Representing spatial information in working memory

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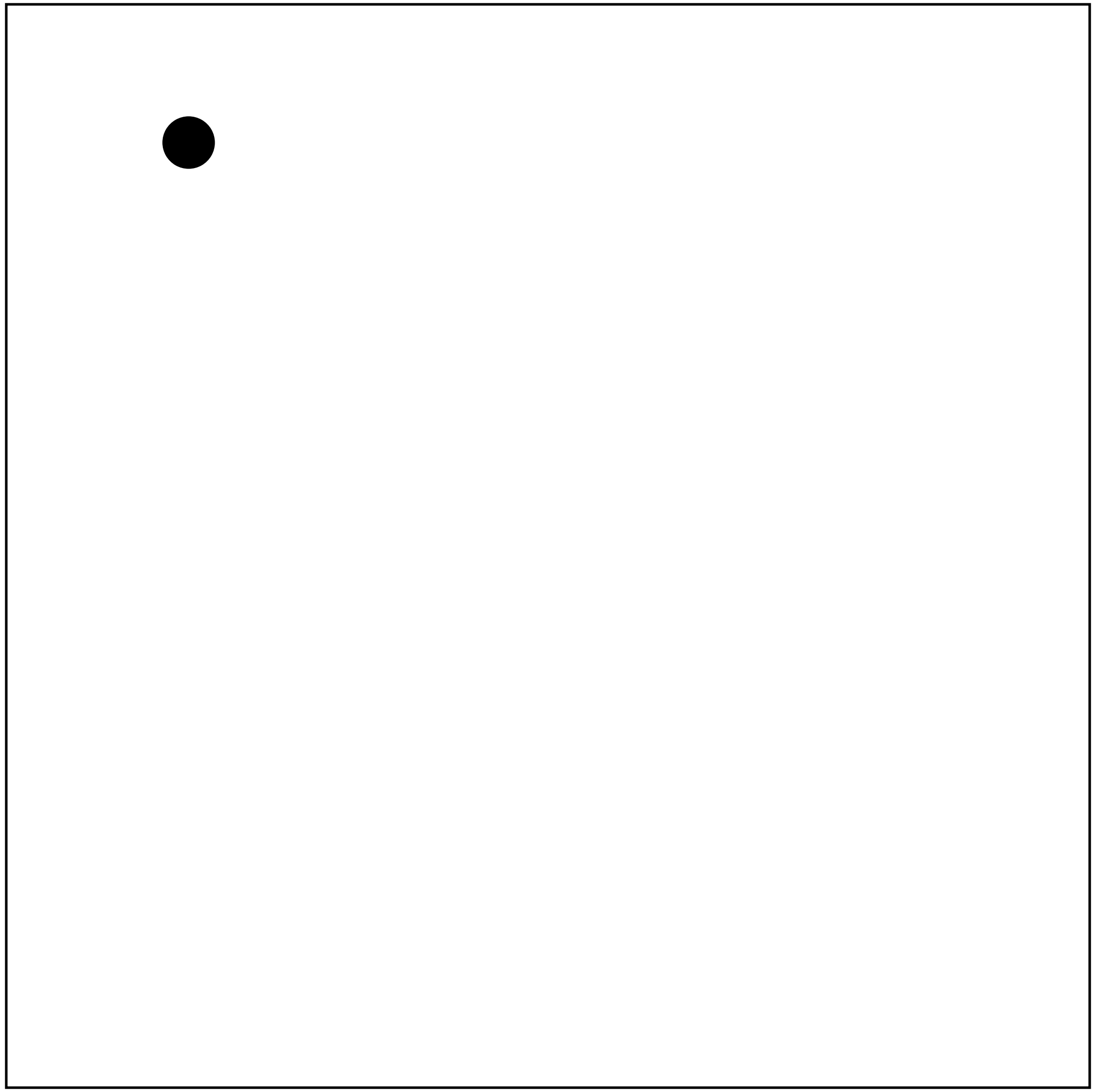
Introduction

Introduction



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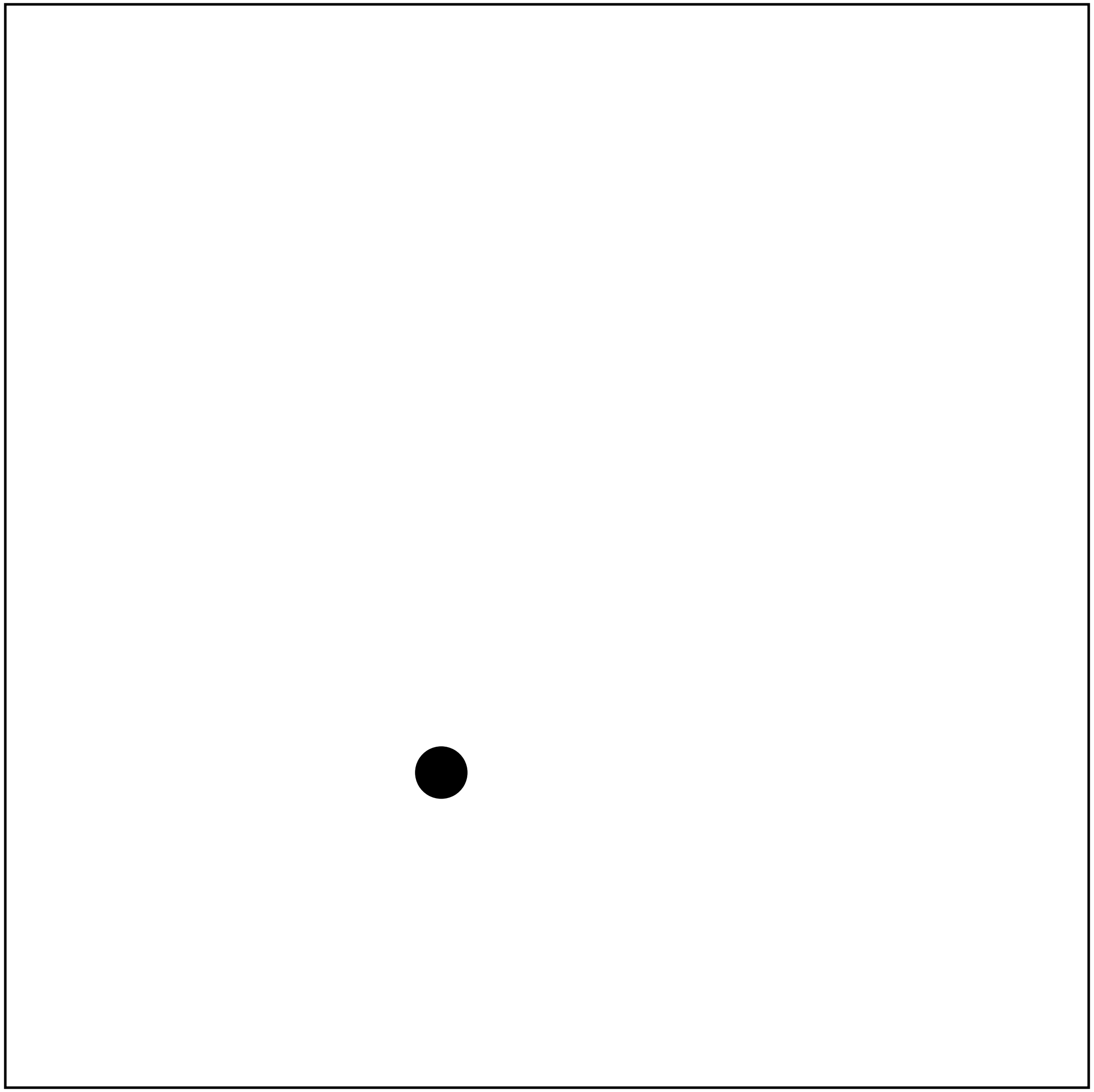

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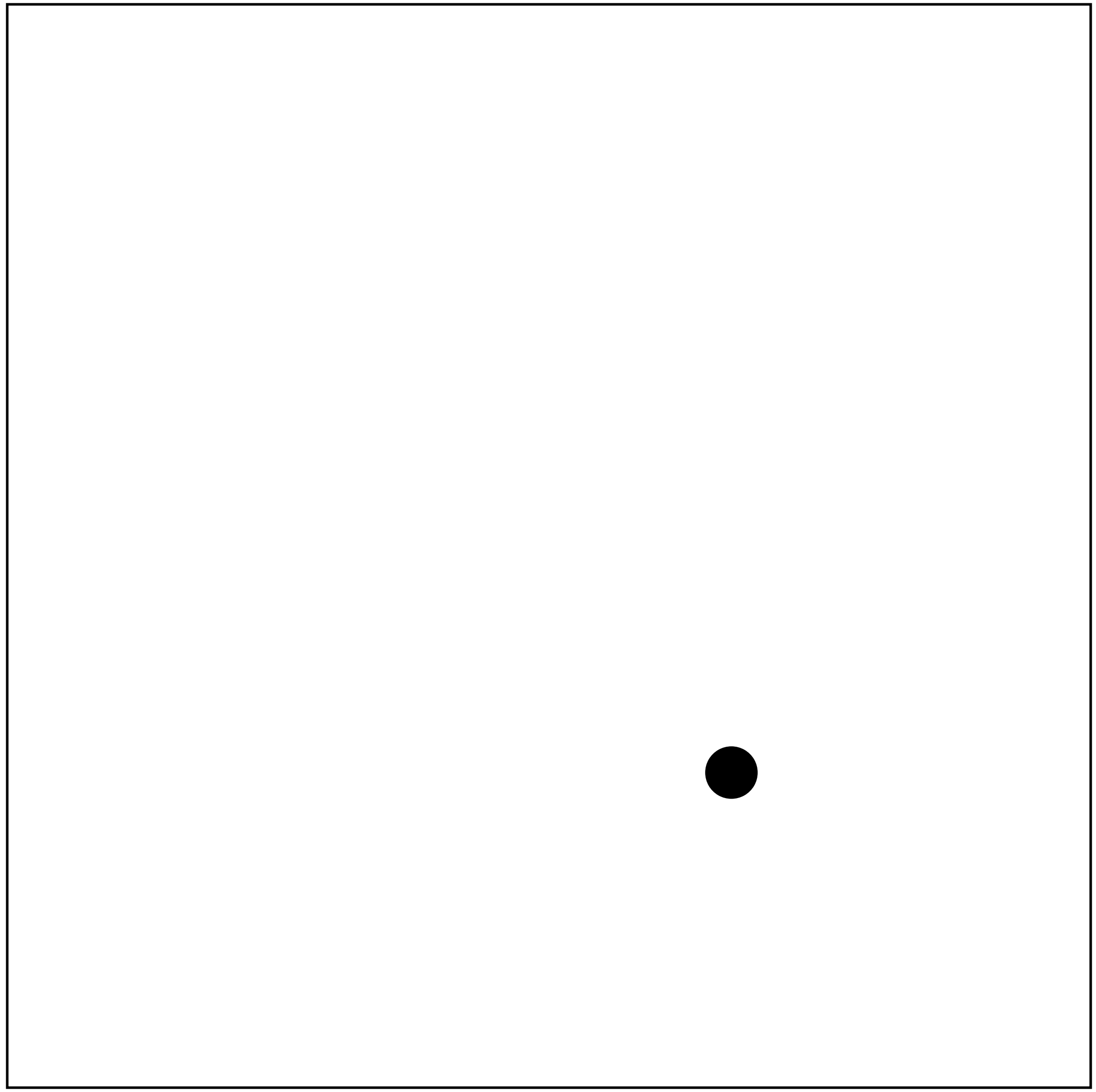

