

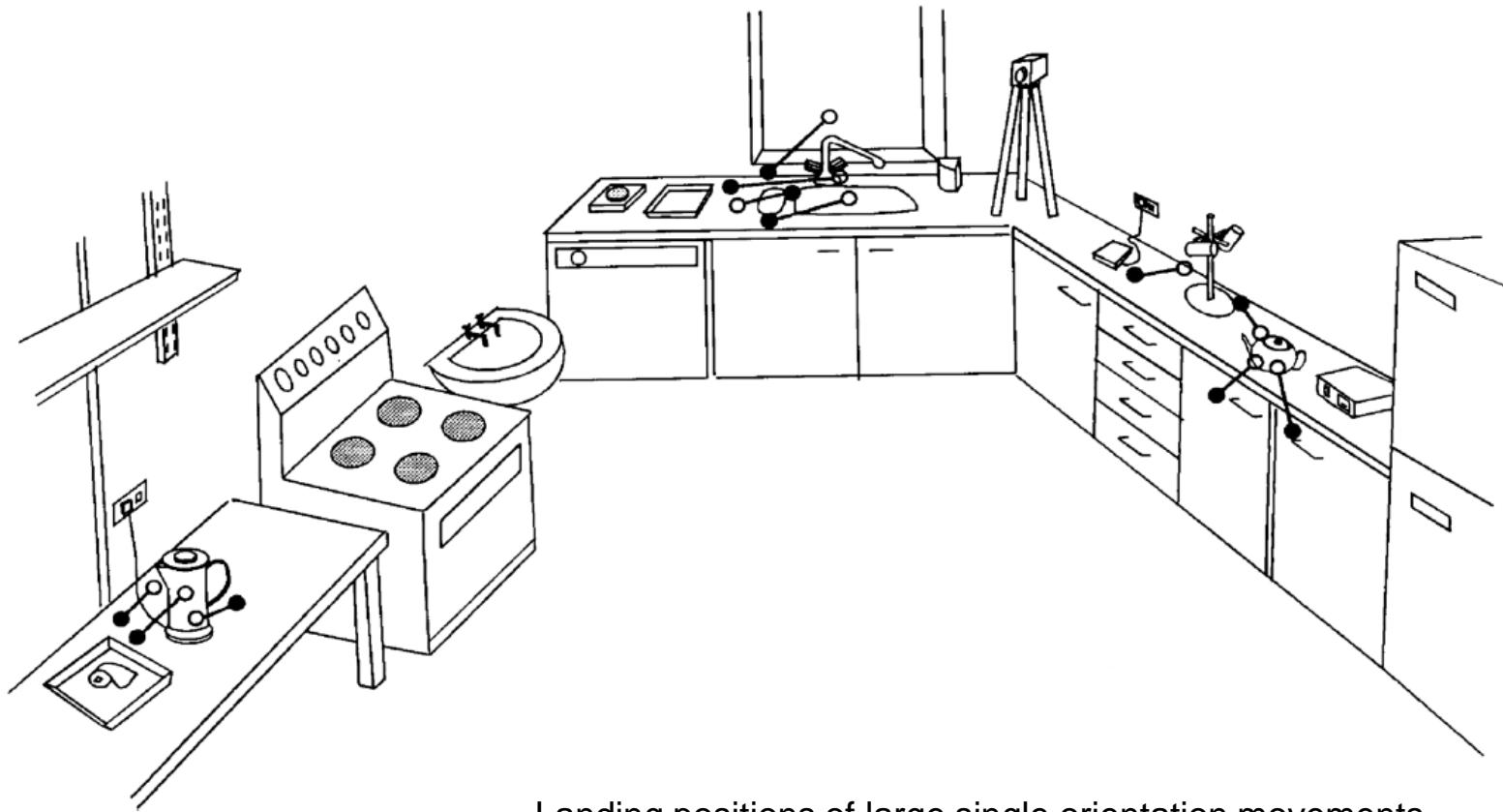
# The hippocampus is necessary for binding object identity to location in visual working memory.

Yoni Pertzov

Department of Psychology  
The Hebrew University of Jerusalem



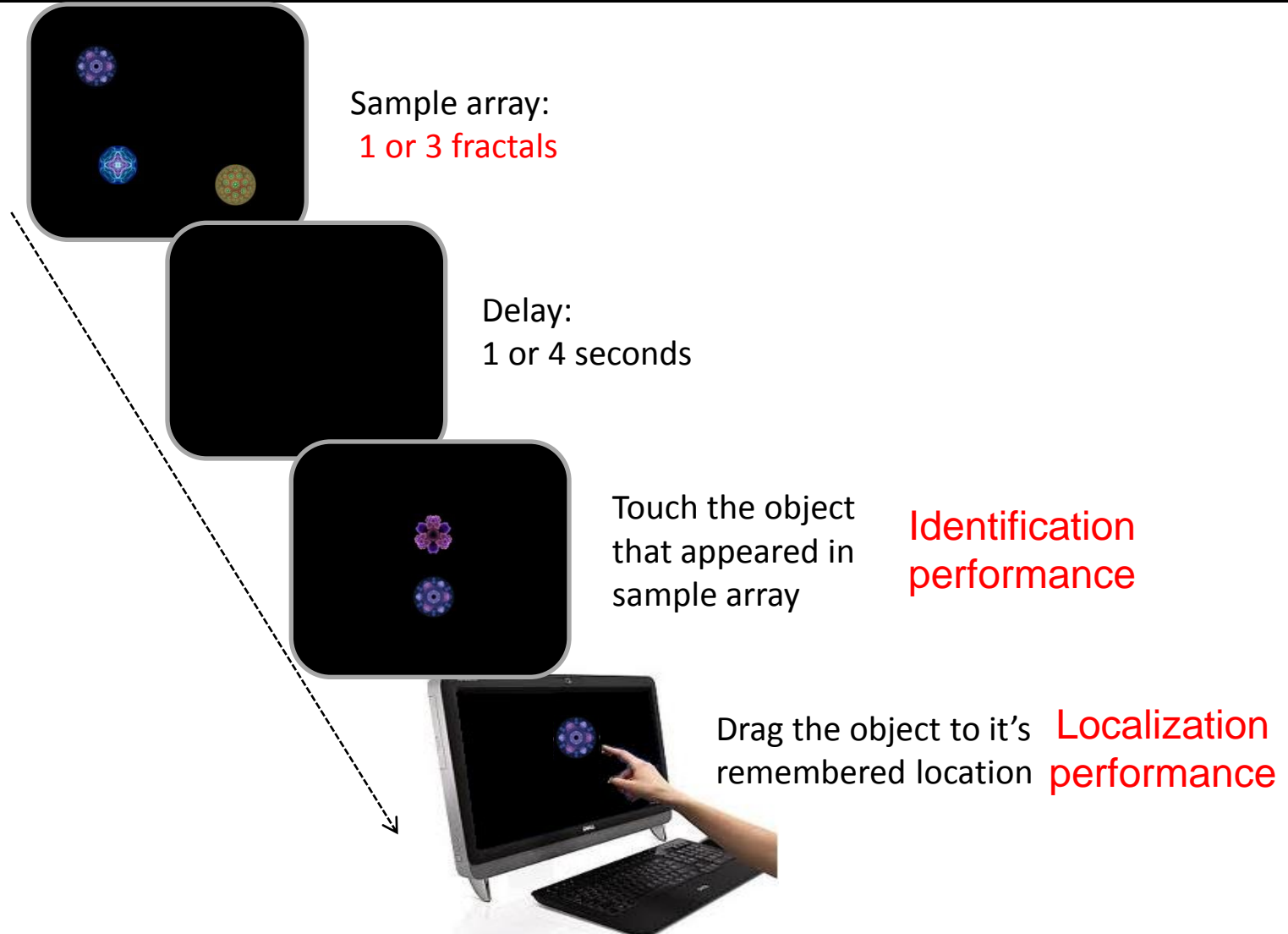
# Visual working memory is often used for localizing objects



