Similarity-based confusions in visuospatial working memory

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Introduction

Working memory
The ability to temporarily maintain new information

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Working memory is subject to similarity-based confusions

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Items in lists composed of similar items are more often mixed-up than items in lists composed of dissimilar items

Gupta et al. (2005)

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Similar: hide ride side lied tied died

Dissimilar: coke gel bag fin dig seep

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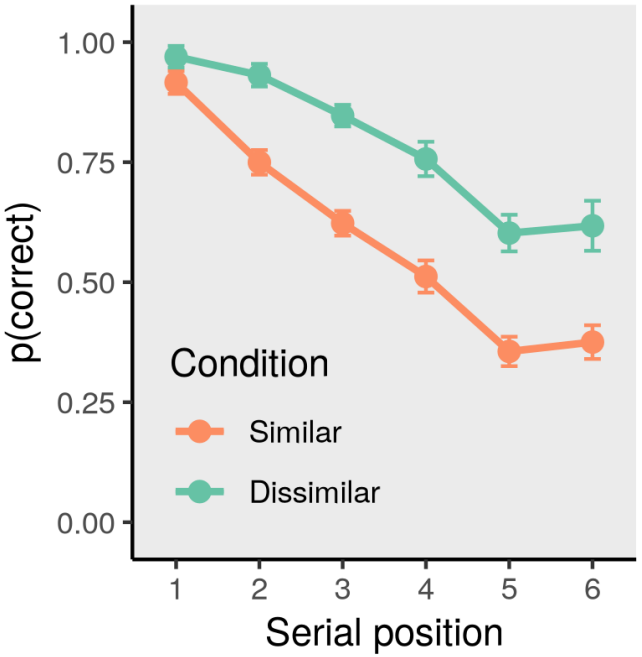

Gupta et al. (2005)

Kowialiewski et al. (2023)

Introduction

Similarity effects are typically explained through **distance in psychological space**.

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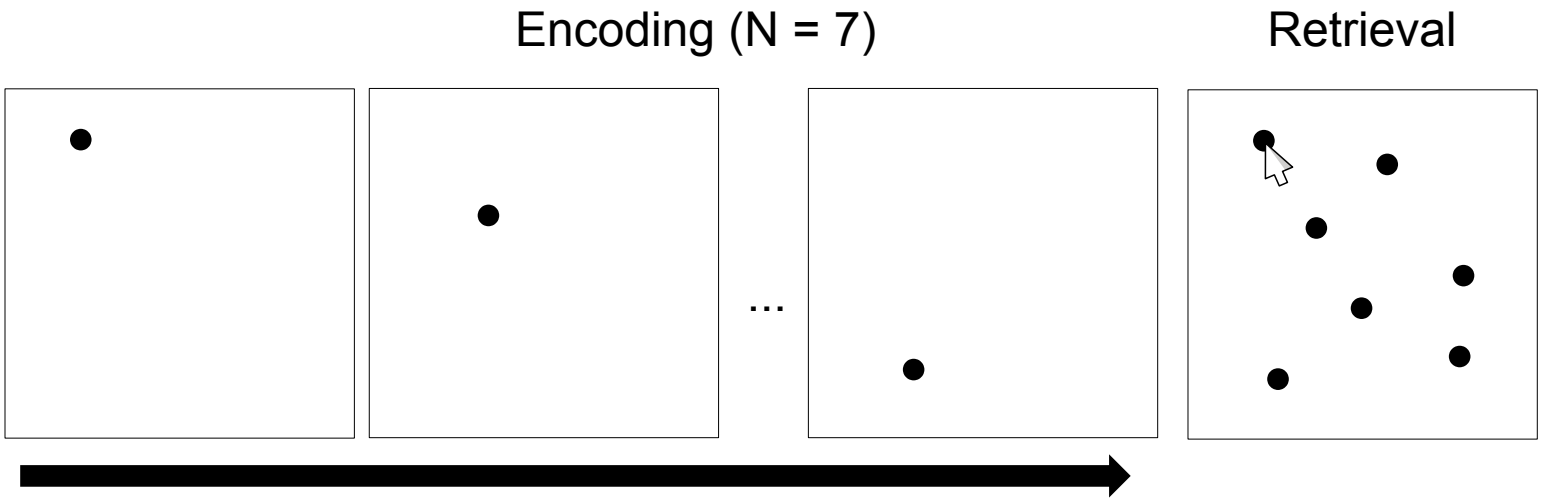
Whether these effects are also present when manipulated in **physical distance** remains ambiguous.

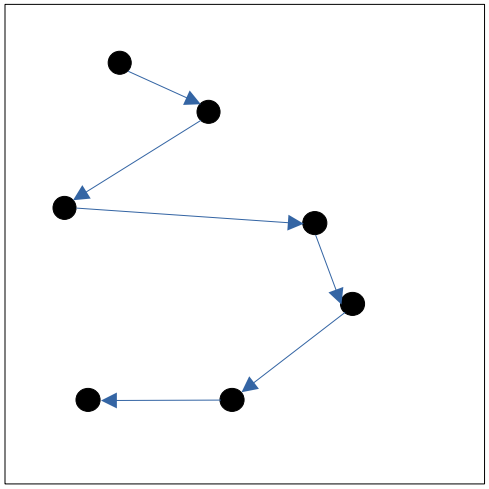
How can we manipulate physical distance?