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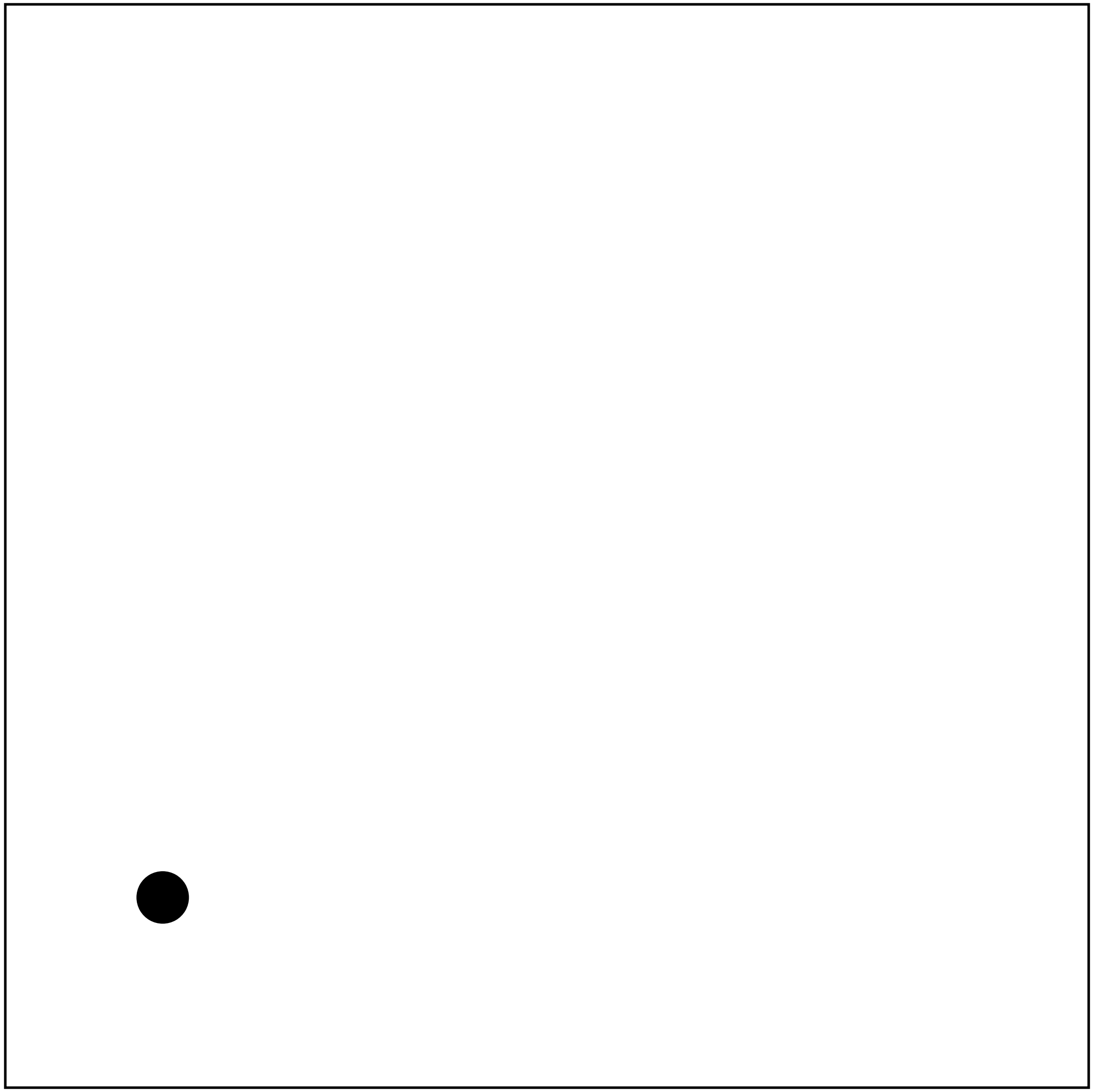

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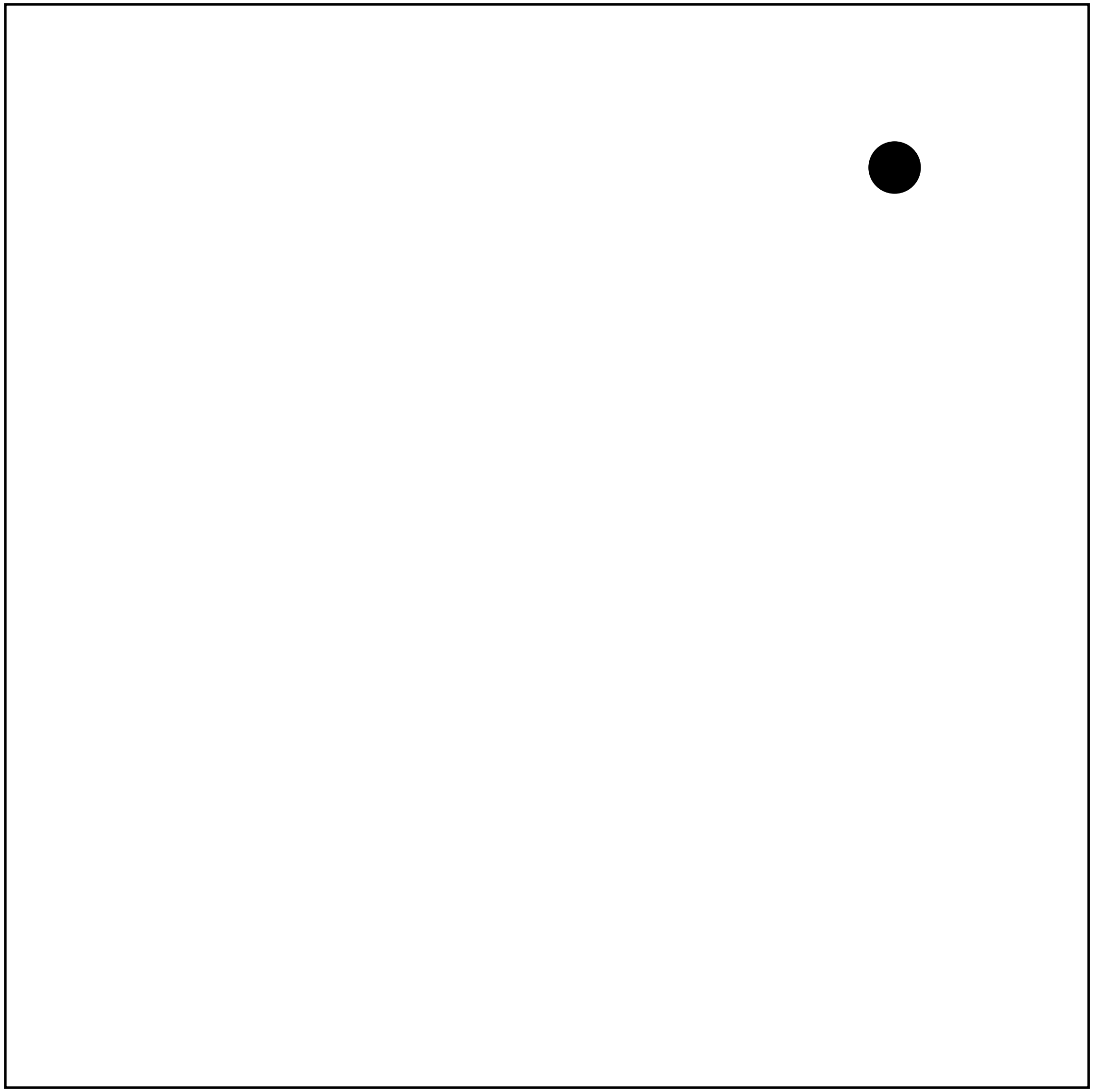

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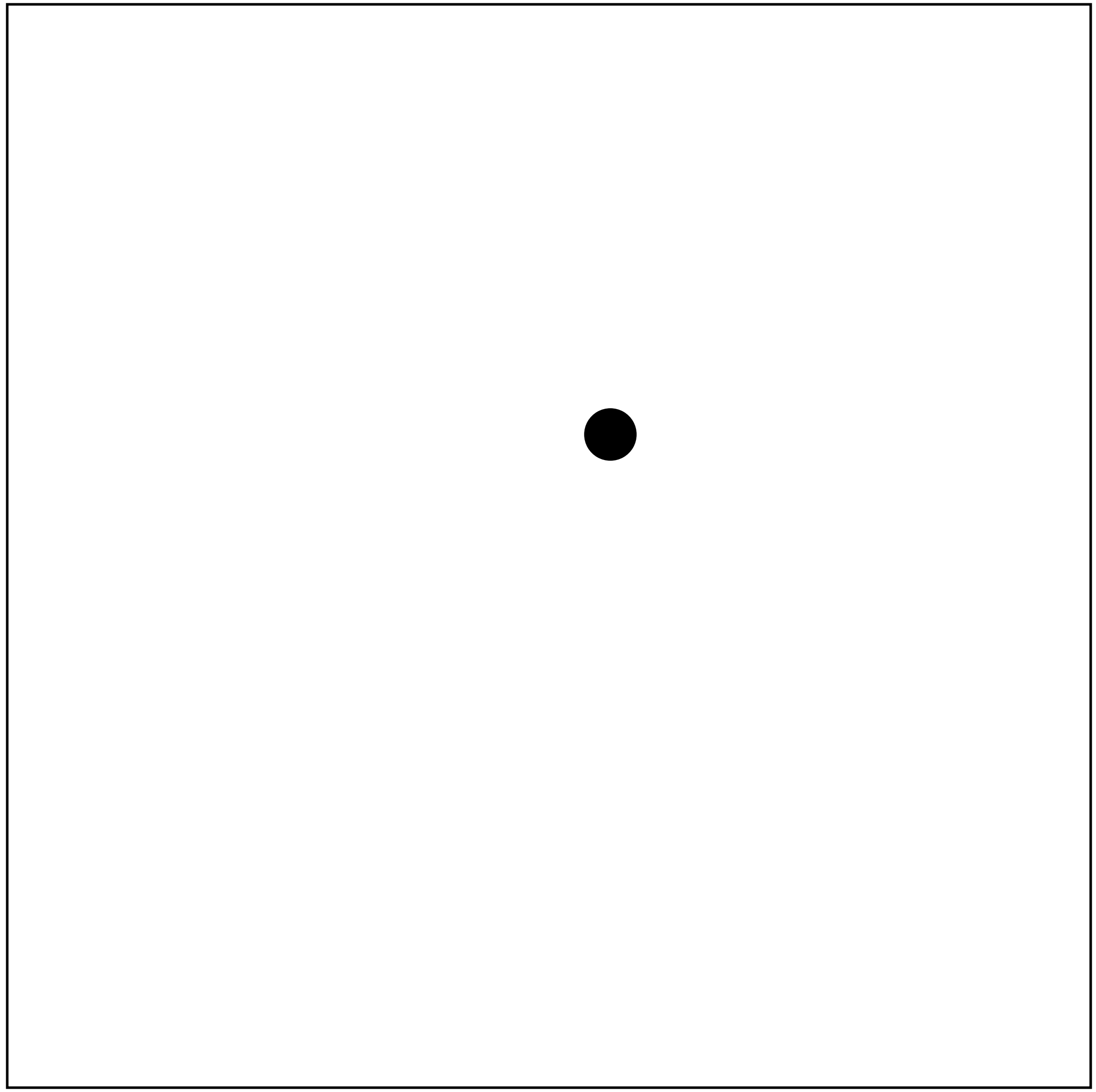