Landing positions of large single orientation movements,  
requires memory (out of the visual field  $>90^\circ$ )

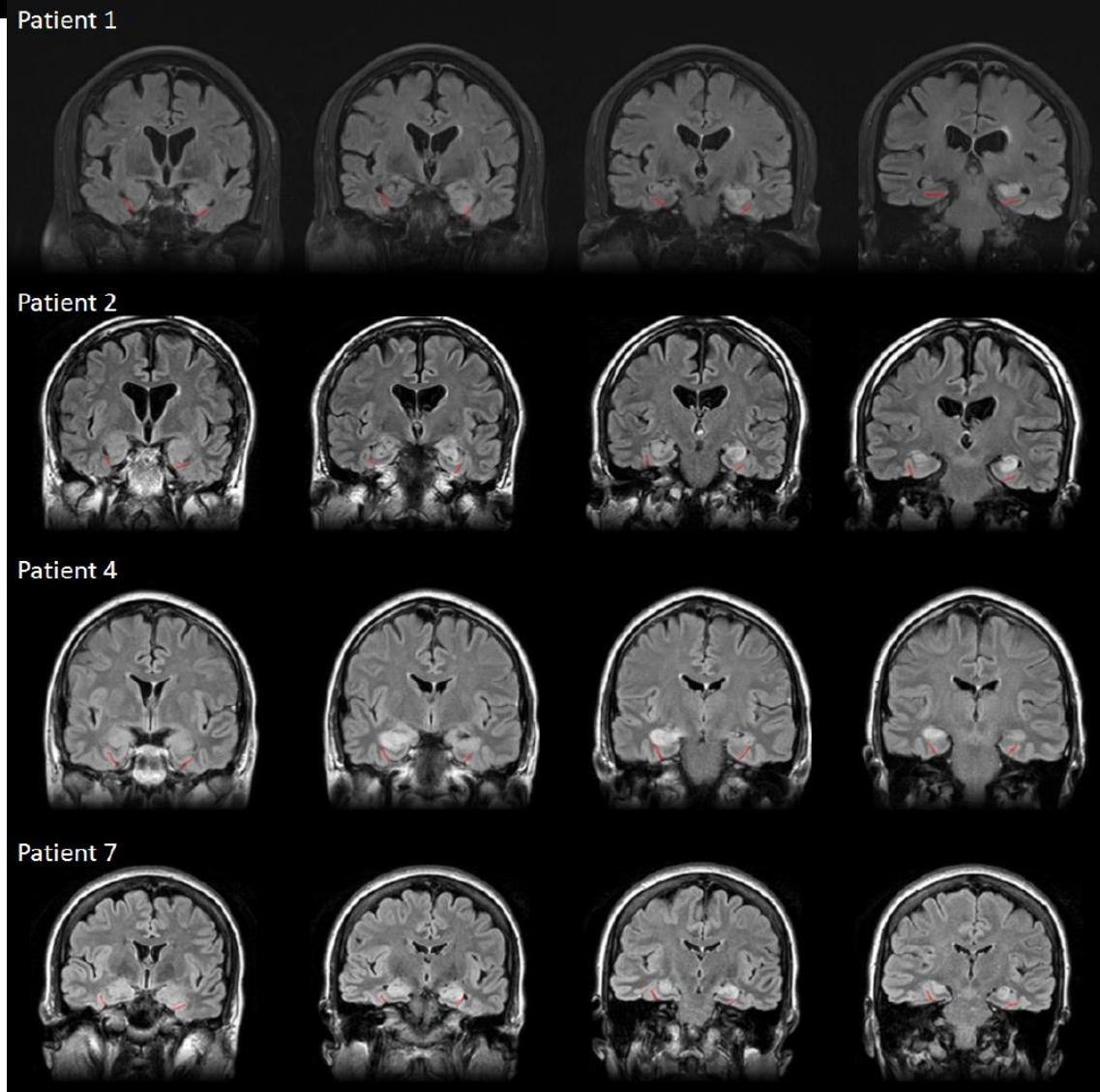
Tatler & Land. *Phil. Trans., B* 2011.