Introduction

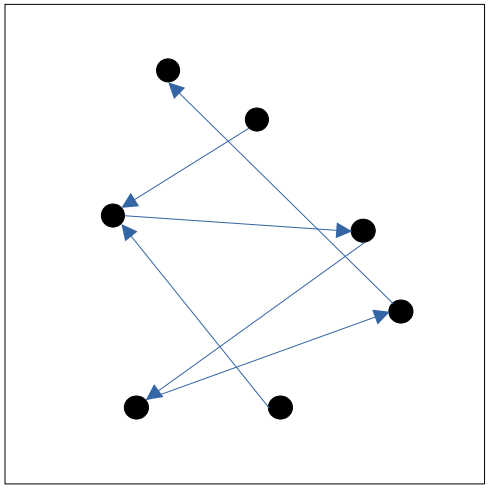


Introduction

Short paths



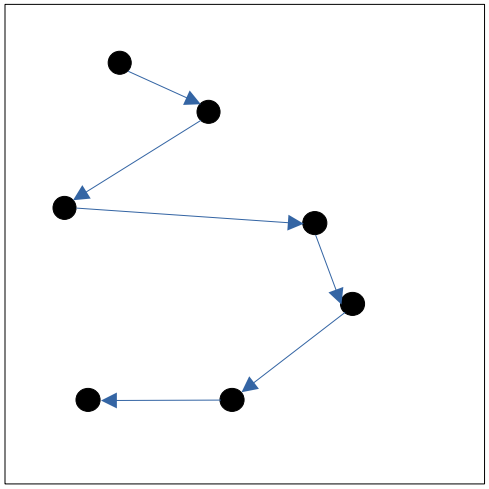
Long paths



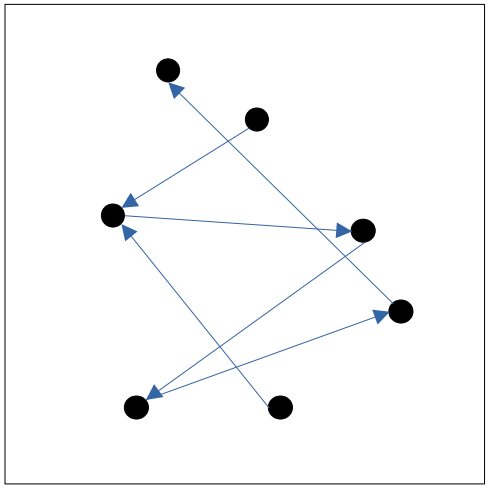
Parmentier et al. (2005)

Introduction

Short paths



Long paths

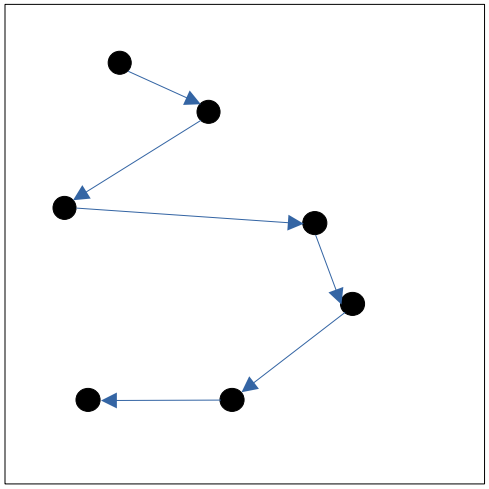


Sequences composed of **short paths are better remembered** than sequences composed of long paths.

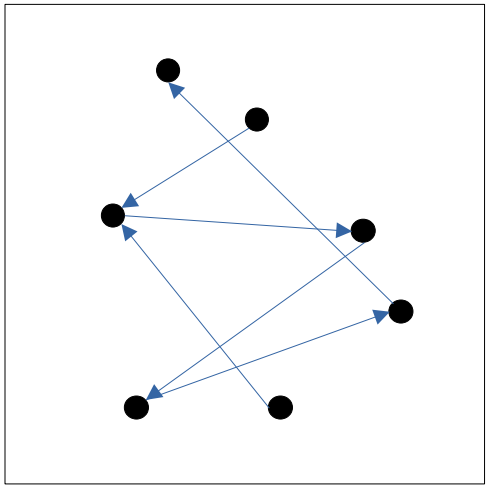
Parmentier et al. (2005)

Introduction

Short paths



Long paths



Sequences composed of **short paths are better remembered** than sequences composed of long paths.

Problem: Path length confounded with complexity.

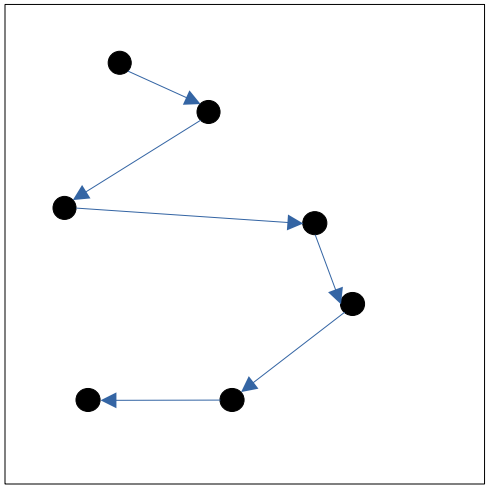
Parmentier et al. (2005)

Introduction

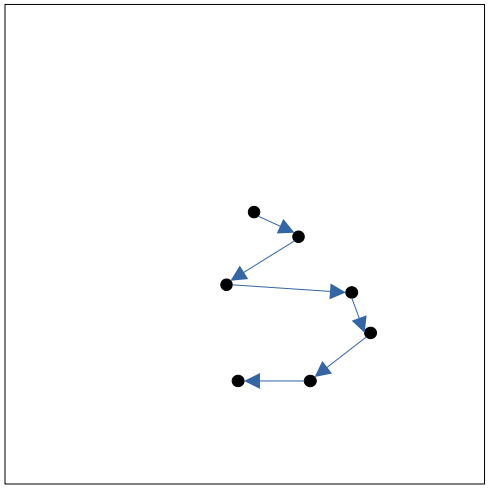
We need a better way of manipulating physical distance.