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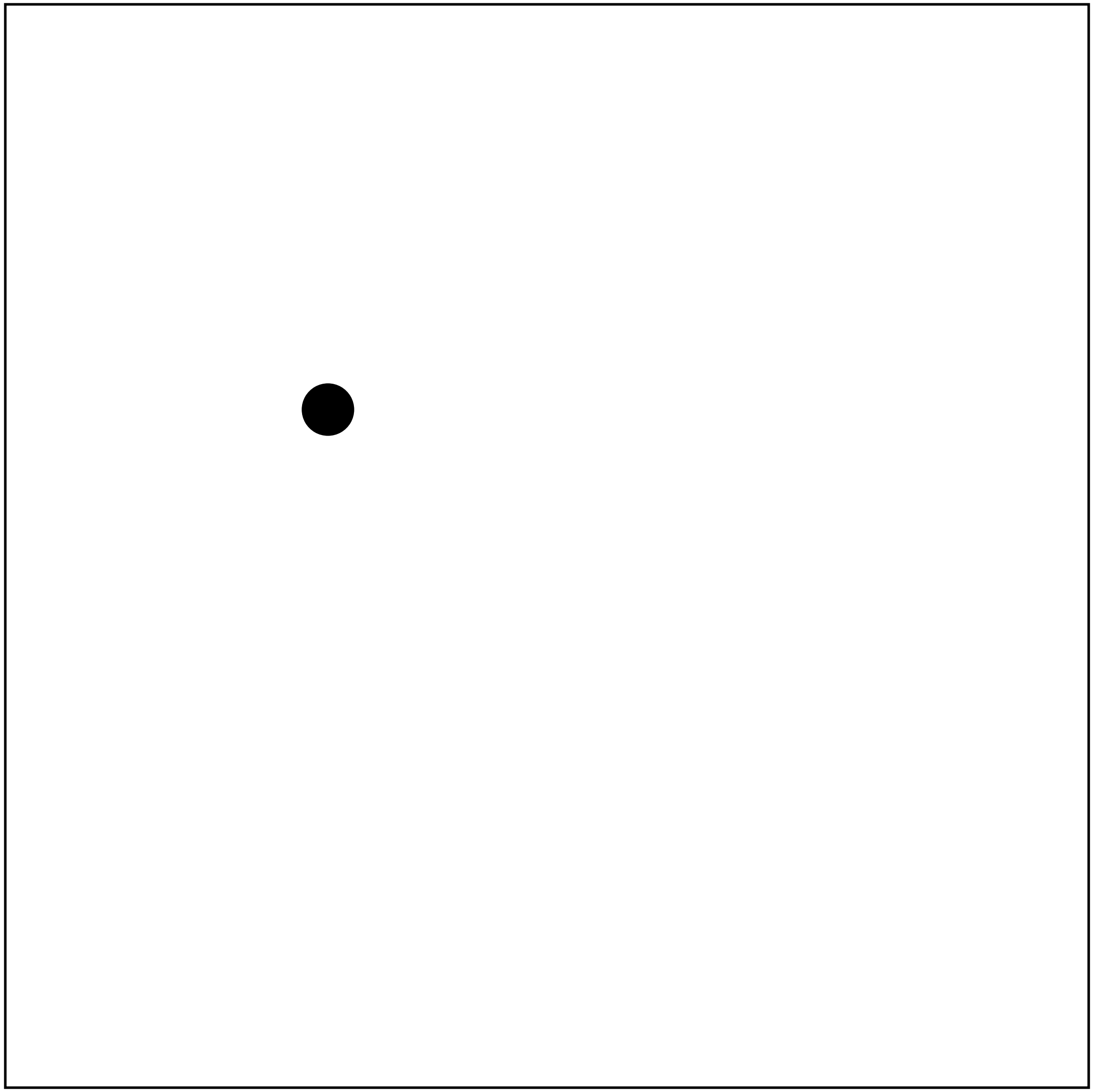


Introduction

Introduction

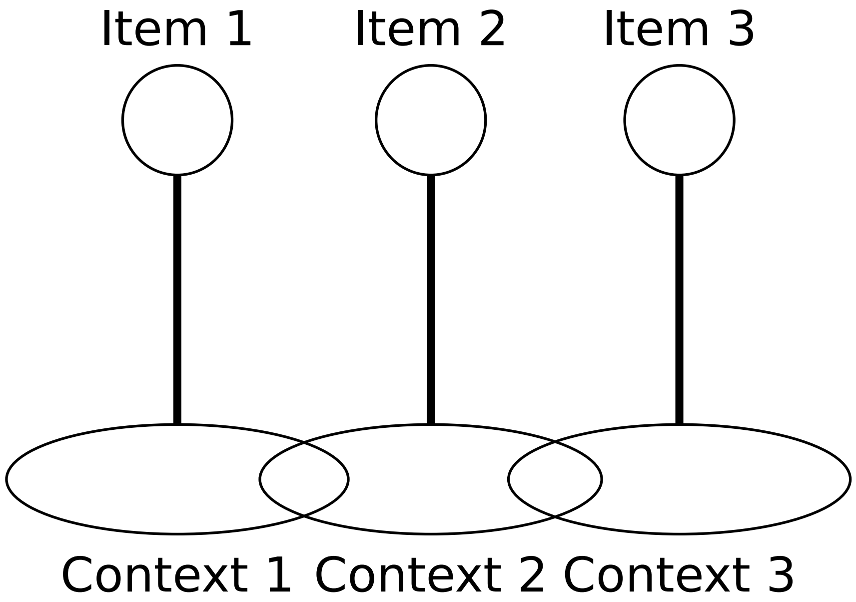
How do we memorize such sequences?

We need to represent:

1. Spatial **locations**
2. The **order** in which they appear

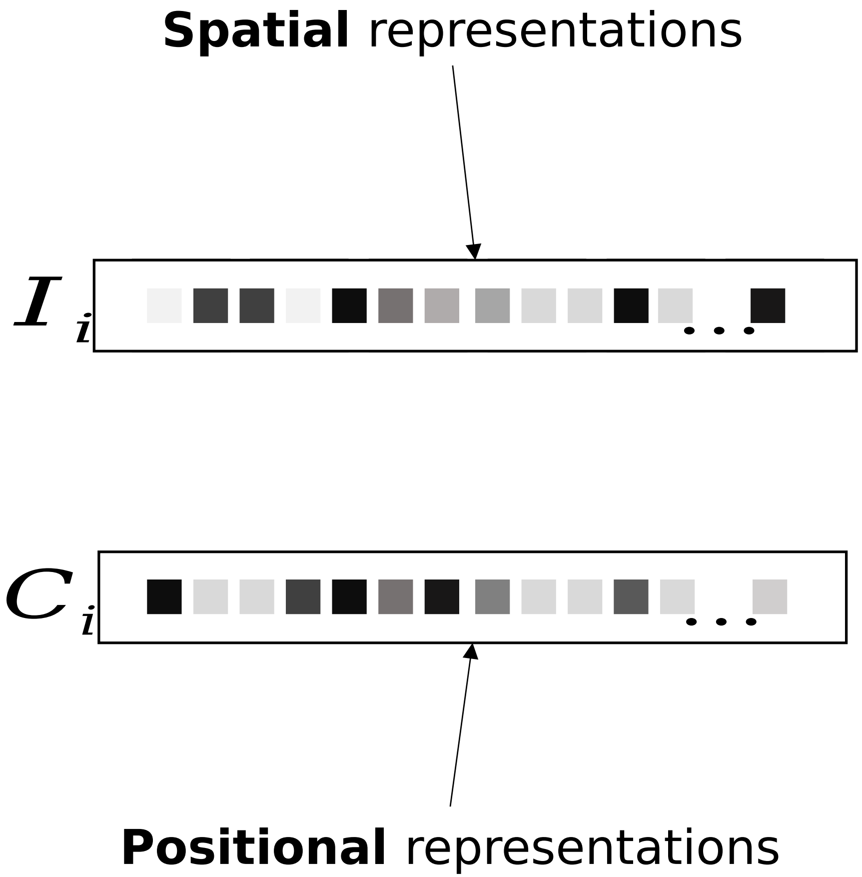
Both should be combined.

Introduction

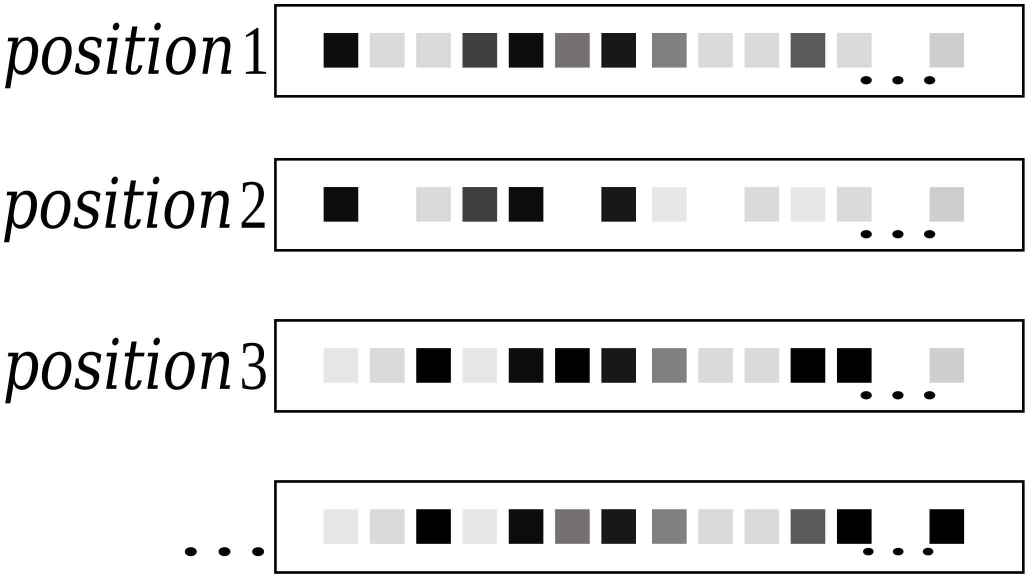


urgess & Hitch (1999) *Psych Review*
arrell & Lewandowsky (2004) *JML*
berauer et al. (2012) *PB&R*
enson (1998) *Cog Psych*

