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Neshatian L[1], Karmonik C[1], Pande R[1], Elias S[1], Quigley E[1], Khavari R[1]
1. *Houston Methodist Hospital*

FUNCTIONAL CONNECTIVITY OF THE DEFECATION NETWORK IN WOMEN

Hypothesis / aims of study
Volitional control of defecation is complex and information on central mechanisms controlling defecation in humans is sparse. Functional connectivity (FC) based on coherent fluctuation of blood oxygenation level (BOLD), allows identification of functional networks in the brain and has been used to examine state-dependent activity. We have recently identified and reported brain regions that are activated or deactivated with defecation, using tasked-based fMRI with simulated defecation. Here, we Hypothesis that there is a consistent pattern of functional connectivity (FC), in the brain between these areas, when performing simulated defecation. We aimed 1) to investigate functional connectivity in the human brain when performing this task, 2) to quantify connections between regions of interest and 3) to express their importance of facilitating flow of information.

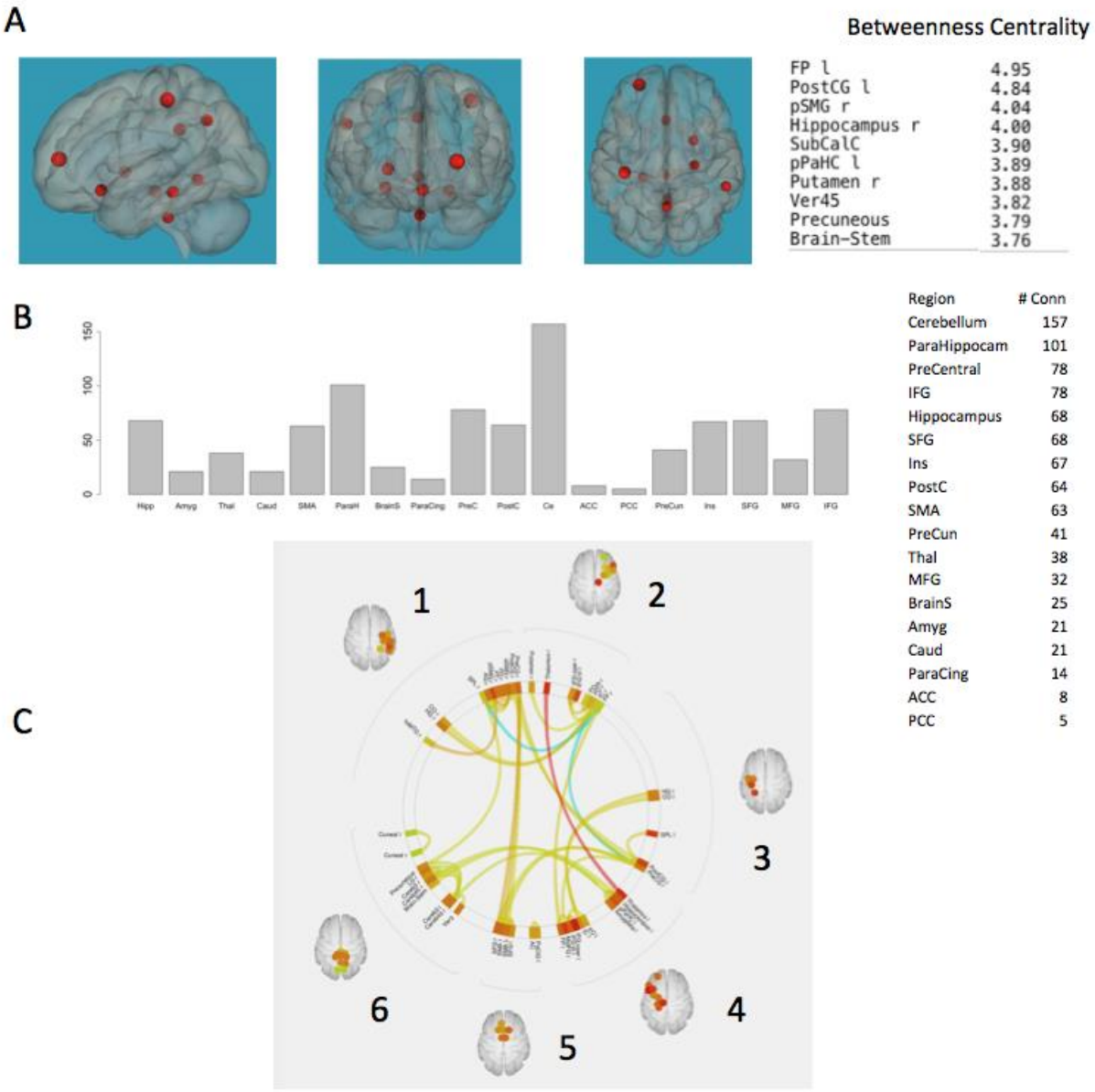
Study design, materials and methods
We performed fMRI with concurrent rectal pressure monitoring, through a 30 ml water-filled rectal balloon, in 11 healthy women. A block-design was used (20 seconds simulated evacuation (bear-down manoeuvre) interspersed by 20 seconds rest, 5 repetitions performed twice). FC was calculated with the CONN connectivity Matlab toolbox (version 15h) for brain regions identified in the SPM atlas. Areas with highest betweenness centrality, a measure of information flow, were identified ($p<0.05$). An explorative hierarchical cluster analysis yielded six brain sub-networks working together to accomplish the defecation process.

