#477 Unraveling functional organization related to visceroceptive processing in the periaqueductal gray

Mathijs M. de Rijk[1,2], Janine M.W. Janssen[2], Susana Fernández Chadily[1], Lori A. Birder[3], Mohammad S. Rahnama'i[2], Job van den Hurk[2,4], Gommert A. van Koeveringe[1,2]

1. Department of Urology, Maastricht University, The Netherlands

2. Department of Urology, Maastricht University Medical Center (MUMC+), The Netherlands

3. Department of Medicine, University of Pittsburgh School of Medicine, Pittsburgh PA 15261, USA

4. Scannexus ultra-high-field MRI center, Maastricht, The Netherlands

Introduction

The periaqueductal gray (PAG) is a brainstem area indicated to play an essential role in lower urinary tract (LUT) control. Post-mortem human and animal studies have indicated that the PAG is symmetrically organized in functionally and anatomically distinct columns which are involved in sympathetic or parasympathetic control of the LUT. In earlier work, we have shown that in vivo parcellation of the PAG into symmetrical clusters can be accomplished using 7T resting-state fMRI. The current study aims to find consistency across subjects and identify homologous clusters between subjects.

Methods

For this follow up analysis we evaluated data from 10 female participants. During a bladder filling protocol, we ran a resting-state fMRI scan while participants experienced a strong desire to void. During this scan we collected 420 T2*-weighted multiband echo planar imaging volumes (mb-EPI sequence, acceleration factor = 2, MB-factor = 2, TR = 1400ms, TE = 22ms, resolution = 1.1 x 1.1 x 1.1mm) we scanned 40 slices covering the supramedullary portion of the brain stem. Next, we ran a T1-weighted whole brain anatomical scan using an MP2RAGE sequence. Data were preprocessed using BrainVoyager and normalized to MNI space. PAG voxels were selected based on a mask covering the PAG of the MNI template. A voxel-by-voxel correlation matrix of the PAG was created and parcellated using the Louvain module detection algorithm. The similarity of resulting clusters between participants was then assessed by computing the Dice similarity coefficient for all cluster comparisons.

Next, we ran 1000 permutations in which we created randomized correlation matrices based on the original data and parcellated these matrices using the Louvain module detection algorithm. From these 1000 parcellation maps we computed the Dice similarity coefficient for 100.000 randomly selected cluster comparisons.

The Dice coefficients between cluster pairs were assessed statistically by ranking them to the Dice values observed in the permutations.

Results

We observed a significantly higher similarity between cluster pairs across subjects compared to permutations. For 23 comparisons we found a higher agreement than based on chance after FDR corrections (see figures).

Conclusion

These results show that the PAG can be parcellated into distinct clusters which show a similar spatial distribution at group level. This analysis is a crucial step to determine the agreement between in vivo PAG parcellations and the functional and anatomical columnar organization of the PAG which is known from previous research. These advancements may enable us to identify the relationship between LUT symptoms, such as urgency, and activity patterns in the PAG in normal and pathological situations.