Model

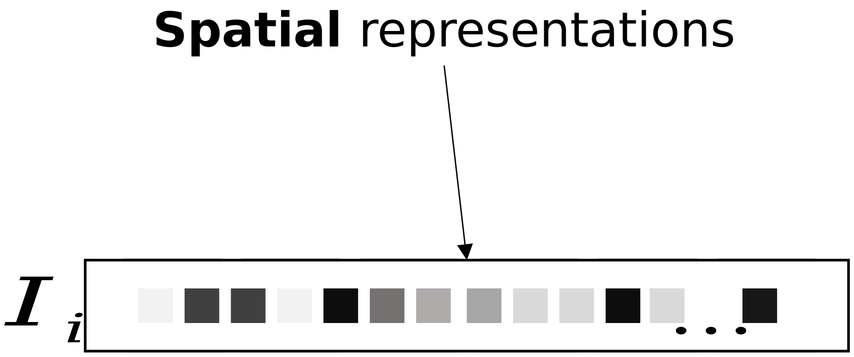

Spatial representations
I_i
C_i
Positional representations

Model

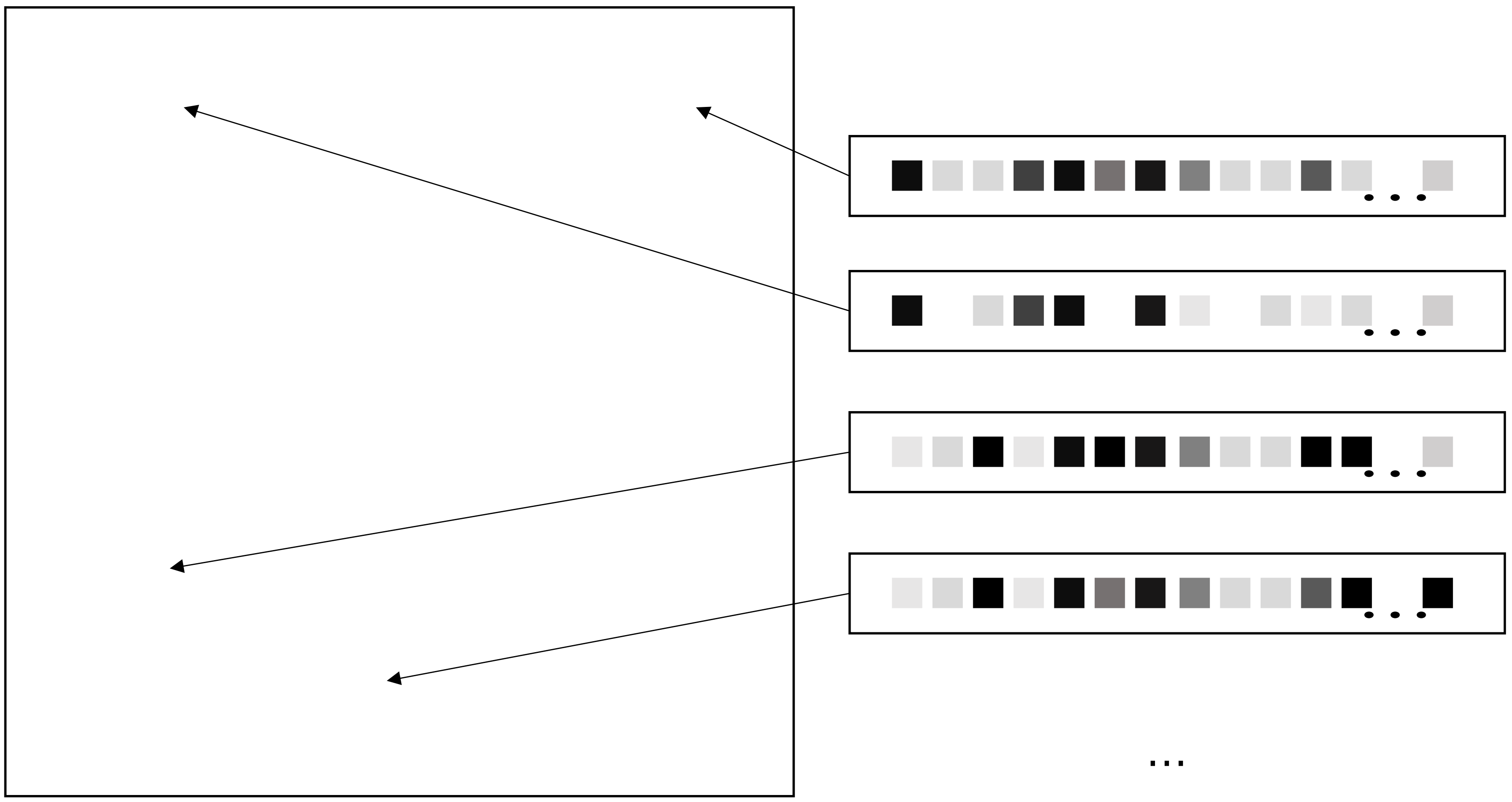


$$\cos\left(C_i, C_j\right) = P^{|i-j|}$$

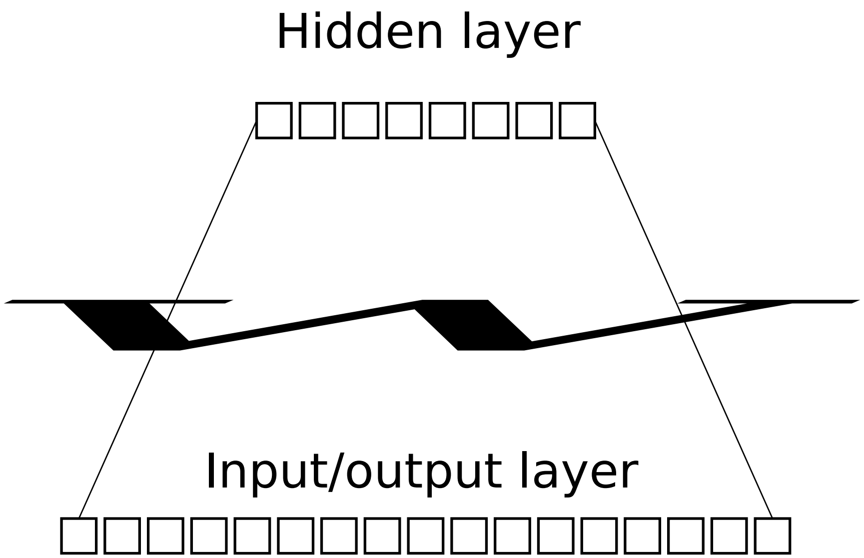
Model



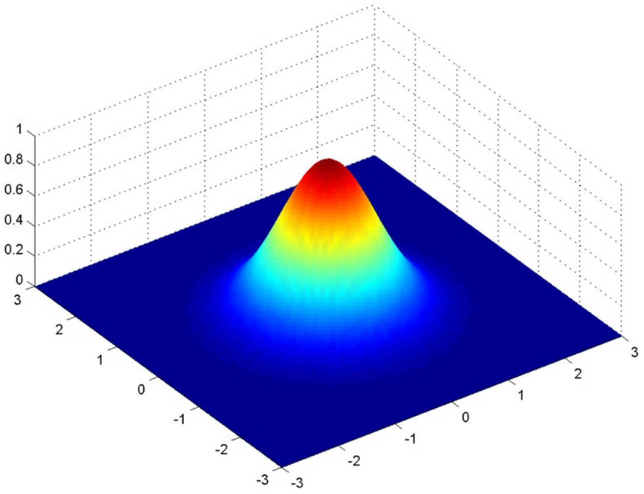
Model



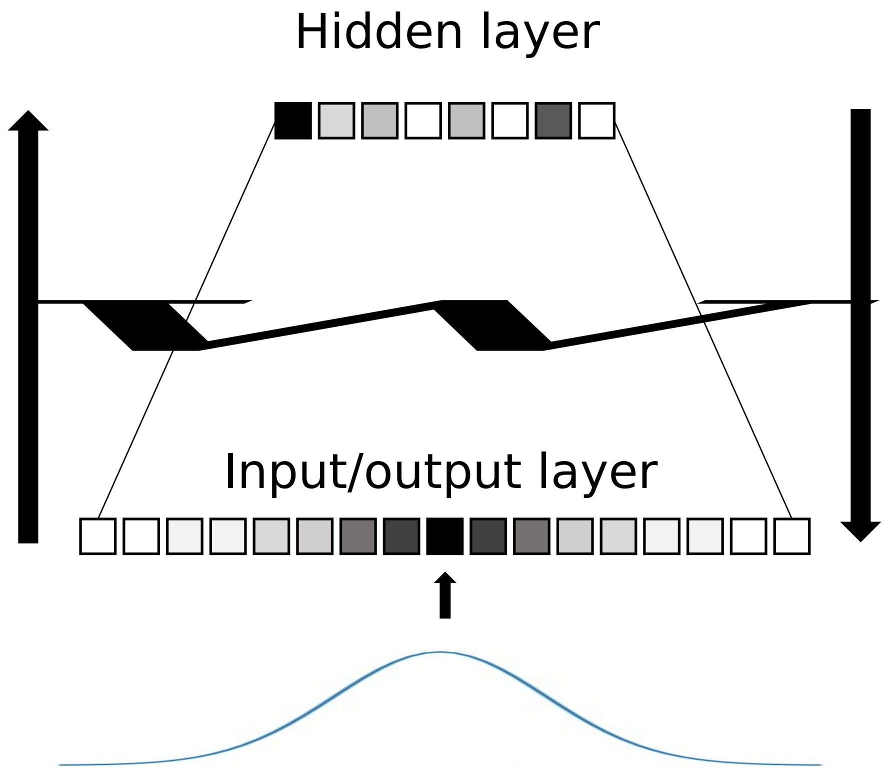
Autoencoder



Autoencoder

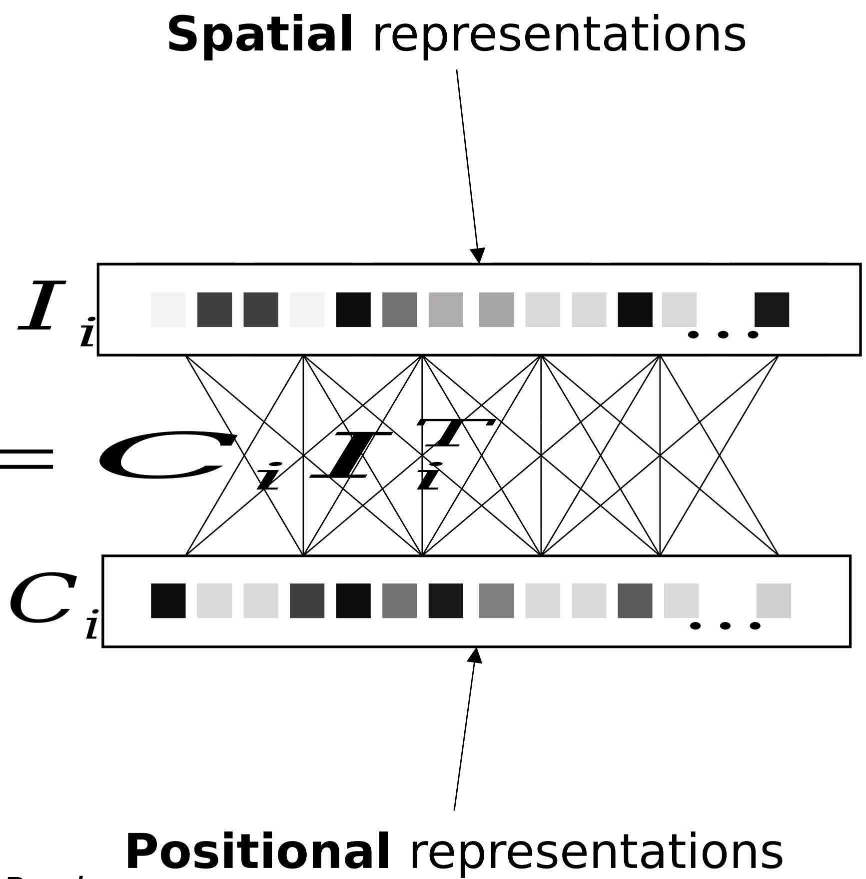


Multivariate normal distribution



Model

$$\Delta W = C_i I_i^T$$



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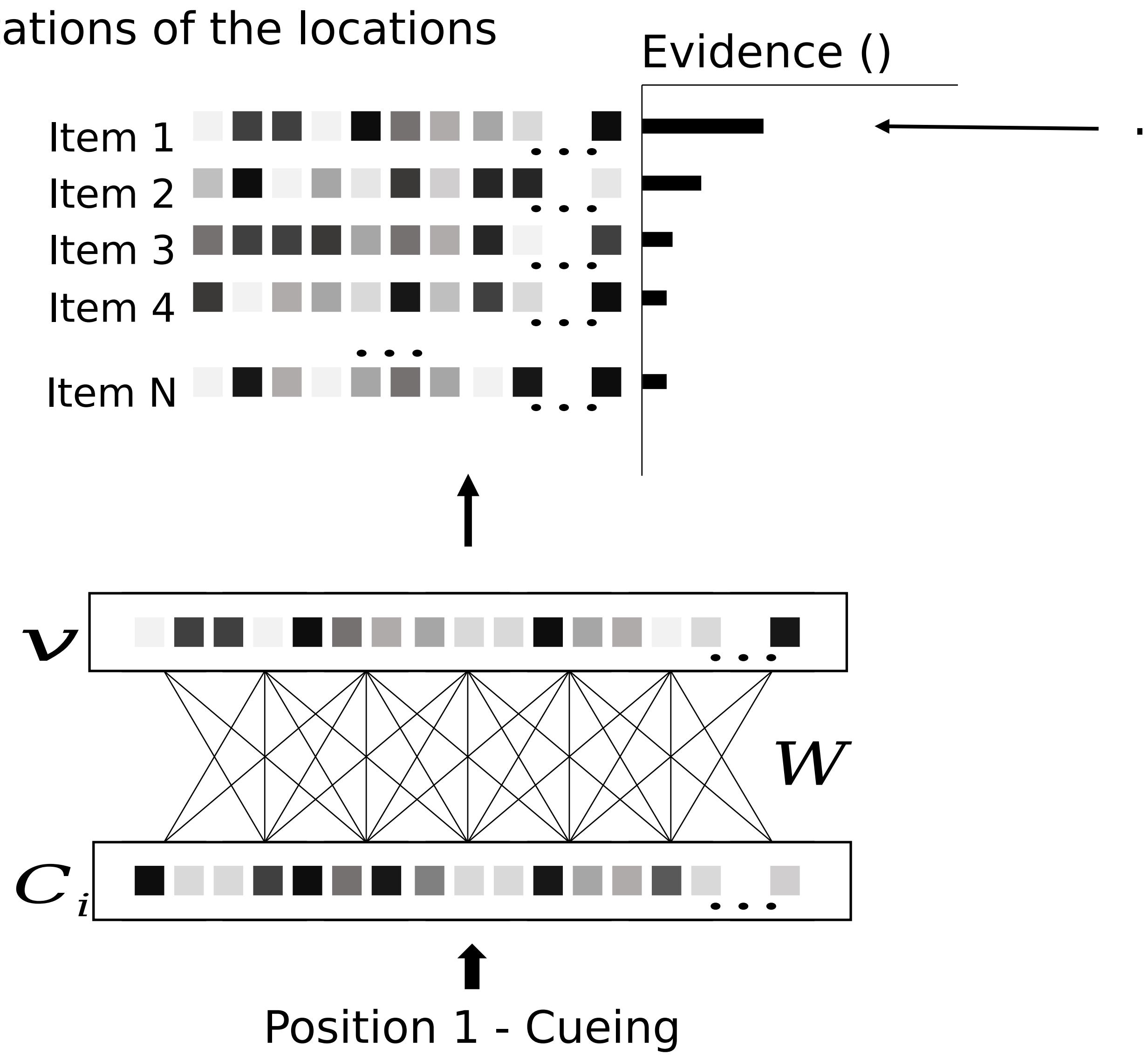
Model

