Neuropsychological Correlates of a Virtual Spatial Navigation Task in Older Adults

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BACKGROUND

- Difficulties with directions or getting lost are common complaints in clinical samples of older adults undergoing neuropsychological evaluation.
- Impairments in spatial learning and memory is an early indicator of medial temporal lobe-hippocampal dysfunction, particularly in amnestic mild cognitive impairment and Alzheimer's disease.
- However, spatial learning and memory is rarely assessed in routine neuropsychological evaluations.
- One of the most used paradigms to study spatial learning and memory abilities in animals is the Morris Water Maze (MWM).
- In recent years, several adaptations of the MWM have been developed for use with human populations such as the virtual computer-generated ARENA.
- Spatial learning and memory is a complex ability with contributions from visual, executive and memory systems; however, little information exists on how this novel task maps onto traditional indices of episodic memory and spatial processing in healthy older adults.
- **Thus, the overall goal of the current study was to evaluate performance on ARENA with performance on standardized neuropsychological measures in a sample of healthy older adults.**

PARTICIPANTS

Table 1. Characteristics and neuropsychological performance of the study sample (n = 53)

	Mean (SD)	Range
Demographics		
Age (Years)	76.8 (7.37)	60 – 93
Education (Years)	16.6 (2.33)	12 – 20
Gender (M/F)	15/38	–
Wechsler Test of Adult Reading (WTAR)	111 (6.00)	97.0 – 119
Mini-Mental State Examination (MMSE)	29.2 (1.16)	26.0 – 30.0
Neurocognitive Performance		
Judgement of Line Orientation (JOLO)	50.4 (10.1)	23.4 – 70.8
Benton Facial Recognition	57.5 (11.1)	36.0 – 76.0
Spatial Span	49.8 (9.37)	26.1 – 65.9
Family Pictures Immediate Recall	51.2 (10.2)	29.0 – 69.8
Family Pictures (FP) Delayed Recall	51.2 (9.94)	31.5 – 70.9
Visual Reproductions (VR) Immediate Recall	50.9 (9.66)	26.0 – 70.3
Visual Reproductions (VR) Delayed Recall	51.1 (9.54)	17.4 – 64.9
Logical Memory (LM) Immediate Recall	50.5 (9.58)	22.3 – 68.4
Logical Memory (LM) Delayed Recall	51.3 (9.73)	25.9 – 72.3
Hopkins Verbal Learning Test-Revised Immediate Recall	54.4 (10.2)	31.0 – 69.0
Hopkins Verbal Learning Test-Revised Delayed Recall	53.4 (9.28)	30.0 – 64.0
Trail Making Test Condition B	50.2 (9.05)	16.0 – 79.0
Digit Span	51.2 (10.1)	31.6 – 76.3
Digit Symbol	51.2 (10.8)	18.7 – 71.8
Boston Naming Test	57.5 (11.1)	36.0 – 76.0
ARENA Performance		
Total Latency to Find Target	0.00 (.487)	-.830 – 1.14
Total Path Length	0.00 (.403)	-1.03 – 0.90
Time in Target Quadrant	0.00 (.351)	-1.11 – 0.55