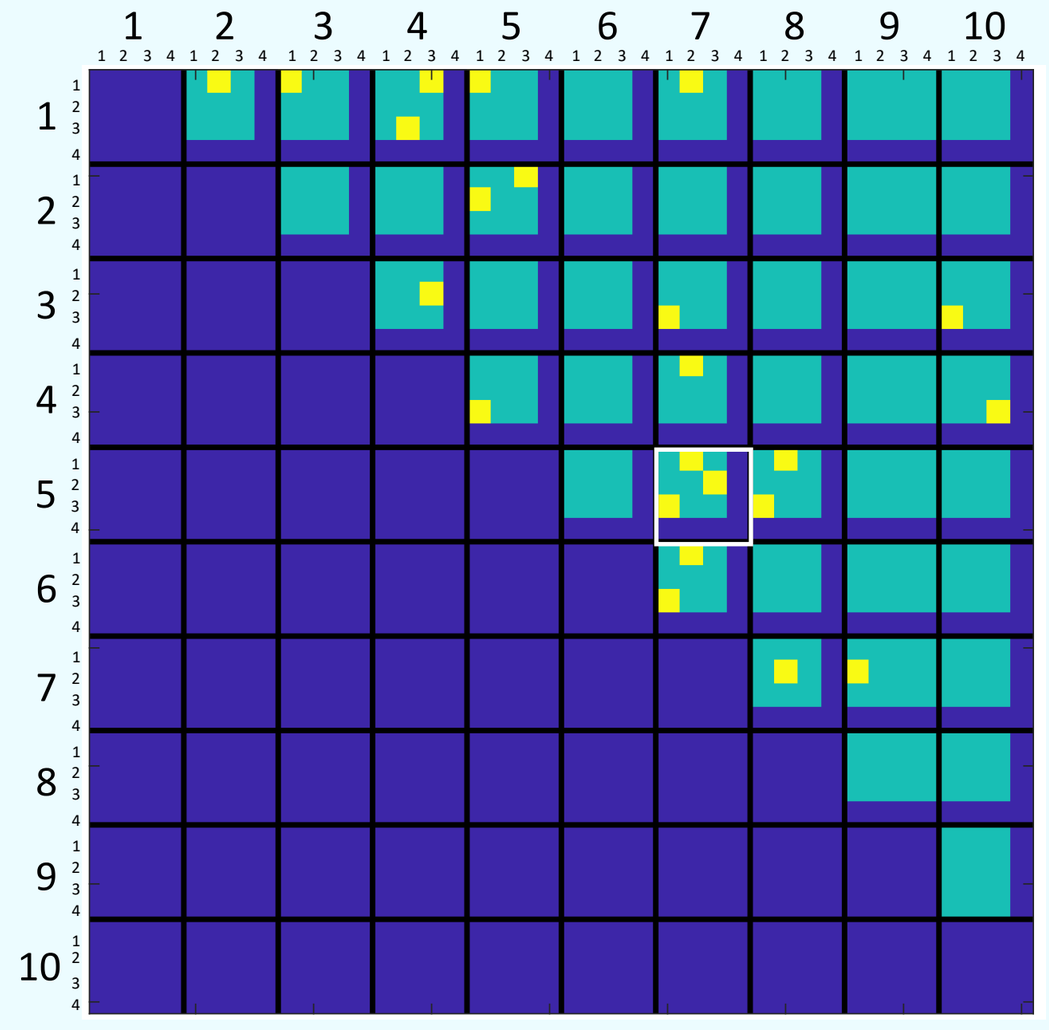

Figure 1: Group level assessment of spatial similarity of PAG clusters across participants. Data from each participant are represented in a single cell. Along the x and y direction comparisons between subjects and clusters are plotted. Subjects are not compared with themselves and only in one direction. Each yellow block marks a statistically significant similarity between clusters ($p = \leq 0.05$, after FDR corrections ($q = 0.05$)). The green area indicates the comparisons made (the Louvain detection algorithm parcellated some PAGs into 4 clusters and others into 3 clusters). The comparison between participants 5 and 7 has been highlighted in white since all clusters from these two participants showed significantly high similarity.