Retrieval phase

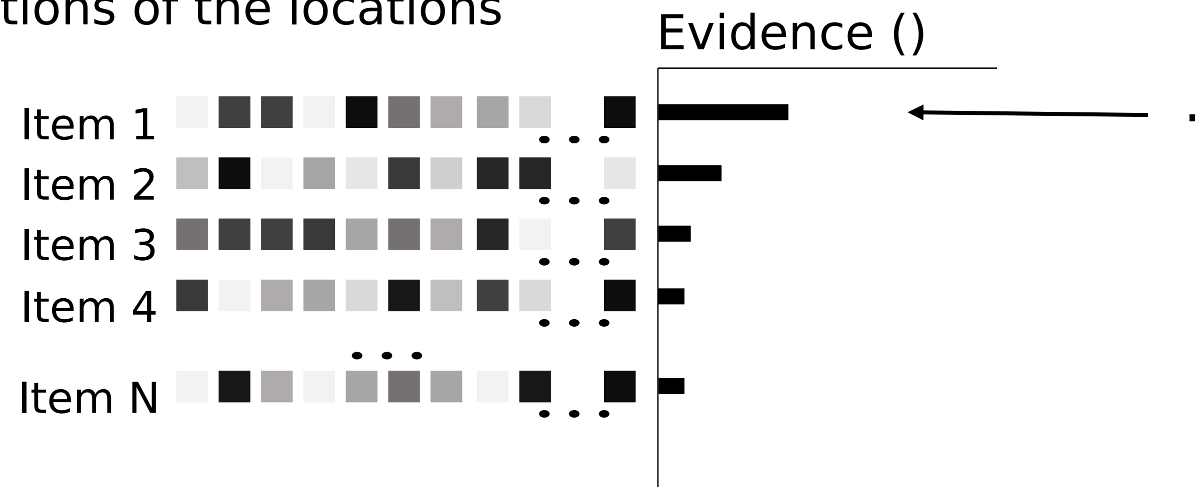
Model



Representations of the locations
Evidence ()
Item 1
Item 2
Item 3
Item 4
Item N
v
W
c_i
Position 1 - Cueing

Model

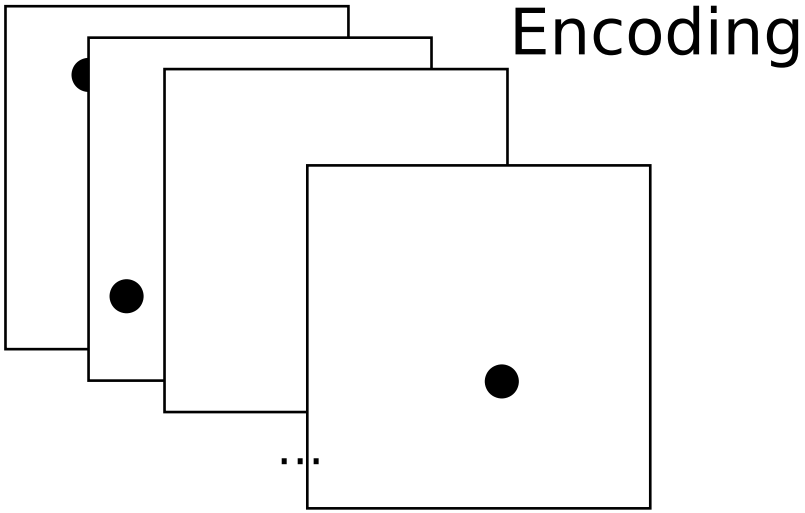
Representations of the locations



Luce's choice rule (exponential version)

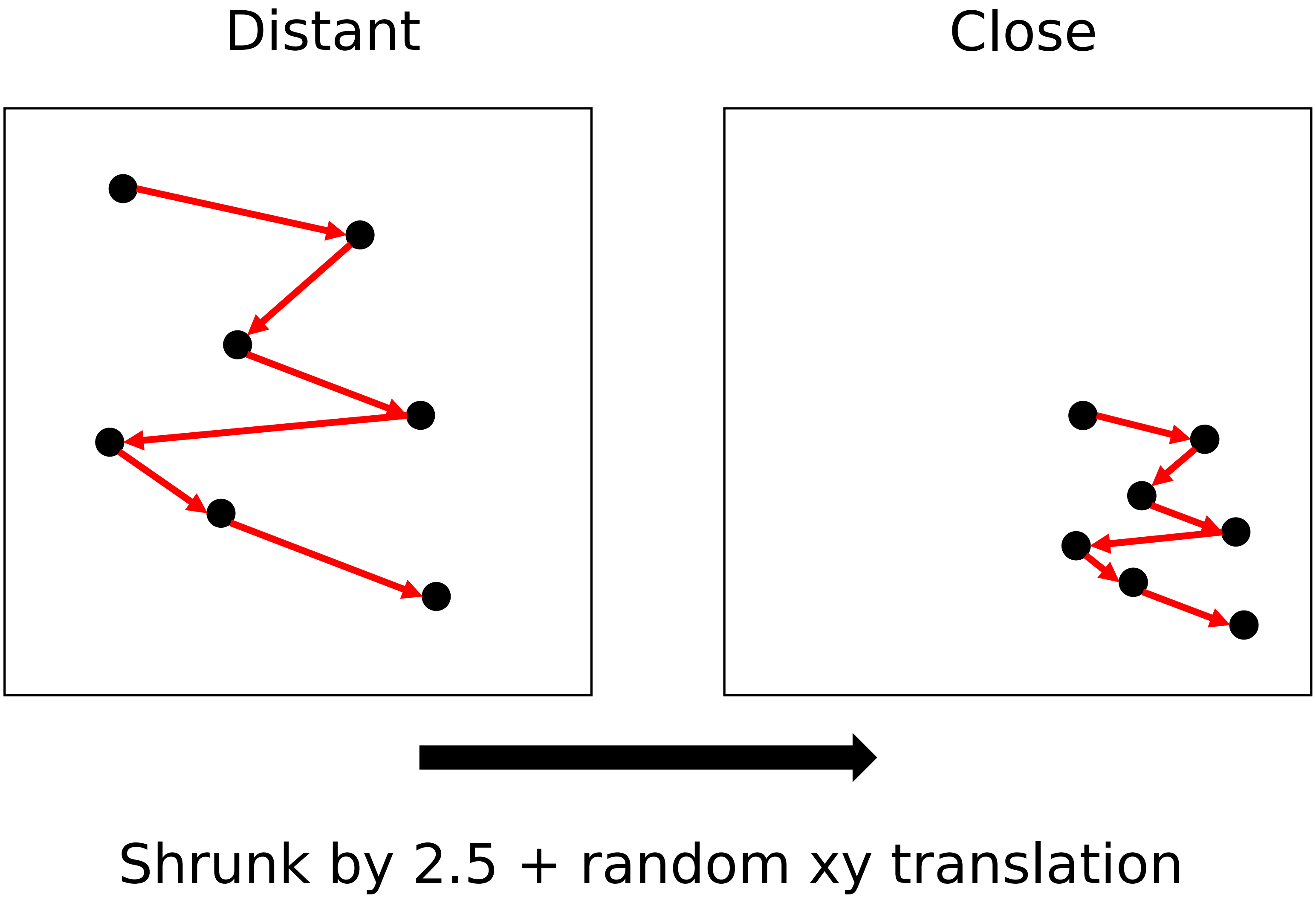
= Temperature (free parameter)