ARENA

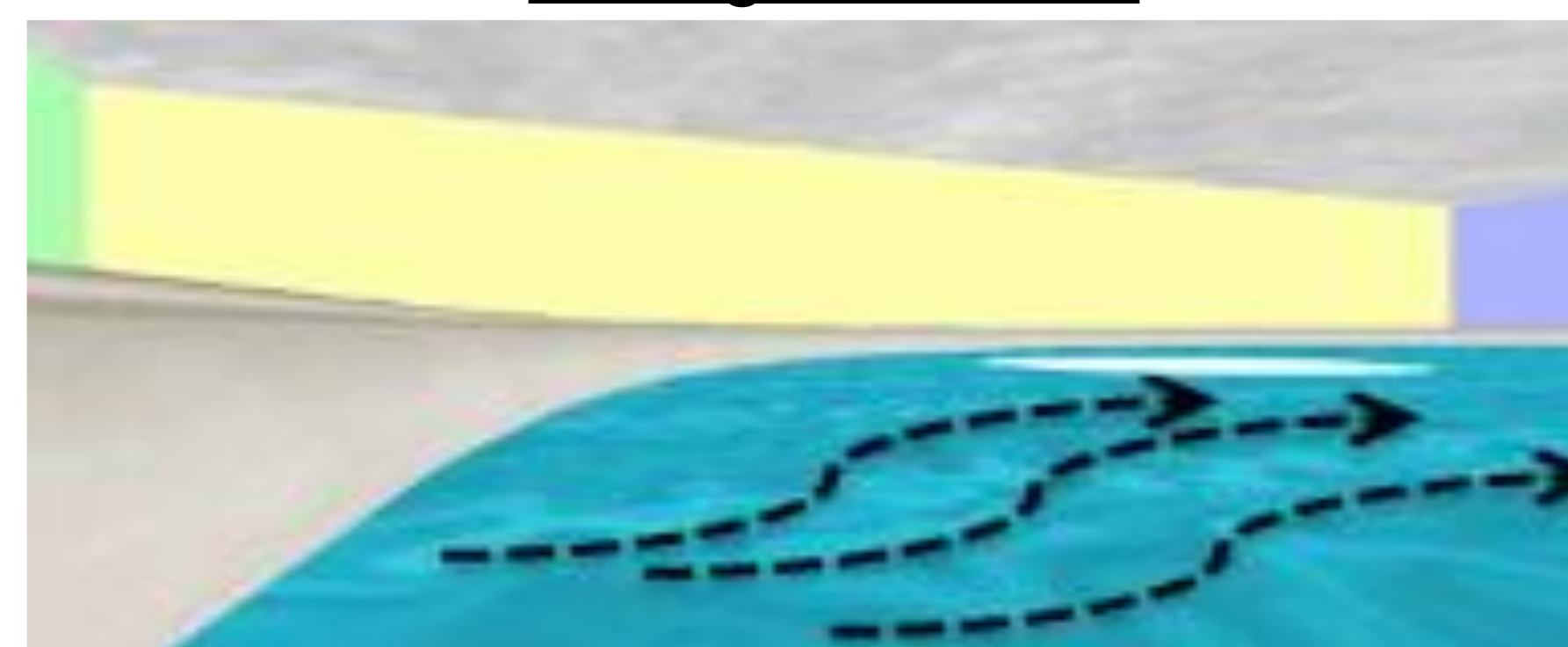### Four Quadrants of the Virtual Spatial Navigation Task
