Functional Connectivity Between the Cerebellum and Neocortex during Working Memory

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INTRODUCTION

The cerebellum forms several closed loops with neocortical regions important to working memory and has been implicated in virtually every major domain of cognitive processing (Stoodley & Schmahmann, 2009). However, the precise role of the cerebellum in this extended network remains under examined. Previous imaging studies have shown the cerebellum to be responsive to task load in working memory (WM) tasks similar to responsiveness to load in neocortical regions (Desmond et al., 1997). However, it is unclear whether this responsiveness represents activity supporting primarily motor or cognitive processes. It remains an important goal to document the relationships between the cerebellum and motor and prefrontal regions and by examining the direction of these influences, the involvement of the cerebellum in WM may be clarified. In the current study, BOLD fMRI is used to examine the cerebellum's functional connectivity within a distributed neural network in order to clarify its "cognitive" contribution to WM.

MATERIALS/PARTICIPANTS

Participants:
12 Healthy adults
Age 18-49 (M= 32.17, SD=12.23)
7 Males, 5 Females
Education: M=14.08 years, SD= 1.93)

Data Acquisition and Processing
•Siemans 3T Magneton Trio
•SPM5
•MarsBar region of interest toolbox
•WFU PickAtlas

METHODS

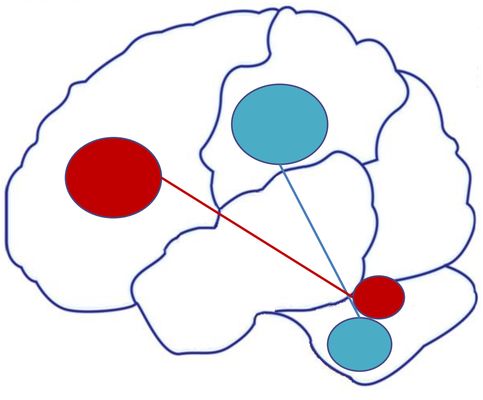
Healthy participants performed eight blocks of 2-back during fMRI data acquisition (80 total volumes)

•All EPI data were realigned, coregistered to a 150-slice MPRAGE, spatiallly normalized and smoothed.

•Regions of Interest (ROIs) were selected using the WFUPickAtlas for SPM

- Bilateral anterior and posterior cerebellum
- Motor cortices (BA6)
- Prefrontal cortices (BA46)
- Parietal lobes (BA39)

Figure 1: Schematic of ROIs



HYPOTHESES

Hypothesis 1: Relationships between the anterior cerebellum and contralateral PFC will be equal to or greater than those with motor regions

Hypothesis 2: Relationships between the posterior cerebellum and contralateral parietal lobe will be equal to or greater than those with motor regions

RESULTS

Table 1: Relationships between the cerebellum and cortical regions

	L-Ant CB	L-Post CB		R-Ant CB	R-Post CB
RPFC	.41**	.20	LPFC	.18	.07
RParietal	.51**	.30*	LParietal	.65**	.42**
RBA4	.60**	.34**	LBA4	.54**	.43**
RBA6	.68**	.37**	LBA6	.63**	.41*

R/L PFC=Right/Left prefrontal cortex; RBA4= primary motor cortex; RBA 6= Supplementary motor area; R/L-Ant CB= Right/Left anterior cerebellum; R/L-Post CB= Right/Left posterior cerebellum. A * denotes significance at p<.05, ** denotes significance at p<.001.

Table 2: Motor vs. Nonmotor Relationships

RPFC to L-Anterior CB vs: RBA4: p=.22 **RBA6:** p<.05, RBA 6 greater	LPFC to R-Anterior CB vs: **LBA4:** p<.01, LBA 4 greater LBA6: p=.054, LBA 6 greater
RParietal to L-Posterior CB vs: RBA4: p=.74 RBA6: p=.61	LParietal to R-Posterior CB vs: LBA4: p=.86 LBA6: p=.92

CONCLUSION

The relationships between the anterior cerebellum and contralateral PFC were less than cerebellum to motor region relationships. However, the RPFC was highly related to anterior cerebellum activity.

The relationships between the posterior cerebellum and contralateral parietal lobes were equal to cerebellum to motor region relationships.

In general, the cerebellum was highly interactive with nonmotor regions during a cognitive task. The relationship with RPFC may have implications for higher cognitive functions such as cognitive control (cf. Medaglia et al., in press; Hillary et al., 2010).

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