Methods

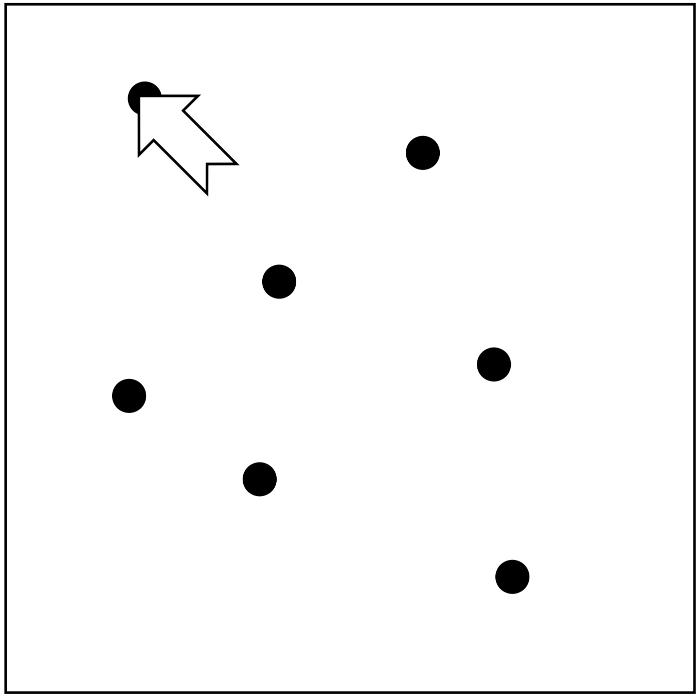


7 items
1s / item

Methods

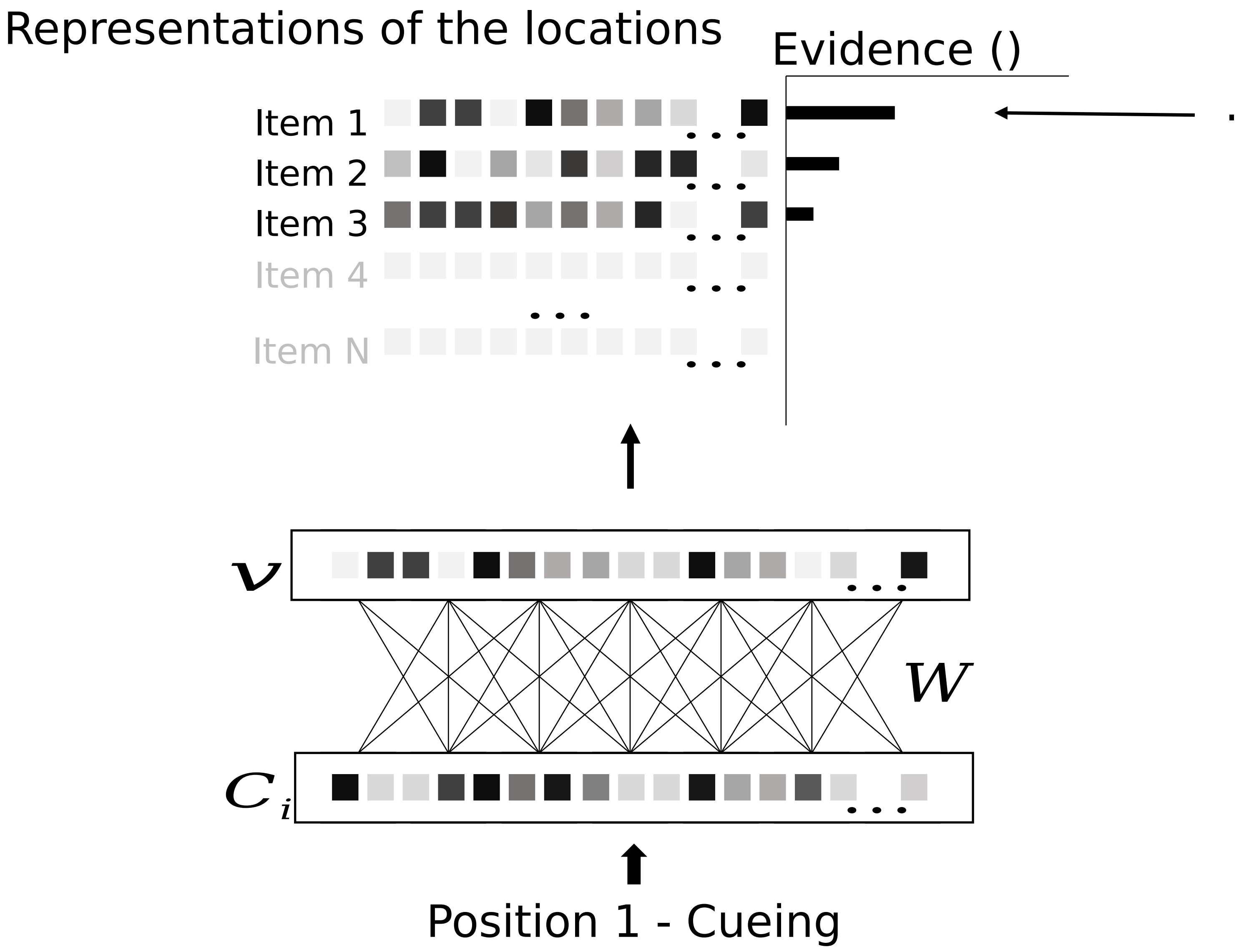


Order reconstruction



Order memory +++

Methods


Representations of the locations
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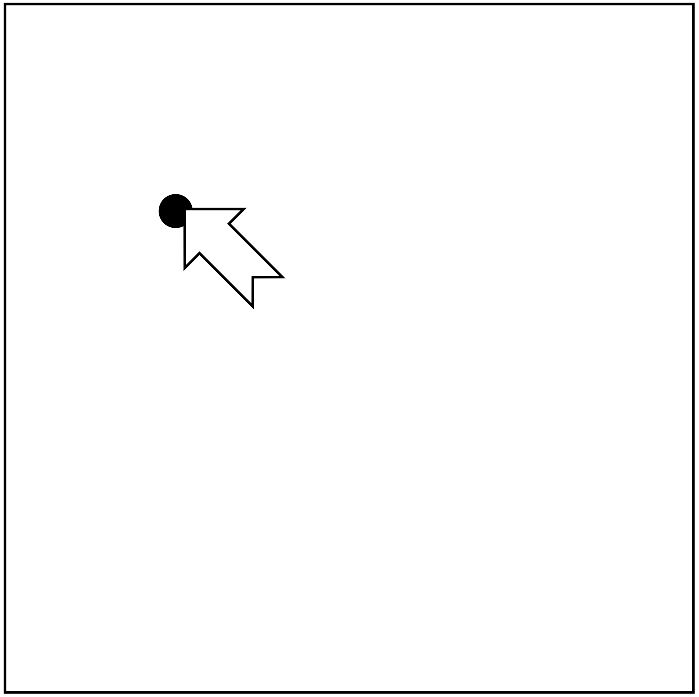
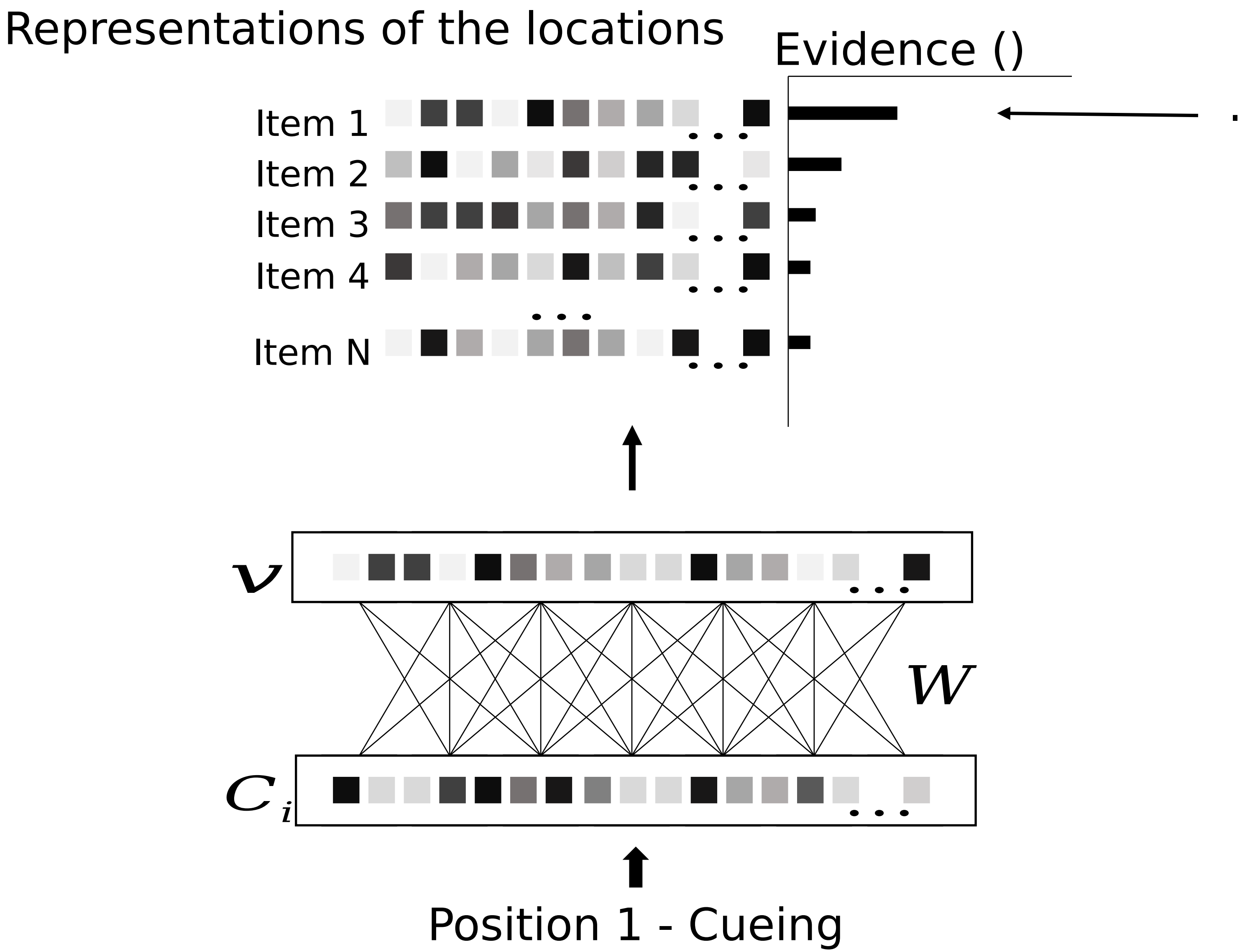
Methods

Serial recall



Item memory ++
Order memory +

Methods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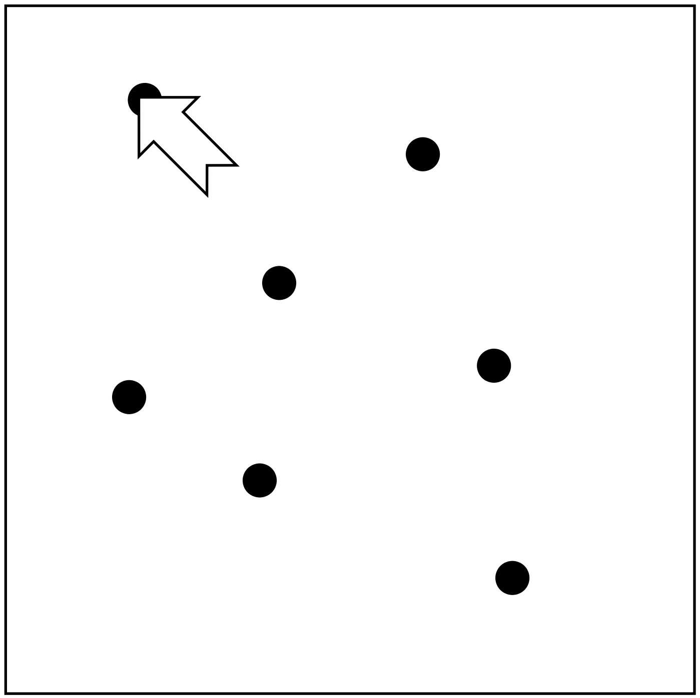
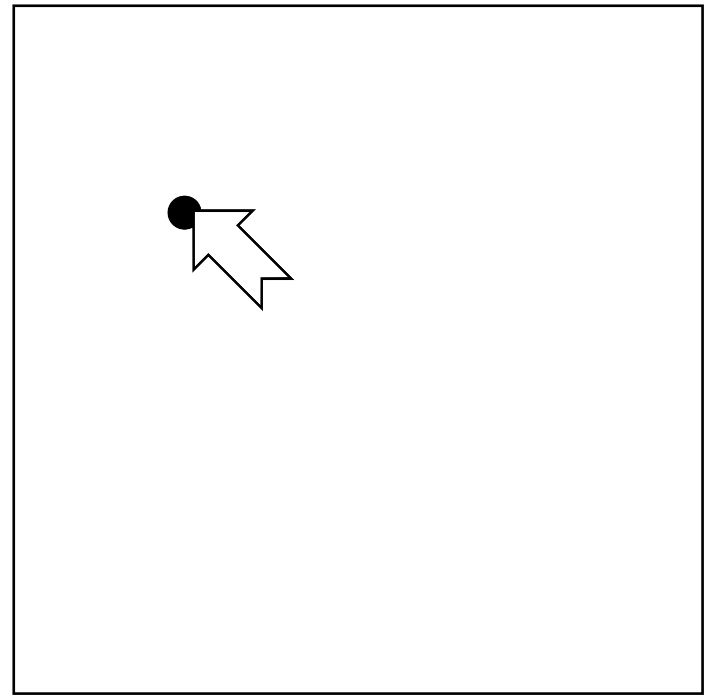


Order memory +++

Serial recall



Item memory ++

Order memory +

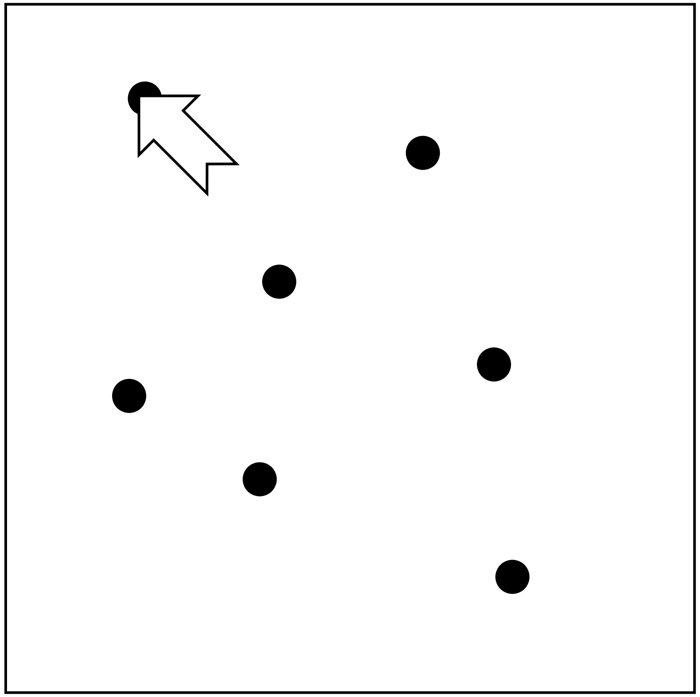
Methods

2x2 design:

- **Proximity manipulation**: Close vs. Distant
- **Task type**: Serial recall vs. Order reconstruction

