Training curriculum matters for cognitive map acquisition

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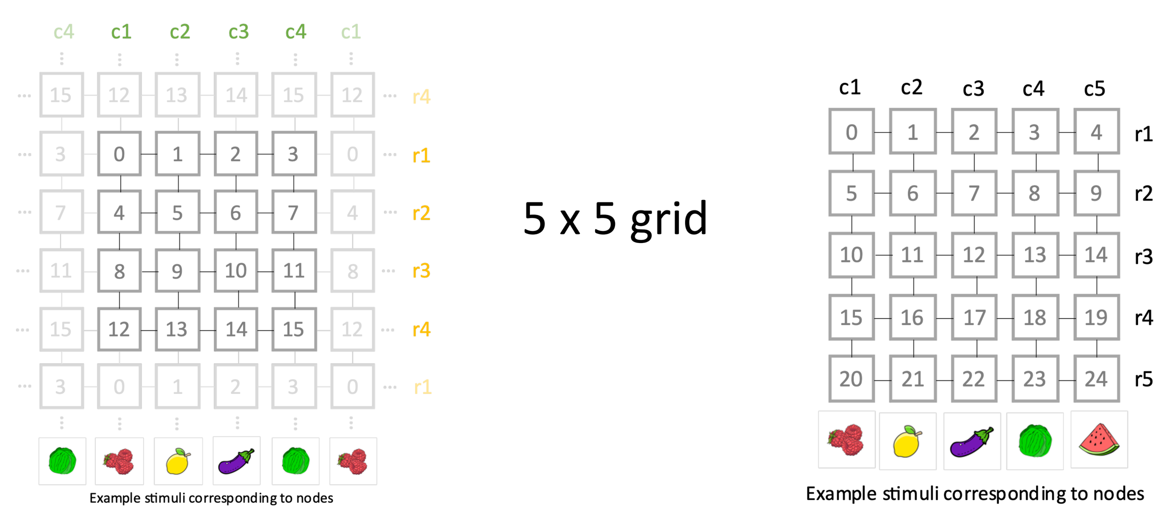
Question: How can we teach people a cognitive map most efficiently?

Experimental manipulations

1. Map shape

4 x 4 torus

5 x 5 grid



2. Training: temporal spacing manipulation

LOCAL: which transitions are **within a block**

1. Row/column: random walk along 1 row/col (8 transitions)
2. Random: set of 8 randomly picked transitions

GLOBAL: **across block** spacing of transitions

Fixed half

Interleaved

3. Training duration: multi-day
4. Design: mixed

Methods

DESIGN

Between subjects factor (GLOBAL)		
	Fixed half row/column	Fixed half random
	Interleaved row/column	Interleaved random

Within subjects factor (LOCAL)
(one random and one row/column map per participant)

