Location of Functional Activation Changes During Recovery from Traumatic Brain Injury

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INTRODUCTION

- Previous research using functional magnetic resonance imaging (fMRI) has revealed greater prefrontal cortex (PFC) activation during cognitive tasks in individuals with traumatic brain injury (TBI) compared to a control group.
- In order to observe how networks adapt to injury, it is of primary interest to use repeat scanning during a critical period of recovery from TBI.
- The current study examines changes in anterior neural networks (brain reorganization) during recovery from TBI, three and six months post-injury.
- In order to understand neural restructuring, the current study observed the extent to which the intensity, and size and location of activated regions varies within a group of subjects.
- Based on the results, methodological considerations are suggested for analyzing data after recovery from TBI.

METHODS

PARTICIPANTS:

- *N* = 7 participants (4 males and 3 females)
- All participants sustained moderate to severe TBI
- Ages ranged from 21 – 56 years (M = 31.6, SD = 12.8)
- Average education = 12.7 years (SD = 1.3)

PROCEDURE:

1. Participants underwent MRI scanning (Images acquired on a 3.0T Philips scanner) in the Department of Radiology, Hershey Medical Center, Hershey, PA.
2. Participants completed a simple non-verbal working memory (WM) paradigm involving matching the identity and location of facial stimuli (Beaupré & Hess, 2005).
3. Data were acquired at 3 and 6 months posttraumatic amnesia.
4. All functional images were preprocessed using SPM5 software.
5. ROIs were defined in right and left dorsolateral PFC (DLPFC) at time 1 using the MarsBar SPM Toolbox (Brett et al., 2002).
6. ROI data was extracted (% signal change, cluster volume, degree of overlap between ROIs).

HYPOTHESES

From Time 1 (3 months) to Time 2 (6 months):

1) There will be a decrease in mean group percent signal change from time 1 to 2.

2) Mean group cluster volume will decrease from time 1 to time 2.

3) Activated voxels in PFC will not overlap between time 1 and 2.

RESULTS: HYPOTHESIS 1

Table 1. Mean group percent signal change from time 1 to 2 (active at p < .001).

Mean **Group Percent Signal Change (%)**						
Group	LPFC			RPFC		
	time 1	time 2		time 1	time 2	
Mean	.76	.59	r (6) = .18, p = .68	.87	.61	r (6) = .06, p = .89
SD	.09	.43		.19	.51	

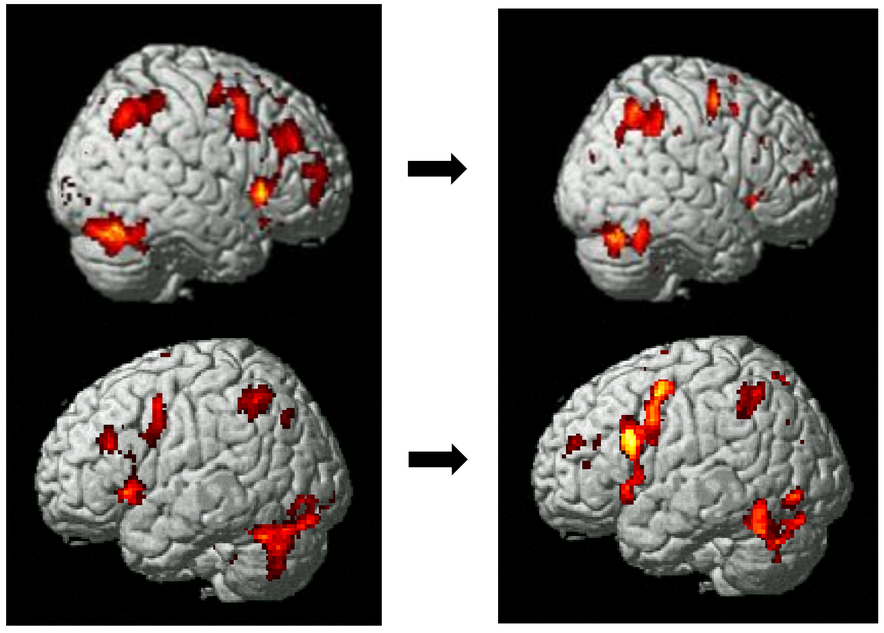
RESULTS: HYPOTHESIS 2

Table 2. Mean cluster volume change from time 1 to 2 (active at p < .001).

Mean Group Cluster Volume (Number of Voxels)				
Group	LPFC		RPFC	
	time 1	time 2	time 1	time 2
Mean	112	2	158	12

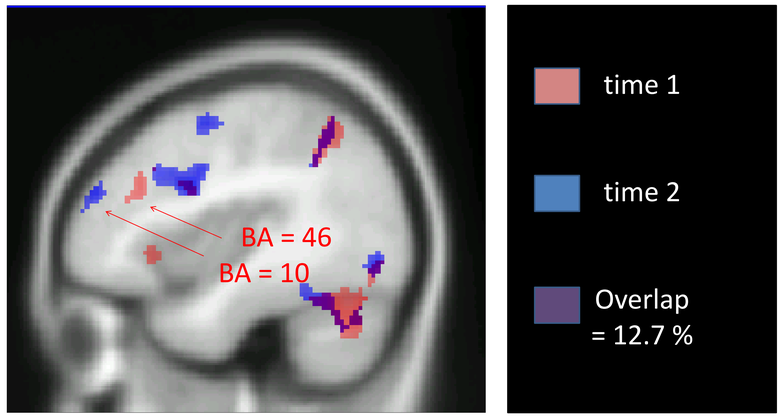
TBI time 1 TBI time 2

Figure 1. Mean group cluster volume from time 1 to 2.



RESULTS: HYPOTHESIS 3

Table 3. Overlap of activated voxels from time 1 to 2 (active at p < .001).



DISCUSSION

• Table 1. Mean group percent signal change decreased in LPFC and RPFC from time 1 to 2, showing a decrease in PFC involvement during a WM task.

•Table 2 and Figure 1. Mean group cluster volume decreased in LPFC and RPFC from time 1 to 2, which also represents less neural recruitment from support networks.

•Table 3. Activated voxels in PFC did not overlap between time 1 and 2, suggesting a shift in PFC activation to further anterior executive functioning regions (from Brodmann's Area 46 to 10).

CONCLUSIONS

• Results revealed that the location of functional activation in left and right PFC change during recovery from TBI.

•It is of importance to further examine the relationship between working memory responses and changes in the location of functional activation (i.e. Does change in the anterior regions effect reaction time and .accuracy in WM tasks).

•Furthermore, these results are important to better understanding how to analyze data at two time-points.

•For example, within the TBI literature, ROIs tend to be similarly used across time-points with the assumption that neural responses are homogenous across time.

• Results from the current study reveal that responses are heterogeneous and therefore ROI's may not have similar utility at two different time points.

•Due to the fact that the current study demonstrates that location of functional activation changes during recovery from TBI, it is important to continue examining how to improve the analysis of longitudinal functional data.

•Furthermore, other methods such as small voxel correction s(SVC) in SPM should be used to define ROIs when examining recovery from TBI, because this type of approach could more accurately accounts for responses in different parts of the region.

REFERENCES

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