Results

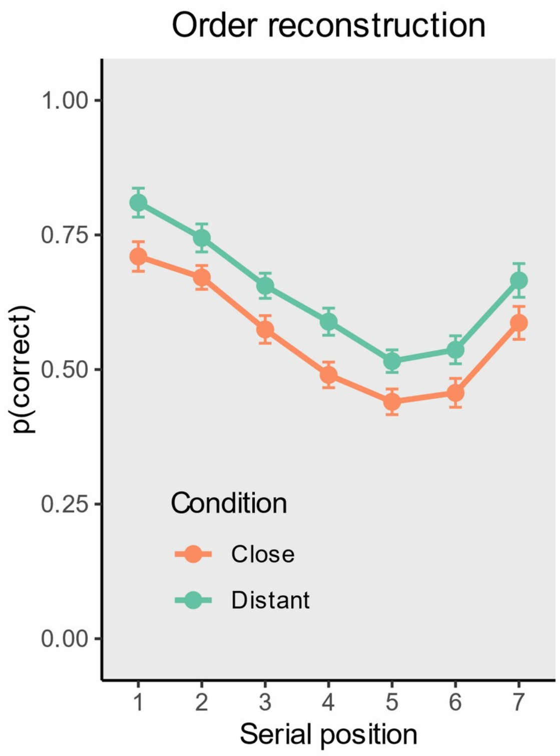
Order reconstruction



Order memory +++

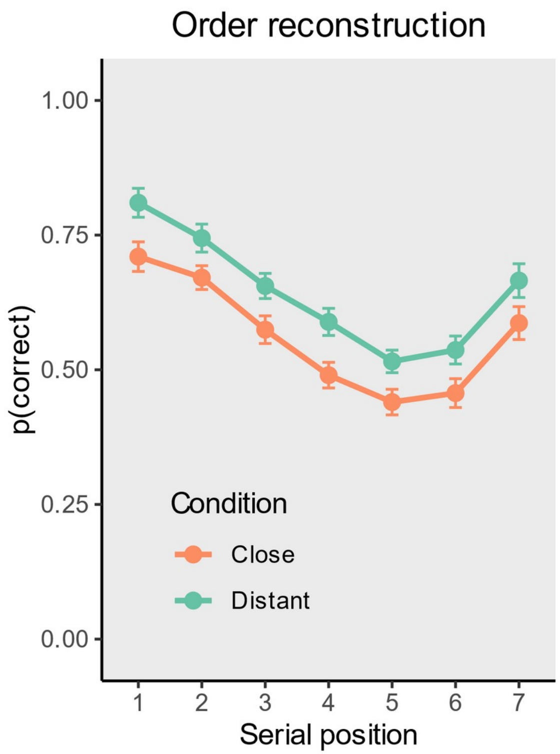
Results

Human data

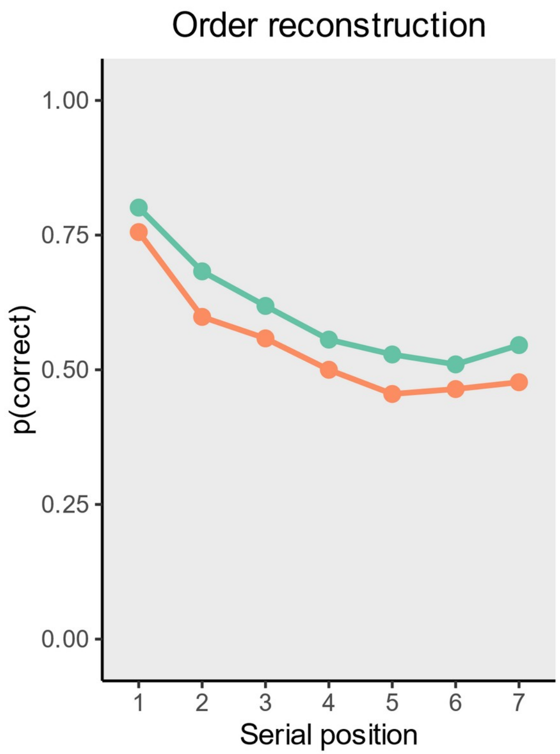


Results

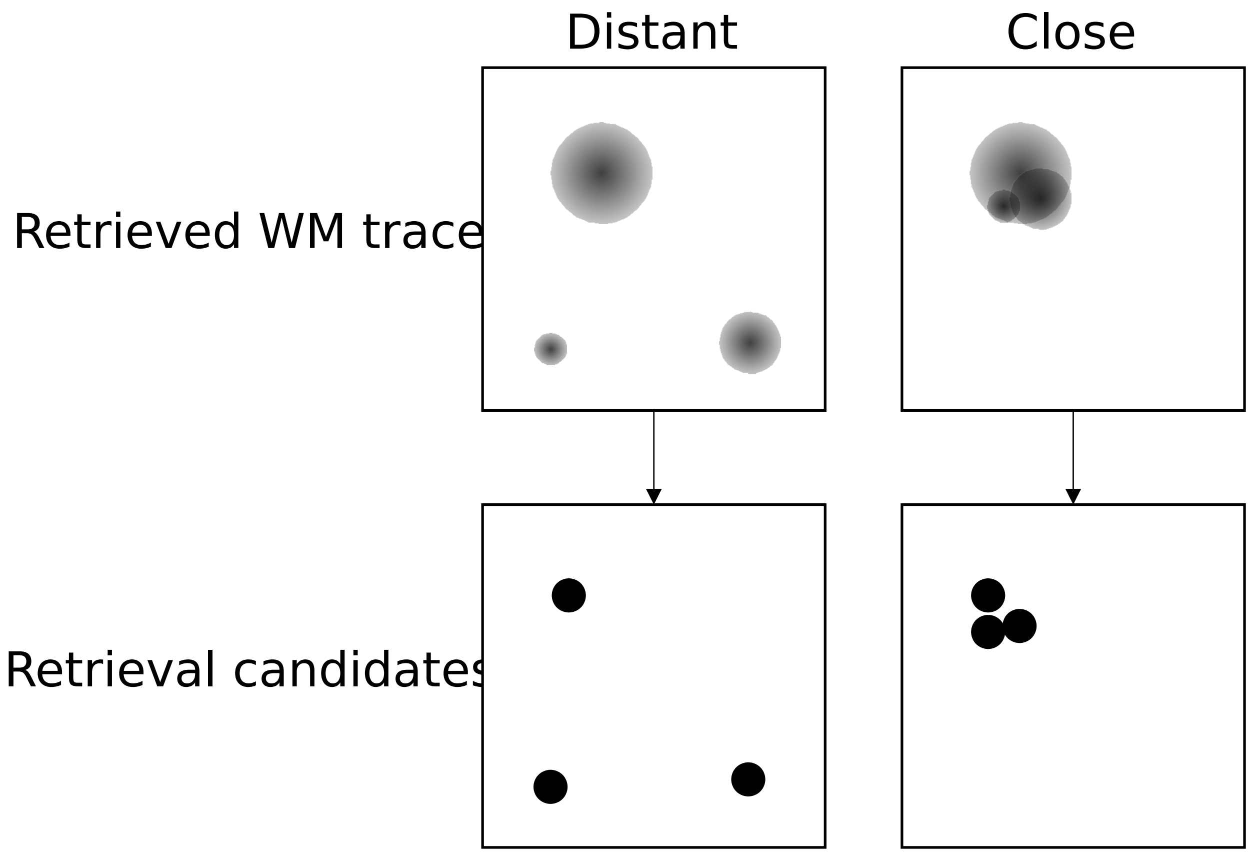
Human data



Simulation



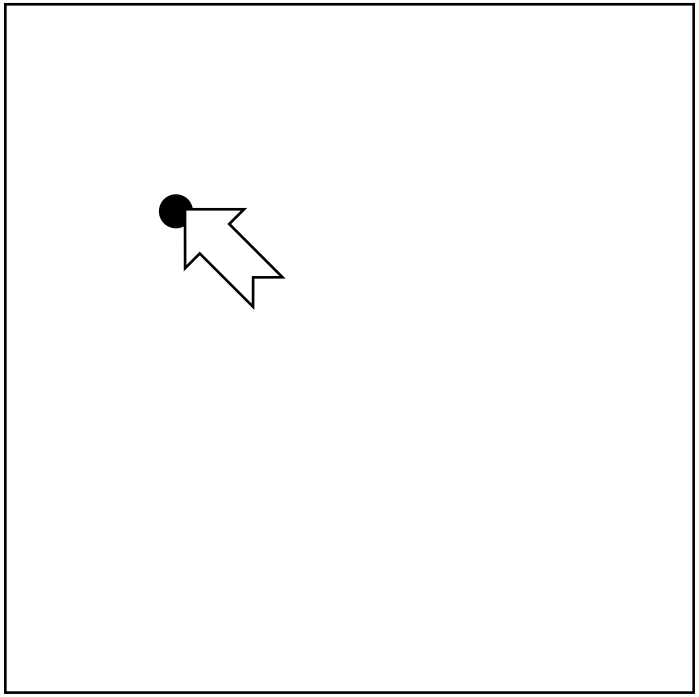
The superposition principle:
In reconstruction



