Is Right *Right*? Hemispheric Differences During Visuospatial Working Memory in TBI

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INTRODUCTION

Recent neuroimaging studies of verbal working memory (WM) in TBI have demonstrated functional recruitment of areas in the prefrontal cortex.[1] Specifically, prefrontal regions in the right hemisphere have been identified as either representative of compensatory processes, formal brain reorganization, or a transient attentional support system.[2] However, the dynamics of right hemisphere involvement in nonverbal WM tasks remains unclear, as previous studies have reported divergent findings.[3,4] Because this hemisphere is widely implicated in spatial processing and reasoning, examining relationships between activation and performance during nonverbal WM may provide insight into the specificity of the right hemisphere for task-induced neural recruitment. The present study investigated the relationship between task activation and performance before and after practice of a visuospatial WM task.

HYPOTHESIS

Visuospatial WM task performance will require greater neural recruitment of right prefrontal regions in the TBI vs. control sample. The magnitude of this recruitment will also be greater in the TBI group after task practice.

METHODS

Participants: 12 individuals with moderate to severe TBI and 12 age-matched healthy adults. Injury severity was determined by score on the Glasgow Coma Scale (GCS).

Data acquisition: Participants were scanned twice in one visit, before and after practice of a visuospatial WM task. Imaging data were acquired using a Siemens 3.0 T system. An analog of the Sternberg paradigm using computerized human faces was administered (Fig. 1). To examine task habituation, the first (T1) and last (T2) of five total task runs were considered. Accuracy was defined by percent correct responses.

fMRI analyses: Twenty (ten bilateral) ROIs (Figs. 2 & 3) commonly implicated in types of nonverbal WM were defined using the SPM8 WFUPickAtlas. Percent signal changes were calculated in the MarsBar toolbox and correlated with performance indices. Paired samples t-tests and a between-group ANOVA examined practice effects and group differences in activation, respectively.

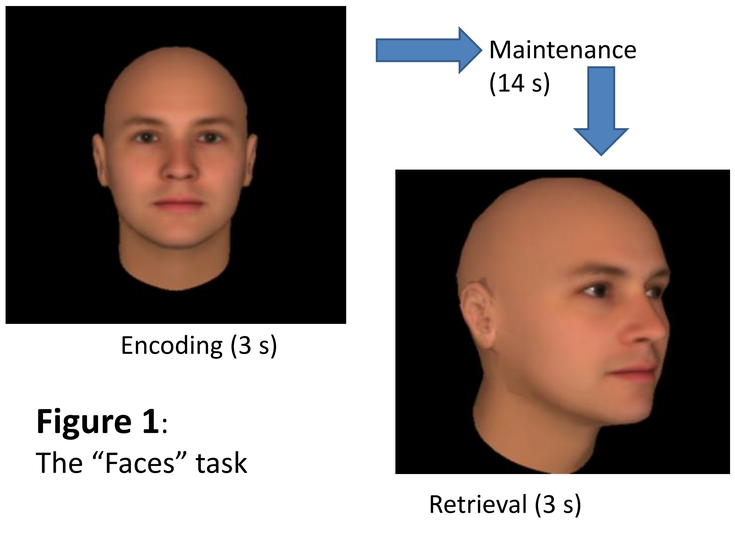

Figure 1:
The "Faces" task

RESULTS

- In the TBI group, a negative relationship was found between bilateral Brodmann Area (BA) 7 and accuracy at T1. T1 activation in BA32 and left hippocampus was related to T2 accuracy (Table 1).
- Nearly all significant relationships between activation and accuracy at T2 were within right hemisphere regions in TBI (Table 3).
- Greater activation in the hippocampus was associated consistently with better accuracy at T2 only in the TBI sample.
- Healthy participants did not show these relationships, but performed with greater accuracy at both time-points (Table 2). No between-group differences in whole-brain activation were found at T1 or T2.

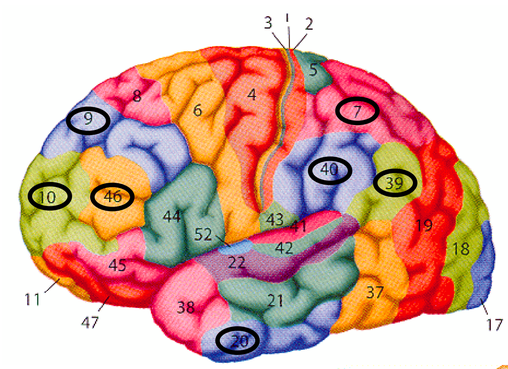

Figure 2:
Brodmann ROIs selected, lateral surface view

Source: http://www.mrc-cbu.cam.ac.uk/people/jessica.grahn/neuroanatomy.html

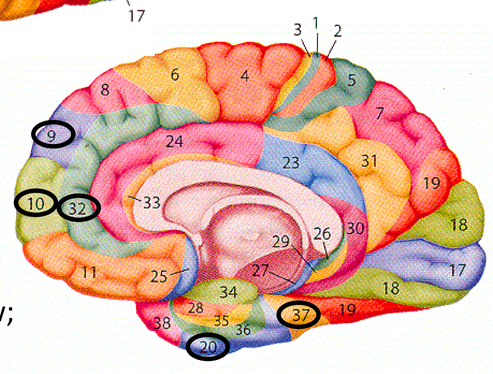

Figure 3:
ROIs selected, sagittal view; not shown: hippocampus

ROI	r	p
R BA20	-.614	.034
L BA32	.695	.012
R BA32	.627	.029
L hipp.	.609	.036

Table 1: Correlations between ROI activation at T1 and accuracy at T2 in the TBI group

	Time 1		Time 2	
	Avg. responses	% correct	Avg. responses	% correct
TBI	5.75	75.55	7.42	75.65
HC	7.25	80.44	6.92	95.83

Table 2: Average responses made and percentage of correct responses at each time-point

ROI	r	p
L BA10	.576	.050
R BA20	.580	.034
R BA37	.649	.012
R BA39	.647	.029
L BA46	.605	.037
R BA46	.619	.036
R BA7	.581	.048
L hipp.	.615	.033
R hipp.	.644	.024

Table 3: Correlations between ROI activation at T2 and accuracy at T2 in the TBI group

CONCLUSIONS

- In a brief visuospatial WM practice paradigm, healthy individuals and those with TBI recruit similar neural resources. This suggests that prefrontal recruitment does shift leftward during task. Therefore, utilization of additional right-lateralized resources may be masked.
- Bilateral parietal and hippocampal regions may play a role in efficiently learning the task.
- In those with TBI, right-hemispheric processing may make greater contributions to accurate performance as the task is proceduralized.

References

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