# Remembering what was where

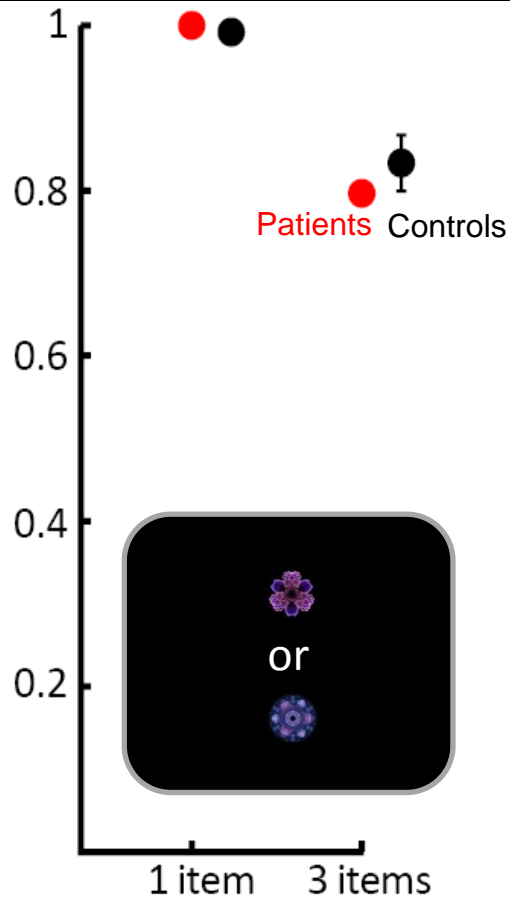


# Voltage Gated Potassium Channel Antibody encephalitis

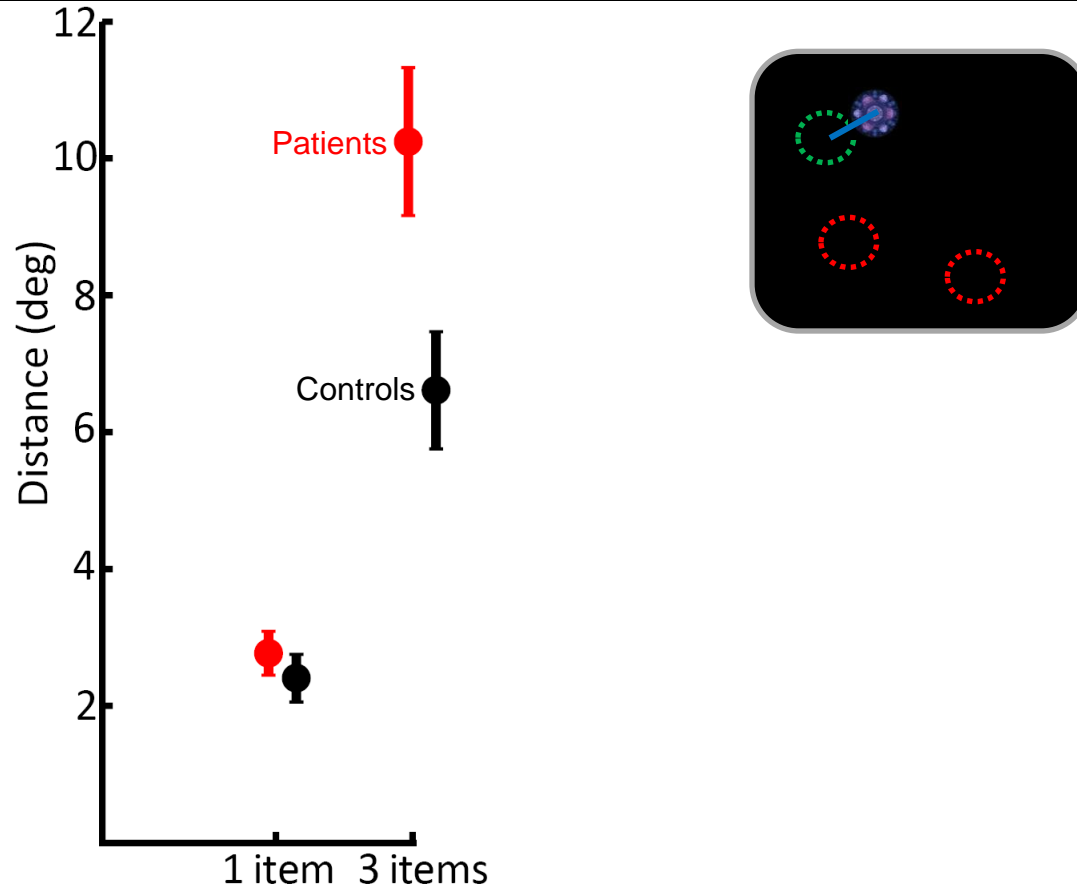
- 7 patients.
- Recently recognized:  
Vincent et al 2004.  
Responds to treatment.
- Antibodies target LGI1  
protein which is expressed  
very restrictively in the  
hippocampus.
- Post mortem study  
revealed neural loss  
exclusively in the  
hippocampus and  
amygdala.
- Abnormal signal restricted  
to the MTL.



## Identification



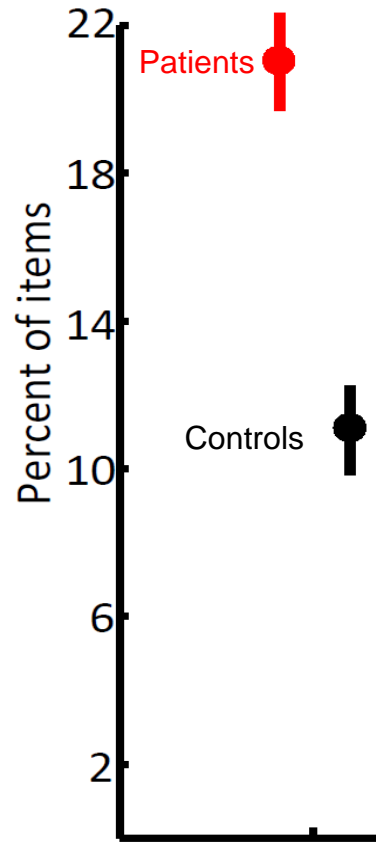
## Localization (correctly identified items)



Are locations “lost” from memory ?