Prolific

$N_{GRID,\ FIXED\ HALF} = 49$

$N_{GRID,\ INTERLEAVED} = 43$

$N_{TORUS,\ FIXED\ HALF} = 46$

$N_{TORUS,\ INTERLEAVED} = 44$

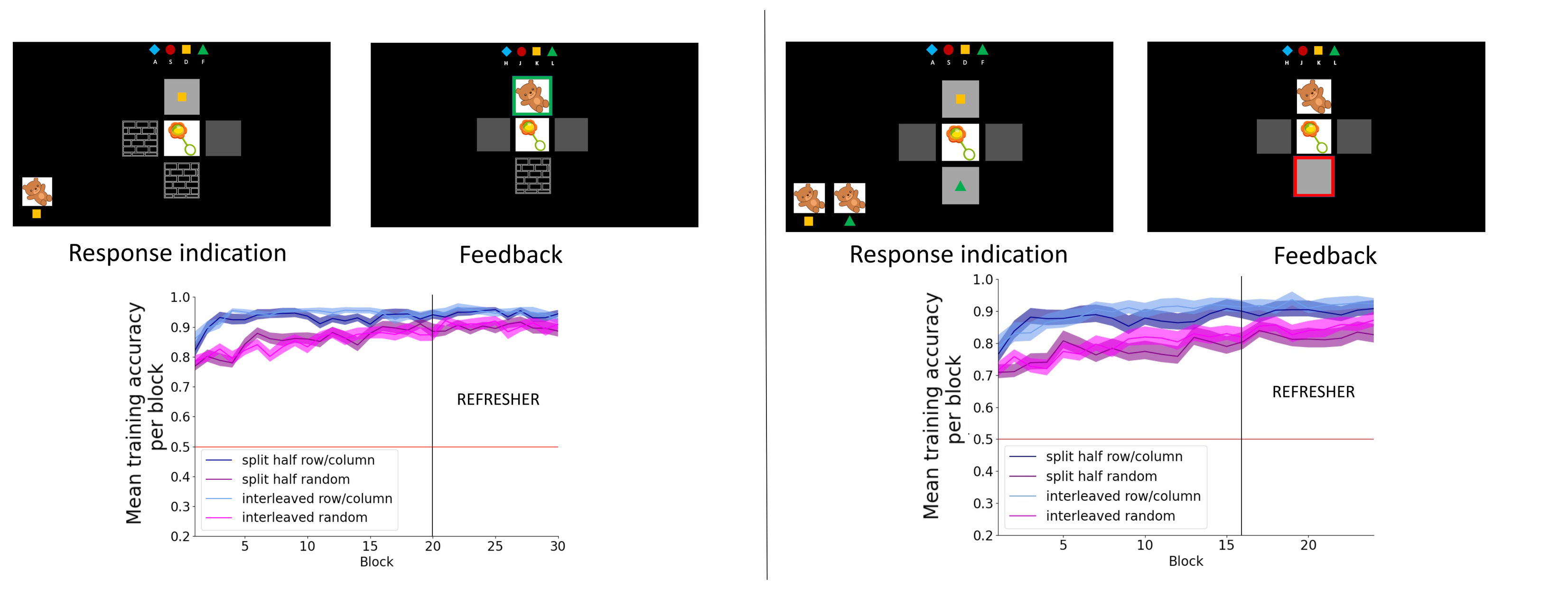
TRAIN			TEST		
LEARN MAP 1	LEARN MAP 2	REFRESHER	NAVIGATION TEST	PROXIMITY TEST	MAP RECONSTRUCTION
Day 1	Day 2	Day 3			

Results I: training and navigation

First day of training: all blocks experienced *twice*; 4 repeats per transition per block
Refresher: all blocks experienced *once*; 4 repeats per transition per block