Experiment 1: Methods

Distant



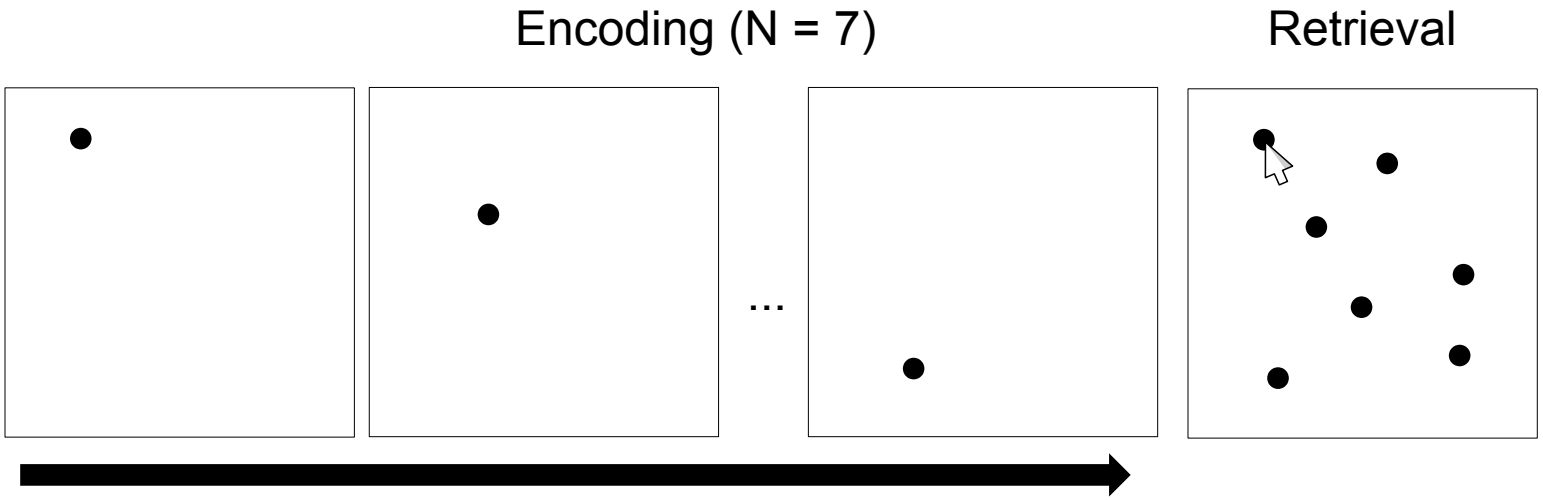
Close



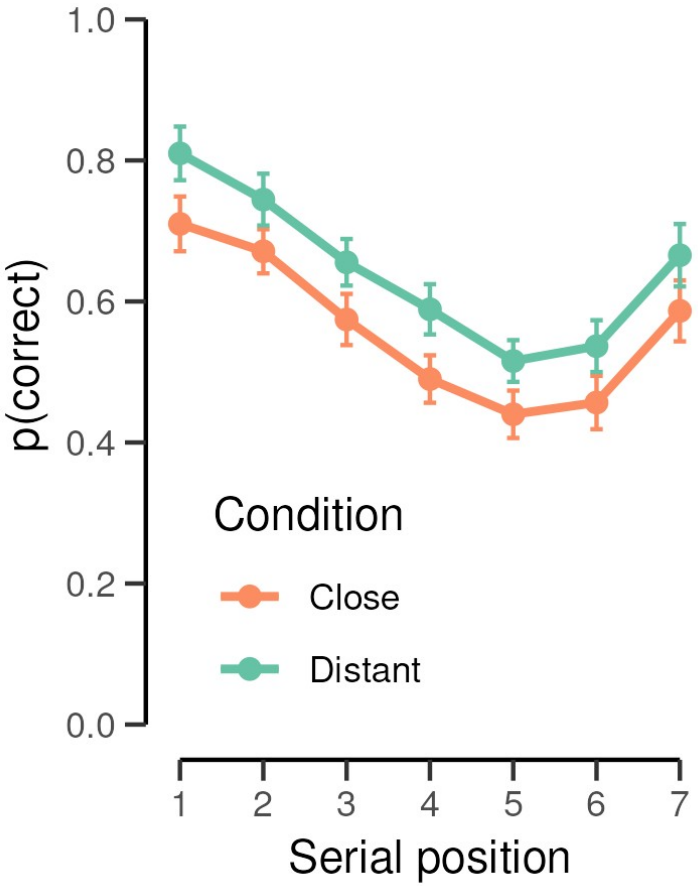
Proximity manipulation

Sequences shrunk by a constant factor (2.5)

Experiment 1: Methods



Experiment 1: Results



Experiment 1: Discussion

Items located close to each other were confused more often.

Where do these confusions occur?

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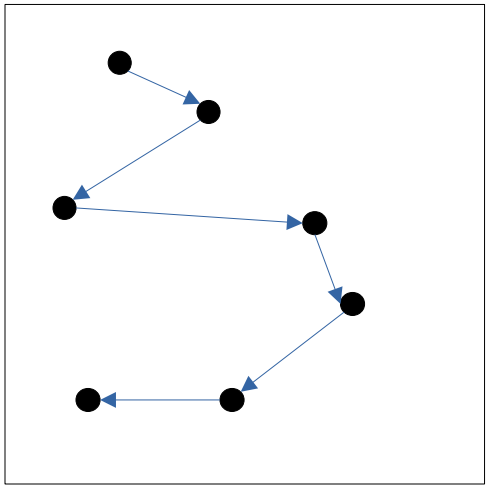
Where do these confusions occur?

Hypothesis 1: **Perceptual errors** - close locations are more difficult to discriminate from a purely perceptual point of view

Hypothesis 2: **Psychological space** - close locations are more difficult to discriminate in memory, leading to increased confusions

Experiment 2: Methods

Distant



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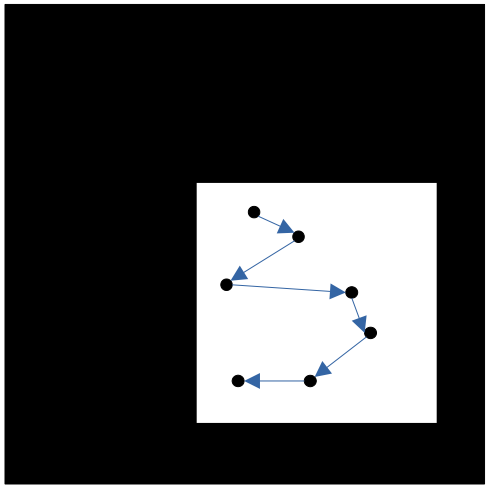
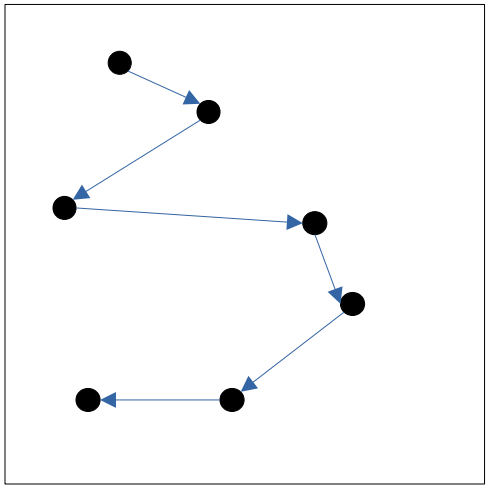