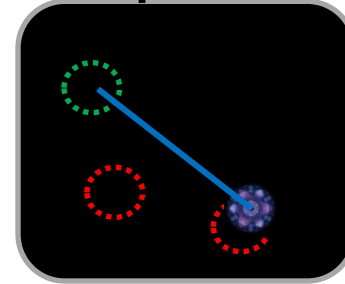
Leading to random localizations ?

## Swap errors

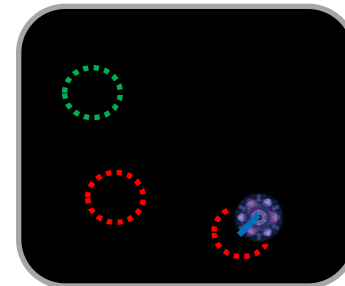


## Localization

### Swap errors



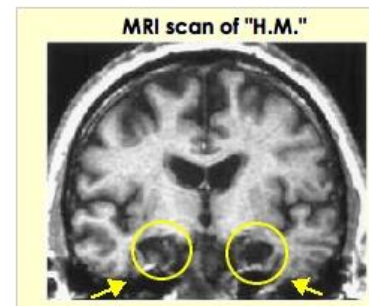
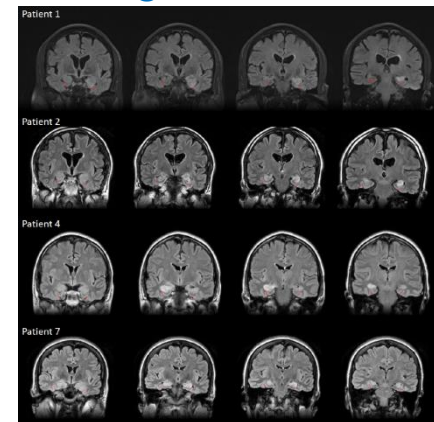
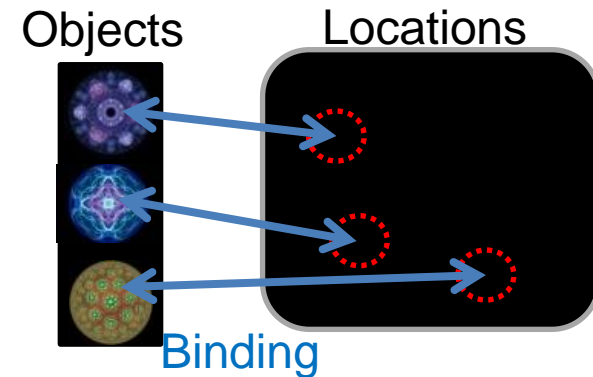
### Nearest item control



Patients' impairment is associated with swap errors.

# Binding in working memory: Neural mechanisms

- When forgotten, items are lost in their entirety ?
- The links that bound objects to their locations could be forgotten in spite of intact memory of item identity and position.
- Medial temporal lobes (MTL) involved in long term memory but not in working memory?
- MTL is involved in binding isolated properties also across **brief retention intervals**. But not ID or position alone.
- Challenging the 'multi-store hypothesis'.



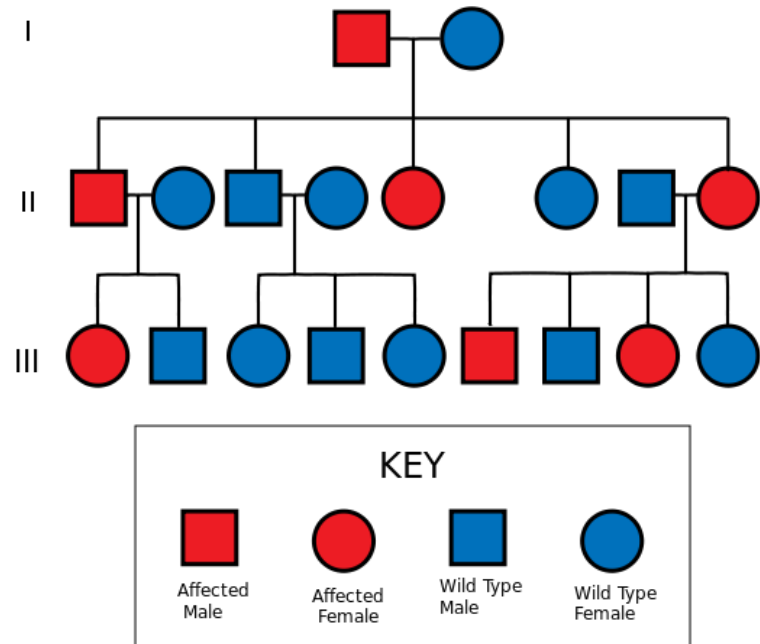
# Binding in working memory: Clinical practice ?

- Recent failures of clinical trials imply that we must treat Alzheimer's Disease (AD) prior to its mild to moderate stages.
  - Requires early detection of the disease.
- The MTL is compromised in AD – years before onset of behavioral symptoms.
- Standard tests of episodic memory are crude and uncontrolled. Maybe use binding in memory ?
- How can we test patients BEFORE they are diagnosed with AD



