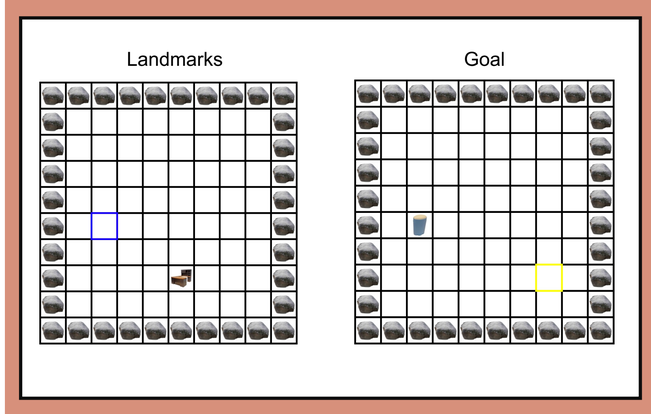


- **How do we combine the two strategies?**
  - Knowing more states allow more accurate (transition-based) navigation, but implausible to know all
  - Idea: Use vector-based strategies to head in general goal direction, fine-tune using transition-based strategies at well-learnt states

Task Design

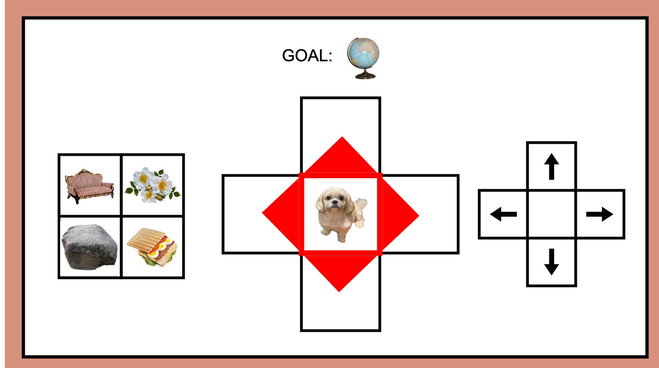
- **Question:** does use of strategy depend on knowledge of states?
- Participants performed an online experiment in which they navigated through an 8x8 grid of 'objects'
- 4 blocks x 6 trials, each trial consists of 2 phases:

1. Learning Phase: *manipulate knowledge of states*



- Click on blue squares to reveal 'landmarks'
  - 16 clicks total
  - 2, 4, 8, or 16 landmarks
- Click on yellow square to reveal 'goal'

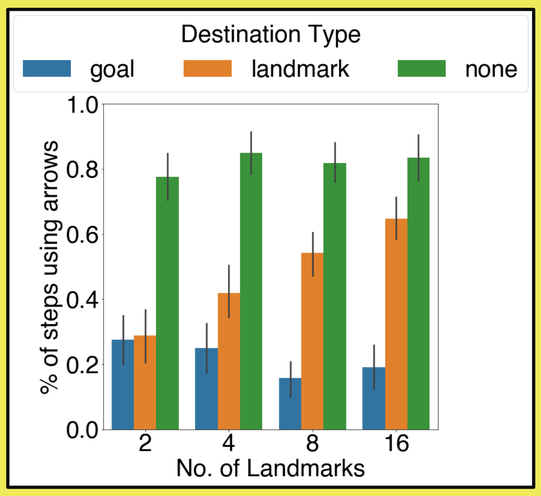
2. Navigation Phase: *assess use of navigation strategies*



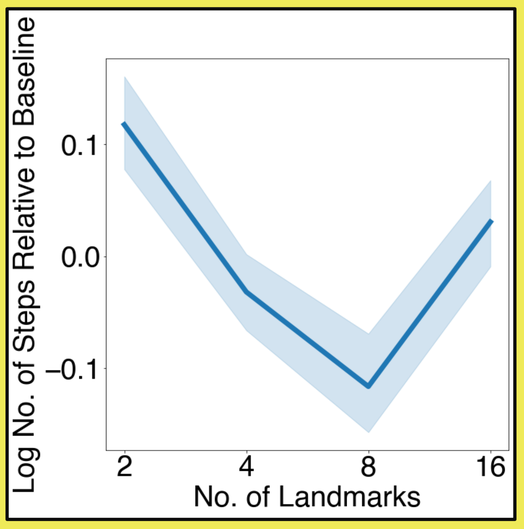
- Navigate to goal in two ways
  - **'Vector'** – click arrow to move one step in direction
  - **'Transition'** – click object to move to that state

Both movement methods allow movement only to **adjacent states** (i.e, they are equivalent but allow dissociation of strategies)

Human Behaviour



Participants use 'transitions' more at well-learnt 'landmarks'

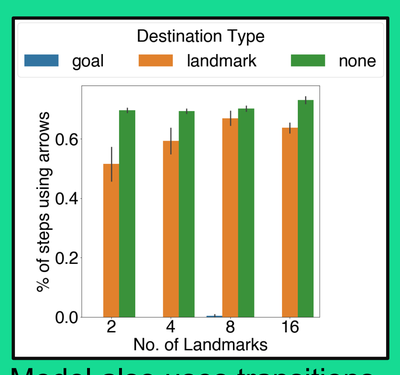


Participants perform best at an intermediate number of landmarks

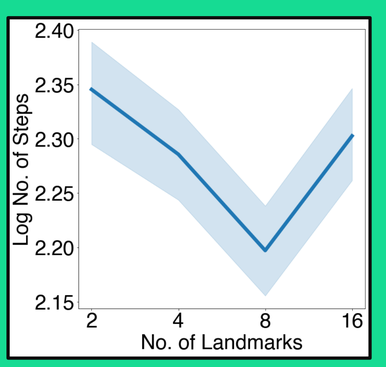
Trade-off between **familiarity** and **environmental coverage**

Computational Model

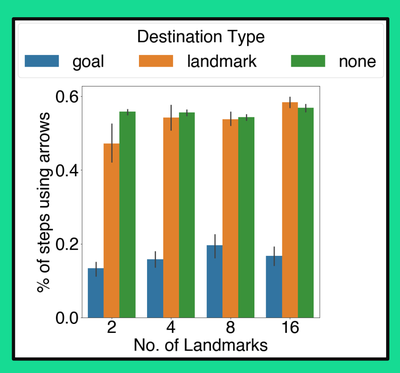
- **MLP** trained to predict x/y-coordinates of landmarks
  - Training iterations kept the same for all numbers of landmarks
- Agent chooses actions based on **estimated coordinates** and **uncertainty** (estimated via sampling of MLP)



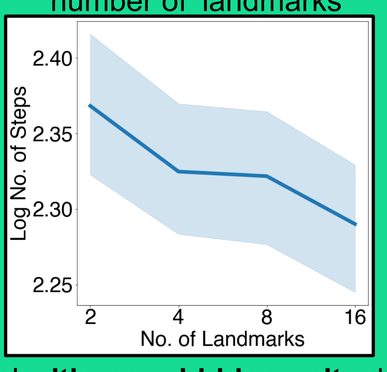
Model also uses transitions more at 'landmarks'



Model performs best at intermediate number of 'landmarks'



Model **without confidence-weighting** does not use transitions at landmarks



Model **with more hidden units** does not exhibit U-shaped pattern

Conclusions

- **Participants flexibly use transition-based strategies near well-learnt 'landmarks'**
- Participants perform best at intermediate number of landmarks, likely due to memory constraints
- Paradigm for understanding use of transition- vs-vector-based strategies

Summerfield Lab Posters
Twitter: @DenisLan_

Summerfield Lab Abstracts
Email: denis.lan@psy.ox.ac.uk