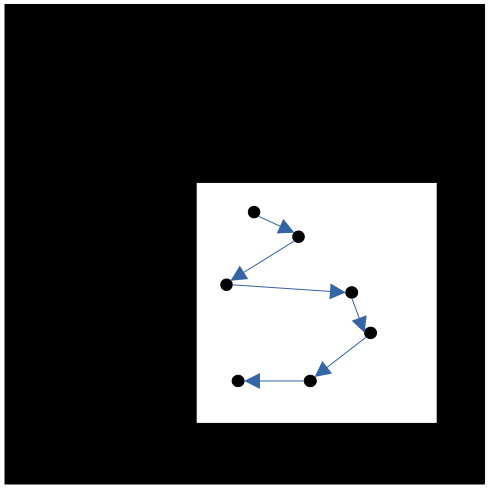
Change of reference frame

Experiment 2: Methods

Distant



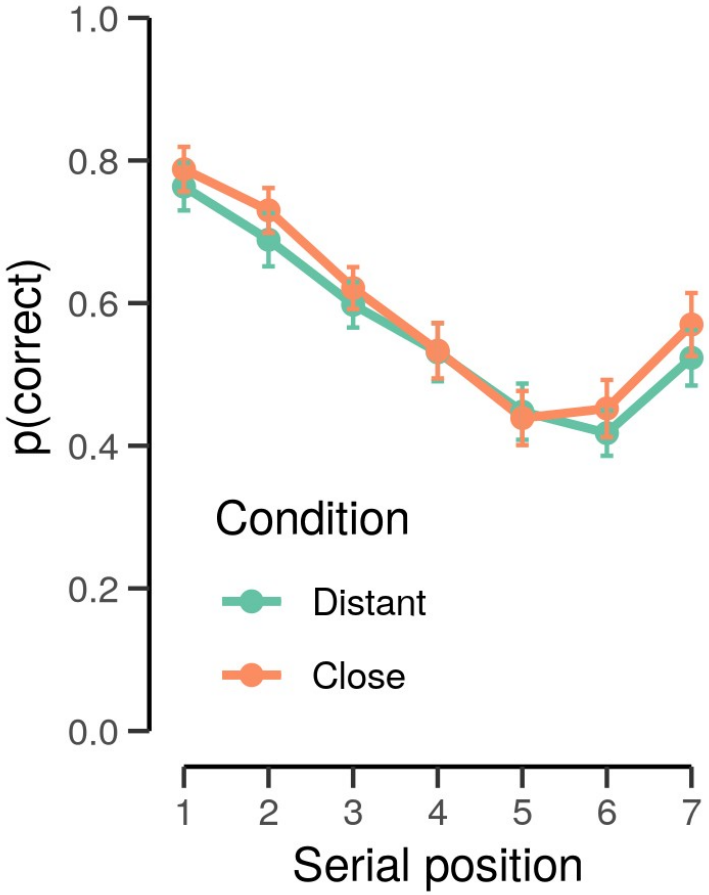
Close



Change of reference frame

Perceptual error: Should not matter
Confusions in memory: Should abolish the proximity effect

Experiment 2: Results



Experiment 2: Discussion

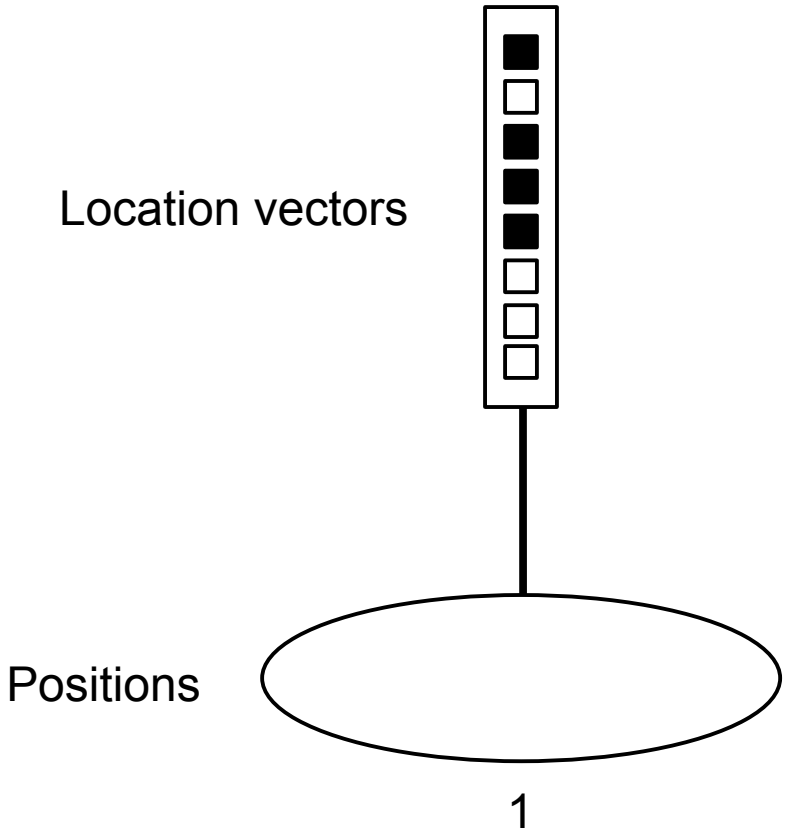
Changing participants' reference frame **abolished** the proximity effect.

This suggests that **confusion errors** resulting from decreasing the physical distance between locations **arise in psychological space**.