# Familial Alzheimer's Disease (FAD)

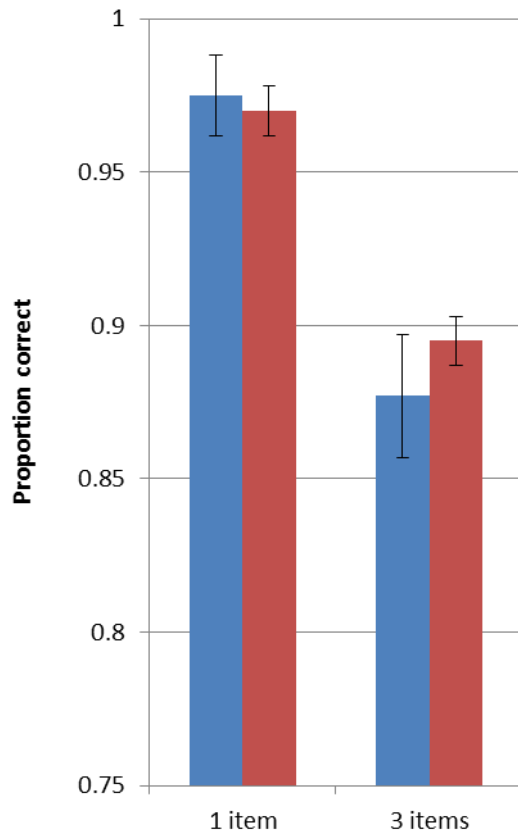
- Autosomal Dominance disease
- Mutation Carriers have 100% chances of developing FAD at the parents age.
- Invaluable for studying presymptomatic stages.
- 12 asymptomatic mutation carriers with no deficits on standard neuropsychological tasks
- 62 healthy controls
- “double blind” design.



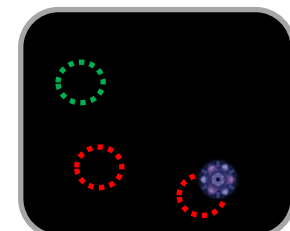
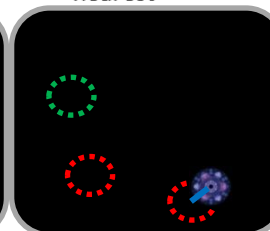
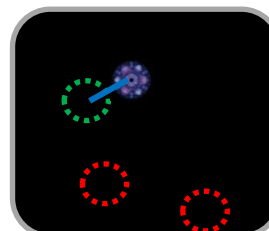
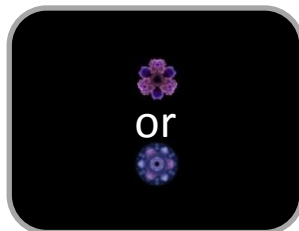
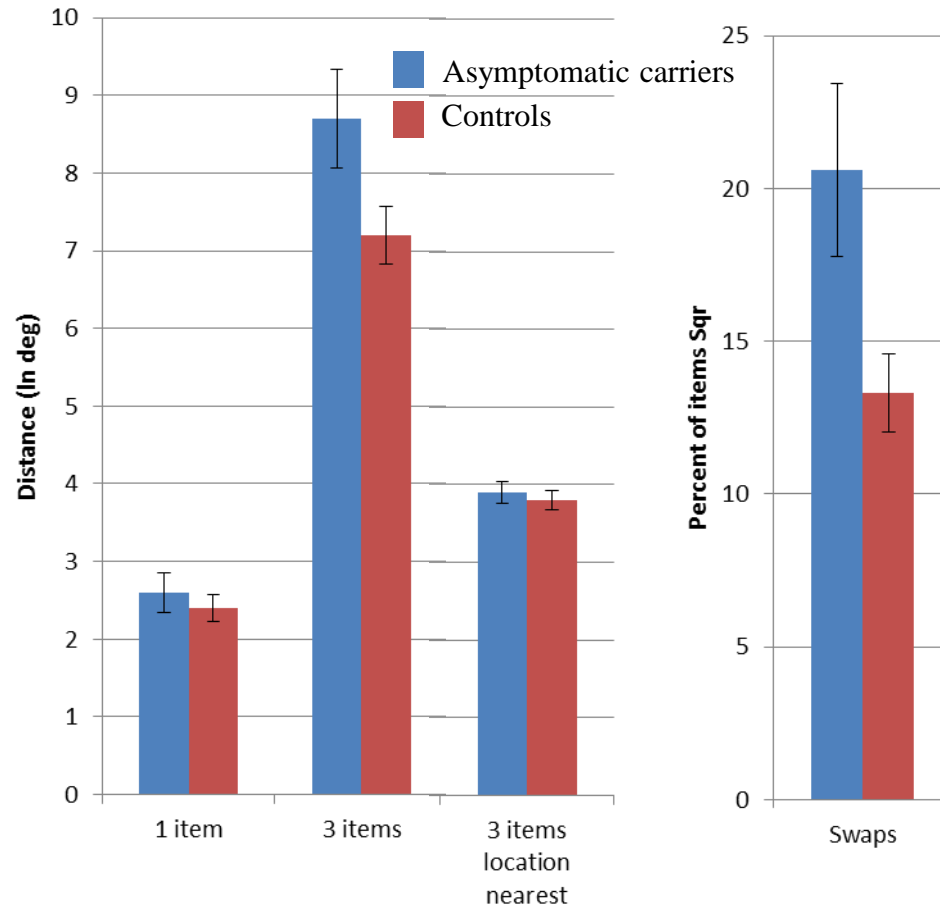
In Autosomal Dominance the chance of receiving and expressing a particular gene is 50% regardless of the sex of parent or child.

