A Longitudinal Study of Working Memory in Neurotrauma using functional MRI
Peechatka, A., Medaglia, J.D., Chiou, K.S., Slocomb, J., Ramanathan, D. M., Hillary, F.G.

INTRODUCTION

The disruption of neural networks following neurological insult often results in deficits in fundamental processes that are integral to day-to-day functioning. Working memory (WM) is one of these processes that are notably susceptible to damage following traumatic brain injury (TBI). Previous literature using functional imaging to examine WM in TBI has shown recruitment of network areas that correlates with a higher level of performance and performance improvement over time (Sanchez-Carrion et al. 2008b). However, other research has shown that recruitment of prefrontal regions, specifically the right prefrontal cortex (RPFC), is part of a latent support system that is observed with lesser task performance (Hillary et al. 2010, Medaglia et al. 2011). Some longitudinal literature in early recovery from TBI show an increase in BOLD signal over time along with an increase in performance on verbal working memory tasks (Sanchez-Carrion et al. 2008a). The current study examined the changes in BOLD signal and performance over time during a non-verbal working memory task during early recovery from moderate to severe TBI.

MATERIALS/PARTICIPANTS

Participants:
- 10 Adults with moderate to severe TBI defined by the Glasgow Coma Scale (3-12)
- 3 Females, 7 Males
- Age 19-32 (M=24.22, SD=4.49)
- Education (M=12.56, SD=1.13)

Data Acquisition and Processing
- Siemens 3T Magnetron Trio
- SPM5
- WFUpickatlas
- SPSS Statistics

METHODS

- Participants were scanned at 3 months, 6 months, and 12 months after recovery from posttraumatic amnesia. At each time point participants completed two runs of a forced choice non-verbal working memory task with face stimuli during fMRI acquisition.
- All EPI data were realigned, coregistered to a slice designated MPRAGE, spatially normalized and smoothed.
- Paired Sample t-tests were performed in SPM5 to assess the increase or decrease in BOLD signal change over the whole brain.
- Paired Sample t-tests were run using SPSS Statistics to assess the change in participant reaction time over time.
- WFUpickatlas was used to chose regions of interest (ROIs) containing prefrontal areas of interest including Broadman’s areas 44, 45, 46 and 9. Left and right PFC activation was compared at each time point.

HYPOTHESES

Hypothesis 1: Participant reaction time and performance will significantly improve from time 1 to time 2 and from time 2 to time 3.

Hypothesis 2: BOLD signal will significantly decrease in participants during task performance from time 1 to time 2 and from time 2 to time 3.

RESULTS

Table 1: Behavioral Data Mean Values

<table>
<thead>
<tr>
<th></th>
<th>RT mean (ms)</th>
<th>RT SD</th>
<th>Accuracy mean</th>
<th>Accuracy SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 months</td>
<td>1465</td>
<td>248.28</td>
<td>70.8%</td>
<td>15.53</td>
</tr>
<tr>
<td>6 months</td>
<td>1319</td>
<td>243.27</td>
<td>74.1%</td>
<td>12.72</td>
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<tr>
<td>12 months</td>
<td>1374</td>
<td>333.78</td>
<td>73.8%</td>
<td>8.745</td>
</tr>
</tbody>
</table>

Paired sample t-test results
- Time 1 to Time 2
  - Reaction Time: p=0.025
  - Accuracy: p=0.277
- Time 2 to Time 3
  - Reaction Time: p=0.465
  - Accuracy: p=0.880

BOLD fMRI results

Overall signal at T2 was significantly higher than T1 as seen in figure 1. Overall signal at T3 was significantly higher than T2 as seen in figure 2. RPFC signal decreased from T1 to T2 and LPFC signal increased from T1 to T2. Neither region significantly changed from T2 to T3.

CONCLUSION

The overall BOLD signal increased significantly from T1 to T2, then increased again from T2 to T3. This increase suggests that as participants recover from injury more neural support mechanisms are recruited to permit task completion. Yet analysis of behavioral data reveal that increased BOLD signal on a whole brain level is not necessarily predictive of task performance.

Literature shows a relationship between decreased RPFC involvement and RT during WM tasks (Medaglia, 2011). Consistent with this literature, these data demonstrate elevated RPFC signal in T1 followed by a decrease in RPFC signal at T2 and T3 in conjunction with a pattern of longer RT at T1 and shorter RT at T2 and T3. These findings support a latent support hypothesis in which less activation is seen during better performance during more rapid task processing.

REFERENCES