Modeling

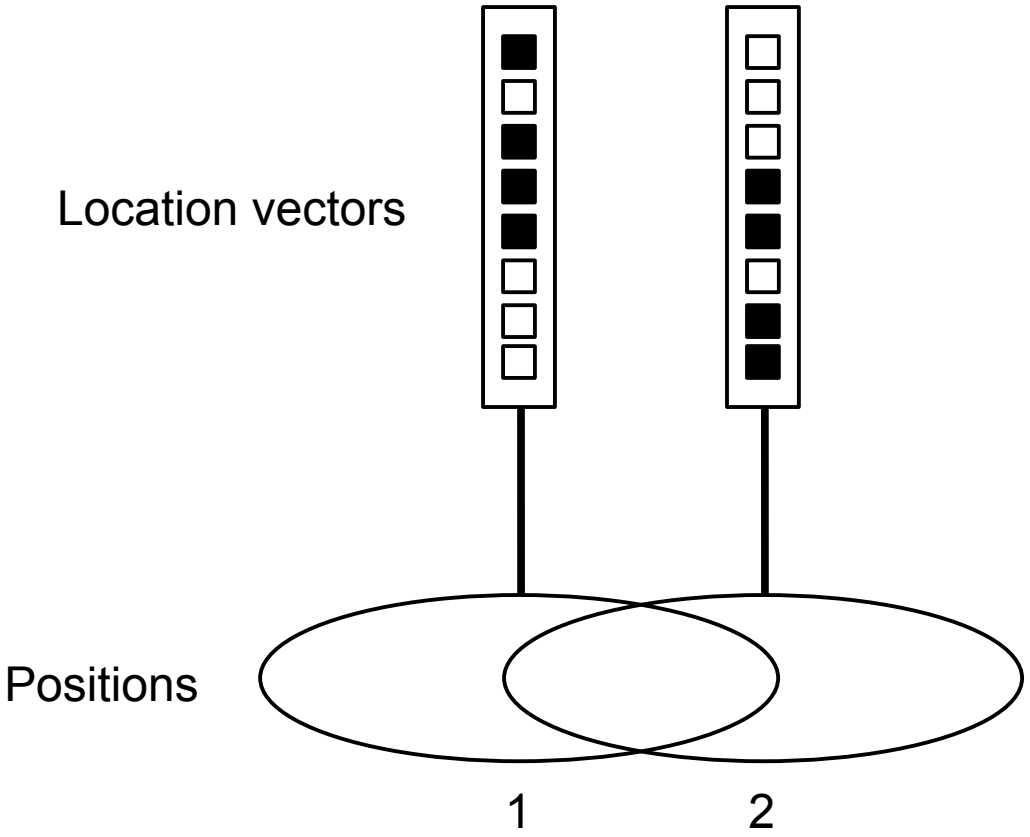
How are these effects explained?

Modeling



Oberauer & Lin (2024)

Modeling



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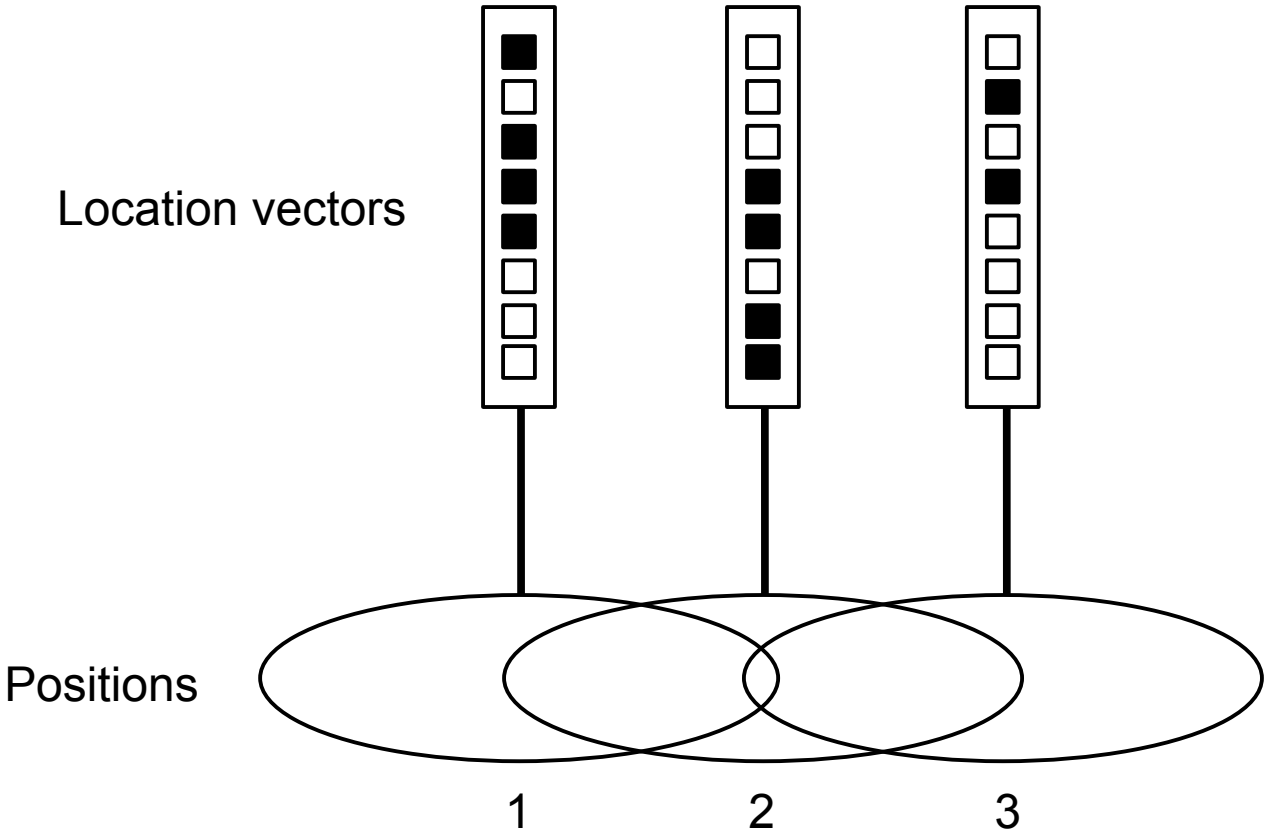

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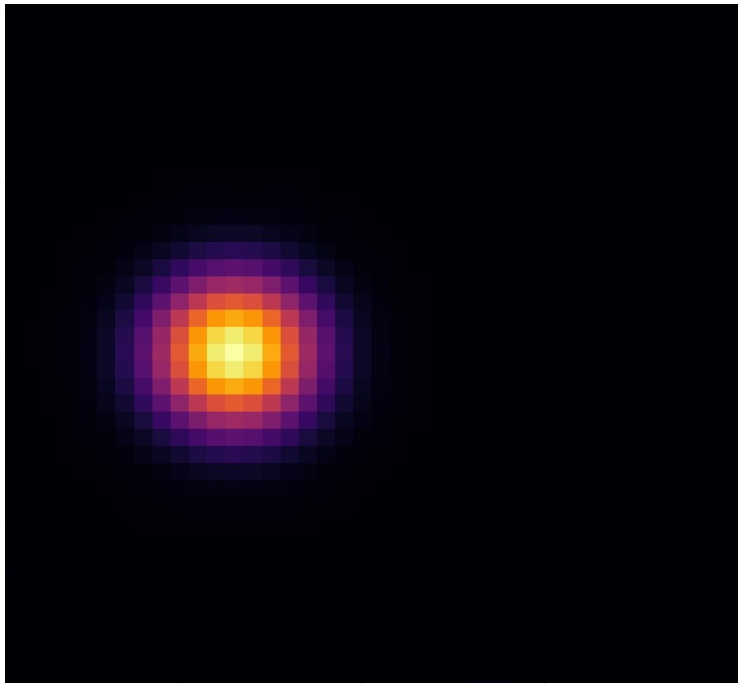
Modeling