# Asymptomatic carriers vs. controls

## Identification

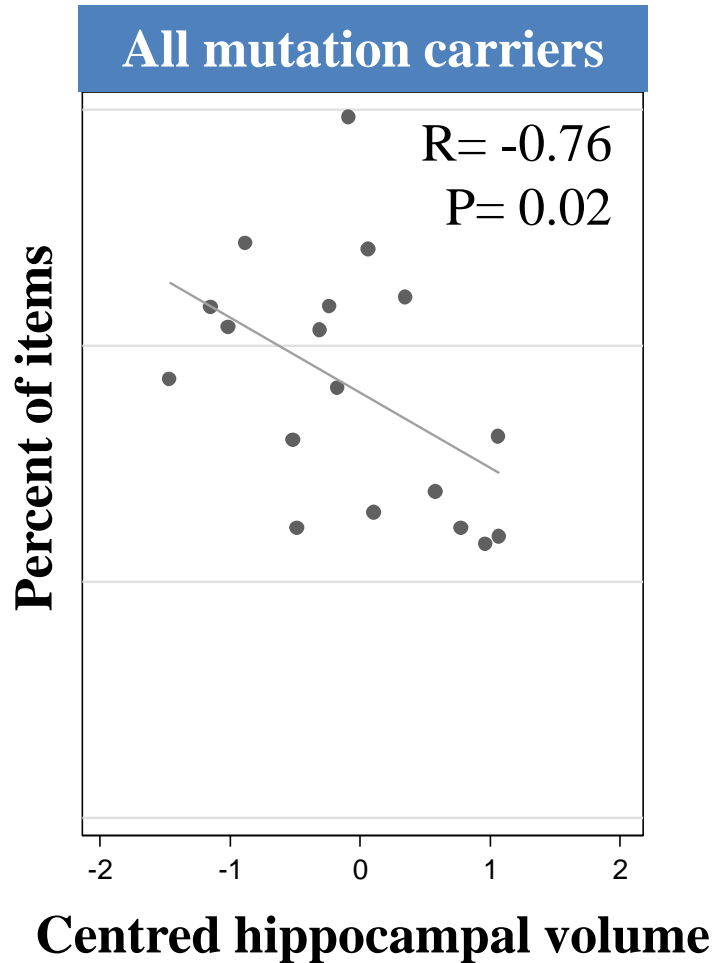


## Localisation performance

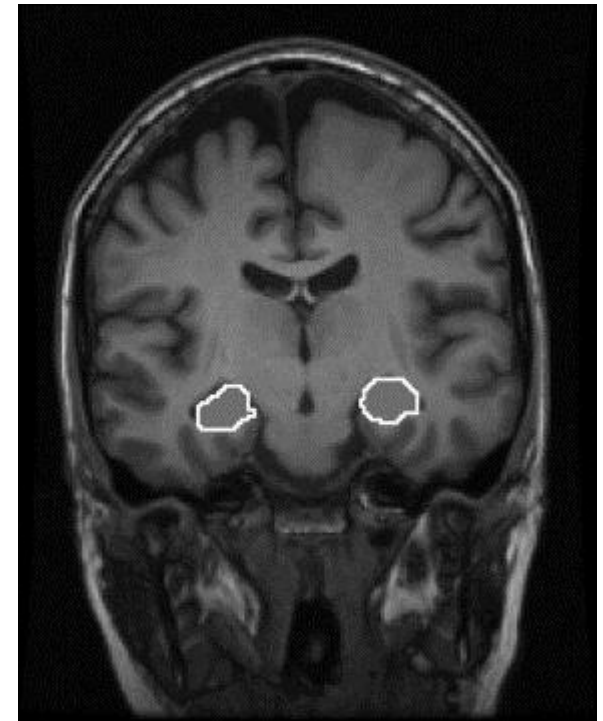


# Correlation with hippocampal volume

## Swap errors



Automatic segmentation of Hippocampal volume

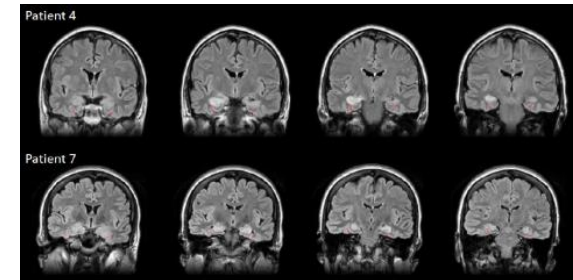
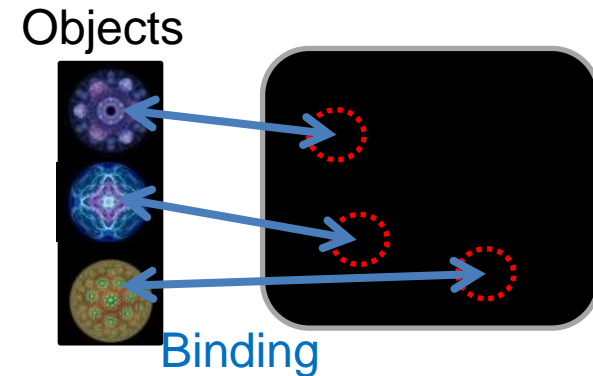


# Conclusions

Items and their locations are represented independently in visual working memory

Binding in visual working memory related to hippocampal integrity

Binding errors in WM may provide a means for early detection in Alzheimer's disease



# Thanks to:

**Masud Husain**

*Cognitive Neurology Research Group  
Cognitive Neuropsychology Centre  
University of Oxford*

MTL patients:

**Chris Butler**

**Tom Miller**

*Department of Clinical Neurology  
University of Oxford*

Alzheimer patients:

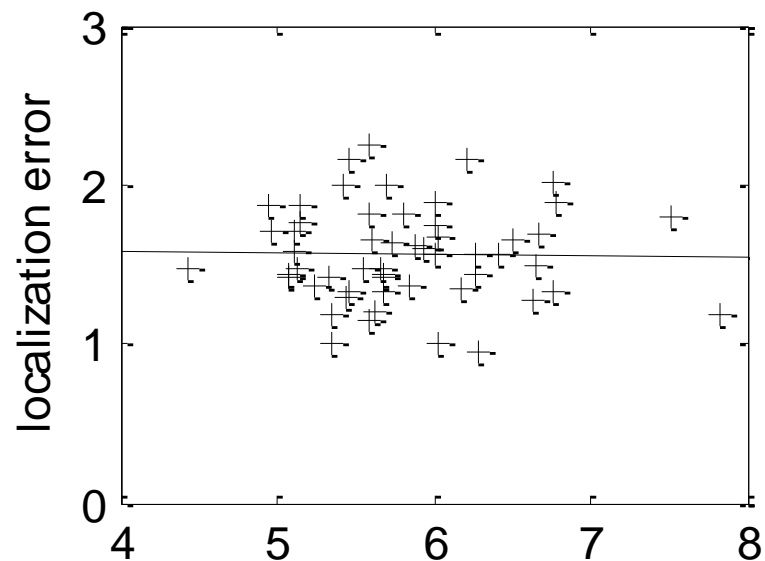
**Yuying Liang**

**Sebastian Crutch**

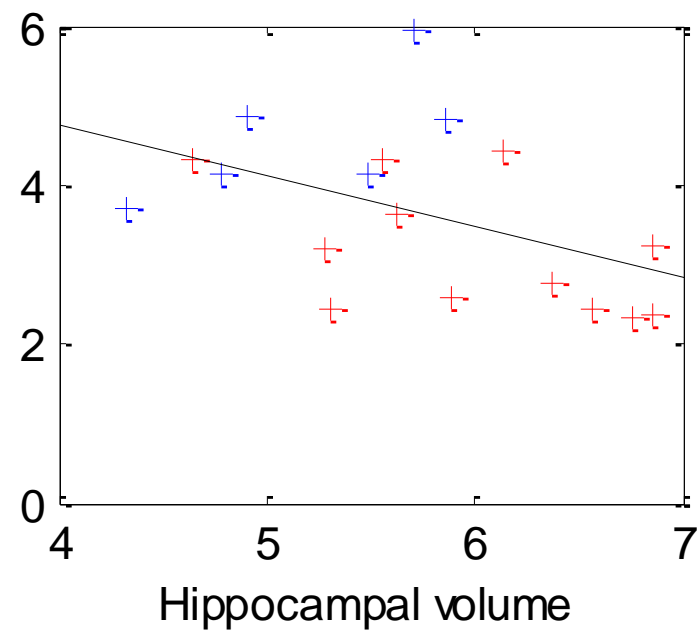
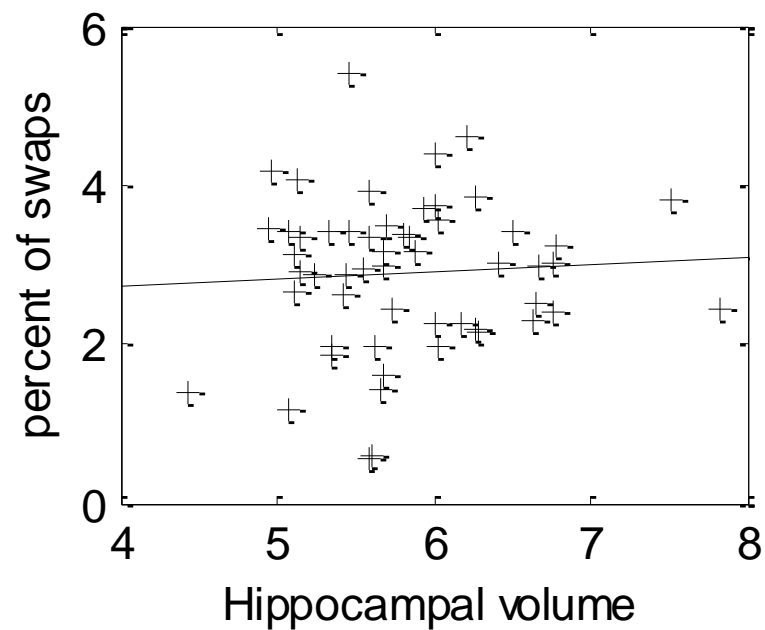
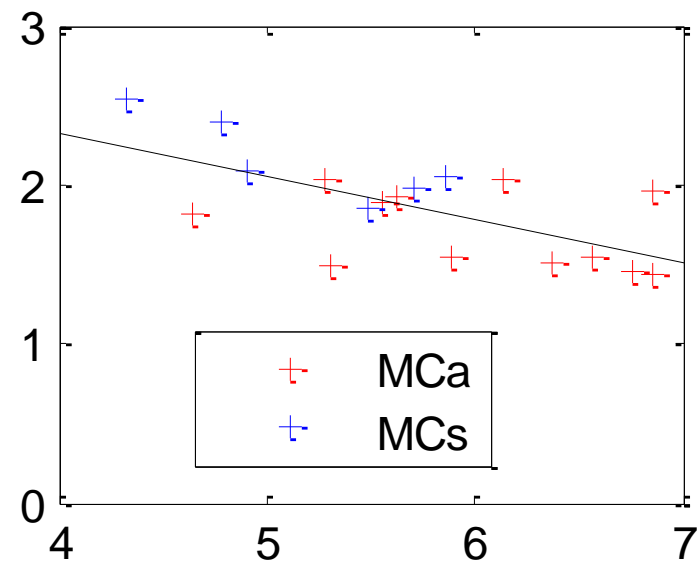
*Dementia Research Centre  
University College London*

# Back-up slides

Controls

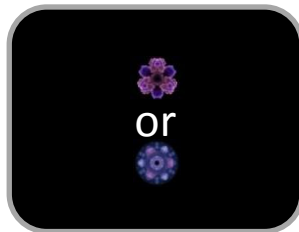
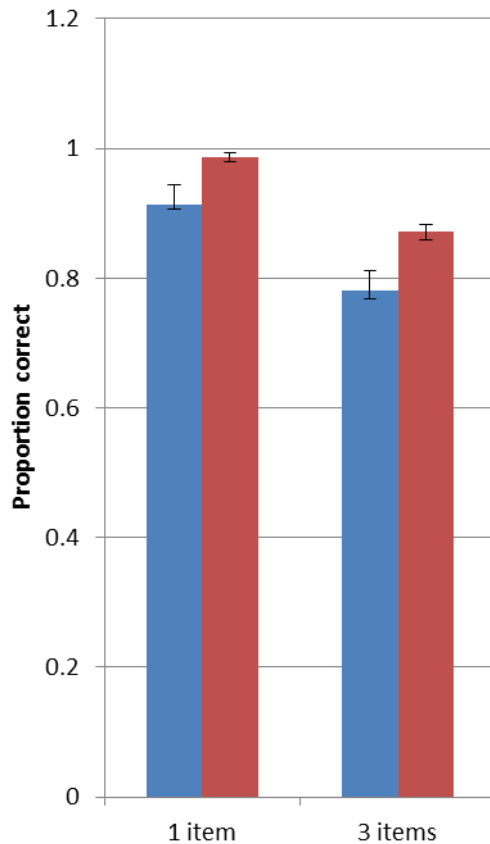