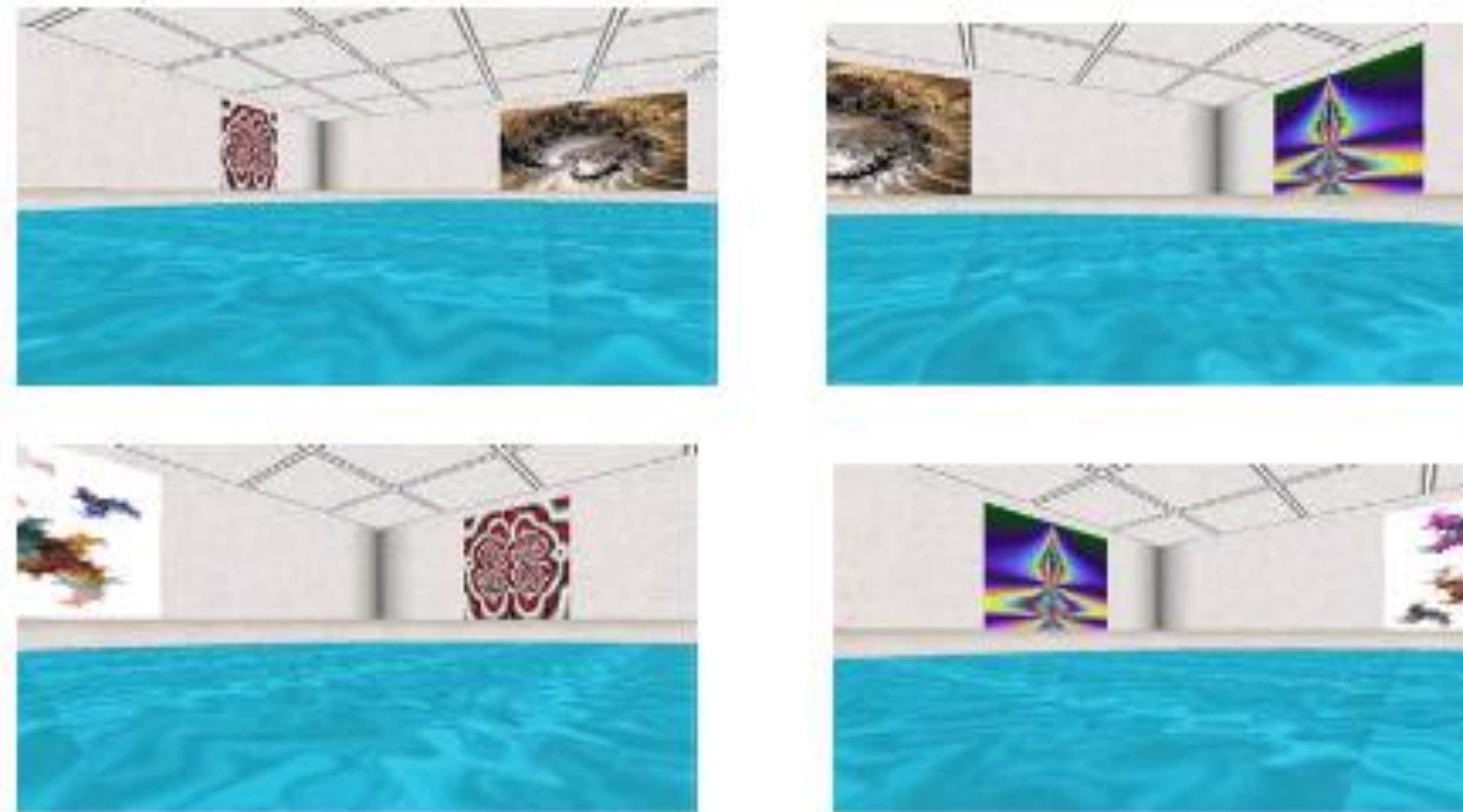
Practice Trials
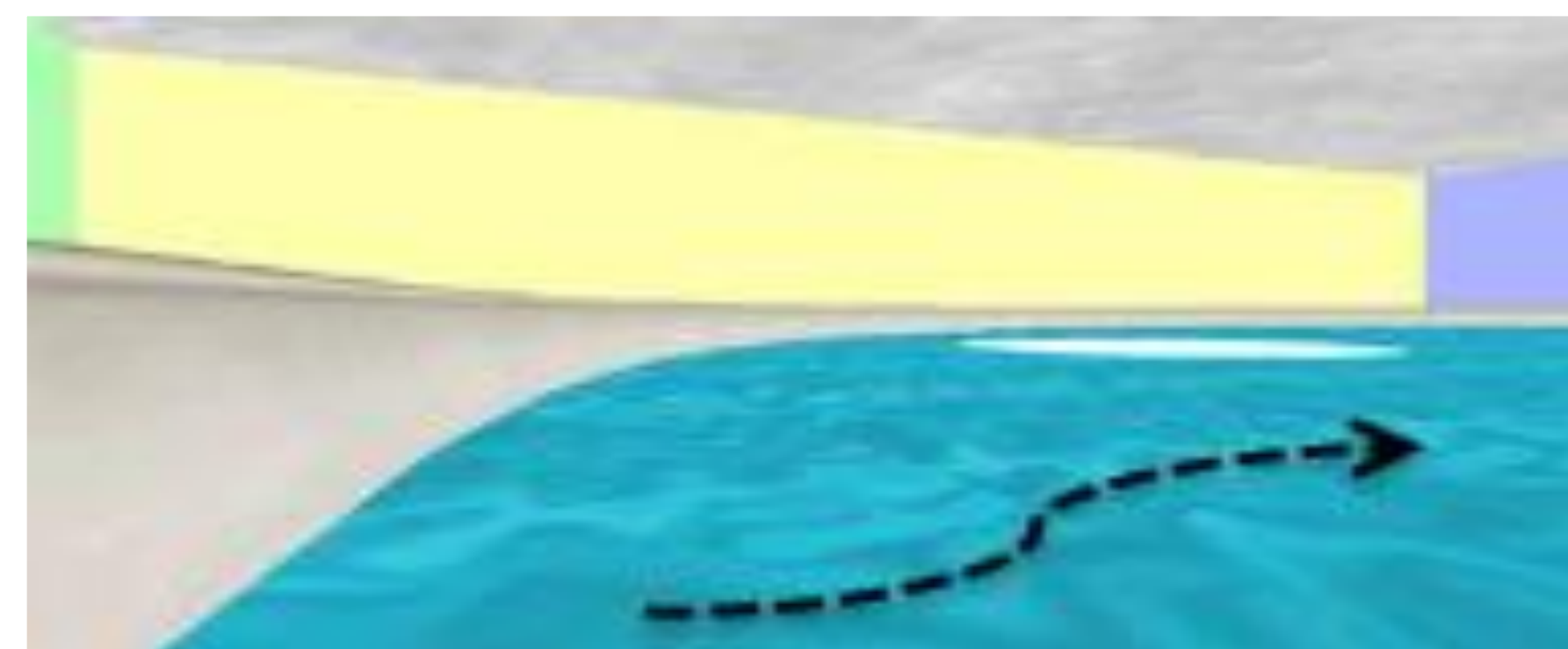
8 Learning Trials

