

# REARRANGED REALITY

## Spatial memory for virtual objects in a shifting physical world



Contact info, poster and videos for Learning and Recall Phase

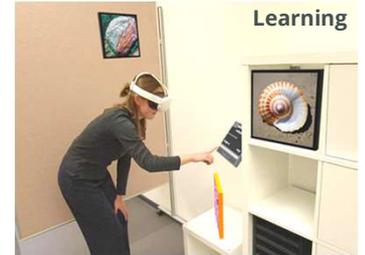
### Background

In Augmented Reality (AR) applications, virtual objects are often placed near to real-world objects like walls, furniture or bulletin boards. This study examines how spatial memory for **virtual** objects is affected if the **physical** reference objects are moved.

Physical objects act as **landmarks** – object locations are encoded in reference to them (McNamara, 2003). Participants recall **spatial patterns in AR** with higher accuracy in a furnished (vs. empty) room, due to using the **furniture** as landmarks/anchors (Liu, Satriadi, Ens & Dwyer, 2024).

Our results show that participants mentally represent locations of virtual objects in relation to nearby physical reference objects, even if the **locations are task-irrelevant**. This representation is strong enough that changes in the physical world affect how we represent objects in the virtual world.

### Method



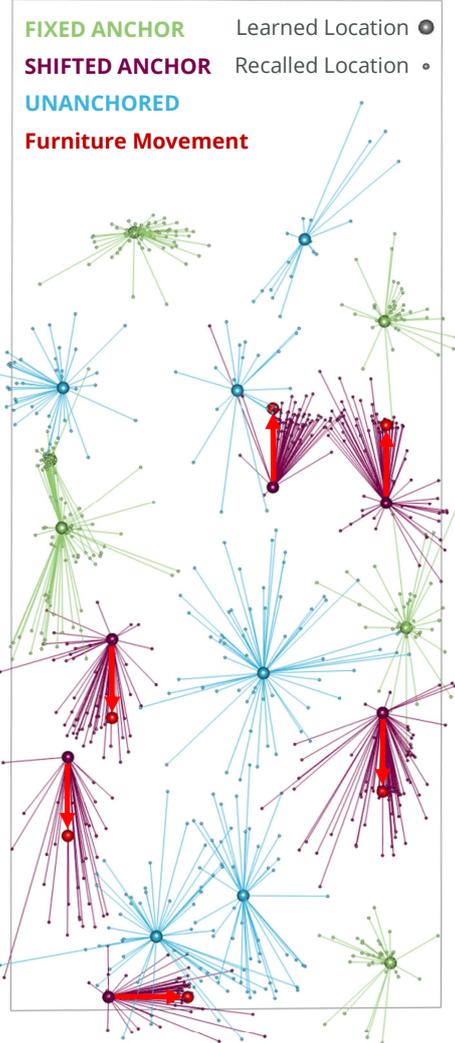
**Learning:** N = 51 participants rated 18 AI-generated images on two different scales, while implicitly learning image locations.

**Delay:** Participants returned after 3-4 days. Some furniture has been **shifted** by 0.5 m.

**Surprise Recall:** Participants placed each image separately where they remember it, without time pressure.



### Measure: Displacement Vectors



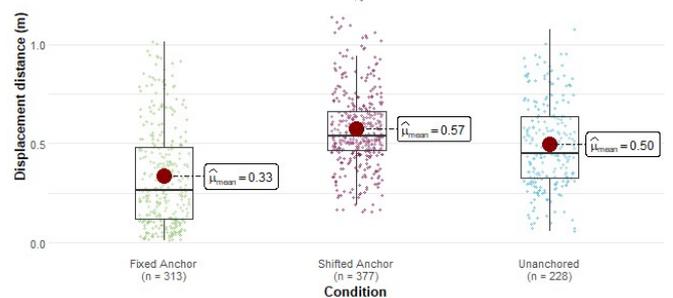
### Results

#### H1 – DISTANCE of displacement vectors:

We expected that displacement distances are **higher** in the **Shifted Anchor** condition and **smaller** in the **Fixed Anchor** (not-shifted furniture) condition, representing the 0.5m shift of the furniture between sessions.

Linear Mixed Model:  
 $dist \sim condition + (1 | subj)$

$\chi^2 = 171.99$  \*\*\*  
 $R^2 = 0.23$



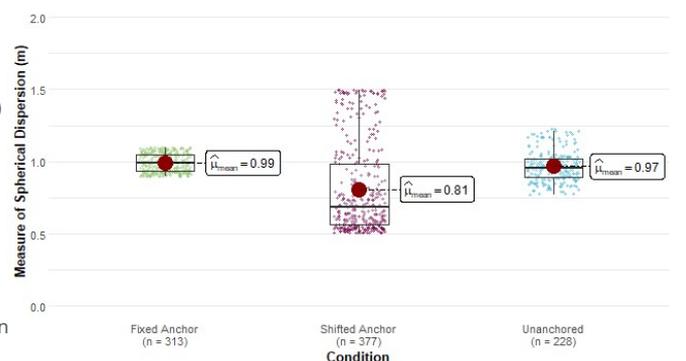
#### H2 – DIRECTION of displacement vectors:

We expected that the dispersion measure is **smaller** in the **Shifted Anchor** condition and **larger** in the **Fixed Anchor** condition.

This measure represents the clustering of vector directions:  
 mean of 1: unsystematic or uniform spread of vectors in all directions,  
 mean smaller than 1: systematic or clustered spread of vectors in one direction.

Linear Mixed Model:  
 $displ \sim condition + (1 | subj)$

$\chi^2 = 97.276$  \*\*\*  
 $R^2 = 0.13$



Note: **Unanchored** is only included as an exploratory condition and is not included in the analyses presented here.