Mutation carriers

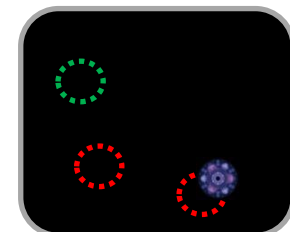
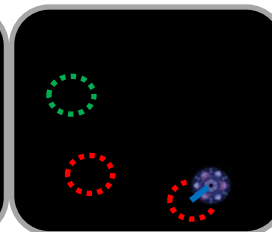
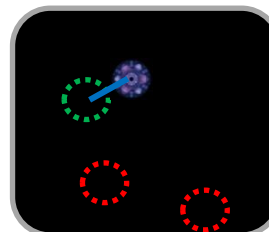
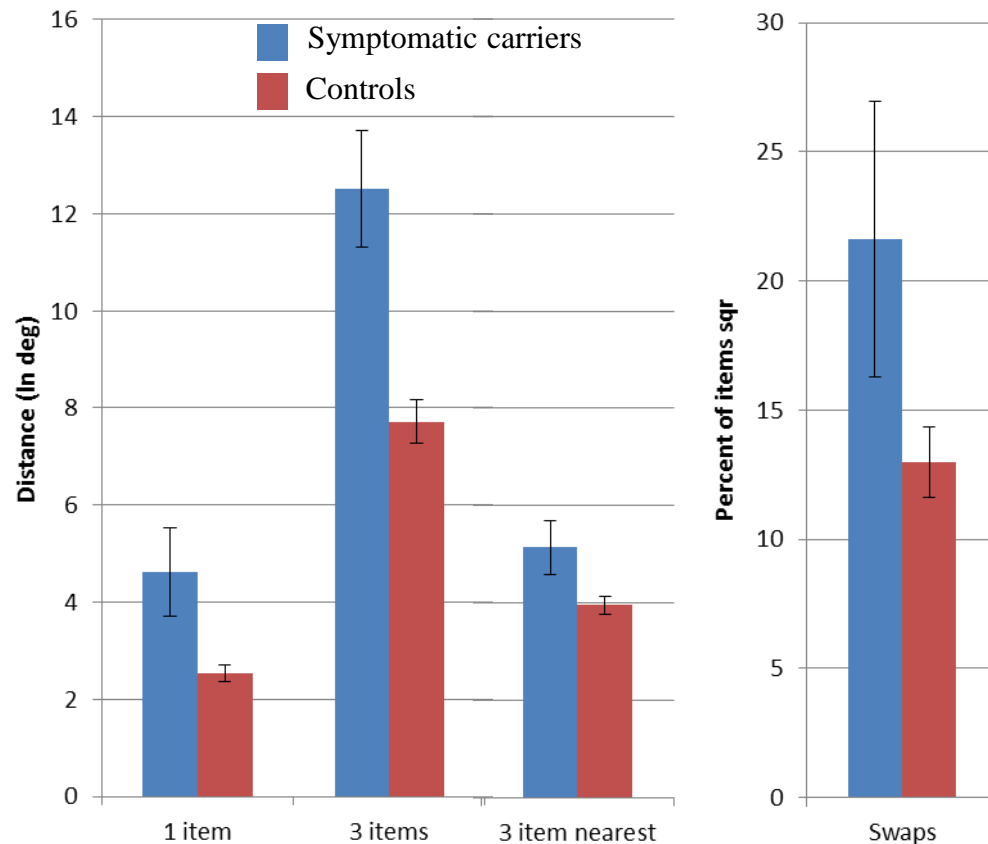


# Symptomatic carriers vs. controls

## Identification

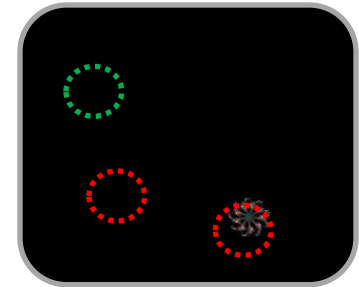
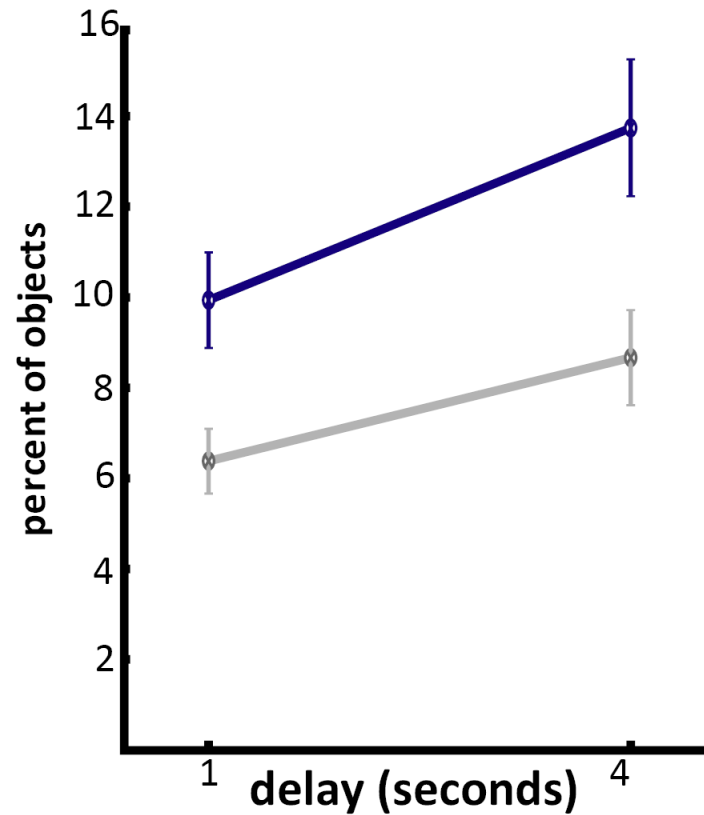


## Localisation performance





# Swap errors



Contribution of swap errors to localization ?

# Swap across time