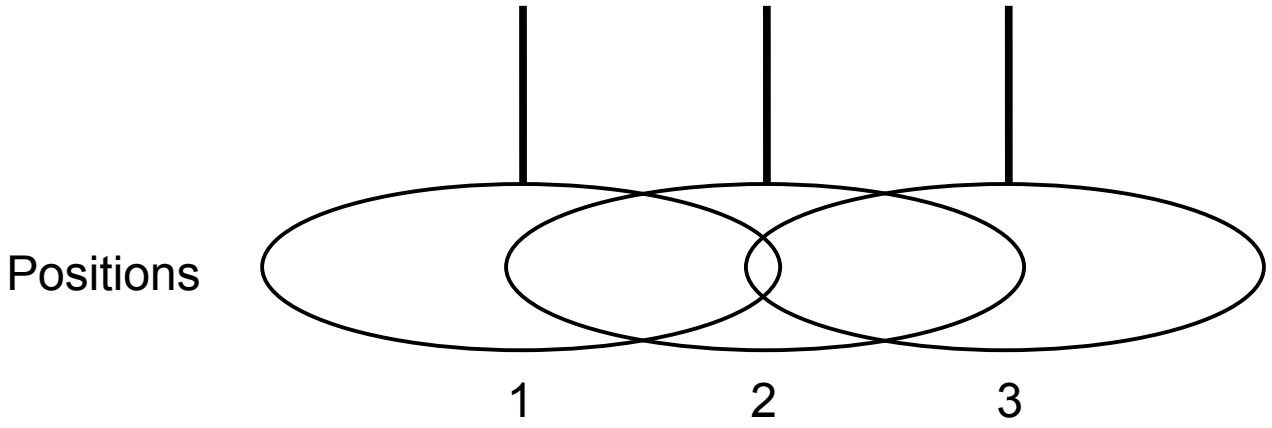
Laplace distribution

$S_{a,b} = \exp(-cd)$
d = euclidean distance
c = scale parameter



Modeling

Location vectors



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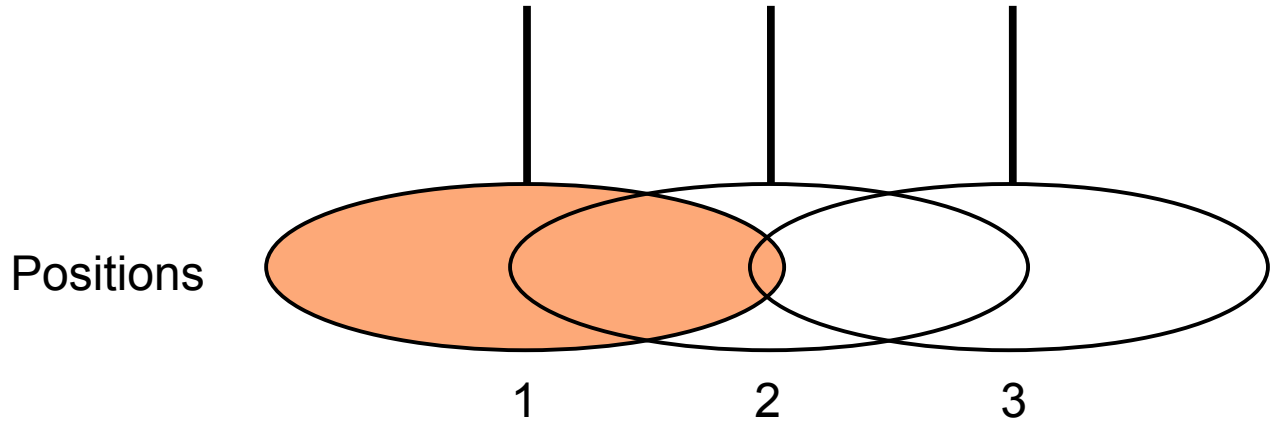

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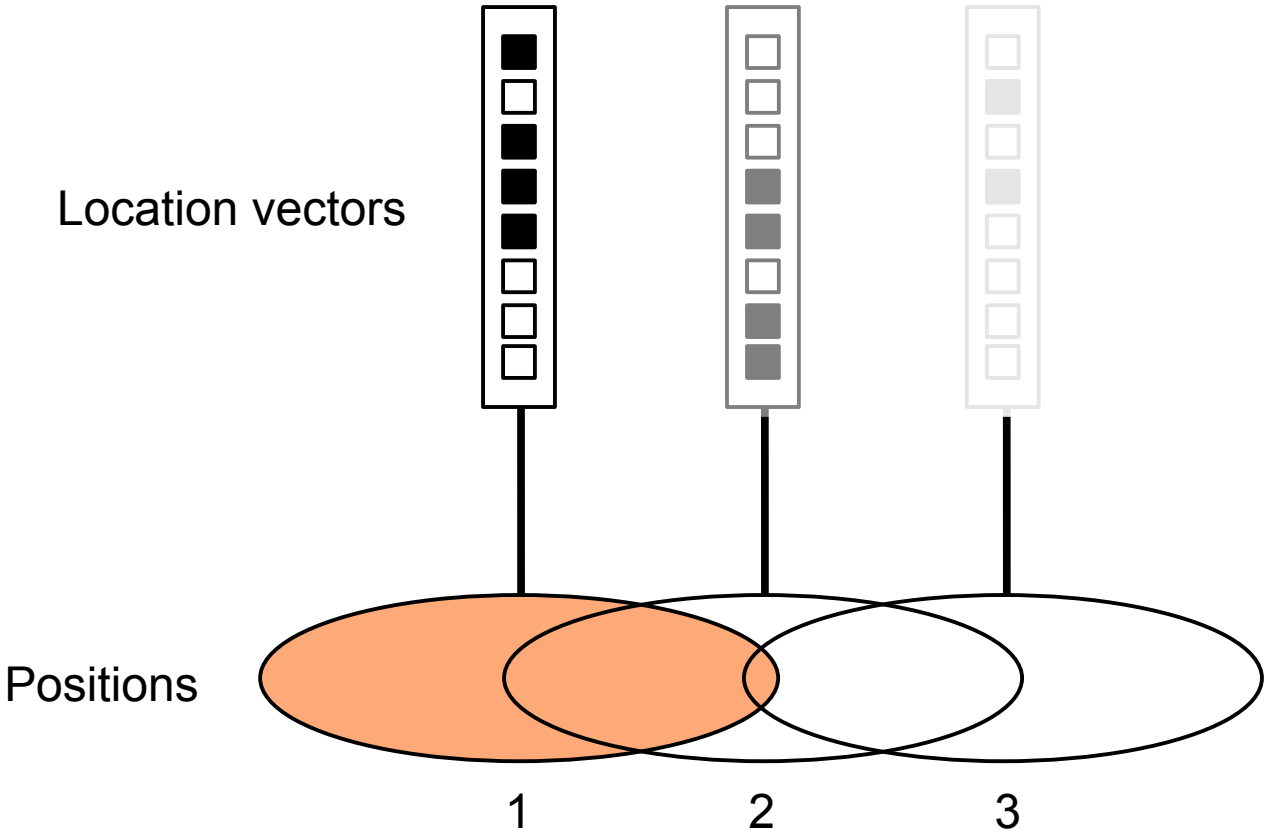