Results
The following areas: left frontal pole, left post-central gyrus, left posterior supra-marginal gyrus, right hippocampus, sub-callosal cortex, left posterior parahippocampal gyrus, right putamen, vermis, precuneus and regions in the brain stem showed the highest betweenness centrality (figure 1A). Besides the cerebellum (n=157), other areas in brain that showed the largest number of connections (figure 1B) included the parahippocampus (101), precentral gyrus (78), supplementary motor area (SMA, 63), brainstem (25) and amygdala (21). Sub-networks included the following brain regions (figure 1C): 1: right hemisphere: pre and post central gyrus, supra-marginal gyrus, superior parietal lobule, 2: right hemisphere: inferior frontal gyrus, frontal orbital cortex, frontal pole, 3: left hemisphere: pre and post central gyrus, superior parietal lobule, 4: left hemisphere: thalamus, hippocampus, parahippocampus, amygdala, frontal cortex, 5: bilateral: SMA, anterior cingulate, superior frontal gyrus, 6: bilateral: brainstem, precuneus, and cerebellum.

Interpretation of results
Areas with highest information flow, i.e. hubs for FC, were recruited from cortical brain regions indicated in procession memory, executive function, self-expression and the motor system. Subcortical areas included a defecation centre located in the brain stem. Regions with largest number of connections reflected their importance as centres of information flow. Identified sub-networks included parts of the frontal-parietal attention network (1), the thalamo-insular network (4) and other connections between the motor network and regions with high anatomical connectivity (5, 6).

Concluding message
This is the first study to show that defecation activated neural networks maintain a consistent pattern of functional connectivity. We confirmed that combined fMRI and rectal pressure monitoring can study mechanisms of regulation of simulated defecation in humans. This could further be used to provide unique information on the pathophysiology of defecatory disorders.

Figure 1: A) 3D view (sagittal, coronal and axial) of brain networks including regions with highest functional connectivity, table on the left with T-values (FP: frontal pole, PostCG: post-central gyrus, pSMG: posterior supra-marginal gyrus, SubCalC: subcallosal cortex, pPaHC: posterior parahippocampus, Ver45: vermis area #45. B) Number of functional connections in selected brain areas (left: bar plot, right: corresponding table) C) Schematic overview of sub-networks identified with hierarchical clustering, details given in text.



<u>Disclosures</u>

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