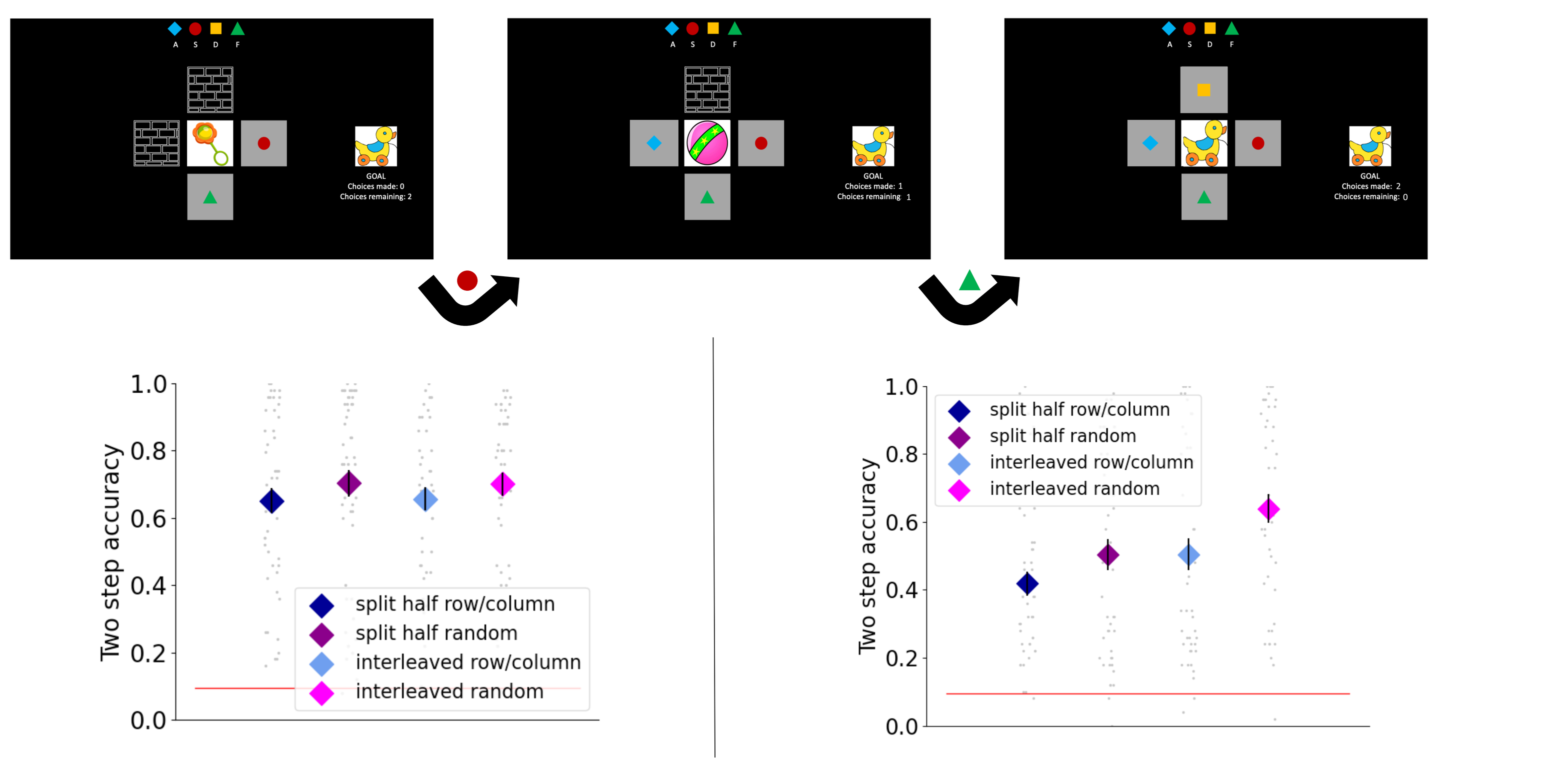
5 x 5 GRID

4 x 4 TORUS



Row/column > random during training in grid ($F(1,90) = 108.20$, $p < .001$) and torus ($F(1,88) = 77.92$, $p < .001$)