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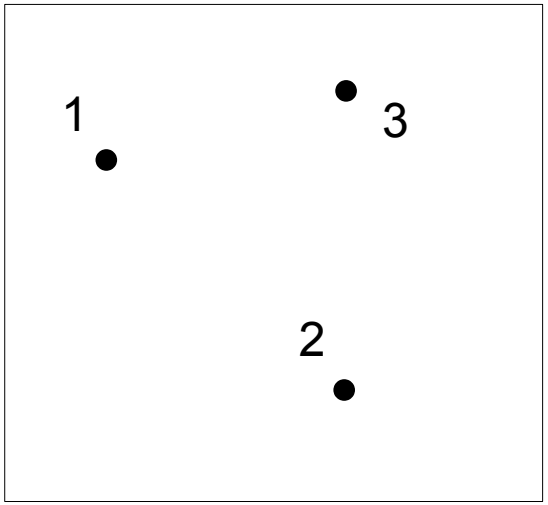

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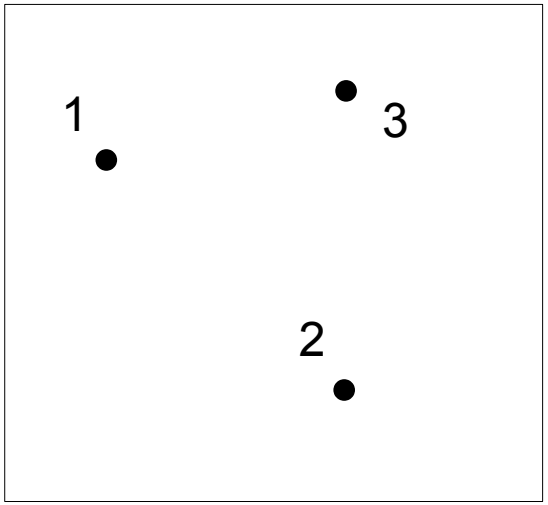

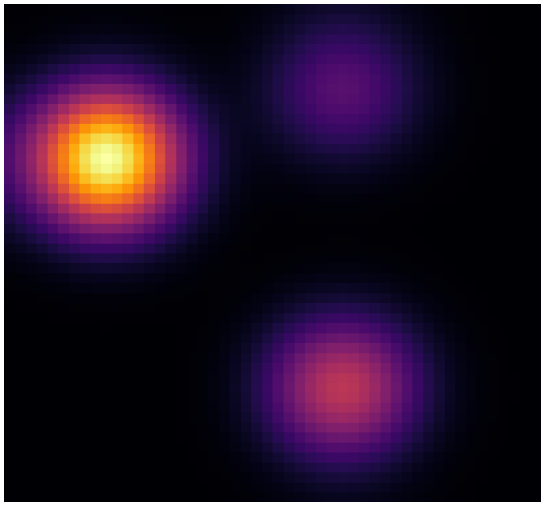

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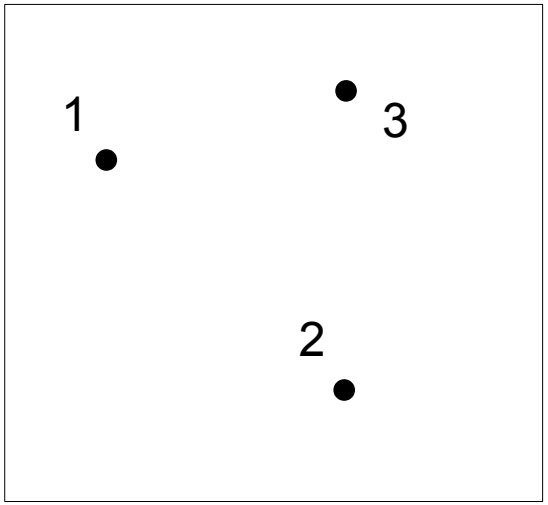