Recognition Trial

ACKNOWLEDGEMENTS

RESULTS

Table 2. Unique Predictors of ARENA Composite

	β	R²	F	Δ R²
Model I		.008	.197	
Spatial Span	-.030			
JOLO	-.077			
Model II		**.168**	**3.57**	**.148**
Spatial Span	-.023			
JOLO	.065			
LM Delayed Recall	-.042			
VR Delayed Recall	**-.470**			

Table 3. Unique Predictors of Total Path Latency

	β	R²	F	Δ R²
Model I		**.192**	**4.04**	
Age	**.380**			
WTAR	.264			
Spatial Span	-.202			
JOLO	-.019			
Model II		**.357**	**5.71**	**.165**
Age	**.405**			
WTAR	.236			
Spatial Span	-.079			
JOLO	.107			
Trail Making Test B	**-.362**			
FP Delayed Recall	-.242			

Table 4. Unique Predictors of Time in Target Quadrant

	β	R²	F	Δ R²
Model I		.008	.197	
Spatial Span	-.029			
JOLO	-.078			
Model II		**.168**	**3.57**	**.148**
Spatial Span	-.023			
JOLO	.064			
LM Delayed Recall	-.047			
VR Delayed Recall	**-.470**			

CONCLUSION

- Since impairments in spatial navigation may manifest as decrements in safety and functional independence and are associated with pathological aging, the identification of well-validated tasks of spatial learning and memory is critical.
- Findings from the current study revealed that spatial learning and memory as measured by a virtual spatial navigation task were associated with performance on traditional neuropsychological indices of visual episodic memory and set-shifting.
- Limitations include homogenous sample characteristics, small sample size, and indirect measurement of biomarkers presumed to be involved in spatial learning and memory.
- Although additional investigation in larger samples is warranted, the findings offer preliminary evidence for validation and future use of the virtual computer-generated ARENA as a complimentary tool in older adults undergoing neuropsychological evaluation.