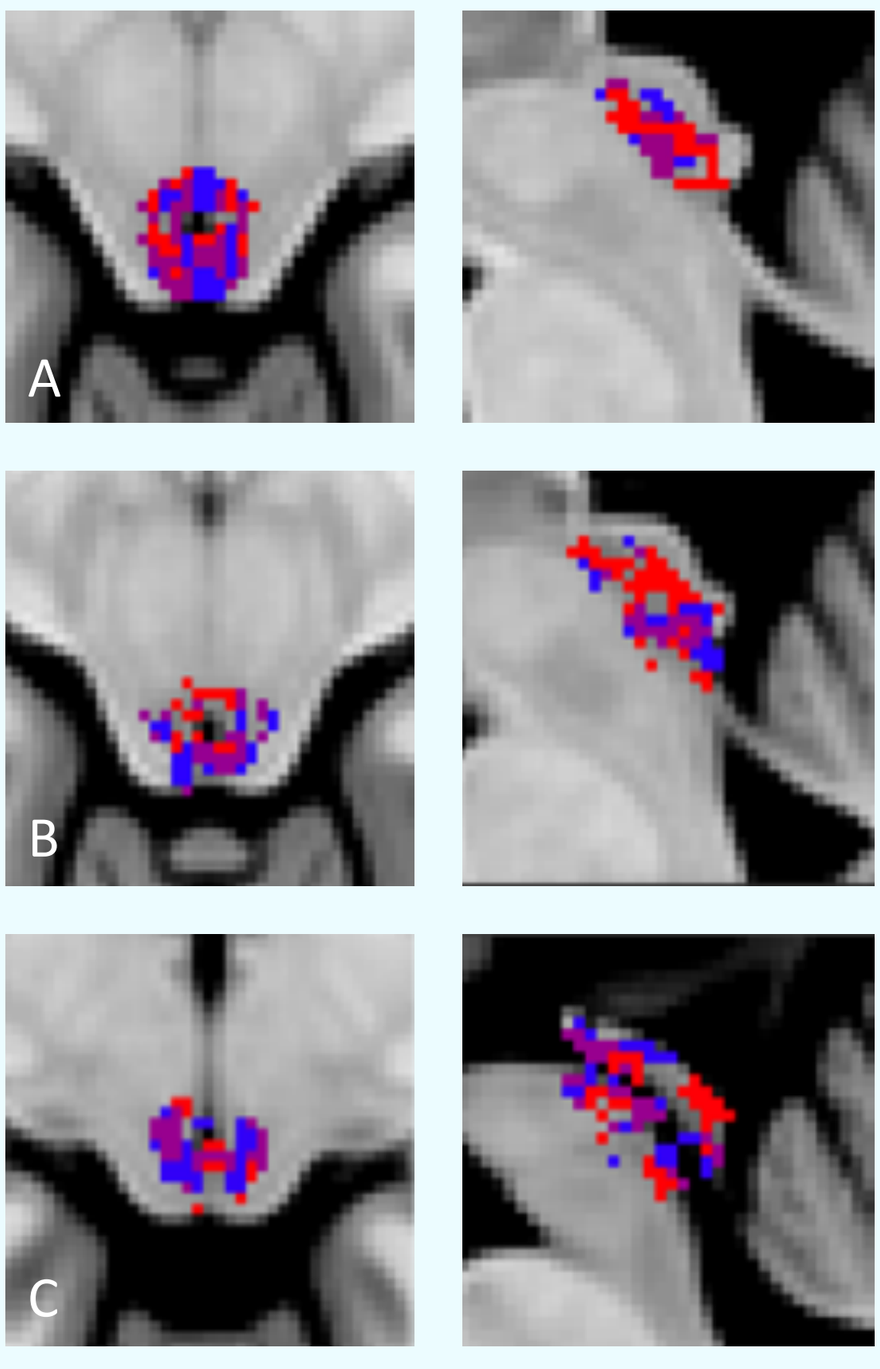

Figure 2: Similarity between the different clusters from participants 5 and 7. The purple area indicates the region of overlap between participants. ***A)*** *Transversal and sagittal view of the overlap between participant 5, cluster 1 (red) and participant 7, cluster 2 (blue)* ***B)*** *Transversal and sagittal view of the overlap between participant 5, cluster 2 (red) and participant 7, cluster 3 (blue)* ***C)*** *Transversal and sagittal view of the overlap between participant 5, cluster 3 (red) and participant 7, cluster 1 (blue).*

Correspondence to:
Mathijs de Rijk, Department of Urology
m.derijk@maastrichtuniversity.nl
043-388 18 39