78 Dynamic connectivity in the periaqueductal gray matter measured by 7 Tesla functional MRI during a bladder filling protocol

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Introduction & Objectives: The periaqueductal gray (PAG) has been an area of great interest in the study of brain activity related to bladder function. The PAG is implicated to be involved in both storage and voiding of urine, and is assumed to serve as a relay station projecting afferent information from the bladder to cortical and subcortical brain areas. The use of ultra-high-field functional MRI (fMRI) will allow for the investigation of PAG activity at sub-millimeter resolution in human participants. This study aims to investigate PAG activity related to bladder sensations using 7 Tesla resting-state (RS) fMRI at during a bladder filling protocol. We hypothesize that dynamic RS connectivity between PAG clusters will show significant changes during filling of the bladder with saline.

Materials & Methods: After obtaining ethical committee approval, and gathering informed consent, we evaluated data from 3 healthy female participants (ages 24, 27, and 53). Two sets of RS fMRI datasets were acquired for each subject: the first during filling of the bladder and the second when the participants indicated they experienced urge. After preprocessing the data, we anatomically defined the PAG for each participant and selected all voxels within this region-of-interest (ROI) during the scan with a full bladder. We computed a voxel-by-voxel correlation matrix and subsequently parcellated this matrix using the Louvain module detection algorithm (Fig. 1.A). The resulting clusters were used as input for a dynamic connectivity analysis, which measures changes of functional interaction between ROIs over time.

Results: A linear regression analysis was used to determine whether the connectivity between the PAG clusters changed as a function of bladder filling (Fig. 1.B). For each participant, we found a significant change in dynamics between PAG sub-clusters as a function of bladder filling. Our findings are illustrated in Fig. 1.C.

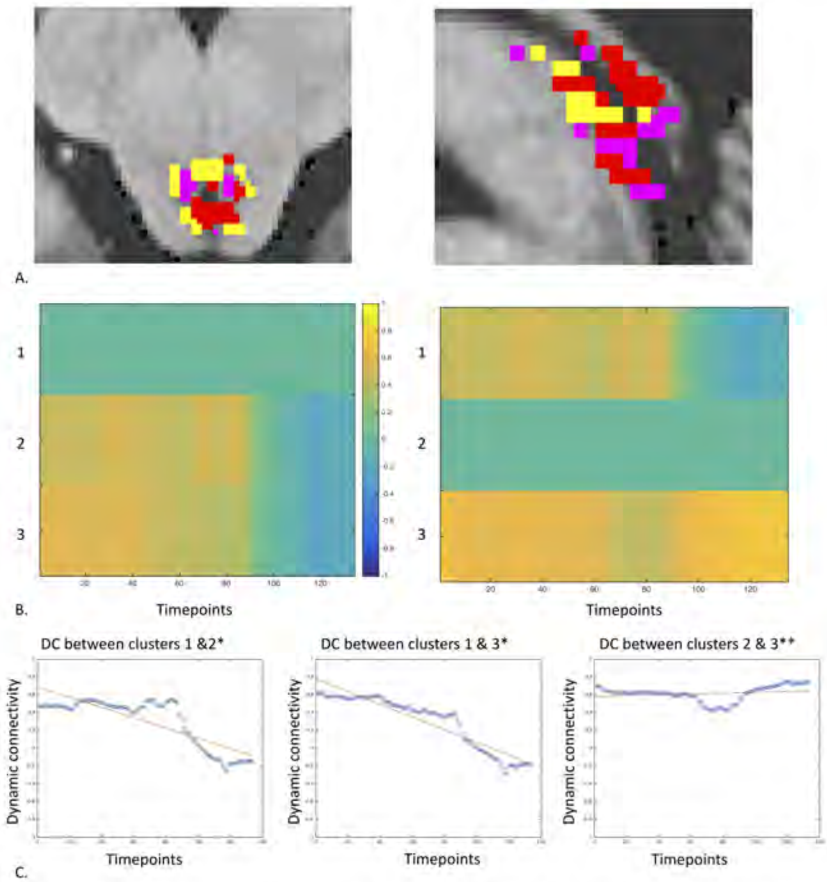

Figure 1. A: Transversal and sagittal view, respectively, of the clusters identified using the Louvain module detection algorithm in the full bladder resting state MRI scan of a representative participant. Pink = cluster 1, yellow = cluster 2, red = cluster 3. B: Dynamic connectivity between clusters during bladder filling for a representative participant. Bladder volume increases at a rate of 30 ml/min across timepoints. The total length of the scan was 362 seconds, and the timewindow length used was 80 volumes. C: Pairwise comparisons for the dynamic connectivity between clusters during bladder filling at 30 ml/min for the same participant. * = significant at the 0.01 level, ** = significant at the 0.05 level, after correction for multiple comparisons (FDR, q = 0.05).

Conclusions: Our results indicate that PAG activity in a full bladder state can be subdivided in clusters, and these clusters show significant changes in dynamic connectivity during bladder filling. We have shown that ultra-high-field 7T fMRI dynamic connectivity analysis indicates differences in connectivity between areas inside the PAG. This opens new avenues to investigate treatment or disease-specific bladder filling related dynamic signal processing in this small brain structure.