Problem to discriminate the retrieval candidates

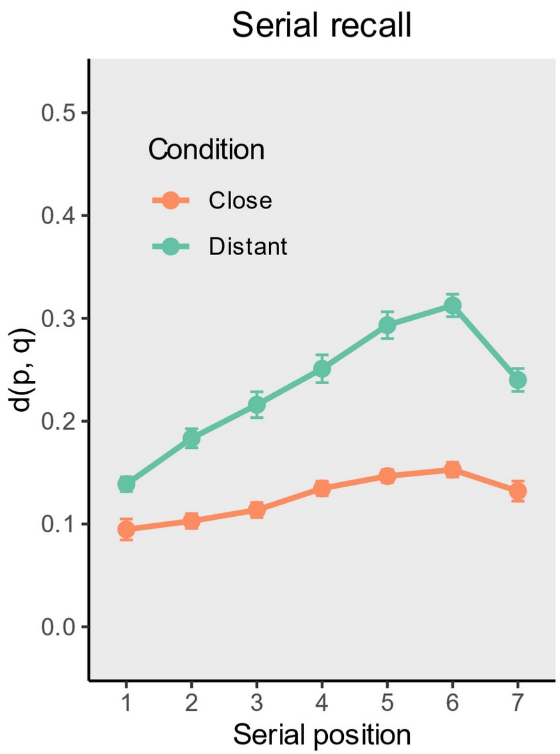
Results

Serial recall

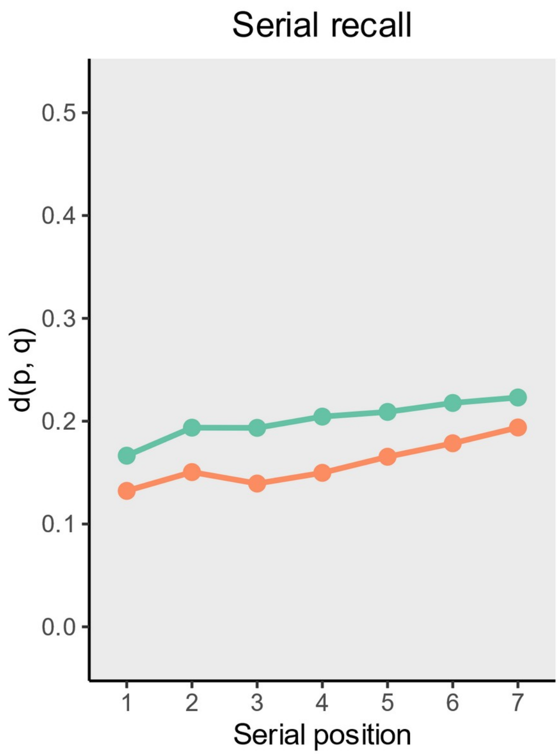


Item memory ++
Order memory +

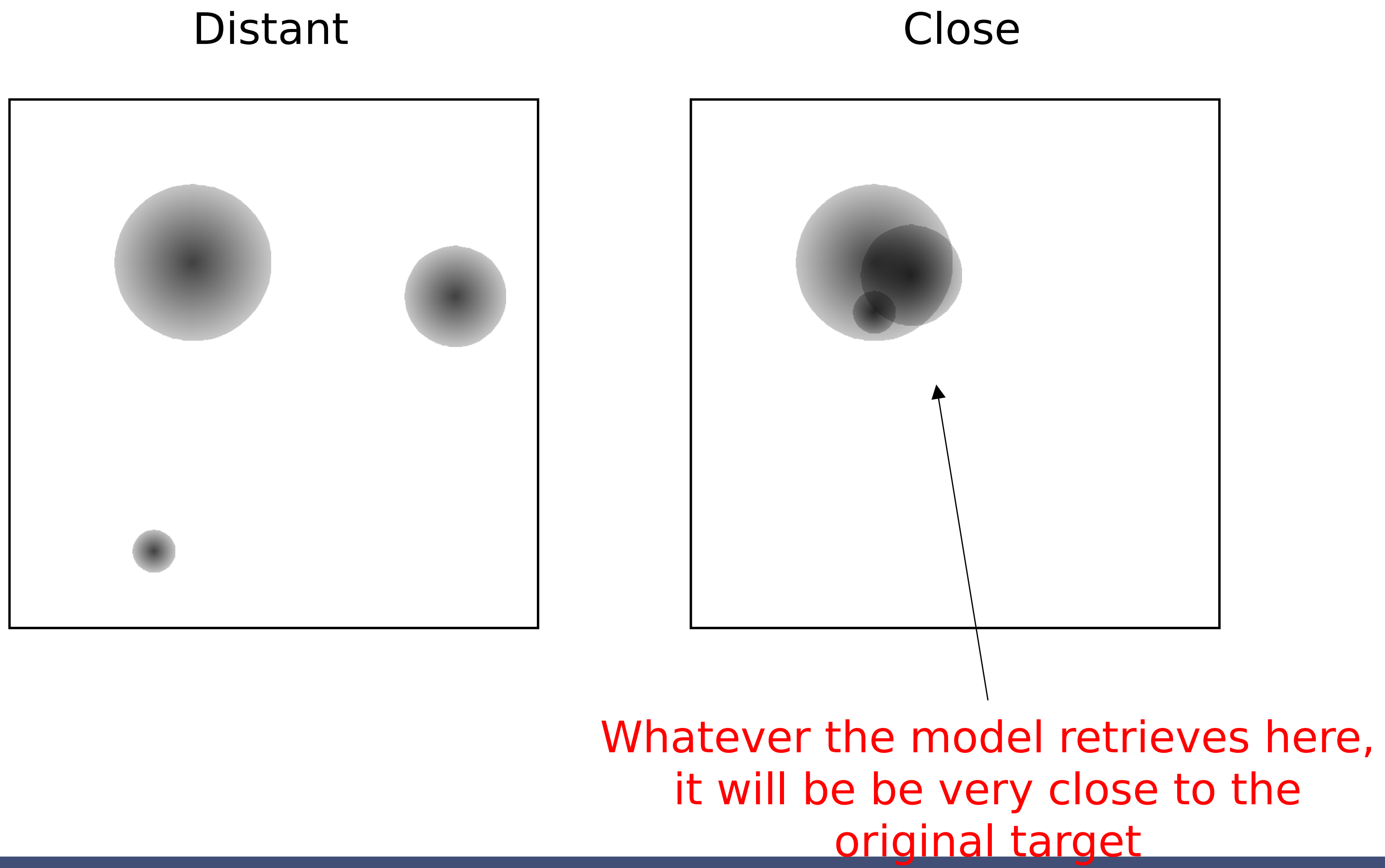
Human data



Simulation



The superposition principle:
Recall



Discussion

Proximity has **two opposing effects** on WM performance:

1. Increases confusion errors
2. Increases the ability to retrieve the information stored

Discussion

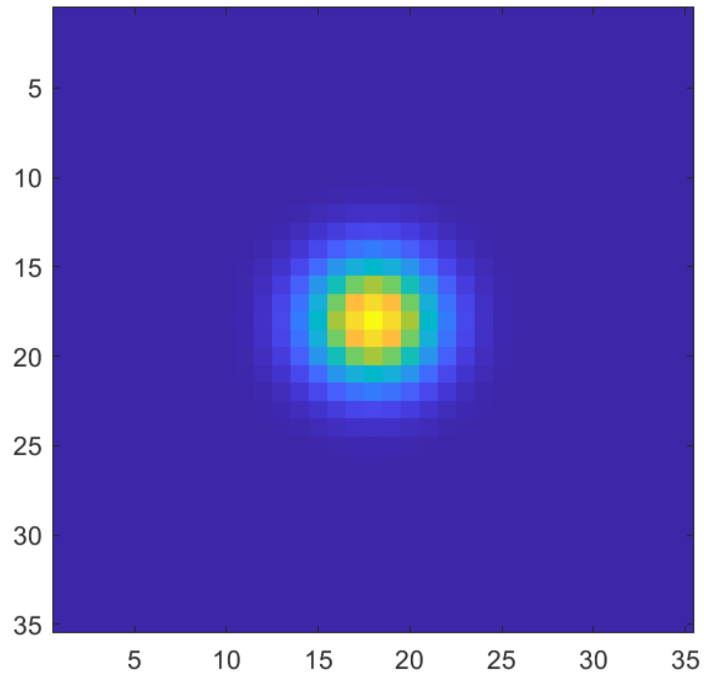
This impact of similarity on WM performance is observed:

For **colors** (Jalbert et al., 2008)
For **tones** (Visscher et al., 2007)
For **verbal** items (Gupta et al., 2005)

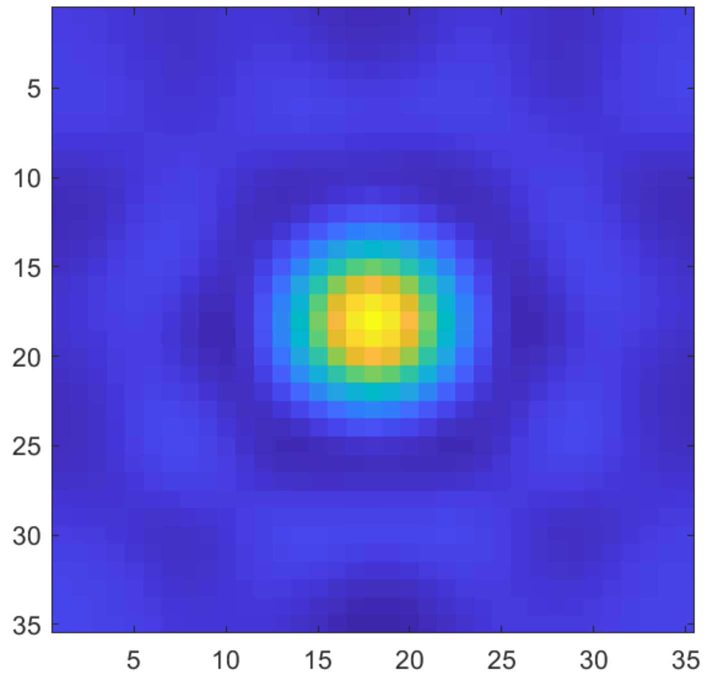
The spatial domain is no exception to this rule

Thank you for your attention

Original vectors



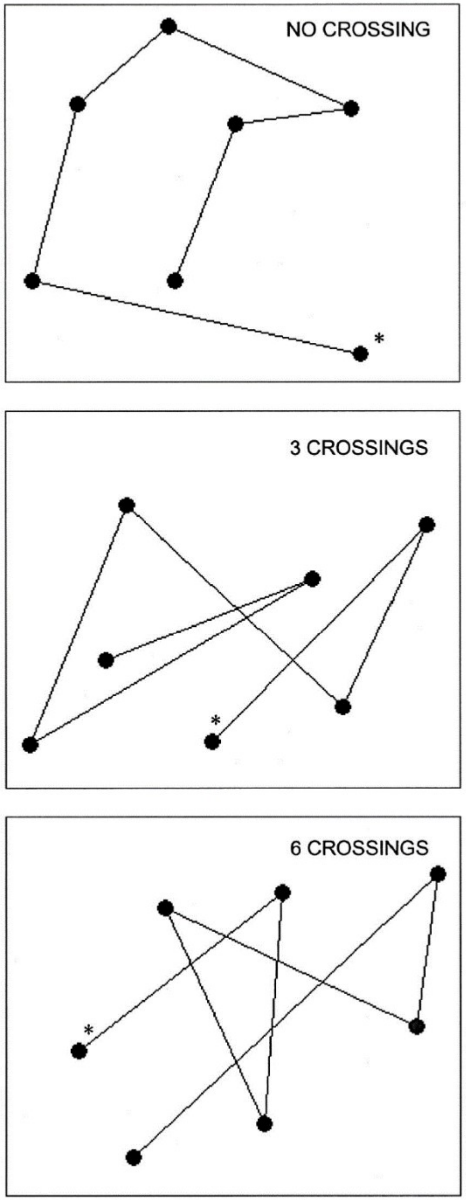
Hidden layer



Discussion

Memory performance decreases as complexity increases

Unexplained in the model

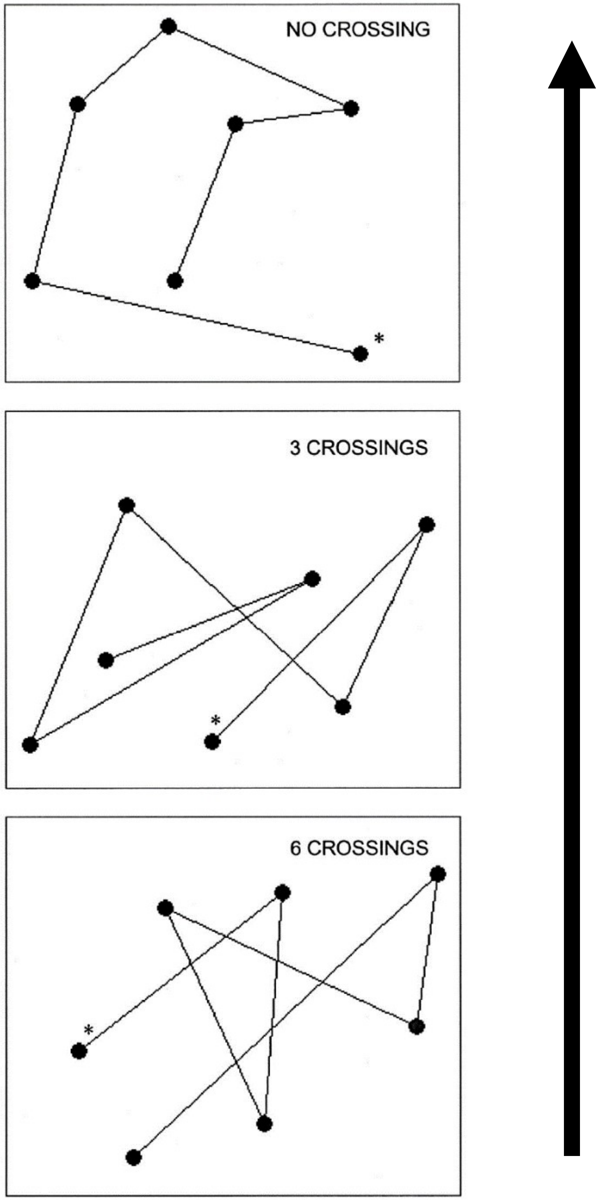


Parmentier et al. (2005)

Discussion

Memory performance decreases as complexity increases

Unexplained in the model



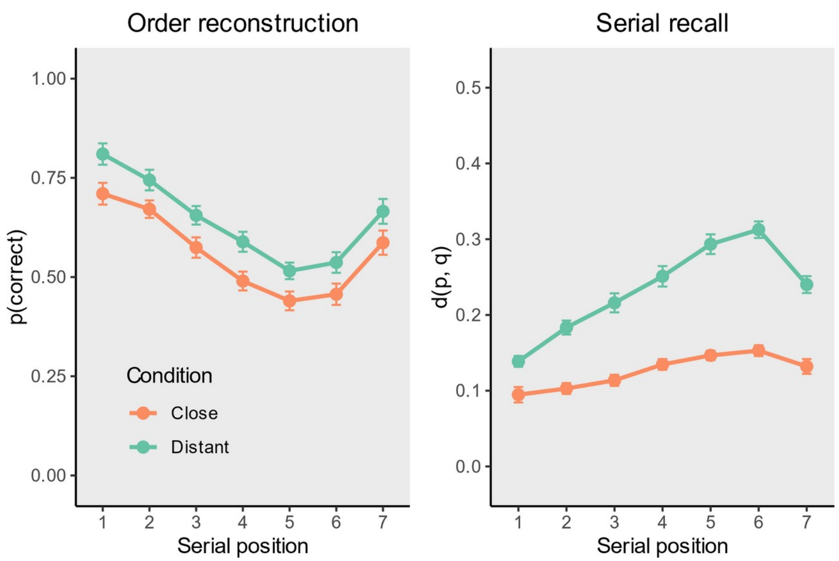
Complexity is confounded with the ability to rely on **pre-existing representations**.

Those representations aren't implemented anywhere.

Parmentier et al. (2005)

Results

Human data



Model