Two-step navigation

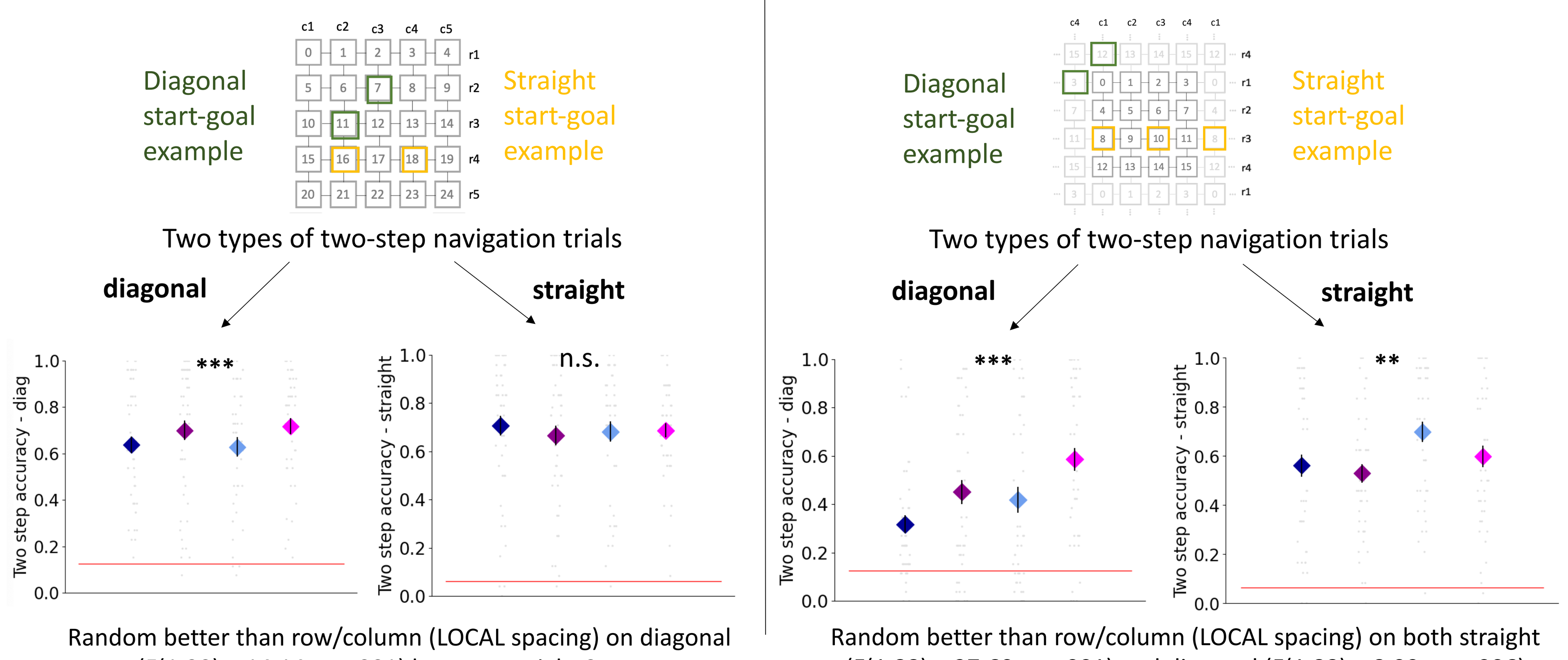


Random training associated with better 2-step navigation performance
(main effect of LOCAL spacing: grid $F(1,90) = 9.66$, $p = .003$; torus $F(1,88) = 21.53$, $p < .001$); no significant effect of GLOBAL spacing (grid $F(1,90) = .001$, p = .98; torus $F(1,88) = 3.89$, $p = .052$)

Results II: navigation and proximity

5 x 5 GRID

4 x 4 TORUS

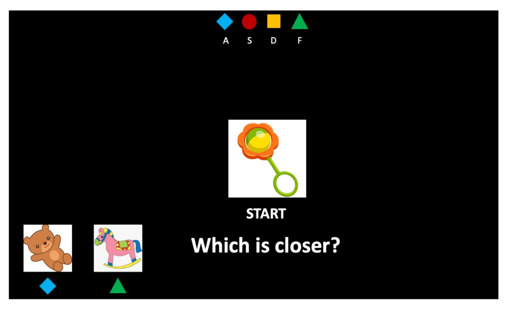


Random better than row/column (LOCAL spacing) on diagonal ($F(1,90) = 14.14$, $p < .001$) but not straight 2-steps