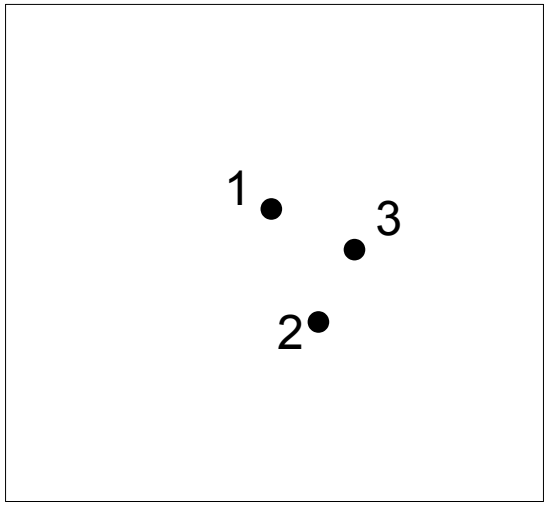

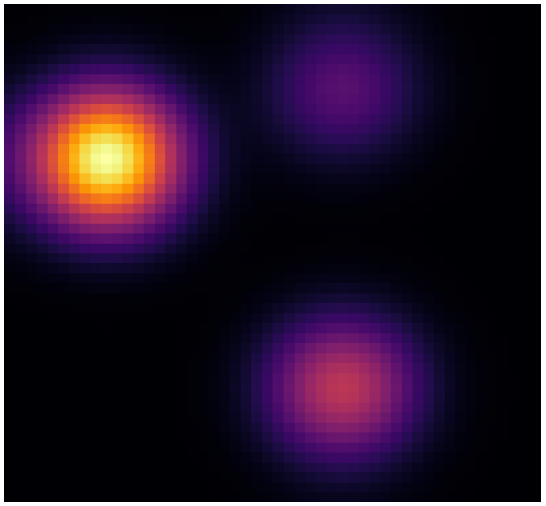

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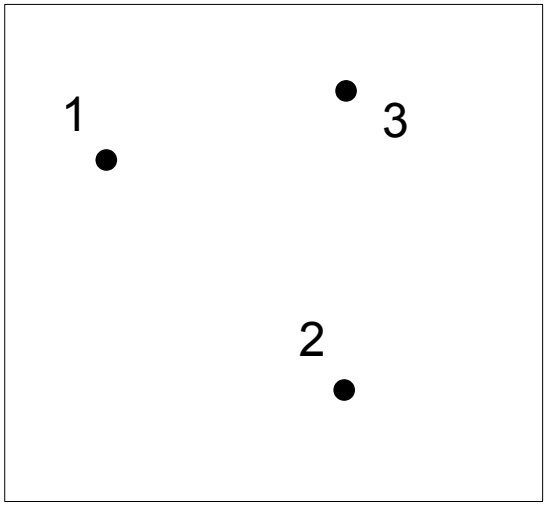
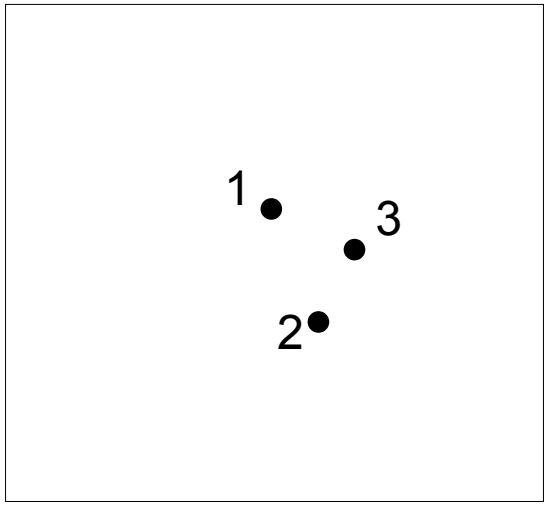
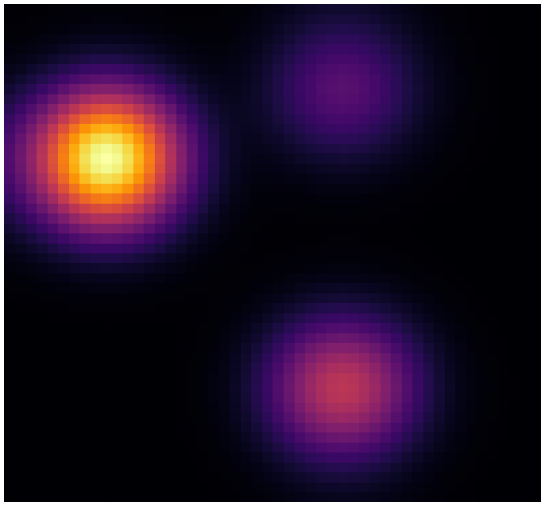
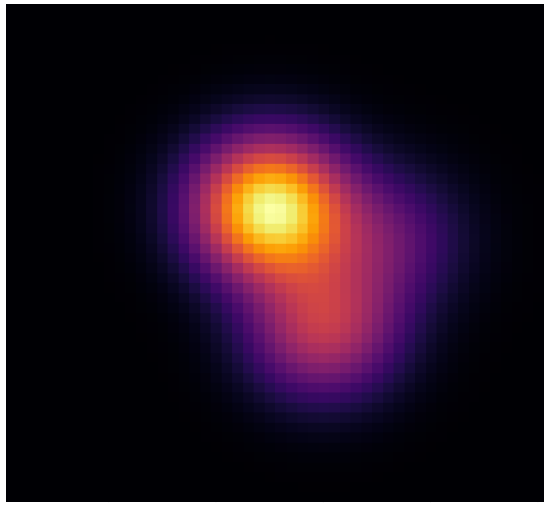
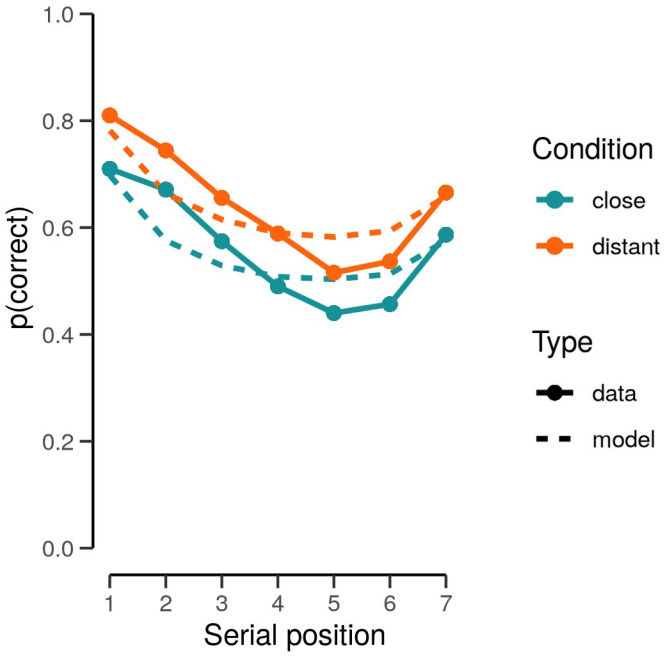








Modeling: Results



Conclusion

Similarity induces confusion errors in working memory
This principle generalizes in the visuospatial domain

Theoretically, close location induce more confusions errors because they generate a stronger overlapping signal than distant locations

Danke schön
Merci
Dank u wel

Modeling: Results