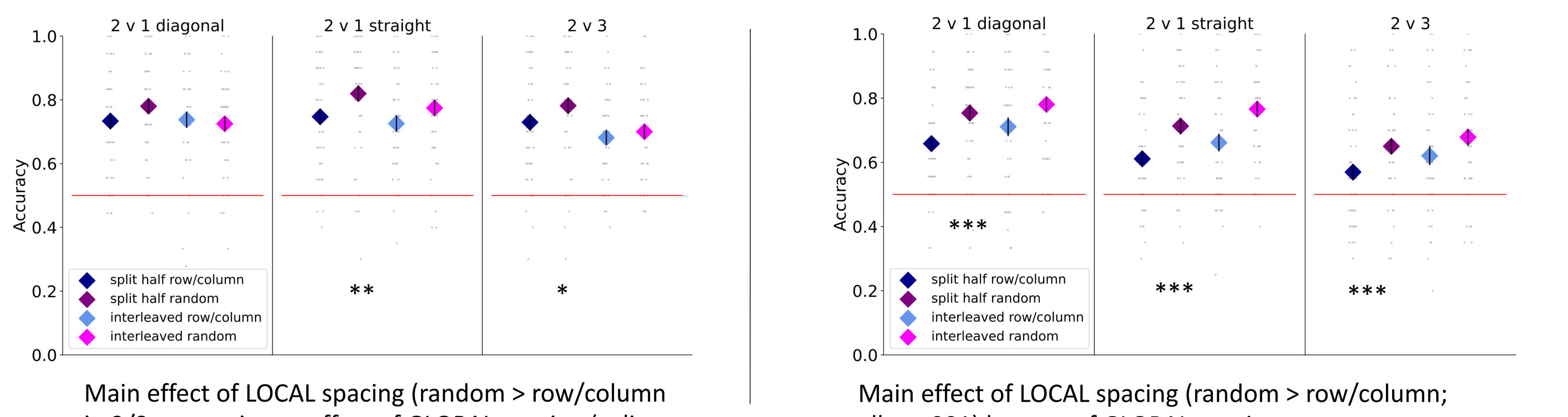
Random better than row/column (LOCAL spacing) on both straight ($F(1,88) = 27.60$, $p < .001$) and diagonal ($F(1,88) = 8.00$, $p = .006$)

Proximity judgements: 2AFC

a) 1 step away vs 2 steps straight
b) 1 steps vs 2 steps diagonal
c) 2 steps diagonal vs 3 steps diagonal



(no feedback)



Main effect of LOCAL spacing (random > row/column in 2/3 comparisons; effect of GLOBAL spacing (split half > interleaved in 2v3; $p = .04$)

Main effect of LOCAL spacing (random > row/column; all $p < .001$) but not of GLOBAL spacing

<u>CONCLUSION</u>: random training is associated with better map integration and more flexible deployment of learned information than row/column training (LOCAL manipulation)

Summary

- We manipulated both the content of a training block (LOCAL) and the order of training blocks (GLOBAL) when teaching people novel (spatial) cognitive maps
- The content of training blocks (LOCAL) had the biggest effect on learning
- Participants were better during training on the map where they were trained in a row/column (random walk) fashion in each block
- In contrast, navigation performance and proximity judgements were better in map with randomly sampled transitions in each training block
- This suggests that random walk type learning may *not* be the most efficient at teaching someone a flexible representation of a novel cognitive map

Future directions

- Explain why learning disjointed transitions during training helps with flexible and robust cognitive map acquisition
- Discuss whether our previous model (or an adaptation of it) can still sensibly account for this given the data presented on this poster
- Use a neuroimaging version of the task (grid, fixed half) to help constrain the hypothesis space of what might underlie this effect and where in the brain it is implemented (presumably medial temporal lobe; N = 24/48 collected)

Sanity checks

Are more test trajectories (especially diagonal ones) experienced during random than row/column training?

- No, no difference between accuracy of trajectories where all components were experienced in the same block and those where this was not the case (interleaved$_{random,\ TORUS}$ $t(42) = 1.50$, $p = .15$; split half$_{random,\ TORUS}$ $t(45) = 0.07$, $p =. 93$; interleaved$_{random,\ GRID}$ $t(42) = 0.50$, $p = .62$; split half$_{random,\ GRID}$ $t(48) = -0.44$, $p =. 66$)

Is the random advantage because the link connectivity of randomly sampled transitions was higher during the training phase than in the row/column condition?

- No, there are only 2.65 average linked two-step and less than 0.3 >= three step trajectories in the random condition

Is this an effect of training order? No, training order was randomised (and the order of training days and refresher reversed).

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